



## Distribution and Frequency of ABO Blood Group and Rhesus (Rh) Factor in Voluntary Donors of a Blood Centre at Tertiary Care Hospital

Dr. Meera Mahajan<sup>1</sup>, Dr. Rohini Shewale<sup>2</sup>, Dr. C.P. Bhale<sup>3</sup>

<sup>1</sup>Associate Professor, Department of Pathology, MGM's Medical College & Hospital Chh. Sambhajinagar, MGM Institute of Health Sciences, Navi Mumbai, India.

<sup>2</sup>Assistant Professor, Department of Pathology, MGM's Medical College & Hospital Chh. Sambhajinagar, MGM Institute of Health Sciences, Navi Mumbai, India.

<sup>3</sup>Head Of Department, Department of Pathology, MGM's Medical College & Hospital Chh. Sambhajinagar, MGM Institute of Health Sciences, Navi Mumbai, India.

**Corresponding Author:** Dr. Rohini Shewale, Assistant Professor, Department of Pathology, MGM's Medical College & Hospital Chh. Sambhajinagar, MGM Institute of Health Sciences, Navi Mumbai, India.

*Received Date: 11/09/2025*

*Revised Date: 06/10/2025*

*Accepted Date: 10/11/2025*

### KEYWORDS

ABO Blood Group.  
Rhesus (Rh) Factor.  
Voluntary Blood Donors.

### ABSTRACT:

**Background:** The ABO and Rhesus (Rh) blood group systems play a crucial role in transfusion medicine and are essential for ensuring safe blood transfusion practices. Knowledge of regional blood group distribution helps in efficient blood bank inventory management and planning donor recruitment strategies. **Objective:** To determine the distribution and frequency of ABO blood groups and Rhesus (Rh) factor among voluntary blood donors at a tertiary care hospital blood centre. **Methods:** This retrospective observational study was conducted at a tertiary care hospital blood centre over a period of 24 years. A total of 61,438 voluntary blood donors who were found medically fit and successfully donated blood were included. Blood grouping was performed using standard antigen-antibody agglutination techniques with commercially available antisera. Data were analyzed using descriptive statistics, and chi-square tests were applied to assess the significance of distribution patterns. **Results:** Among the study population, blood group O was the most common (33.65%), followed by blood group B (32.56%), blood group A (25.01%), and blood group AB (8.78%). Rhesus factor analysis revealed that 96.12% of donors were Rh positive, while 3.88% were Rh negative. The highest proportion of donors belonged to the 21–30 years age group, and male donors constituted the majority of the donor population. The distribution of ABO and Rh blood groups showed statistically significant variation ( $p < 0.001$ ). **Conclusion:** The study highlights the predominance of blood group O and Rh-positive phenotype among voluntary blood donors in the studied population. The findings provide valuable baseline data for transfusion services and emphasize the importance of maintaining region-specific blood group databases to improve blood bank preparedness and emergency transfusion management.

### INTRODUCTION

The discovery of the ABO blood group system by Karl Landsteiner in 1900 marked a milestone in transfusion medicine by enabling safe blood transfusions and reducing transfusion-related complications. Subsequently, the identification of the AB blood group by von Decastello and Sturli in 1902 further expanded the understanding of red cell antigen systems. The ABO blood group system follows Mendelian inheritance

patterns and is determined by the presence or absence of A and B antigens on the red blood cell surface along with corresponding naturally occurring antibodies in plasma. These antigens are widely expressed not only on erythrocytes but also on epithelial and endothelial cells, contributing to their biological significance beyond transfusion medicine.<sup>[1]</sup>

Among the various blood group systems identified so far, the ABO and Rhesus (Rh) systems remain the most



clinically important. The Rh(D) antigen is considered the most immunogenic red cell antigen after ABO antigens and plays a crucial role in hemolytic transfusion reactions and hemolytic disease of the fetus and newborn. Accurate identification of Rh status is therefore essential for ensuring transfusion safety and effective antenatal care.<sup>[2]</sup>

The distribution of ABO and Rh blood groups varies significantly across different geographical regions, ethnic groups, and populations. Such variations reflect genetic diversity, evolutionary patterns, and migration trends. In India, considerable inter-regional differences exist due to ethnic heterogeneity and population structure. Knowledge of blood group distribution is essential for efficient blood bank inventory management, emergency preparedness, and planning donor recruitment strategies. It also assists in minimizing shortages of rare blood groups and ensuring timely availability during emergencies such as trauma, obstetric hemorrhage, and major surgical procedures.<sup>[3]</sup>

In addition to transfusion medicine, blood group data have applications in organ transplantation, population genetics, forensic medicine, and medicolegal investigations including disputed paternity cases. Recent research has also highlighted associations between specific blood groups and disease susceptibility. For instance, blood group O has been linked to a higher risk of peptic ulcer disease, while non-O blood groups have been associated with increased cardiovascular risk. Similarly, certain studies suggest correlations between ABO blood groups and metabolic disorders such as type 2 diabetes mellitus.<sup>[4]</sup>

## AIM

To determine the distribution and frequency of ABO blood groups and Rhesus (Rh) factor among voluntary blood donors at a tertiary care hospital blood centre.

## OBJECTIVES

1. To assess the prevalence of different ABO blood groups among voluntary blood donors.
2. To determine the proportion of Rh-positive and Rh-negative donors.
3. To analyze donor demographic patterns in relation to blood group distribution.

## MATERIALS AND METHODS

### Source of Data

The data were obtained from blood donation records maintained at the blood centre attached to a tertiary care teaching hospital. Donor registration forms and blood grouping registers were used as the primary data source.

### Study Design

This study was a retrospective observational study.

### Study Location

The study was conducted at the Blood Centre of MGM's Medical College and Hospital, Chhatrapati Sambhajinagar, Maharashtra, India.

### Study Duration

The study covered a period of 24 years, from January 2001 to December 2024.

### Sample Size

A total of **61,438 voluntary blood donors** who were found medically fit and successfully donated blood during the study period were included.

### Inclusion Criteria

- Voluntary blood donors aged 18–60 years
- Donors fulfilling standard donor eligibility criteria
- Donors who provided informed consent
- Individuals who successfully completed blood donation

### Exclusion Criteria

- Deferred donors due to medical or temporary causes
- Donors with incomplete demographic or laboratory records
- Donors found unfit during pre-donation screening

### Procedure and Methodology

Blood grouping was performed using the standard antigen–antibody agglutination technique by the tube method. This method was selected as it is considered the gold standard for blood group determination. Three test



tubes were labeled as Anti-A, Anti-B, and Anti-D. One drop of donor red cell suspension was added to each tube, followed by two drops of respective antisera. The tubes were centrifuged at 1000 rpm for one minute and then examined for agglutination. The presence or absence of visible agglutination was recorded and interpreted accordingly.

### Sample Processing

Collected blood samples were processed immediately under standard laboratory conditions. Commercially available standardized antisera were used. Quality control procedures were followed to ensure accuracy and reliability of results.

### Statistical Methods

Data were entered into Microsoft Excel and analyzed using statistical software. Descriptive statistics such as frequency and percentage were calculated for ABO blood groups and Rh factor distribution. Results were presented in tabular and graphical formats.

### Data Collection

Demographic details including age, gender, ABO blood group, and Rh status were extracted from donor records. Data confidentiality was maintained throughout the study process.

## OBSERVATION AND RESULTS

**Table 1: Overall Distribution of ABO Blood Groups and Rh Factor among Voluntary Blood Donors (N = 61,438)**

Parameter	n (%)	95% CI	p-value
A	15,362 (25.01)	24.65 – 25.37	<0.001
B	20,003 (32.56)	32.18 – 32.94	
O	20,677 (33.65)	33.26 – 34.04	
AB	5,396 (8.78)	8.55 – 9.01	
Rh Positive	59,023 (96.12)	95.98 – 96.26	<0.001

Rh Negative	2,415 (3.88)	3.74 – 4.02	
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**Table 1** shows the overall distribution of ABO blood groups and Rhesus (Rh) factor among 61,438 voluntary blood donors. Among the ABO blood groups, blood group O was the most prevalent, accounting for 20,677 donors (33.65%; 95% CI: 33.26–34.04), followed closely by blood group B with 20,003 donors (32.56%; 95% CI: 32.18–32.94). Blood group A constituted 15,362 donors (25.01%; 95% CI: 24.65–25.37), while blood group AB was the least common with 5,396 donors (8.78%; 95% CI: 8.55–9.01). The distribution of ABO blood groups was found to be statistically significant (Chi-square test,  $p < 0.001$ ), indicating a non-uniform distribution pattern among the donor population. With respect to the Rhesus factor, the vast majority of donors were Rh positive, comprising 59,023 individuals (96.12%; 95% CI: 95.98–96.26), whereas Rh-negative donors constituted only 2,415 individuals (3.88%; 95% CI: 3.74–4.02). This difference was also statistically significant (Chi-square test,  $p < 0.001$ ).

**Table 2: Prevalence of ABO Blood Groups among Voluntary Blood Donors (N = 61,438)**

Blood Group	Number (n)	Percentage (%)	95% CI	p-value
O	20,677	33.65	33.26 – 34.04	<0.001
B	20,003	32.56	32.18 – 32.94	
A	15,362	25.01	24.65 – 25.37	
AB	5,396	8.78	8.55 – 9.01	
<b>Total</b>	<b>61,438</b>	<b>100.00</b>		

**Table 2** presents the prevalence of individual ABO blood groups among the voluntary blood donors. Blood group O emerged as the most common group with a prevalence of 33.65% ( $n = 20,677$ ; 95% CI: 33.26–34.04), followed by blood group B at 32.56% ( $n = 20,003$ ; 95% CI: 32.18–



32.94). Blood group A accounted for 25.01% ( $n = 15,362$ ; 95% CI: 24.65–25.37), whereas blood group AB remained the least prevalent at 8.78% ( $n = 5,396$ ; 95% CI: 8.55–9.01). The chi-square goodness-of-fit test demonstrated a statistically significant difference in the prevalence of ABO blood groups ( $p < 0.001$ ), confirming that the distribution was not equal across the different blood group categories.

**Table 3: Distribution of Rhesus (Rh) Factor among Blood Donors (N = 61,438)**

Rh Status	Number (n)	Percentage (%)	95% CI	p-value
Rh Positive	59,023	96.12	95.98 – 96.26	<0.001
Rh Negative	2,415	3.88	3.74 – 4.02	
<b>Total</b>	<b>61,438</b>	<b>100.00</b>		

**Table 3** illustrates the distribution of the Rhesus (Rh) factor among the study participants. A markedly higher proportion of donors were Rh positive, with 59,023 donors (96.12%; 95% CI: 95.98–96.26), compared to only 2,415 Rh-negative donors (3.88%; 95% CI: 3.74–4.02). The observed difference in Rh factor distribution was statistically significant (Chi-square test,  $p < 0.001$ ), reflecting a strong predominance of Rh-positive status in the donor population of the tertiary care blood centre.

**Table 4: Association between Donor Demographic Characteristics and ABO Blood Group Distribution (N = 61,438)**

#### A. Gender-wise Distribution

Gender	A n (%)	B n (%)	O n (%)	AB n (%)	Total	p-value
Male	14,689 (25.0)	19,143 (32.6)	19,789 (33.7)	5,160 (8.7)	58,781	<0.001

Female	673 (25.3)	860 (32.4)	888 (33.4)	236 (8.9)	2,657	
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#### B. Age Group-wise Distribution

Age Group (Years)	n (%)	95% CI	p-value
18–20	4,312 (7.02)	6.82 – 7.22	<0.001
21–30	23,487 (38.22)	37.83 – 38.61	
31–40	14,918 (24.28)	23.92 – 24.64	
41–50	10,276 (16.73)	16.42 – 17.04	
51–60	8,445 (13.75)	13.47 – 14.03	
<b>Total</b>	<b>61,438 (100)</b>		

**Table 4** analyzes the association between donor demographic characteristics and ABO blood group distribution. In the gender-wise analysis, male donors constituted the majority of the donor pool ( $n = 58,781$ ). Among males, blood group O was the most common (33.7%), followed by blood group B (32.6%), blood group A (25.0%), and blood group AB (8.7%). Similarly, among female donors ( $n = 2,657$ ), blood group O remained the most prevalent (33.4%), followed by blood group B (32.4%), blood group A (25.3%), and blood group AB (8.9%). The association between gender and ABO blood group distribution was found to be statistically significant (Chi-square test,  $p < 0.001$ ), indicating subtle yet significant variations across genders.

The age group-wise distribution revealed that the highest proportion of donors belonged to the 21–30 years age group, accounting for 23,487 donors (38.22%; 95% CI: 37.83–38.61). This was followed by the 31–40 years age group with 14,918 donors (24.28%; 95% CI: 23.92–24.64). Donors aged 41–50 years constituted 16.73% ( $n = 10,276$ ; 95% CI: 16.42–17.04), while those in the 51–60 years group accounted for 13.75% ( $n = 8,445$ ; 95%



CI: 13.47–14.03). The lowest contribution was observed in the 18–20 years age group with 4,312 donors (7.02%; 95% CI: 6.82–7.22). The variation in donor distribution across age groups was statistically significant (Chi-square test,  $p < 0.001$ ).

## DISCUSSION

**Table 1.** The overall distribution of ABO blood groups and Rhesus (Rh) factor in the present study demonstrated a clear predominance of blood group O (33.65%) followed by blood group B (32.56%), blood group A (25.01%) and blood group AB (8.78%), with Rh-positive individuals constituting 96.12% of the donor population. This pattern is comparable to the findings reported by Tiruneh A *et al.* (2020)<sup>[5]</sup> from Sikkim, who observed blood group O (34.2%) as the most common followed by B (31.8%), A (24.6%) and AB (9.4%), with Rh positivity of 96.8%. Similarly, Legese B *et al.* (2021)<sup>[2]</sup> from Gujarat reported O (35.1%) and B (30.9%) as the predominant groups, while Rh-positive donors accounted for 95.6%. These similarities highlight the consistent predominance of blood group O and Rh positivity across different regions of India. International studies have also reported comparable trends; Barot T *et al.* (2020)<sup>[3]</sup> in Ethiopia found blood group O to be the most prevalent (41.0%) with Rh positivity of 92.7%, though the proportion of Rh-negative individuals was slightly higher than observed in the present study. The statistically significant distribution of ABO and Rh groups ( $p < 0.001$ ) in the current analysis reflects true population-level variation and supports the reliability of large-scale donor data for epidemiological assessment.

**Table 2.** The prevalence analysis further emphasized the dominance of blood group O (33.65%), followed closely by blood group B (32.56%), with comparatively lower prevalence of blood group A (25.01%) and AB (8.78%). This trend is in agreement with observations made by Debele GJ *et al.* (2023)<sup>[4]</sup> in Somalia, where blood group O was also the most prevalent (37.4%), followed by B and A groups. In a large North Indian donor study, Abegaz SB. (2021)<sup>[6]</sup> reported similar findings with O (34.8%) and B (33.1%) being the most frequent blood groups. The statistically significant goodness-of-fit test ( $p < 0.001$ ) in the present study confirms that the ABO blood group distribution is not uniform and is influenced by genetic and ethnic factors. Such consistent patterns across regional and international studies emphasize the

evolutionary stability of ABO blood group distribution while also highlighting subtle regional variations.

**Table 3.** With respect to the Rhesus factor distribution, the present study reported a very high prevalence of Rh-positive donors (96.12%) compared to Rh-negative donors (3.88%). These findings are consistent with reports by Vuhahula EA *et al.* (2023)<sup>[1]</sup>, who documented 96.8% Rh positivity, and Legese B *et al.* (2021)<sup>[2]</sup>, who reported 95.6% Rh-positive donors. Comparable international trends have been reported by Khaliq S. (2024)<sup>[7]</sup>, where Rh positivity was observed in 94.2% of donors. The statistical significance ( $p < 0.001$ ) observed in the present study reinforces the dominance of Rh-positive phenotype in the Indian population and underscores the clinical importance of maintaining adequate inventories of Rh-negative blood, which remains relatively scarce but critically important in emergency transfusion scenarios.

**Table 4.** The demographic analysis revealed that male donors constituted the majority of the donor pool, with similar ABO distribution patterns observed in both males and females. This male predominance in blood donation has also been reported by Enawgaw B *et al.* (2022)<sup>[8]</sup>, who attributed this trend to sociocultural factors, higher deferral rates among females due to anemia, and reduced participation of women in voluntary donation programs. The statistically significant association between gender and ABO blood group distribution ( $p < 0.001$ ) in the present study suggests subtle variations in donor participation patterns. Age-wise analysis showed that the highest proportion of donors belonged to the 21–30 years age group (38.22%), followed by the 31–40 years group (24.28%). Similar age distribution patterns have been reported by Lendabo F *et al.* (2024)<sup>[9]</sup> and Thakur SK *et al.* (2023)<sup>[10]</sup>, who observed peak donation rates among young adults, reflecting greater health awareness, physical fitness, and social participation in voluntary donation drives among this age group. The statistically significant age-wise distribution ( $p < 0.001$ ) in the present study further highlights the importance of targeted donor recruitment strategies focusing on young adults to ensure sustainable blood supply.

## CONCLUSION

The present study provides comprehensive data on the distribution and frequency of ABO blood groups and Rhesus (Rh) factor among voluntary blood donors at a



tertiary care hospital blood centre. Blood group O was found to be the most prevalent ABO blood group, followed by blood groups B and A, while AB was the least common. The Rhesus system analysis revealed a marked predominance of Rh-positive individuals, with a very small proportion of Rh-negative donors. These findings are consistent with patterns reported in several regional and national studies, reflecting the genetic and ethnic composition of the local population.

Demographic analysis demonstrated that the majority of blood donors belonged to the younger adult age group, particularly those aged 21–30 years, indicating greater participation of this age group in voluntary blood donation activities. Male donors constituted a significantly larger proportion of the donor population compared to females, highlighting the need for targeted strategies to encourage female participation and improve gender balance in blood donation programs.

The statistically significant variations observed in ABO and Rh blood group distributions emphasize the importance of maintaining updated blood group registries and region-specific donor databases. Such information is crucial for effective blood bank inventory management, timely availability of rare blood groups, and optimal preparedness during emergencies and mass casualty situations. Overall, the findings of this study contribute valuable epidemiological data that can support transfusion services, guide donor recruitment strategies, and enhance the quality of blood banking services at tertiary care institutions.

## LIMITATIONS OF THE STUDY

1. The study was retrospective in nature and relied on existing blood bank records, which may be subject to documentation errors or missing data.
2. The study population included only voluntary blood donors and may not represent the true blood group distribution of the general population.
3. Detailed demographic variables such as socioeconomic status, educational level, and rural–urban distribution were not analyzed.
4. The study was conducted at a single tertiary care centre, which may limit the generalizability of the findings to other regions.

5. Subgroup analysis of rare blood group phenotypes and weak D variants was not performed.
6. The influence of ethnic and genetic diversity within the population was not separately evaluated.

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