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Prevalence of ABO & Rh-D Blood group systems with Gene frequency among Blood Donors in South Indian Urban Population

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ABSTRACT
Introduction: ABO and Rh-D blood group systems are the two most important blood group systems from amongst 29 different blood group systems identified so far and are widely used for blood transfusion, organ transplantation, medico legal and genetic studies. The distribution of ABO and Rh-D blood groups vary in different populations and regions. Therefore, the knowledge of blood group distribution in respective regions and areas is essential in maintaining the appropriate blood bank inventory and reserves for emergency requirements.
Materials and Methods: This retrospective observational study was undertaken at HHS & HMS Blood Centre, a standalone blood bank from June 2022 to May 2024.The blood group of all the donors was detected by slide and tube method by agglutination technique. Distribution of the various blood groups was estimated and the gene frequencies were calculated by using Hardy-Weinberg formula.
Results: The most common blood group detected was O (38.85%), followed by B (30.121%), A(23.72%) and AB (7.303%). 94% of the donors were Rh-D positive and 6% were Rh-D negative. Majority of the donors were males (93.86%) and only 6.13% were females. Gene frequencies estimated were 0.1835 for I^A (p), 0.1933 for I^B (q) and 0.6232 for I^O (r).
Conclusion: The most common blood group in donors was O Positive and AB Negative was least common group.
KEYWORDS: ABO & Rh-D Blood group, Donor, Genotype, Phenotype, Allele frequency.

I. INTRODUCTION

Karl Landsteiner was the first person who described the ABO Blood group system based on the presence or absence of A and B antigens and antibodies on the surface of the red blood cells and plasma/serum respectively. Initially he identified A, B and O groups based on their reactions to each other. AB group was identified a year later by a different research team [1]. A group has been sub classified as **A1, A2, Aint, A_X, A_m, A_{end}, A_{el} and A_{bantu}** based on the reactivity of red cells with human anti A and anti AB. Group A cells reacting with both Anti-A and Anti $-A_1$ are classified as A_1. 80% of the A blood group population are A1.A2 constitutes 20% of the A blood group population which reacts with Anti-A and not agglutinated with Anti A_1 [2]. B group has been sub classified as B_3, B_X, B_m and B_h and occurs less frequently than group A[3]. In addition to the ABO blood group system the most important is the Rh system, which comprises around 49 highly immunogenic antigens of which the significant one is D antigen. Human beings with the presence of D antigens on their RBC's are labelled as Rh-D positive and those without the D antigens on their RBC's are labelled as Rh-D negative individuals [4]. The ABO and Rh-D genes are located on the chromosomes 9 and 1 respectively. These blood group genes are inherited genetically from both their parents to the child in Mendelian fashion [5]. Therefore the blood groups are genetically determined. A total of 29 blood group systems have been described with over 600 different blood group antigens.

Among them the most ABO and Rh-D are the most important blood group systems [6]. Blood group distribution data's are useful for population genetic studies, population migration studies, resolving Medico legal issues, disputed paternity issues and during criminal investigation procedures [7]. Certain blood groups are also known to have some associations with certain diseases like duodenal ulcers, Diabetes Mellitus, Urinary tract infection, Rh incompatibility, cardiovascular diseases and certain malignancies [8]. It is therefore important to have an information on the distribution of blood groups in the population in this region and hence the study has been undertaken to estimate the distribution pattern and gene frequency among blood donors in south Indian urban population.

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II. MATERIALS AND METHODS

This retrospective study was undertaken was taken at HHS & HMS Blood Centre, a standalone blood Centre, Bangalore, Karnataka, South India. The study was conducted between June 2022 and May 2024. During the study period 2314 voluntary donors were registered. All the donors were requested to sign the Questionnaire/consent form before the brief medical examination for physical fitness of the donor like weight, temp, Pulse rate, blood pressure and Hemoglobin levels. Initially blood grouping was done by slide method using commercially available Anti-A, Anti-B and Anti-D antisera before the blood collection procedure. After blood collection blood grouping was determined by forward and reverse grouping by tube method from the pilot samples of the donors following standard operating procedures of the blood Centre as prescribed by the NBTC and Drug Controller. All the groups were statistically analyzed for calculating the distribution pattern of various blood groups. Findings were compared with other similar studies from different regions. The gene/allelic frequencies were estimated using the Hardy-Weinberg formula with Ceppilini corrections.

III. RESULTS

ABO blood group of 2314 individuals were evaluated .The distribution pattern of ABO Blood groups in donors was in decreasing order as follows O > B > A > AB. Of the total 2314 donors 899(38.85%) were of blood group O, 697(30.121%) were of group B, 549(23.725%) were of group A and 169(7.303) were of group AB (Fig.1) Of the total 2314 donors Rh-D positive individuals were 2185 amounting to 94.42% and Rh-D negative individuals were 129 amounting to 5.57% of the donors. (Fig.2). 2172(93.86%) of the donors were males and females constituted only 142(6.13%).

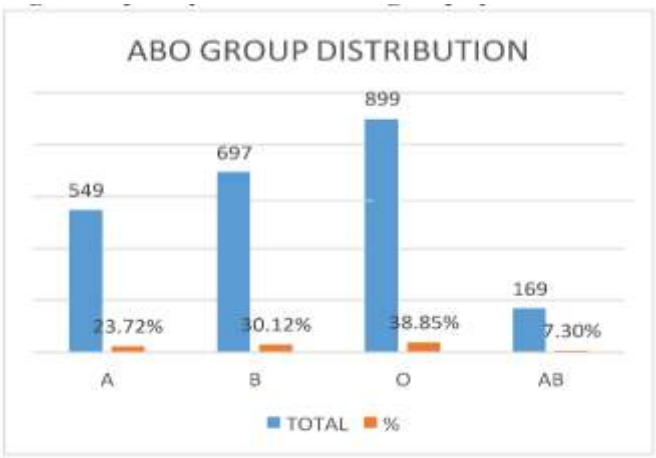

Fig.1 Frequency of ABO blood group system

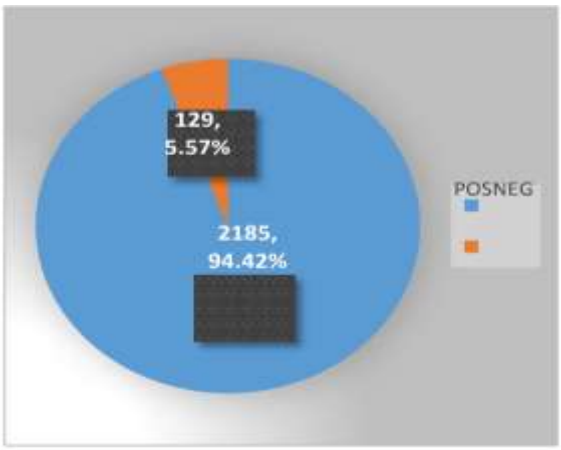

Fig.2 Frequency of Rh-D blood group system

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Expected phenotype frequency calculation using Hardy-Weinberg formula:
O allele frequency(r)
r^2 = frequency of O phenotype $r = \sqrt{r^2}$
$r = \sqrt{0.3885}$ r = 0.6232

A allele frequency (p)
p = frequency of A phenotype
p = frequency of A phenotype + frequency of O phenotype $p^2 + 2pr + r^2 = (p+r)^2$ $p = \sqrt{(p^2+2pr+r^2)} - r$
$p = \sqrt{(0.237)^2} + (2x0.237x0.3885) + (0.3885)^2 - (0.3885)$ p = 0.1835

B allele frequency (q) p + q + r = 1.0
q = 1.0 – (p + r)
q = 1.0 – (0.183 +0.623)
q = 0.1933

Calculation of d allele frequency (u) u^2 = frequency of d phenotype
$u = \sqrt{0.0557}$ u = 0.2360

Calculation of D allele frequency (v) v + u = 1.0
v = 1.0 – u
v = 1.0 – 0.236
v = 0.7640

Calculating genotype frequency AA = $p^2 = (0.1835)^2 = 0.0337$
AO = 2pr = (2x0.1835x0.6232) = 0.2278 BB = $q^2 = (0.1933)^2 = 0.0373$
BO = 2qr = (2x0.1933x0.6232) = 0.2409 OO = $r^2 = (0.6232)^2 = 0.03882$
AB = 2pr = (2x0.1835x0.6232) = 0.0709 DD = $r^2 = (0.764)^2 = 0.5836$
Dd = 2uv = (2x0.2360x0.764) = 0.3606 Dd = $u^2 = 0.0556$
Distribution of ABO and Rh-D allele frequency in Bengaluru urban population I^A allele = 0.1835
I^B allele = 0.1933 I^O allele = 0.6232 I^D allele = 0.7640 I^d allele = 0.2360

Table 1. Showing Frequency of Phenotype and genotype of ABO and Rh-D System.

Blood Group System	Phenotype	Observed frequency	Genotype	Expected frequency	
ABO	A	0.2372	AA	0.0337	0.2624
			AO	0.2287	
	B	0.3012	BB	0.0373	0.2782
			BO	0.2409	
	O	0.3885	OO	0.3882	0.3882
	AB	0.0730	AB	0.0709	0.0709
Rh-D	D Positive	0.9442	DD	0.5836	0.9442
			Dd	0.3606	
	D Negative	0.0557	dd	0.0557	0.0557

IV. DISCUSSION

All human beings share the same blood group system. The most significant among different blood group systems is ABO and Rh-D system. The distribution of ABO blood groups vary from one population to another and from time to time in same population. Also the distribution of ABO and Rh-D groups vary markedly in different races, ethnic and socio economic groups in different parts of the world [9]

The most prevalent blood group in the present study was O, followed by B and A respectively. Least common was AB Group in Rh-D positive individuals. Similar pattern of

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distribution was observed in Rh-D negative individuals. Both males and females showed consistently similar pattern. Females donors showed a relatively higher negativity 10/142(7.04%) when compared to males 119/2172(5.48%) corresponding with the study of Raja K A et al,[10].

Table 2. Showing Region wise distribution of ABO & Rh-D Blood group systems in India

REGION	AUTHOR	STUDY SIZE	BLOOD GROUP FREQUENCY					
North India			**A**	**B**	**O**	**AB**	**Rh-D+ve**	**Rh-D-ve**
Lucknow	Chandra T et al	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
North zone	Agrawal A et al	2042	24.54	34.47	29.43	11.55	94.8	5.19
Punjab	Sindhu S et al	1150	21.91	37.57	31.22	9.3	97.3	2.7
South India								
South zone	Agrawal A et al	1808	20.68	33.07	38.99	6.25	93.91	6.08
Karnataka	Periyavan S et al	36964	23.85	29.95	39.81	6.37	94.21	5.79
South India	Das et al	150536	18.85	32.69	38.75	5.27	94.53	5.47
Present Study		**2314**	**23.72**	**30.12**	**38.85**	**7.30**	**94.42**	**5.57**
Central India								
Centre zone	Agrawal A et al	2021	23.1	26.57	43.24	7.07	96.23	3.72
Indore	Gupta NK et al	17080	24.15	35.25	31.5	9.1	95.43	4.57
East India								
East zone	Agrawal A et al	1595	21.88	33.85	37.55	6.7	95.23	4.76
Durgapur	Ipsita N et al	3850	23.9	33.6	34.8	7.7	94.7	5.3
West India								
West zone	Agrawal A et al	2220	23.69	32.74	36.75	6.8	92.97	7.02
Rajasthan	Rajshree B et al	83631	22.2	36.4	31.7	9.4	91.75	8.25

As shown in table 2, there is significant variation in the distribution pattern of ABO Blood groups in India [11---19]. North and western Indian population show predominantly B group individuals(34---40%) followed by O , A and AB. Multicentric study by Agarwal A et al concludes that O Blood group was predominant blood group in western India [13]. Studies from eastern and southern states show predominantly O group followed by B, A and AB [15, 16, 18]. Central Indian states study groups show conflicting reports. Gupta N K et al. shows B group as leading and Agarwal

A et al. shows O group as leading [11, 12, 13, 14, 17, and 19]. The present study findings correlate well with other south Indian study groups showing O as predominant blood group [13, 15, and 16]. The distribution pattern of Rh-D blood group system is consistently uniform and predominantly Rh-D positive. The present study showed 94.42% individuals were positive for Rh-D and 5.57% showed negativity for Rh-D. Various studies in India and abroad showed Rh-D positivity in the range of 91—97%. The present study correlates well with all other studies in India and abroad [11—19].

Table.3. Showing ABO and Rh-D allele distribution in various studies.

Author	Calculated ABO and Rh-D allele frequency				
	$_{I}$**A**	$_{I}$**B**	$_{I}$**O**	$_{I}$**D**	$_{I}$**d**
Kruti A. Raja et al	0.1844	0.2477	0.5679	0.7794	0.2206
Sindhu S et al	0.171	0.27	0.559	0.836	0.164
Amit Agrawal et al	0.1653	0.2254	0.6093	0.7679	0.2321
Present study	**0.1835**	**0.1933**	**0.6232**	**0.7640**	**0.2360**

The gene frequency of ABO and Rh-D system was calculated and compared with 3 different study groups as shown in Table 3.The actual distribution of gene frequency of ABO and Rh-D blood groups did not differ significantly from the calculated gene frequencies.

V. CONCLUSION

The commonest blood group in the study population in this particular region is O, followed by B and A respectively. The least common group was AB. The distribution pattern of ABO blood groups here in south India differ significantly with patterns seen in western , central and northern states where B blood group is more common. Regarding Rh-D blood group system Rh-D negativity was found only in5.57% individuals.

The findings of such prevalence studies will surely help in designing and establishing a database for organizing Quality Blood Bank services. The various comparison studies conclude that the heterogeneity encountered in different populations may be due to genetic factors. The data analyzed from different regional studies will be a useful tool to probe into the probable influencing factors responsible for the diverse pattern of distribution.

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