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Distribution and Prevalence of ABO and Rh Blood Group Phenotypes Among Voluntary Blood Donors in a Tertiary Care Hospital at Kolhapur, Maharashtra, India: A Retrospective Study

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ABSTRACT

The ABO and Rh blood group systems (BGS) hold paramount significance in both "blood transfusion and transplant medicine". The antigens on the surface of red blood cells (RBCs) play a crucial role in unraveling aspects of genetics, inheritance patterns, medicolegal issues, susceptibility to diseases and ensuring the safety of transfusions. Investigating the distribution of blood groups (BG) in diverse peoples is required for clinical research, understanding their associations with diseases and environmental factors. To effectively manage blood banks and ensure safe transfusion services, it is crucial to comprehend the variations in the frequency of ABO and Rh Blood Group across various populae over time. The primary aim of our present study is to analyze the distribution patterns and frequencies of ABO and Rh Blood Group among voluntary blood donors in our hospital. This endeavor aims to assess the readiness of our blood center and establish correlations with similar studies conducted in various areas of India. A retrospective analysis was conducted at our hospital's blood center, focusing on voluntary blood donors who underwent initial screening based on blood donation criteria. Blood samples were acquired through the venipuncture method and the ABO and Rhesus blood grouping were determined using the "antigen-antibody micro-agglutination tube test". The collected data was then organized in a Microsoft Excel (2015) spreadsheet with appropriate coding and subjected to analysis using "Statistical Package for Social Sciences (SPSS) software version 28.0.0." Among 5,377 donors, 4,988 were male and 389 were female. The most prevalent BG among males was B (30.37%), with the least common being AB (9.90%). Among females the most common BG was O (33.68%) and the least common was AB (11.83%). The distribution of ABO BG in the donor population revealed that B BG had the highest prevalence (30.24%), followed by BG O (30.09%), BG A (29.63%) and the least common was BG AB (10.04%). Regarding Rh grouping, 95.09% of donors were Rh-positive, while 4.91% were Rh-negative. This investigation gives important information of the precise distribution of BG within our local community. Furthermore, by gathering data from diverse regions across India, the study contributes to proactive health planning, ensuring the efficient operation of transfusion services. It aims to ensure the continuous availability of specific BG at all times, meeting heightened demands and averting fatalities linked to the unavailability of blood during emergencies.

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Key Words
ABO, rhesus, blood group, voluntary blood donor

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INTRODUCTION

Karl Landsteiner was a pioneering figure in the field of blood grouping and immunochemistry. His revolutionary contributions to the ABO blood group system (ABO-BGS) significantly influenced the field of medication. He and colleagues "Decastello and Sturli" revealed the "AB" blood group (BG) in 1902, enhancing our understanding of blood types and compatibility in medicine. In acknowledgment of his essential contributions to transfusion science, Landsteiner was honored with the Nobel Prize in Physiology and Medicine in 1930[1].

Levine and Stetson made a significant discovery by identifying the "Rh blood group system (Rh-BGS) in the mid-1940s. Understanding the local and regional distribution of ABO and Rh- BG is vital for efficiently operating blood banks and ensuring the safety of blood transfusion services[2].

With around 29 BG systems and an extensive array of over 700 distinct BG antigens the ABO-BGS and Rh-BGS stand out as the foremost in importance, playing a pivotal role in understanding and ensuring blood compatibility[3]. ABO-BGS and Rh-BGS adhere to the principles of Mendelian genetics. The ABO and Rh-BG gene is situated on "chromosome 9 and 1" correspondingly[4]. In this system, antibodies are present in the serum without prior exposure through transfusion or pregnancy[5].

ABO and Rh-BG combinations differ extensively across races, ethnicities, and socioeconomic groups globally. Understanding these variations is vital for tailored healthcare and efficient blood transfusion services worldwide. In addition to its applications in blood transfusion and organ transplantation, this technique finds utility in various medical and scientific fields, including medicolegal matters, genetic study, "forensic pathology", "anthropology" and the investigation of population migration outlines. In contemporary times the significance of comprehending the association of ABO and Rh- BG with ailments and the atmosphere has grown. Consequently, it is crucial to possess data on the prevalence of these BG in any residents[6].

Transfusing ABO-incompatible blood poses risks such as acute intravascular hemolysis, renal failure, and potentially fatal outcomes[7]. Understanding ABO and Rh- BG is crucial for managing blood Centre inventory, whether at a local blood transfusion facility or a national level ensuring safe and effective transfusion practices[8]. This study will document the spreading and occurrence of ABO and Rh phenotype BG and produce social responsiveness about safe blood transfusion facilities. The goal of the present study was to recognize the distribution of ABO and Rh phenotype BG between intended blood donors in tertiary care centres.

MATERIALS AND METHODS

In this retrospective study, data from 5377 blood donors were evaluated who were amongst the age group of 18-65 years, blood collection was carried out in the blood centre itself and outdoor blood donation camps organized by tertiary care hospital in Kolhapur during the period January 2021to October 2023.

To meet eligibility criteria, donors were required to have a weight exceeding 50 kg and a hemoglobin concentration greater than 12.5 gms. Additionally, donors were carefully screened to ensure they were free from any medications or diseases, adhering to the guidelines set by the "World Health Organization (WHO)". Following the act of blood donation, the BG was ascertained through both "Forward grouping (cell grouping) and Reverse grouping (serum grouping)" methods using the conventional "Test Tube Agglutination Method". This analysis was conducted on pilot samples collected from the donors, adhering rigorously to the established standard operating measures of the blood centre[1].

To conduct a thorough ABO grouping (including both forward and reverse grouping), monoclonal antibodies such as "Anti-A, Anti-A1, Anti-B, Anti-AB, and Anti-H antisera, along with A, B and O pooled cells, were employed. Rh typing was performed using anti-D antisera". The confirmation of the final BG was only established when both forward and reverse groups matched. Rh-negative BG was affirmed through the Anti-Human Globulin (AHG) gel card method.

The BG information of donors was documented using specially designed proforma, then organized, analyzed and compared with analogous studies conducted by other researchers. The data was obtained in an MS Excel (2015) spreadsheet coded properly and evaluated using a statistical package for Social Sciences (SPSS) software version 28.0.0 and associated with parallel research conducted by other authors.

RESULTS

A total of 5377, voluntary blood donors participated in the study, with ABO BG typing revealing a prevalence pattern consistent with that observed in the general Indian population B>O>A>AB. Among the donors, 4988 were males and 389 were females. (Table 1). In our study focusing on the ABO phenotype system, the analysis reveals that the highest frequency is attributed to BG-"B" (30.24%), closely trailed by "O" (30.09%), "A" (29.63%) and "AB" (10. 04%). This distribution provides a clear representation of the incidence of different ABO-BG within the studied population, offering valuable data for understanding the composition of blood types in our samples. (Table 1) (Fig. 1).

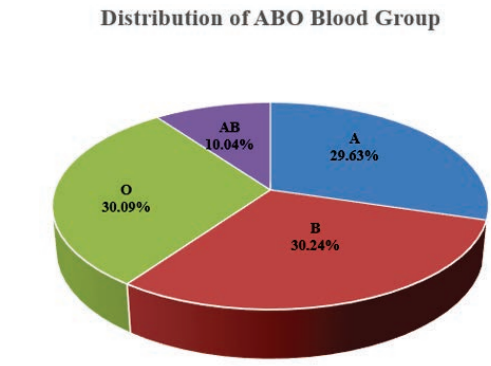

Fig. 1: Distribution of ABO-BG

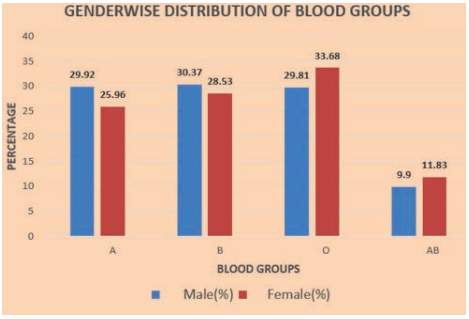

Fig. 2: Gender wise distribution of BG

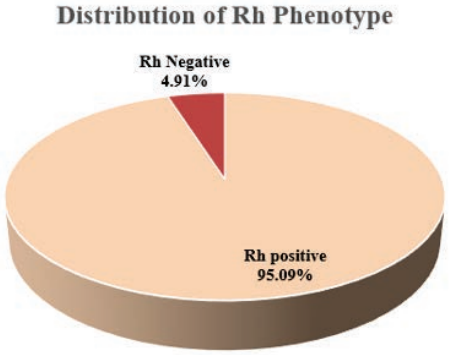

Fig. 3: Distribution of Rh Phenotype

In this, the distribution of BG between males reveals that the most prevalent blood type is “B” Positive (29.17%), succeeded by “O” Positive (28.33%), “A” Positive (28.25%), “AB” positive (9.39%), “A” Negative (1.66%), “O” Negative (1.48%), 'B' Negative (1.20%) and “AB” Negative (0.52%). Among females in this study the distribution of BG demonstrates that “O” Positive is the most prevalent (32.65%), followed by “B” Positive (26.74%), “A” Positive (23.66%) and “AB” Positive (11.57%). Additionally, “A” Negative comprises (2.31 %), “B” Negative (1.80%), “O” Negative (1.02%), and “AB” Negative (0.25%). (Table 2). In the Rh phenotype, 5113 donors were Rh-Positive (95.09%) and 264 donors were Rh Negative (4.91%). (Table 3.) (Fig. 3).

DISCUSSIONS

As revealed in table 4, there are differences in ABO-BG distribution across India[9-17]. Based on research conducted in “Northern India and Western India” the B-BG demonstrated the highest occurrence, ranging from 34-40%, followed by O (29-36%), A (21-24%) and AB (5-11%) BG[9-13]. In our study, ABO-BG distribution closely matches previous research findings, with the notable exception of Agarwal *et al.*[9] multicentric study. Their research highlighted Western India as having the maximum incidence of BG-O.

Research conducted in Eastern India and Southern India indicated that BG- O has the peak occurrence, ranging from 34-40%, followed by B (30-40%), A (20-24%) and AB (6-7%) BG. The research conducted by Agrawal *et al.*[15-17] identified BG-O with the maximum incidence, while Gupta *et al.*[9-14] study highlighted B as the predominant BG in Central India.

The diversity in ABO and Rh blood grouping across regions and ethnicities highlights the significance of precise blood typing. This information is crucial for maintaining thorough records at blood centers, ensuring effective transfusion services and addressing legal and medical issues with accuracy[4].

In numerous studies conducted in India, a notable trend emerges there is a substantial disparity between the number of male and female blood donors. This phenomenon is often attributed to factors such as limited education, prevailing social taboos, cultural practices, insufficient motivation and apprehension or fear associated with blood donation. This observed gender difference underscores the need for targeted efforts to address these specific challenges and encourage broader participation in blood donation, especially among women[18].

Understanding the distribution of ABO and Rh-BG is vital for the efficient administration of blood centers. Therefore, it is crucial to possess evidence regarding the prevalence of these BG in any given resident. Knowledge of the distribution of BG is not only important for the operations of blood centers but also holds significant importance in clinical studies and the collection of reliable geographical information. Moreover, this knowledge is instrumental in addressing public health challenges, particularly in decreasing the maternal death rate. Having access to a secure and ample blood supply emerges as a critical factor in preventing preventable deaths during childbirth. In this way, an improves healthcare outcomes and contributing to broader public health

Table 1: Distribution of blood donors categorized by ABO-BG phenotype and gender

BG	Male	Female	Total
A	1492 (29.92%)	101 (25.96%)	1593 (29.63%)
B	1515 (30.37%)	111 (28.53%)	1626 (30.24%)
O	1487 (29.81%)	131 (33.68%)	1618 (30.09%)
AB	494 (9.90%)	46 (11.83%)	540 (10.04%)
Total	4988 (100%)	389 (100%)	5377 (100%)

Table 2: Distribution of ABO-BG along with Rh factor with gender

	Cases (%)		Total cases	
BG	Male n (%)	Female n (%)	Total	Prevalence (%)
A Positive	1409 (28.25)	92 (23.66)	1501	27.92
B Positive	1455 (29.17)	104(26.74)	1559	28.99
AB Positive	468 (9.39)	45 (11.57)	513	9.54
O Positive	1413 (28.33)	127(32.65)	1540	28.64
A Negative	83 (1.66)	9 (2.31)	92	1.71
B Negative	60 (1.20)	7 (1.80)	67	1.25
AB Negative	26 (0.52)	1 (0.25)	27	0.50
O Negative	74(1.48)	4 (1.02)	78	1.45
Total	4988	389	5377	100%

Table 3: Distribution of Blood donors according to Rh phenotype

Phenotype	"Rh" positive	"Rh" negative	Total (%)
A	1501 (27.92 %)	92 (1.71%)	1593 (29.63)
B	1559 (28.99 %)	67 (1.25%)	1626 (30.24)
O	1540 (28.64 %)	78 (1.45 %)	1618 (30.09)
AB	513 (9.54%)	27(0.50 %)	540 (10.04)
Total	5113 (95.09 %)	264 (4.91 %)	5377 (100)

Table 4: Distribution of ABO and Rh-BG across different regions

			Blood group frequency (%)					
Region	Author	Study size(n)	A	B	O	AB	Rh D positive	Rh D negative
North India								
North zone	Agrawal *et al.*[15]	2042	24.54	34.47	29.43	11.55	94.8	5.19
Lucknow	Chandra *et al.*[10]	140320	21.38	39.92	29.27	9.43	95.71	4.29
	Nanu and Thapliyal	6334	24.7	37.5	32.5	5.3	95.37	4.63
Punjab		1150	21.91	37.57	31.22	9.3	97.3	2.7
West India								
West zone	Agrawal *et al.*[15]	2220	23.69	32.74	36.75	6.8	92.97	7.02
Rajasthan		83631	22.2	36.4	31.7	9.4	91.75	8.25
South Gujrat	Raja *et al.*[1]	40732	24.35	34.43	32.26	8.94	95.12	4.87
Central India								
Central zone	Agrawal *et al.*[15]	2021	23.1	26.57	43.24	7.07	96.23	3.72
Indore	Gupta *et al.*[14]	17080	24.15	35.25	31.5	9.1	95.43	4.57
East India								
East zone	Agrawal *et al.*[15]	1595	21.88	33.85	37.55	6.7	95.23	4.76
Durgapur	Nag *et al.*[15]	3850	23.9	33.6	34.8	7.7	94.7	5.3
South India								
South zone	Agrawal *et al.*[15]	1808	20.68	33.07	38.99	6.25	93.91	6.08
Karnataka		36964	23.85	29.95	39.81	6.37	94.21	5.79
South India	Das *et al.*[16]	150536	18.85	32.69	38.75	5.27	94.53	5.47
Present study		5377	29.63	30.24	30.09	10.04	95.09	4.91

initiatives. In current medicine, BG are not only crucial in evolution but are increasingly recognized for their relevance to disease and environmental factors. This understanding informs personalized approaches in healthcare, emphasizing the evolving role of BG information in medical research and practice[19]. Therefore, this information will be beneficial to blood centres particularly in the development of blood transfusion programs for the most efficient use of blood collected from voluntary blood donors[20].

This study focuses on understanding the distribution and occurrence of ABO and Rh- BG among voluntary blood donors at camps organized by a tertiary care hospital in Kolhapur. The findings reveal that among males, BG-"B" is the most common, while 'AB' is the least common. Among females, BG "O" is the most predominant and "AB" is the least common.

CONCLUSION

The study conducted at a tertiary care hospital in Kolhapur provides comprehensive insights into BG distribution among donors. It identifies "B" as the most prevalent BG and "AB" as the least common among male donors. conversely, in female donors, "O" is the most prevalent, and 'AB' is the least common BG. Notably, 95.09% of donors are 'Rh' Positive, while 4.91% are "Rh" Negative. The findings highlight a potential area of improvement, suggesting a need for targeted counseling and motivation initiatives to boost female participation in blood donation drives.

The establishment of a systematic blood center donor database is emphasized in the study. This structured database not only aids in emergencies but also facilitates efficient inventory management. Furthermore, the study's insights can contribute to

the formulation of well-informed national policies regarding blood donation practices and strategies. Overall, the study serves as a valuable resource for enhancing blood center operations and ensuring preparedness in critical situations.

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