

## The Overall Distribution of ABO and Rh (D) Groups in The Most Populous City Istanbul as Representing the Complex Ethnicity of Turkey

### Türkiye'nin Karmaşık Etnik Kökenini Temsil Eden İstanbul'da ABO ve Rh (D) Gruplarının Dağılımı

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#### ABSTRACT

**Objective:** In humans, 38 different critical blood type classification systems are currently recognized. They differ in frequencies in distinct populations. It is aimed to visualize ABO and Rh(D) groups distribution in Istanbul as having the largest community in Turkey.

**Method:** Volunteered blood donor's data on the automation system were screened retrospectively. Blood donation acceptance criteria were based on the guidelines prepared by the Ministry of Health. ABO and Rh(D) groups were analyzed using column agglutination/gel centrifugation methods.

**Results:** The study covered six years' data between the dates of January 2014 and December 2019, including 136,231 donors. The majority of the donors were found to have blood group A with a frequency of 41.88%(n=57,059). The second most common blood group was group O, and had a frequency of 34.92%(n=47,576). The blood group B (n=20,790;15.26%) and group AB (n=10,806;7.93%) were found to be the rare encountered blood groups. Among the Rh(D) group, 85.02% of the donors were Rh(D) positive.

**Conclusion:** In transfusion medicine, ABO and Rh(D) groups' compatibility is mandatory. According to the monthly and or annual blood products requirement, there are some suggested quantities of blood units to be available at blood centres. Determining the frequency of blood group distribution of populations will help to coordinate the ratio of blood groups to be stored. The Turkish genetic makeup is a fascinating mixture of European and Asian DNA, necessitates to find out the countries' specific ABO and Rh(D) groups ratio. We compared our results with the previously reported studies performed in different cities of Turkey and the world around. Thus, our research as giving the overall distribution of ABO and Rh(D) groups from the largest city of Turkey reflecting the general ethnic background of the country, would help to the establishment of a databank of ABO and Rh(D) group's ratio.

**Keywords:** ABO, Rh, blood group, blood donor, Turkey, Istanbul

#### Öz

**Amaç:** İnsanda 38 farklı kan grubu sistemi tanımlanmıştır. Kan grupları farklı popülasyonlarda farklı sıklık gösterir. Çalışmamızda Türkiye'nin en fazla nüfusa sahip ili İstanbul'da ABO ve Rh (D) gruplarının dağılımını belirleyerek Türkiye'yi temsilen kan grubu dağılımını öngörmek hedeflenmektedir.

**Yöntem:** Gönüllü kan bağışçılarının verileri hastane kan merkezi otomasyon sisteminden geriye dönük olarak tarandı. Kan bağışçısı kabulü Sağlık Bakanlığı tarafından hazırlanan kılavuzlar doğrultusunda yapılmıştır. ABO ve Rh (D) grubu tayini kolon aglütinasyon / jel santrifüjasyon yöntemi kullanılarak analiz edildi.

**Bulgular:** Çalışma Ocak 2014 ve Aralık 2019 tarihleri arasında 6 yıllık dönemde kan merkezine başvuran 136.231 kan bağışçısını kapsamaktadır. Kan bağışçılarının çoğu A kan grubu % 41.88 (n = 57.059) oranında bulundu. İkinci en yaygın olarak O kan grubu idi, % 34.92 (n = 47.576) sıklıkta izlendi. B kan grubu (n = 20.790; % 15.26) ve AB grubu (n = 10.806; % 7.93) nadir görülen kan grupları olarak bulundu. Kan bağışçılarının % 85.02'si Rh (D) pozitif.

**Sonuç:** Transfüzyon tıbbında ABO ve Rh (D) gruplarının uyumluluğu zorunludur. Aylık ve / veya yıllık kan ürünleri ihtiyacına göre, kan merkezlerinde önerilen bazı miktarlarda kan stoğu bulundurulur. Popülasyonların kan grubu dağılım sıklığının belirlenmesi, depolanacak kan gruplarının miktarının koordine edilmesine yardımcı olacaktır. Türkiye'de yaşayanların genetik yapısı, Avrupa ve Asya DNA'sının bir karışımıdır. Sonuçlarımızı, Türkiye'nin ve dünyanın farklı bölgelerinden farklı şehirlerde daha önce bildirilmiş çalışmalarla karşılaştırdık. ABO ve Rh (D) gruplarının ülkenin genel etnik kökenini yansıtan Türkiye'nin en büyük kentinden toplam dağılımını sağlamaya yönelik çalışmamız, ABO ve Rh (D) grubu dağılımı konusunda ülke veri bankasının oluşturulmasına yardımcı olacaktır.

**Anahtar kelimeler:** ABO, Rh, kan grubu, kan bağışçısı, Türkiye, İstanbul

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## INTRODUCTION

Erythrocyte blood group antigens are polymorphic, carbohydrate, or protein molecules located on the outer membrane of erythrocytes that transmit from generation to generation. These antigenic structures are also found in some cells other than erythrocytes, such as saliva, serum, tear, urine, and similar body secretions <sup>(1)</sup>.

At the beginning of the twentieth century, Karl Landsteiner pointed out that the serum of certain people agglutinates the blood group system of ABO <sup>(2)</sup>. Later, his colleague Alexander S. Wiener described the Rh blood group system. The presence of one, both, or none of the A and B antigens in erythrocytes, constituted the ABO blood group system. The associated anti-A and anti-B antibodies are usually IgM antibodies, produced in the first years of life by sensitization to environmental substances such as food, bacteria, and viruses <sup>(2)</sup>.

The five antigens D, C, c, E, are the most essential Rh blood group system antigens. An individual is typically described as Rh-positive when the Rh (D) antigen does exist on erythrocytes. In contrast, someone who lacks the Rh (D) antigen is referred to as Rh-negative <sup>(2)</sup>. The Rh (D) antigen is extremely immunogenic, and in the condition of exposure, IgG type anti-D develops <sup>(3)</sup>.

The blood group systems are essential in many clinical aspects. ABO and Rh (D) blood group system must be investigated before transfusions, stem cell, and solid organ transplantations for safety. Besides that, there are some relationships between some blood groups and diseases <sup>(4)</sup>.

The variations in the distribution of four distinct ABO blood groups, A, B, AB, and O, are worldwide <sup>(5-7)</sup>. The frequency of the three alleles of the ABO gene has been estimated in various populations. For example, blood group O is the most common blood type in Hispanic donors (a group of Mexican donors, Puerto Ricans, and Cubans) with a ratio of 57 percent <sup>(2)</sup>. Again, North American Indian and black donors had the highest proportions of blood group O i.e. 55%, and 50%, respectively <sup>(2,6)</sup>.

The Turkish genetic background is a complex mixture of European and Asian DNAs <sup>(8)</sup>. Istanbul, with the largest population in the country, may reflect the broad ethnic diversity in Turkey.

In our study, it was aimed to identify the frequency of ABO and Rh (D) blood groups among blood donors. Our secondary goal was to find out whether there is a difference from previously reported studies, regarding mostly from restricted regions of the country and world around.

## MATERIAL and METHODS

Volunteered blood donors admitting to our hospital Blood Center, were screened retrospectively. The study was conducted based on the data retrieved from the hospital automation system available between 01.01.2014 - 31.12. 2019.

Blood donation was accepted according to the National Blood and Blood Products Guide (2011) and the National Blood and Blood Components Preparation, Usage and Quality Assurance Guide (2016) prepared by the Ministry of Health <sup>(9,10)</sup>.

ABO and Rh (D) groups were analyzed using column agglutination/gel centrifugation methods (Ortho BioVue System, Ortho Clinical Diagnostics, Inc, Johnson&Johnson Company, Raritan, NJ, USA; Across, Dia Pro A.Ş, Gebze, Kocaeli, Turkey).

All donors gave their written consent with blood donor registration, information, and inquiry form and blood donor consent form.

Descriptive statistical methods determined the distribution of blood groups.

## RESULTS

Data of 136,231 blood donors were screened. Most of the donors (93.27%) were male, as depicted in Figure 1.

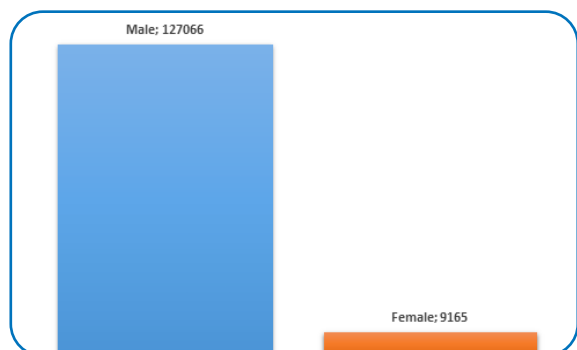


Figure 1. Gender distribution of blood donors.

More than half of blood donors were between the ages of 25 and 55 (Table 1).

**Table 1. Distribution of blood donors by age and gender.**

Age group (years)	Total (%)	Female (%)	Male (%)	M/F ratio
18-24	5.05	0.58	4.48	7.07
25-34	33.23	2.22	31.01	13.94
35-44	35.86	1.92	33.94	17.63
45-54	21.12	1.39	19.73	14.18
55-64	4.51	0.54	3.97	7.35
>65	0.22	0.01	0.21	15.00
<b>Total</b>		6.67	93.33	13.99

The majority of donors were found to be group A with a frequency of 41.88% (n=57,059). The second much common blood group was group O and had a distribution frequency of 34.92% (n=47,576). The blood group B (n= 20,790; 15.26%) and group AB (n=10,806; 7.93%) were proved to be more seldom encountered blood groups.

Among the Rh blood group, the majority of donors (n=115,819; 85.02%) were Rh (D) positive (Table 2).

**Table 2. Distribution frequencies of ABO and Rh (D) among voluntary or referred donors in our blood centre.**

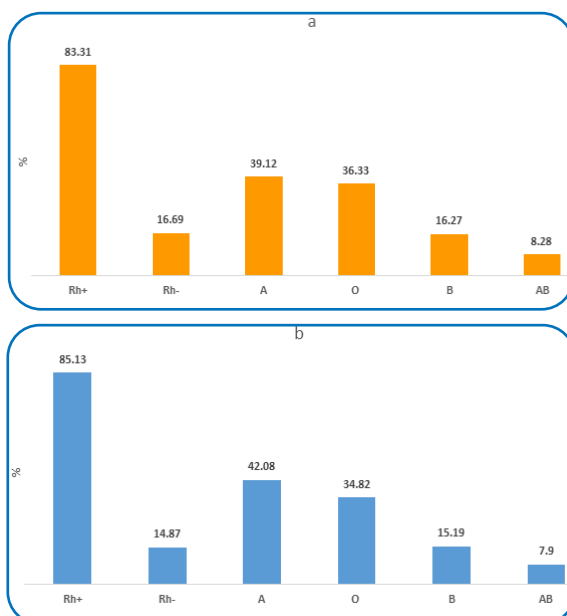
Blood group	A	O	B	AB
n (%)	57.059 (41.88)	47.576 (34.92)	20.790 (15.26)	10.806 (7.93)
Rh positive	49.519 (36.35)	39.644 (29.10)	17.350 (12.74)	9.306 (6.83)

The distribution frequency of Rh positivity in ABO blood groups are given in Table 3.

**Table 3. Distribution of Rh factor frequency with ABO blood groups.**

	A		O		B		AB	
	Rh+	Rh-	Rh+	Rh-	Rh+	Rh-	Rh+	Rh-
n.	49.519	7.540	39.644	7.932	17.350	3.440	9.306	1.500
%	87	13	83	17	83	17	86	14

Distribution of blood groups , according to the gender of the donors is given in Figures 2a and 2b.



**Figure 2. Percentage distribution of ABO Rh groups by gender a. Female donors, b. Male donors.**

## DISCUSSION

The gene determining the human ABO blood groups is located on chromosome 9 (9q34.1), and the product is called glycosyltransferase (5). The gene has three primary alleles for blood groups A, B, and O. Each of the alleles contributes to different gene products. The alleles are inherited from parents which define the ABO blood antigens in different individuals and so in different populations (5).

Blood types of human beings may belong to ancient genetic indicators developing over several million years. However, it was assumed that the blood groups of three primary human races namely blood group A in Europe, B in Asia, and finally O in South America might point to eventual migration and race-mixing (5). There are other theories. One of them put forward that blood groups A and B originated from a fundamental group of blood O. The second theory based on the assumption that the original blood group is AB and other blood groups A, B, and O emerged from this blood type due to various mutations (5).

Beyond genetic mutations, natural selection against environmental factors may also play in varied blood group distribution in different populations (5).

Determining the blood group distribution frequency of populations is primarily required for preparing a critical stock in blood centers. Another scientific issue is the

relationship of some disorders with blood groups, which may provide academic and epidemiological data. Indeed several studies are showing this correlation. The low risk of having heart disease in people with type O blood is an example. <sup>(1,11)</sup>.

Intricate distribution patterns of ABO and Rh (D) groups around the world correlate with the assumption of the complicated evolutionary history of humanity. In general, the A blood allele is somewhat more common than the B group. The majority of the people in the world have Rh-positive blood type <sup>(12)</sup>.

Studies are evaluating the relationship between blood groups and ethnicity from different countries <sup>(6,7,13)</sup> (Table 4). It is noteworthy that the blood group O in the American continent is with a frequency of 45% and above, and this rate reaches 50% in Native Americans and African Americans. Hispanic people also have mostly O blood type. The data from England, the country of the primary source of immigrants to the American continent, and from Germany, which could be used as a representa-

tive of Caucasians, showed that the distribution frequency of the blood group O is approximately 40% <sup>(12)</sup>.

**Table 4. Distribution of ABO and Rh blood groups in different countries around the world**

Country	A (%)	O (%)	B (%)	AB (%)	Rh (%)	
Asia (China) <sup>(7)</sup>	30.50	30.40	29.40	9.70	Rh+:	98.98
					Rh-:	1.02
America reflecting Indians <sup>(6)</sup>	35.00	54.60	7.90	2.50	Rh+:	90.30
					Rh-:	9.70
America reflecting Caucasians <sup>(6)</sup>	39.70	45.20	10.90	4.10	Rh+:	82.70
					Rh-:	17.30
America reflecting Africans <sup>(6)</sup>	25.80	50.20	19.70	4.30	Rh+:	92.90
					Rh-:	17.10
England <sup>(14)</sup>	42	47	8	3	Rh+:	85.00
					Rh-:	15.00
Germany <sup>(15)</sup>	42.00	42.80	11.00	4.20	Rh+:	85.00
					Rh-:	15.00

**Table 5. ABO and Rh blood group distribution reported from different regions of Turkey.**

Region, city	Investigator	Study Group (n)	A (%)	O (%)	B (%)	AB (%)	Rh+ (%)	Rh- (%)	Publication Year
Turkey	Akbay T <sup>(18)</sup>	9,931	42.84	32.67	16.46	8.03	88.54	11.46	1989
Istanbul	Eren C <sup>(17)</sup>	123,900	43.82	33.79	15.21	7.16	87.31	12.69	2019
Istanbul	Salduz Ziy <sup>(16)</sup>	6,041	43.44	33.02	15.00	8.54	85.95	14.05	2015
Sanliurfa	Zerin M <sup>(19)</sup>	28,994	36.38	34.69	21.25	7.68	90.79	9.21	2004
Sivas	Dogan E <sup>(20)</sup>	99,207	43.80	31.80	16.40	8.00	87.00	13.00	2015
Sakarya	Cekdemir E <sup>(21)</sup>	13,116	44.30	35.70	12.50	7.50	84.90	15.10	2018
Thrace	Yaprak M <sup>(22)</sup>	6,777	45.95	31.05	16.54	6.46	87.66	12.34	1993
Diyarbakir	Temiz H <sup>(23)</sup>	206,673	40.81	33.66	18.53	6.98	89.17	10.82	2008
Diyarbakir	Arac E <sup>(24)</sup>	127,091	39.69	33.62	18.63	8.06	88.44	11.56	2019
Balıkesir	Alpdemir M <sup>(25)</sup>	128,862	42.70	30.70	18.20	8.40	89.00	11	2014
Cukurova, Adana	Yildiz SM <sup>(26)</sup>	136,038	38.90	37.10	17.00	6.90	89.90	10.10	2016
Denizli	Balci YI <sup>(27)</sup>	64,840	42.60	33.30	16.80	7.40	89.90	10.10	2010
Eastern Black Sea, Rize	Ozkasap S <sup>(28)</sup>	38,329	44.07	44.07	9.26	2.60	83.70	16.30	2013
Van	Akin G <sup>(29)</sup>	6,982	39.99	28.26	17.09	14.66	89.49	10.51	2005
Eastern Anatolia, Van	Dilek J <sup>(30)</sup>	33,193	43.80	30.80	16.20	9.20	85.00	15.00	2006
Van	Ciftci IH <sup>(31)</sup>	18,308	45.05	30.65	16.14	8.16	90.37	9.63	2004
Eastern Anatolia, Van	Ekinci O <sup>(32)</sup>	108,368	44.00	31.20	16.20	8.60	87.70	12.30	2019
Kayseri	Torun YA <sup>(33)</sup>	86,797	44.00	33.30	16.20	6.50	88.20	11.80	2012
Erzurum	Kocak AO <sup>(34)</sup>	27,587	46.11	31.62	14.77	7.50	86.01	13.99	2017
Yozgat	Kader C <sup>(35)</sup>	5,257	44.30	31.70	15.90	8.10	88.00	12.00	2014
Malatya	Kuku J <sup>(36)</sup>	65,277	41.21	37.23	14.99	6.56	89.30	10.70	2004
Gaziantep	Coskun Y <sup>(37)</sup>	33,317	40.01	35.09	18.10	6.80	81.90	9.10	1990
Malatya	Genc M <sup>(38)</sup>	2,500	39.32	41.28	13.36	6.04	89.04	10.96	1997
<b>Istanbul (Our Study)</b>	<b>Yanasik M</b>	<b>136,231</b>	<b>41.88</b>	<b>34.92</b>	<b>15.26</b>	<b>7.93</b>	<b>85.02</b>	<b>14.98</b>	

Turkey is a country of a mixture of different ethnic groups<sup>(8)</sup>. However, giving an overall distribution rate for ethnicity is not possible since from 1965 the ethnicity is not interrogated in the country. Istanbul is Turkey's most populous city. The diversity of Istanbul population reflects the ethnic heterogeneity of Turkey.

In two previously performed studies concerning the distribution of blood groups in Istanbul, Salduz et al.<sup>(16)</sup> and Eren<sup>(17)</sup> demonstrated that blood group A is the most encountered blood group in contrast to the American continent and/or the European population. Our study conducted with a greater number of individuals confirms that blood group A has the highest prevalence in Istanbul. (Table 5)

We evaluated all of the published Turkish studies regarding the distribution frequencies of ABO and Rh (D) blood groups. (Table 5). It was striking that in the population from a restricted region of the Anatolian cities, the frequency of blood group A was less than 40 percent<sup>(19,24,26,29,38)</sup>. Distribution pattern of blood groups in the population of these cities mainly reflects the geopolitical evolution in this region. Another remarkable result came from the Black Sea region<sup>(28)</sup>, where the frequency of blood group O was more than 40% similar to the Caucasian and American population<sup>(6)</sup>, which also points to a genetic mixture of the country.

In conclusion, the emergence and evolution of blood groups in humans have not been clearly elucidated yet. The ethnic colouration changed over time in Turkey related to a mass immigration problem in the past century, resulting in population displacement and marriages within different ethnic groups. This issue also creates some basis for local differences in the distribution frequency of blood groups among different regions.

Knowing the frequency of the ABO and the Rh blood type in the country, and also in cities with complex ethnical populations will make it easier to manage blood and blood product storage and to plan the donor acquisition programs. We believe that our study will contribute to our country's blood group database and world literature.

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