GLAND SURGERY

DISTRIBUTION OF ABO AND RH-D BLOOD GROUPS IN MADINAH, SAUDI ARABIA

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Abstract

This study investigates the distribution of ABO and Rh-D blood groups in Madinah, Saudi Arabia, from January 1 to December 31, 2022. Data were collected on ABO and Rh blood group testing alongside sociodemographic information. During the study period, there were 17,368 blood donors in Madinah. The O blood group, particularly O Rh-D +ve, had the highest donation rates, while the AB blood group, specifically AB Rh-D −ve, had the lowest. Males comprised 97.77% of the blood donor population (n = 16,980), with nearly half of the donors belonging to the O blood group (46.44%). A total of 15,363 donors (88.45%) were Rh-D-positive. Most donations (99.58%) were whole blood, and 65.28% of donors contributed altruistically. Further research across Saudi Arabia is recommended to obtain more comprehensive data regarding ABO and Rh blood group distributions in the population.

Keywords: Blood Groups, ABO Distribution, Rh-D Type, Blood Donation, Sociodemographic Analysis

Introduction

In the 19th century, Karl Landsteiner explored the causes of transfusion-related deaths and identified unique agglutination patterns in blood serum, leading to the establishment of the modern blood classification system in 1901. He initially identified three blood types (A, B, and O) by examining serum's agglutination effects on healthy red blood cells (RBCs). The AB blood group was discovered in 1902 by Landsteiner's students, von Decastello and Sturli. Thirty-eight years later, Landsteiner and Wiener identified the Rhesus (Rh) blood group system, named after the Rhesus monkey, which earned them the Nobel Prize in Physiology or Medicine in 1930. These antigens are crucial for RBC functionality, influencing their morphology and lifespan. The absence of Rh proteins results in Rh-null phenotypes with altered RBC survival. Unlike ABO antigens, Rh antigens are associated with transport functions across the lipid bilayer and maintaining RBC membrane integrity.

ABO antigens are produced by enzymes encoded by genes on chromosome 9, modifying carbohydrate antigens on RBC membranes. A and B antigens arise from the addition of N-acetylgalactosamine or galactose to H antigen. The O blood group occurs due to the absence of A and B enzymes. ABO antigens are not limited to RBC surfaces; they are also found in bodily fluids and tissues. Based on agglutination patterns with specific antibodies, blood can be categorized into four primary groups.

The Rh blood group system comprises over 55 antigenic specificities, with only five (D, C, E, c, e) having significant clinical relevance due to their immunogenicity. This system is governed by two genes on chromosome one that code for Rh-D and RhCcEe transmembrane proteins, which traverse the RBC membrane. Rh antigens are exclusively expressed on RBCs and may facilitate ammonium transport while contributing to membrane integrity. Rh status is classified as Rh positive or negative depending on the presence of the D antigen, with negative individuals typically producing anti-D antibodies only after exposure to Rh-positive blood.

Understanding the prevalence of ABO and Rh-D blood groups is essential for enhancing transfusion protocols and managing blood bank inventories effectively at both local and regional levels. This knowledge plays a vital role in ensuring access to safe blood supplies during emergencies, particularly during Hajj and Umrah. One of the objectives of Saudi Vision 2030 is to increase life expectancy from 74 to 80 years, alongside improving healthcare quality and reducing preventable mortality rates. Thus, assessing ABO and Rh-D blood group prevalence will aid in achieving these goals, particularly in disaster scenarios. Furthermore, there is a scarcity of published data on ABO and Rh-D blood group prevalence among blood donors in Madinah, prompting this study's focus.

Materials and Methods

Study Design

This retrospective study involved data collection from the laboratory and blood bank department to assess the prevalence of ABO and Rh-D blood groups among donors at the donation center throughout 2022.

Data Collection Tools

The technical team at the Security Forces Hospital blood bank in Makkah, Saudi Arabia, generated data using monoclonal antisera for forward blood grouping to identify antigens A, B, and D on donors' RBCs, collected in EDTA tubes. Standard commercial cells for reverse blood grouping were employed to detect ABO and Rh antibodies in donor serum collected in plain tubes, using test tube and column agglutination methods. Blood group confirmation required consistent results from both forward and reverse groupings. Rh-negative blood groups were verified using antigen techniques, treating all weak D groups as Rh-D positive. No exclusion criteria were applied, and the study included gender data for all age groups.

Data Analysis

Data were collected, verified, and cleaned using Microsoft Excel to eliminate errors, such as missing, duplicated, or incorrectly formatted values. Multiple variables were separated into distinct columns. Subsequently, data were analyzed using the Statistical Package for Social Sciences (SPSS) for descriptive statistics, including frequency, mean, median, and mode, with standard deviation (SD) calculated to illustrate observation distribution. A p-value of <0.05 was considered statistically significant.

Results

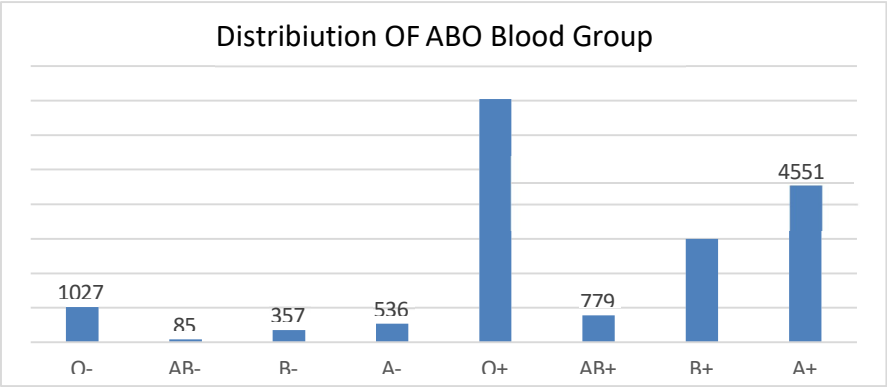
Characteristics of the Included Blood Donors

A total of 17,368 participants contributed to the study in 2022, comprising 16,980 males (97.77%) and 388 females (2.23%), with the majority being Saudi nationals (74.88%, n=13,005). The predominant blood group was O (46.44%), followed by A (29.59%), B (19.3%), and AB (4.98%). Overall, 88.46% of blood donors were Rh-D positive, with 99.58% of donors returning for additional donations.

Variable	Response Option	n	%
Nationality	Saudi	13,005	74.88%,
	Non- Saudi	4,363	25.12%
Gender	Male	16,980	97.77%
	Female	388	2.23%
ABO	A	5,087	29.29%
	AB	864	4.98%
	B	3,351	19.3%
	O	8,066	46.44%

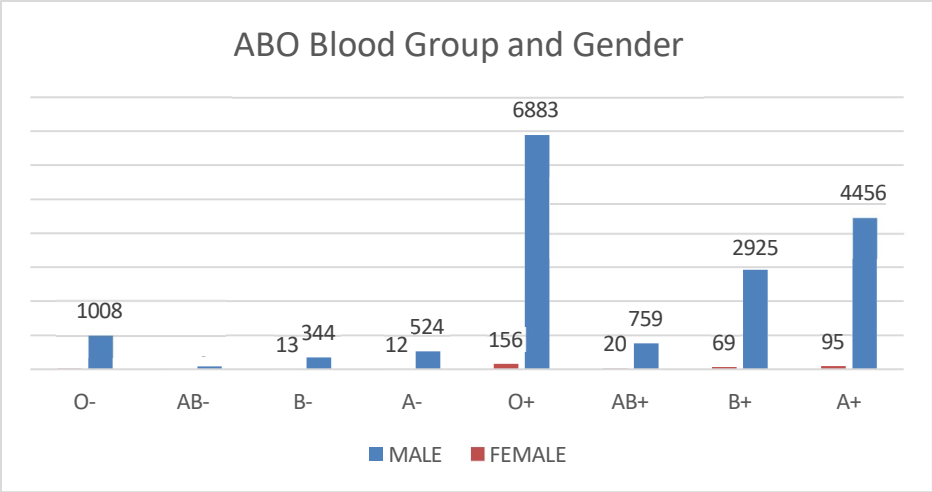
Overall Distribution of ABO Rh-D Groups

The laboratory and local blood bank at King Fahad Hospital in Madinah found that 99.58% of whole blood donations were from patients, with only 0.42% from apheresis. Most patients (65.28%) donated altruistically, while 34.72% did so in the name of God. Among the donors, 15,363 were Rh-D-positive (88.45%). The distribution included 40% O Rh-D+, 26.20% A Rh-D+, 17.24% B Rh-D+, and 4.49% AB Rh-D+. Rh-D-negative distributions were 5.91% for O, 3.09% for A, 2.06% for B, and 0.49% for AB. Donation type did not significantly affect ABO Rh-D distribution (P = 0.63).



ABO Rh-D Groups by Gender

In our study, we found that of the donors with determined blood groups, 97.77% were male (16,980) and 2.23% were female (388). There were no significant gender-related differences in the prevalence of ABO Rh-D blood groups.



Discussion

As the primary blood bank in the region, this facility supports surrounding health services with blood and components. The study involved 17,368 blood donors in Madinah, with a male predominance (97.77%). Previous research from King Faisal Specialist Hospital and Research Center indicated that male donors outnumber female donors, potentially due to medical factors affecting female eligibility, such as low hemoglobin, body weight, pregnancy, and breastfeeding.

The most prevalent blood group identified was O (46.44%), followed by A (29.29%), B (19.3%), and AB (4.98%). Consistent with other studies, blood group O frequently emerges as the most common type, though variations in findings, such as studies in Turkey and Pakistan indicating a higher prevalence of A, may stem from genetic differences among participants.

The Rh-positive population constituted 88.46%, aligning with findings from Debre Tabor, Ethiopia, where 92.7% were Rh-positive. Another Saudi study indicated 91% Rh positivity, while a study in Gambela, Ethiopia, reported a higher prevalence of Rh-negative individuals (19.37%). The distribution revealed that O positivity (40.53%) was most common, while AB negativity (4.49%) was least common, corroborating findings from Ethiopia and Uganda. However, a Tanzanian study noted a different order of prevalence, indicating genetic diversity in blood groups across regions.

Conclusion

The study found that blood group O was the most common among donations, followed by A and B, with AB being the least prevalent. Rh-positive blood groups accounted for 88.46% of donors. The varying distribution of ABO and Rh blood groups among blood donors in Madinah, Saudi Arabia, underscores the importance of adjusting blood stock according to type for effective blood bank management.

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