Vol. 5 No. 1 (2026)

Pakistan Journal of Medical & Cardiological Review

https://pakjmcr.com/index.php/1/about

Online ISSN 3007-2387

Print ISSN 3007-2379

GENDER-WISE DISTRIBUTION OF ABO AND RH BLOOD GROUPS IN THE POPULATION OF DERA ISMAIL KHAN, KHYBER PAKHTUNKHWA, PAKISTAN

Muhammad Naseer
Lab technologist
muhammadnaseer1995@gmail.com[1].
Khursheed
Lecturer MLT UVAS Swat, Ms biochemistry and molecular biology
Khursheed@uvasswat.edu.pk[2]
Din Muhammad
Assistant Professor cum senior demonostrater FAHS MLT UAD
danishwazir11609@gmail.com[3]
Alyan Khan
Medical Laboratory Technologist
aliankhanmaddi567@gmail.com[4]
Gohar Yousaf
BS Zoology/zoologist
goharyousaf440@gmail.com[5]
Shakir ullah
BS Zoology/zoologist
shakirullah21107@gmail.com[6]
Muhammad Bin Asim
Medical Lab Technologist
muhammadbinasim07@gmail.com[7]
Shafqat Ullah
Lecturer, Medical laboratory technology
shafqatullah49aqihs@gmail.com[8]
Muhammad Umar Nafees*
Medical Laboratory Technology/Coordinator of Faculty Allied Health Sciences/Head of the Department (HoD) Medical Laboratory Technology, The University of Agriculture, Dera Ismail Khan
nafees.khattak@uad.edu.pk

Vol. 5 No. 1 (2026)

Pakistan Journal of Medical & Cardiological Review

https://pakjmcr.com/index.php/1/about

Online ISSN 3007-2387

Print ISSN 3007-2379

Author Details

Keywords: ABO blood group, Rh factor, blood group distribution, gender, blood transfusion, Dera Ismail Khan, Pakistan, Chi-square test.

Received on 25 Feb 2026
Accepted on 19 March 2026
Published on 21 March 2026

Corresponding E-mails & Authors*:
Muhammad Umar Nafees*
nafees.khattak@uad.edu.pk

Abstract

Background: The ABO and Rhesus (Rh) blood group systems are the most clinically important blood group systems and play a vital role in blood transfusion, organ transplantation, and emergency medical care. Knowledge of the distribution of ABO and Rh blood groups in a population is essential for effective blood bank management, transfusion services, and public health planning. However, limited data are available regarding the gender-wise distribution of ABO and Rh blood groups in Dera Ismail Khan, Khyber Pakhtunkhwa, Pakistan. Objective: To determine the gender-wise distribution of ABO and Rh blood groups among the population of Dera Ismail Khan, Khyber Pakhtunkhwa, Pakistan, and to assess the association between gender and blood group distribution.

Methodology: A cross-sectional descriptive study was conducted among 500 participants from Dera Ismail Khan. The study included 257 (51.4%) males and 243 (48.6%) females. Blood samples were collected, and ABO and Rh blood grouping was performed using standard immunohematological methods. Data were entered into Microsoft Excel and analyzed using the Statistical Package for the Social Sciences (SPSS). Frequencies and percentages were calculated, and the Pearson Chi-square test was used to determine the association between gender and blood group distribution. A p-value of less than 0.05 was considered statistically significant.

Results: Among the ABO blood groups, blood group B was the most prevalent (33.6%), followed by blood group O (31.4%), blood group A (27.2%), and blood group AB (7.8%). Analysis of individual blood groups showed that B-positive (31.2%) was the most common, while AB-negative (0.4%) was the least common. Regarding the Rh system, 458 (91.6%) participants were Rh-positive, whereas 42 (8.4%) were Rh-negative. Gender-wise analysis demonstrated that B-positive was the most frequent blood group among males, while A-positive was the most frequent among females. The Pearson Chi-square test revealed a statistically significant association between gender and blood group distribution ($\chi^2 = 17.68$, df = 7, p = 0.0135).

Conclusion: Blood group B was the most prevalent ABO blood group, while AB was the least prevalent among the study population. Rh-positive blood groups were markedly more common than Rh-negative blood groups. A statistically significant association was observed between gender and blood group distribution. The findings provide valuable baseline information for blood banks, healthcare

institutions, and transfusion services in Dera Ismail Khan and may assist in improving blood inventory management and planning future epidemiological studies.

Keywords: ABO blood group, Rh factor, blood group distribution, gender, blood transfusion, Dera Ismail Khan, Pakistan, Chi-square test.

INTRODUCTION

The discovery of the ABO blood group system by Karl Landsteiner was one of the most important milestones in the history of blood transfusion. This discovery was later followed by the identification of the Rh (D) antigen. In 1940, Karl Landsteiner and Alexander S. Wiener discovered the Rh factor while conducting experiments on rabbits that had been immunized with the blood of the Rhesus monkey (Macaca rhesus). (Landsteiner, K et al., (1900). The Rh antigen is also present on the surface of human red blood cells. Approximately 85% of the world's population carries the Rh antigen and is therefore classified as Rh-positive, while the remaining people who do not have this antigen are classified as Rh-negative. The gene responsible for the Rh blood group system is located on the short arm of chromosome 19 (19p34.3–p36.1).(Garratty, G et al., (2000). Blood groups are inherited from parents according to the principles of Mendelian genetics, where different alleles at a single gene locus determine an individual's blood group. According to the International Society of Blood Transfusion (ISBT), more than 700 red blood cell antigens have been identified. These antigens are grouped into 30 recognized blood group systems. Every individual has a unique combination of blood group antigens, except for identical twins or triplets, who have the same blood group profile (Mollison, P et al., 1994). Among all blood group systems, the ABO and Rh systems are the most clinically important because they play a vital role in blood transfusion and transfusion safety. Based on the ABO system, people are classified into four major blood groups: A, B, AB, and O, depending on the type of antigen present on the

surface of their red blood cells. Similarly, individuals whose red blood cells carry the Rh (D) antigen are known as Rh-positive (Rh+), whereas those who lack this antigen are known as Rh-negative (Rh−). (Von decastello, A et al.,). The discovery of the ABO and Rh blood group systems has made a significant contribution to blood banking and transfusion medicine. These blood group systems are important not only for ensuring safe blood transfusions but also for genetic studies of different populations. They are also useful in solving medico-legal cases, such as disputed parentage. Several studies have reported that ABO blood groups are associated with certain diseases. For example, individuals with blood group A have a higher risk of developing gastric (stomach) cancer, while people with blood group O are more susceptible to malaria infection than individuals with non-O blood groups. (Mollison, P et al., 1994). In addition, the ABO blood group system has been identified as a strong genetic marker and has been linked to differences in body weight and national suicide rates. (Ndoula, S et al., 2014).

Sickle cell hemoglobin (HbS) differs from normal hemoglobin (HbA) because the amino acid valine replaces glutamic acid at the sixth position of the beta-globin chain. When oxygen levels decrease, red blood cells containing HbS change from their normal round shape into a sickle shape. (Rajshree, B et al., 2013). Individuals with sickle cell disease who inherit two HbS genes (HbSS) usually develop severe anemia and may experience serious health complications. In contrast, individuals with one normal hemoglobin gene and one HbS gene (HbAS) generally have mild or no symptoms and are more resistant to malaria. The severity of sickle cell disease varies from person to person. Some patients experience only mild symptoms, while others may suffer from severe complications that affect their quality of life. (Rahman, M et al., 2004). The discovery of blood groups has greatly improved modern medicine, especially in blood transfusion, organ transplantation, legal medicine, genetic research, and anthropology. It allows blood to be safely transfused between people from different populations and ethnic backgrounds. (Storry, J. R et al., 2003). Human red blood cells have different glycoproteins and glycolipids on their surface that act as blood group antigens. These antigens are controlled by genes, develop early during fetal life, and remain unchanged throughout a person's lifetime. (Firkin, F et al., 1989). Blood groups have also been linked with several diseases, including

duodenal ulcer, diabetes mellitus, urinary tract infections, Rh incompatibility, and ABO incompatibility in newborn babies. (Skaik, Y et al., 2006). Over the years, many blood group antigens and their corresponding genes have been identified, and their biological functions have been studied in detail (Mollison, P. L. et al., 1979). Blood group antigens are important not only for safe blood transfusion but also for understanding genetics, inheritance patterns, and the relationship between blood groups and certain diseases (Mohammad, K. et al., 2004).

The distribution of ABO and Rh blood groups varies among different populations, ethnic groups, and geographical regions due to genetic inheritance and population diversity. Knowledge of local blood group distribution is essential for blood banks, hospitals, and healthcare planners to ensure an adequate supply of compatible blood and to improve emergency transfusion services.

In Pakistan, previous studies have shown that blood group B is generally the most common blood group, followed by O, A, and AB, while Rh-positive individuals constitute the majority of the population. However, blood group frequencies differ among provinces, districts, and ethnic groups. Therefore, region-specific studies are necessary to provide accurate information for local healthcare planning.

Dera Ismail Khan is an important district of Khyber Pakhtunkhwa with a diverse population. Despite the growing demand for blood transfusion services, updated information regarding the gender-wise distribution of ABO and Rh blood groups in this region remains limited. Determining the frequency of blood groups among males and females can help blood banks maintain appropriate blood inventories, support donor recruitment programs, and provide baseline data for future epidemiological and clinical research.

1.1 ABO Blood Group System

Human ABO blood group antigens are genetically determined carbohydrate structures (glycoconjugates) found on the surface of red blood cells. These antigens play an important role in the normal function of red blood cells as well as in various physiological and disease processes. (Mohandas, N et al., 2005). The ABO blood groups are defined by specific oligosaccharide (carbohydrate) structures present on the red blood cell membrane. Blood group antigens are considered secondary gene

products because they are formed through the action of glycosyltransferase enzymes, which are the primary gene products responsible for attaching specific sugar molecules to the oligosaccharide chain. These carbohydrate antigens are recognized by the immune system. When a person is exposed to a different blood group antigen, the immune system identifies it as foreign and produces antibodies against it. This immune response is the basis of blood group compatibility during blood transfusion. (Denomme, G et al., 2011). The presence or absence of certain ABO blood group antigens has also been linked to the risk of developing some infectious and non-infectious diseases. Differences in blood group antigens can affect the structure and function of the red blood cell membrane, which may influence an individual's susceptibility to certain diseases as well as overall health. (Sandler, S et al.,1995). Although ABO antigens are mainly found on red blood cells, they are also present on leukocytes (white blood cells), platelets, plasma proteins, various tissues, and several cell surface enzymes. (Green, C et al., 1989). In addition, soluble forms of these antigens can be detected in different body fluids, including saliva, sweat, breast milk, urine, gastric secretions, seminal fluid, and amniotic fluid. (R. Ewald et al., 2016). Most blood group antigens are produced by a single gene. Genetic changes such as deletions, insertions, inversions, alternative splicing, or single nucleotide polymorphisms (SNPs) can alter antigen expression. These genetic variations may result in changes to existing antigens, the formation of new antigens, or complete absence of antigen expression. (G. A. Denomme et al., 2011).

1.1 RH Blood Group System

The Rhesus (Rh) blood group system is the second most important blood group system after the ABO system. (Westhoff, C et al., 2004). It is the most clinically significant protein-based blood group system and consists of 49 identified antigens, making it the largest among the 29 recognized blood group systems. The large number of Rh antigens is due to its complex genetic structure. These antigens are found on two main Rh proteins, RhD and RhCE, and are produced by variations in their protein sequences. In CD nomenclature, these proteins are known as CD240D and CD240CE. Unlike many other blood group proteins, Rh proteins are present only on the membranes of red blood cells and their immediate precursor cells. (Flegel, W et al., 2004). The Rh blood group system is second only to the ABO system in clinical importance. It plays a vital role in blood transfusion and pregnancy. Since the introduction of postpartum anti-D prophylaxis in the late 1960s, followed by both prepartum and postpartum anti-D prophylaxis in the early 1990s, the incidence of haemolytic disease of the newborn caused by Rh incompatibility has decreased by more than 90%. However, up to 1% of pregnant women still develop clinically significant antibodies against red blood cell antigens, which may affect the fetus or newborn. (Howard, H et al., 1998). The first Rh gene, known as the RHCE gene, was

discovered in 1990, while the RHD gene was identified two years later. Researchers found that the complete deletion of the RHD gene is responsible for the Rh-negative phenotype commonly seen in European populations. Since then, more than 170 different alleles of the RHD gene have been identified. Research on this gene is still ongoing, and new variants continue to be discovered. For example, the DNB allele, one of the most common partial D variants in Europeans, was first described in 2002. (Wagner, F et al., 2002). The main difference between Rh-positive and Rh-negative individuals is the presence or absence of the RhD protein on the surface of red blood cells. Individuals who have the RhD protein are classified as Rh-positive, whereas those who lack this protein are Rh-negative. The complete absence of a cell membrane protein is uncommon in humans, which explains why the RhD antigen is highly immunogenic and can easily stimulate antibody production after exposure to Rh-positive blood. (Wagner, F et al., 2000).

Problem Statement

Blood transfusion is an essential part of modern healthcare, and knowing the distribution of ABO and Rh blood groups is important for safe transfusion practices and effective blood bank management. The frequency of blood groups varies from one population to another due to genetic and geographical differences. Although several studies have been conducted on blood group distribution in different parts of Pakistan, there is limited recent information regarding the gender-wise distribution of ABO and Rh blood groups in the population of Dera Ismail Khan, Khyber Pakhtunkhwa. The lack of updated local data may create challenges for blood banks and healthcare facilities in planning blood storage and donor recruitment.

Research Question

1. What is the distribution of ABO blood groups (A, B, AB, and O) among the population of Dera Ismail Khan?
2. What is the distribution of Rh-positive and Rh-negative blood groups among the study population?
3. Which blood group is the most common and which is the least common in the population of Dera Ismail Khan?

Methods and material

Study design: A hospital-based cross-sectional descriptive study was conducted to determine the gender-wise distribution of ABO and Rh blood groups among patients visiting selected hospitals and a private laboratory in Dera Ismail Khan, Khyber Pakhtunkhwa, Pakistan.

Study Area

The study was carried out in Dera Ismail Khan, Khyber Pakhtunkhwa, Pakistan. Blood samples were collected from the following healthcare facilities:

- DHQ Teaching Hospital, Dera Ismail Khan
- Zanana Hospital, Dera Ismail Khan
- Madina Medical Laboratory, Dera Ismail Khan

These institutions provide blood grouping and other laboratory services to a large number of patients from Dera Ismail Khan and nearby areas.

Study Duration

The study was conducted over a period of four months, from **December 2026 to March 2026**.

Study Population

The study population consisted of patients of both genders who visited the selected hospitals and laboratory for blood grouping during the study period.

Sample Size

A total of **500 participants** were included in the study. The sample comprised:

- Male = 257
- Female = 243

Sampling Technique

A convenience sampling technique was used. Participants who fulfilled the inclusion criteria and were available during the study period were included until the required sample size of 500 was achieved.

Inclusion Criteria

The following participants were included in the study:

- Male and female patients visiting the selected hospitals or laboratory for blood grouping.

- Patients willing to participate in the study.
- Patients whose blood grouping results were clearly determined.

Exclusion Criteria

The following participants were excluded:

- Patients who refused to participate.
- Patients with incomplete demographic information.
- Samples showing doubtful or inconclusive agglutination reactions.
- Duplicate patient records.

Study Variables Independent Variable

- Gender

Dependent Variables

ABO Blood Group

Rh Blood Group

Materials Required

The following materials were used:

- Sterile disposable lancets or syringes
- Sterile cotton swabs
- 70% alcohol
- Clean glass slides
- Anti-A antisera
- Anti-B antisera
- Anti-D antisera
- Applicator sticks
- Disposable gloves
- Marker
- Laboratory register/data collection sheet

Blood Sample Collection Procedure

After obtaining informed consent, basic demographic information including gender was recorded.

Blood samples were collected using standard aseptic techniques.
The collected blood was immediately used for ABO and Rh blood grouping.
All procedures were performed according to standard laboratory safety guidelines.

ABO and Rh Blood Grouping Procedure

The **slide agglutination method** was used for blood grouping.

Three separate drops of Anti-A, Anti-B, and Anti-D antisera were placed on a clean glass slide.

A small drop of the participant's blood was added to each antisera. Each mixture was mixed using separate applicator sticks.

The slide was gently rocked for approximately two minutes and observed for visible agglutination.

Agglutination with Anti-A indicated blood group A. Agglutination with Anti-B indicated blood group B. Agglutination with both Anti-A and Anti-B indicated blood group AB.

Absence of agglutination with both Anti-A and Anti-B indicated blood group O. Agglutination with Anti-D indicated Rh-positive blood group, while absence of agglutination indicated Rh-negative blood group.

Quality Control

Quality control measures included:

- Checking expiry dates of antisera before use.
- Using clean and dry glass slides.
- Using separate applicator sticks for each reagent.
- Following standard operating procedures.
- Verifying doubtful reactions before recording results.

Data Collection Procedure

Blood grouping results and participant gender were recorded on a structured data collection sheet.

Each participant was assigned a unique identification number to maintain confidentiality. The completed data were entered into Microsoft Excel and then transferred to IBM SPSS Statistics Version 25 for statistical analysis.

Ethical Considerations

Permission to conduct the study was obtained from the concerned authorities of the participating hospitals and laboratory.

The purpose of the study was explained to all participants before sample collection.

Participation was voluntary.

Confidentiality of participants' information was maintained throughout the study by using identification numbers instead of names. The study was conducted according to accepted ethical principles for biomedical research.

3.2 Data Analysis

Data were entered into Microsoft Excel and analyzed using **IBM SPSS Statistics Version 25**.

Descriptive statistics including frequencies and percentages were calculated.

Cross-tabulation was performed to compare blood group distribution between males and females.

The Pearson Chi-square test was used to determine the association between gender and ABO/Rh blood group distribution.

A **p-value less than 0.05** was considered statistically significant.

Operational Definitions

ABO Blood Group System: A blood group classification consisting of A, B, AB, and O blood groups based on the presence or absence of A and B antigens.

Rh Blood Group System: Classification of blood as Rh-positive or Rh-negative according to the presence or absence of the D antigen.

Gender: Biological classification of the participant as male or female.

Agglutination: Visible clumping of red blood cells after reaction with specific antisera indicating the presence of the corresponding antigen.

Results and discussion:

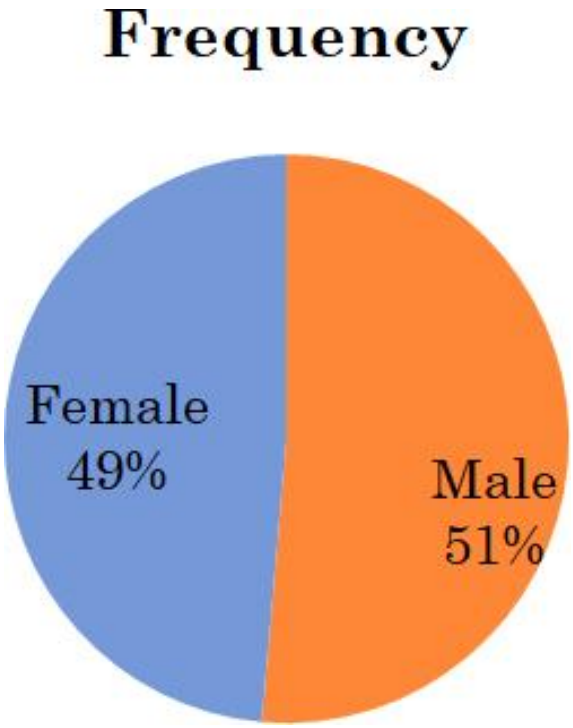
This chapter presents the results of the study entitled **"Gender-wise Distribution of ABO and Rh Blood Groups in the Population of Dera Ismail Khan, Khyber Pakhtunkhwa, Pakistan."** A total of **500 participants** were included in the study. The collected data were entered into Microsoft Excel and analyzed using SPSS. The results are presented in the form of tables, percentages, graphs, and statistical analysis.

Table 4.1: Gender Distribution of Study Participants

Gender	Frequency	Percentage
Male	257	51.4%
Female	243	48.6%

Total Participants = 500

Figure 4.1: RH Blood Group Distribution



(Pie Chart)

Table 4.2: Distribution of Individual Blood Group

Blood Group	Frequency	Percentage
A+	118	23.6%
A−	18	3.6%
B+	156	31.2%
B−	12	2.4%
AB+	37	7.4%
AB−	2	0.4%
O+	147	29.4%
O−	10	2.0%

Figure 4.2: Distribution of Individual Blood Groups

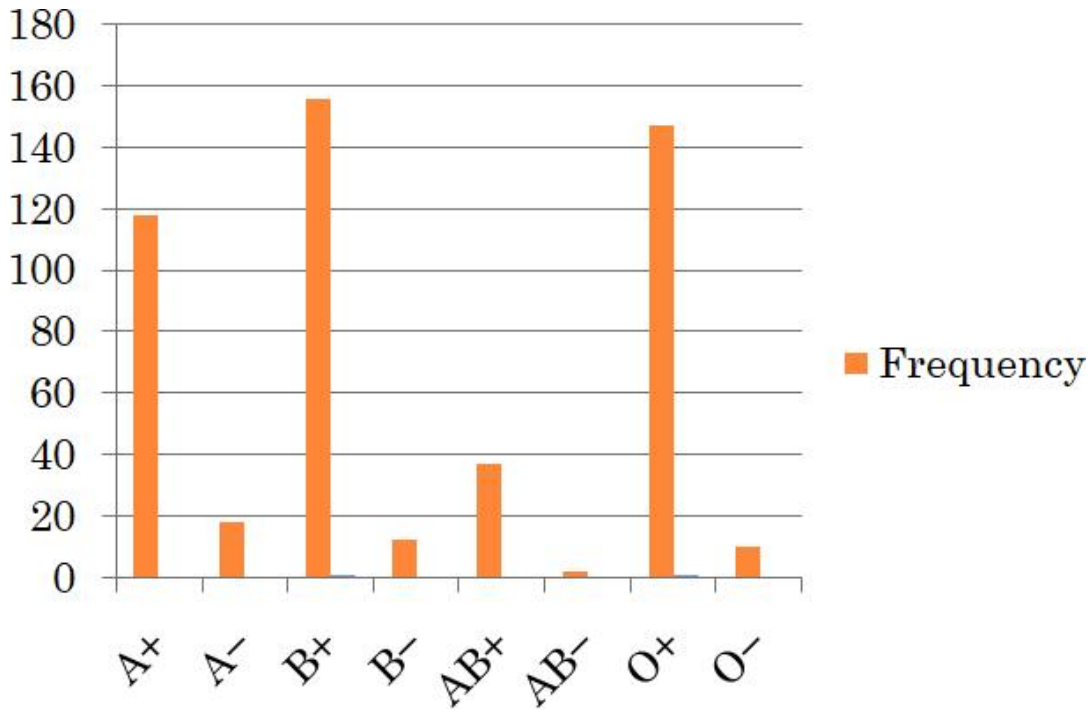
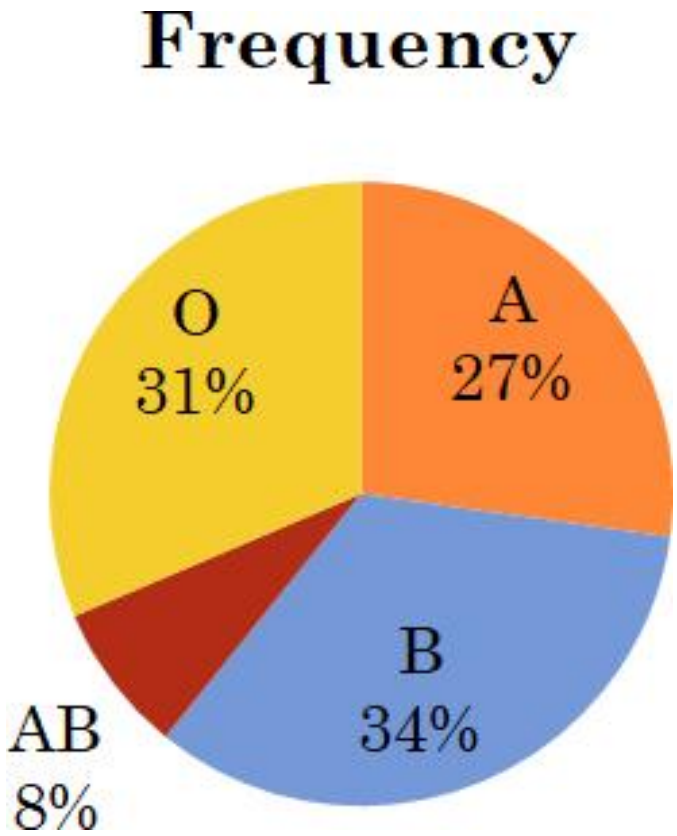


Table 4.3: ABO Blood Group Distribution

Blood Group	Frequency	Percentage
A	136	27.2%
B	168	33.6%
AB	39	7.8%
O	157	31.4%

Most Common: B Least Common: AB

Figure 4.3: ABO Blood Group Distribution

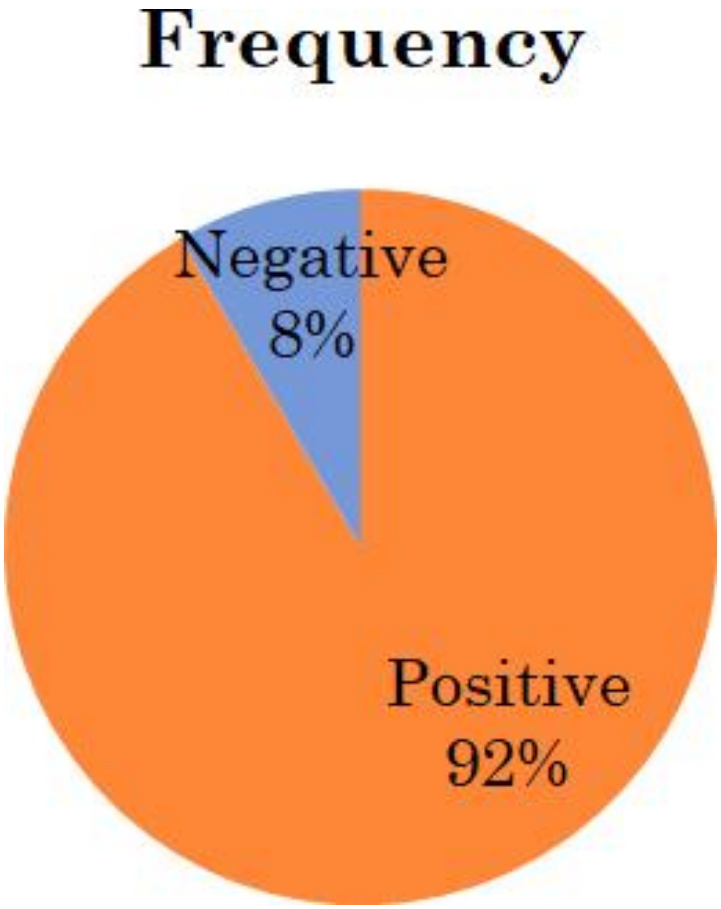


(Pie Chart)

Table 4.4: Rh Blood Group Distribution

Rh Factor	Frequency	Percentage
Positive	458	91.6%
Negative	42	8.4%

Figure 4.4: Rh Blood Group Distribution

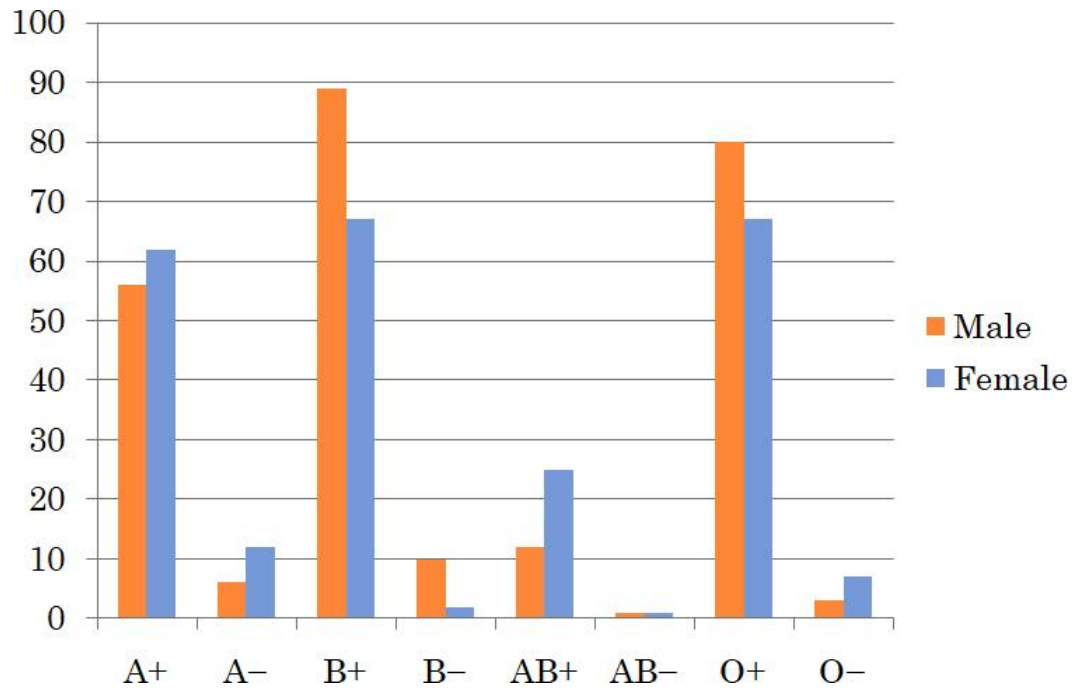


(Pie Chart)

Table 4.5: Gender-wise Blood Group Distribution

Blood Group	Male	Female
A+	56	62
A−	6	12
B+	89	67
B−	10	2
AB+	12	25
AB−	1	1
O+	80	67
O−	3	7

Figure 4.5: Gender-wise Blood Group Distribution



(Column Graph)

Table 4.6: Association Between Gender and Blood Group Distribution

Statistical Test	Value
Pearson Chi-square	17.68
Degrees of Freedom	7
p-value	0.0135

4.1 Interpretation of Results

A total of **500 participants** were included in the present study, comprising **257 (51.4%) males** and **243 (48.6%) females**, indicating a nearly equal representation of both genders.

Analysis of the individual ABO and Rh blood groups showed that **B-positive** was the most prevalent blood group, with **156 (31.2%)** participants, followed by **O-positive** with **147 (29.4%)** participants and **A-positive** with **118 (23.6%)** participants.

AB-negative was the least common blood group, occurring in only **2 (0.4%)** participants.

When ABO blood groups were analyzed irrespective of Rh factor, **blood group B** was the most common, accounting for **168 (33.6%)** participants, followed by **blood group O** with **157 (31.4%)**, **blood group A** with **136 (27.2%)**, and **blood group AB** with **39 (7.8%)** participants.

Regarding Rh factor, **458 (91.6%)** participants were **Rh-positive**, whereas **42 (8.4%)** participants were **Rh-negative**, indicating that Rh-positive blood groups predominated in the study population.

Gender-wise analysis revealed that **B-positive** was the most common blood group among males (**89 participants**), whereas **A-positive** was the most common among females (**62 participants**). **AB-negative** was the least frequent blood group in both males and females.

To assess the association between gender and blood group distribution, a Pearson Chi-square test was performed. The analysis yielded a **Chi-square value of 17.68** with **7 degrees of freedom** and a **p-value of 0.0135**. Since the p-value was less than **0.05**, the association between gender and blood group distribution was **statistically significant**. Therefore, the **null hypothesis was rejected**, indicating that blood group distribution differed significantly between male and female participants in this study.

4.2 Summary of Results

- Total participants: **500**
- Males: **257 (51.4%)**
- Females: **243 (48.6%)**
- Most common ABO blood group: **B (33.6%)**
- Least common ABO blood group: **AB (7.8%)**
- Most common individual blood group: **B+ (31.2%)**
- Least common individual blood group: **AB− (0.4%)**
- Rh-positive: **91.6%**
- Rh-negative: **8.4%**
- Chi-square test showed a **statistically significant association**

between gender and blood group distribution ($\chi^2 = 17.68$, df = 7, $p = 0.0135$).

DISCUSSION

The present study was conducted to determine the gender-wise distribution of ABO and Rh blood groups among the population of Dera Ismail Khan, Khyber Pakhtunkhwa, Pakistan. A total of 500 participants were included in the study, comprising 257 males (51.4%) and 243 females (48.6%).

The findings of this study showed that **blood group B (33.6%)** was the most common ABO blood group, followed by **blood group O (31.4%)**, **blood group A (27.2%)**, and **blood group AB (7.8%)**. These findings are consistent with the study conducted by **Rehman et al. (2020)**, who also reported blood group B as the most prevalent and blood group AB as the least common in Pakistan. Similarly, **Patidar et al. (2021)** reported that blood groups B and O were the predominant blood groups in India, although blood group O showed a slightly higher frequency than blood group B.

In contrast, studies conducted in Ethiopia by Enawgaw et al. (2022) and Debele et al. (2023) reported blood group O as the most common blood group, followed by blood groups A and B. These differences may be due to genetic, ethnic, and geographical variations among different populations.

Regarding the Rh blood group system, the present study found that **91.6%** of the participants were **Rh-positive**, while **8.4%** were **Rh-negative**. These findings are similar to those reported by **Rehman et al. (2020)**, **Enawgaw et al. (2022)**, **Patidar et al. (2021)**, and **Debele et al. (2023)**, all of whom observed that Rh-positive blood groups were much more common than Rh-negative blood groups.

The gender-wise analysis showed that B-positive was the most common blood group among males, whereas A-positive was the most common among females. The Pearson Chi-square test demonstrated a statistically significant association between gender and blood group distribution ($\chi^2 = 17.68$, df = 7, $p = 0.0135$). However, this statistical association should be interpreted cautiously because blood groups

are inherited genetically, and the observed difference may reflect the characteristics of the study sample.

Overall, the findings of the present study are in agreement with previous studies conducted in Pakistan and other countries. The study concludes that blood group B is the most prevalent ABO blood group, blood group AB is the least common, and Rh-positive blood groups predominate among the study population. These findings provide useful information for blood banks and healthcare professionals in planning blood collection and transfusion services in Dera Ismail Khan.

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

The present study was conducted to determine the gender-wise distribution of ABO and Rh blood groups among the population of Dera Ismail Khan, Khyber Pakhtunkhwa, Pakistan. A total of 500 participants were included in the study, comprising 257 (51.4%) males and 243 (48.6%) females.

The findings revealed that **blood group B** was the most prevalent ABO blood group, accounting for **33.6%** of the study population, followed by **blood group O (31.4%)**, **blood group A (27.2%)**, and **blood group AB (7.8%)**. Among the individual blood groups, **B-positive (31.2%)** was the most common, whereas **AB-negative (0.4%)** was the least common.

The study also demonstrated that Rh-positive blood groups (91.6%) were considerably more common than Rh-negative blood groups (8.4%). This pattern is consistent with findings reported in previous national and international studies.

Gender-wise analysis showed variations in the distribution of individual blood groups between males and females. The Pearson Chi-square test indicated a statistically significant association between gender and blood group distribution ($\chi^2 = 17.68$, df = 7, p = 0.0135). However, these findings should be interpreted in the context of the study population and design.

Overall, this study provides valuable baseline information on the distribution of ABO and Rh blood groups in Dera Ismail Khan. The findings can support blood banks, healthcare institutions, and researchers by improving blood inventory management, donor recruitment strategies, and planning for transfusion services.

5.2 Recommendations

Based on the findings of the present study, the following recommendations are proposed:

1. Blood banks in Dera Ismail Khan should maintain adequate stocks of the most frequently occurring blood groups, particularly **B-positive** and **O-positive**, to meet routine and emergency transfusion requirements.
2. Special attention should be given to maintaining an adequate supply of **rare blood groups**, especially **AB-negative** and **O-negative**, through donor registration and targeted recruitment.
3. Public awareness campaigns should be organized to encourage **voluntary blood donation**, thereby increasing the availability of safe blood for patients.
4. A computerized **regional blood donor registry** should be established to facilitate the rapid identification of compatible blood donors during emergencies.
5. Hospitals and blood transfusion centers should conduct **regular blood donation drives** in collaboration with educational institutions, community organizations, and healthcare facilities.

LITERATURE CITED

Akhtar, K., Mehdi, G., Sherwani, R., & Sofi, L. (2010). Relationship between various cancers and ABO blood groups–A Northern India experience. *Int J Pathol*, *13*(1), 3-7.

Anyiam, A. F., Arinze-Anyiam, O. C., Irondi, E. A., & Obeagu, E. I. (2023). Distribution of ABO and rhesus blood grouping with HIV infection among blood donors in Ekiti State Nigeria. *Medicine*, *102*(47), e36342.

Butler, E. A., Parikh, R., Grandi, S. M., Ray, J. G., & Cohen, E. (2023). ABO and Rh blood groups and risk of infection: systematic review and meta-analysis. *BMC Infectious Diseases*, *23*(1), 797.

Calafell, F., Roubinet, F., Ramírez-Soriano, A., Saitou, N., Bertranpetit, J., & Blancher, A. (2008). Evolutionary dynamics of the human ABO gene. *Human Genetics*, *124*(2), 123-135.

Debele, G. J., Fita, F. U., & Tibebu, M. (2023). Prevalence of ABO and Rh blood group among volunteer blood donors at the blood and tissue bank service in Addis Ababa, Ethiopia. *Journal of blood medicine*, 19-24.

Denomme, G. A. (2011). Molecular basis of blood group expression. *Transfusion and Apheresis Science*, *44*(1), 53-63.

Enawgaw, B., Aynalem, M., & Melku, M. (2022). Distribution of ABO and Rh-D blood group antigens among blood donors in the Amhara Regional State, Ethiopia. *Journal of blood medicine*, 97-104.

Firkin, F., Chesterman, C., Penington, D., & Rush, B. (1989). Blood groups; blood transfusion; acquired immune deficiency syndrome. *De Gruchy's Clinical Hematology in Medical Practice*, *5*, 475-96.

Flegel, W. A., & Wagner, F. F. (2004). Blutgruppen: alloantigene auf erythrozyten. In *Transfusionsmedizin: Grundlagen Therapie Methodik* (pp. 145-185). Berlin, Heidelberg: Springer Berlin Heidelberg..

G. A. Denomme, "Molecular basis of blood group expression," Transfusion and Apheresis Science, vol. 44, no. 1, pp. 53–63, 2011.

Garratty, G., Dzik, W., Issitt, P. D., Lublin, D. M., Reid, M. E., & Zelinski, T. (2000). Terminology for blood group antigens and genes—historical origins and guidelines in the new millennium. *Transfusion*, *40*(4), 477-489.