A retrospective study: ABO and Rh phenotype blood group distribution among blood donors in H.N.B. Base Hospital, Srinagar, Uttarakhand, India

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ABSTRACT

Objective: To determine the prevalence of ABO and Rh blood groups based on the antigenic presence on the surface of red blood cells with respect to gender and calculate allele frequency of the blood groups. Globally, approximately 700 type red cell antigens have been identified till now. ABO and Rh blood groups play an important role in the process of blood transfusion, resolving certain medicolegal issues, parental testing, and various genetic studies. Methods: This study was conducted in H.N.B. Base Hospital, Srinagar, Uttarakhand, from January 2012 to December 2016. Relevant data of blood donors were collected from blood bank department of the hospital. Blood grouping was conducted using commercially available standard monoclonal antisera applying test tube and column agglutination techniques. Results: Out of 9883 individuals, 9333 (92.4%) were males and 750 (7.6%) were female individuals. The most common blood group found was B (31.68%) and least common being AB (11.70%). The prevalence of Rh positive and negative distribution in the present studied population was found as 93.51% and 6.49%, respectively. Overall, male ABO group pattern found was shown by formula B > A > O > AB which was similar among Rh-positive male individuals while Rh-negative males’ pattern was found as A > B = O > AB. In females, ABO group pattern was B > O > A > AB which was similar to Rh-positive female pattern while differs in Rh negative. The estimated allele frequencies were found as 0.2403, 0.2475, and 0.5122 for Iᴬ (p), Iᴮ (q), and Iᴼ (r), respectively. Conclusion: The most common blood group found among the Garhwali donors was B positive while the least common was AB negative, which plays an important contribution for making government policies to develop National Health Program.

Keywords: ABO and Rh blood group, allele frequency, blood donor

Introduction

Different types of blood groups are hereditary and determined based on the presence of surface antigens in the RBC and these groups play a vital role during transfusion. In the year 1900, Karl Landsteiner discovered ABO blood group system, which became an important milestone in the history of blood transfusion followed by discovery of Rh (D) antigen.¹ Distribution of ABO and Rh (D) blood groups varies between populations and races. The studies of blood groups are important parameters in various genetic studies for reliable geographical information and in blood transfusion process with associated diseases, which will eventually help in reducing morbidity and mortality rate. Knowledge of blood

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grouping is also essential for effective management of blood bank inventory.\cite{1,2}

Subgroups of A have been further classified as A1, A2, Aint, A3, Ax, Am, Aend, Ael, and Abantu based on the reactivity of red cells with human anti-A and anti-AB. Group A red cells which react with both anti-A and anti-A1 are classified as A1. A1 constituted approximately 80% of entire A blood group population, and Group A cells which react with anti-A and not agglutinated with anti-A1 are designated as A2, making up of remaining 20%.\cite{3} Subgroup of B is very rare and occurs less frequently than subgroup of A and which are B3, Bx, Bm, and Bh.\cite{4}

The cause of Hemolytic Disease of the Fetus and Newborn was linked to the Rh blood group system by Levine and Stetson in the year 1940.\cite{5} The significant Rh antigens are referred to as D and related ones are C and E while anti-thetically related antigens are designated as c and e.\cite{6} Now, nearly 29 blood group systems and approximately 700 different types of blood group antigens were discovered so far but ABO and Rhesus are the most significant blood group systems.\cite{7} This system is also useful in different genetic studies, relation to certain diseases, different migration patterns of population as well as helps in resolving certain medicolegal issues, basically paternity dispute.\cite{8}

## Methods

The present retrospective study was carried out in the blood banks of H.N.B. Base Hospital, under Veer Chandra Singh Garhwali Government Medical Science and Research Institute, Srinagar, Uttarakhand, during the last 5 years from January 2012 to December 2016. Srinagar city is an important cultural and educational center of the Garhwal hilly region located in the foothills of the Sivalik Ranges of the Greater Himalayas. It is nearly 156 km away from its state capital, Dehradun, located on the left bank of river Alaknanda with an average elevation of 560 meters (1837 feet) above sea level.\cite{9,10}

Total numbers of 9883 individuals were considered medically fit for donating their blood. All individuals are more than 18 years in age. All blood collections had been taken either from voluntary donors at blood donation camps or as replacement donors at blood bank of the hospital. The blood samples were collected in vacutainer containing Ethylenediaminetetraacetic acid by the method of venepuncture. The tests were purely based on antigen-antibody agglutination test.

In ABO blood grouping (forward and reverse), monoclonal anti A, anti-A1, anti B, anti AB, anti H antisera, and A, B, O pooled cells are used. For Rh typing, anti-D (R0 and R1), anti IgM and blend of anti IgM and anti IgG antisera were used. Finally, blood groups were selected only when both forward and reverse groups are identical. Rh-negative blood groups were confirmed by anti-globulin technique and remaining all weak D groups were considered as Rh positive.

## Statistical analysis

Collected data were entered into Microsoft Excel and analyzed using Demo version. Descriptive statistical measures such as percentage and confidence interval were applied to identify relationship between the variables.

Allele frequencies were calculated under the assumption of Hardy–Weinberg equilibrium and the results were expressed as percentages, using the following equations:

\[
\rho = 1 - \sqrt{(B + O)}, \quad q = 1 - \sqrt{(A + O)}
\]

\[
r = \sqrt{O}, \quad E = 1 - q, \quad e = \sqrt{dd} \text{ where } p, q, r, E, \text{ and } e \text{ represents the frequencies of the genes for A, B, O, Rh +ve, and Rh −ve, respectively.}\cite{10}
\]

## Results

Observed and expected phenotype frequency patterns were found approximately same. Tables 1 and 2 shows that out of 9883 individuals of blood donors, majority were male individuals, i.e., 9133 (92.4%) and females were 750 (7.6%).

Maximum 58% blood donors were found to be in the age group of ≤30 years whereas 42% blood donors were in the age group >30 years. Blood group B was found highly prevalent (31.68%) followed by blood group A (30.39%), blood group O (26.24%), and AB (11.7%), respectively, i.e., B > A > O > AB [Figure 1]. The positive Rhesus factor was shown to be the most prevalent (93.51%) and negative Rhesus factor was found in 6.49% [Figure 2].

Table 3 shows distribution of blood donors according to rhesus phenotype. Rhesus-positive male pattern was found to be shown as B > A > O > AB, which is similar to overall ABO blood group pattern but female pattern was found to be B > O > A > AB. Prevalence of Rhesus negative patterns in male and female were found to be B > A = O > AB and A > O > B > AB, respectively.

### Table 1: Comparison of observed and expected phenotype frequency among blood donors

| Blood group system | Phenotype | Observed frequency | Genotype | Expected frequency |
|--------------------|-----------|--------------------|----------|-------------------|
| ABO                | A         | 0.3039             | AA       | 0.3038            |
|                    | B         | 0.3168             | BB       | 0.3147            |
|                    | O         | 0.2624             | OO       | 0.2623            |
| Rh                 | AB        | 0.1170             | AB       | 0.1189            |
|                    | D+        | 0.9351             | DD       | 0.9549            |
|                    | D−        | 0.0649             | dd       | 0.0649            |
The present study has calculated the allele frequency of ABO and Rh blood group by following Hardy–Weinberg equation as shown in Table 4. The calculated allele frequency was found to be 0.2403 for I_A, 0.2475 for I_B, and 0.5122 for I_O. In present study, Rhesus group allele frequencies for ID = 0.7452 and for I_d = 0.2548 were found.\cite{11-14}

Table 5 shows the variation in ABO blood group and Rhesus factor in Indian and International studies.\cite{15-26} The present study exhibits that A, AB, and Rh negative blood groups are having the highest prevalence of 30.39%, 11.70%, and 6.49% respectively which is comparatively higher than previous similar studies. Another blood group in the present study B is having last second lowest prevalence (31.68%) when compared among Indian studies but international studies were found second highest prevalence percentage. Next blood group O and Rhesus positive factor are having lowest prevalence of 26.24% and 93.51% when compared among Indian studies but in international comparison were found lowest and second highest position in prevalence percentage, respectively, for the year 2016 onward.

**Discussion**

There are large number of male donors compared to female donors; this has been observed in most of the studies in India being a developing nation. The main reasons behind it were lack of education, social taboo, cultural habits, lack of motivation, and fear of blood donation.\cite{27} A large section of female from the menstruating age groups were occasionally found anemic with low body weight, so they are considered unfit for donating blood and usually eliminated during the predonation screening and counseling. In this regard, the general health status of the female needs to be improved by providing proper nutritional diet and iron supplements. The fear regarding blood donation among Indian females needs to be driven out by educating them with the advantages of blood donations. Most of the older people suffer from hypertension, diabetes mellitus, low hemoglobin, and ischemic heart diseases and found unfit during predonation counseling.\cite{28} In present study, we found significantly higher contribution of female donors. This may be because of higher literacy rate among the females of Uttarakhand in comparison to rest of India as exhibited in Tables 2 and 3.

The phenotype and genotype frequencies of ABO and Rh groups vary widely across different races and geographical areas of the world. Few studies have been done across India to find the variation. The present study has also calculated the gene frequency of ABO and Rh blood group by following Hardy–Weinberg equation, and frequencies are shown in Table 4. The gene frequencies of ABO and Rh blood group found in

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**Table 2: Distribution ABO and Rh blood group systems with respect to gender**

| Blood group | Male (%) | Female (%) | Total (%) | 95% CI | Prevalence rate | 95% CI |
|-------------|----------|------------|-----------|--------|----------------|--------|
| A           | 2797 (30.6) | 206 (27.5) | 3003      | 29.5‑31.3 | 30.39          |
| B           | 2881 (31.5) | 250 (33.3) | 3131      | 31.8‑32.6 | 31.68          |
| AB          | 1079 (11.8) | 77 (10.3)  | 1156      | 11.1‑12.4 | 11.70          |
| O           | 2376 (26.0) | 217 (28.9) | 2593      | 25.4‑27.1 | 26.24          |
| Total       | 9133 (92.4) | 750 (7.6)  | 9883      | 10.0    | NA             |        |

**Rh negative**

| Blood group | Male (%) | Female (%) | Total (%) | 95% CI | Prevalence rate | 95% CI |
|-------------|----------|------------|-----------|--------|----------------|--------|
| Rh positive | 8542 (93.5) | 700 (93.3) | 9242      | 93.1‑93.9 | 93.51          |
| Rh negative | 591 (6.5) | 50 (6.7)   | 641       | 6.1‑6.9  | 6.49           | 06.1‑06.9 |

CI: Confidence interval
other four studies done by Raja et al., Suresh et al., Agrawal et al., and Sidhu et al. are shown in Table 4.[11-14] The actual distribution of ABO blood group did not differ significantly from the calculated gene frequencies in Table 1.

Distribution pattern of blood groups of the present study was compared with the recent studies done across India at Andhra Pradesh,[15] Jharkhand,[16] Delhi and Uttarakhand,[17] Madhya Pradesh,[18] Karnataka,[19] and Assam.[20] The present study revealed that the most common blood group was “B” and the least common was “AB” which is similar to result found in Jharkhand, Delhi, Uttarakhand, and Madhya Pradesh but differs from the other studies. In context to the recent international studies from African countries such as Ethiopia,[21] Uganda,[22] and Libiya,[23] from western Asian countries such as Iran,[24] and Iraq,[25] and from south Asian country Bangladesh,[26] the result of the present study is similar to the study of Bangladesh specifying blood group “B” as the most common and “AB” as the least prevailing blood group, but in rest of the countries, the frequency of blood group O is highest which differs from the present study. Rh negativity status was 6.49% which is relatively higher as compared to the recent other studies across India but least among all the foreign nations except Uganda as shown in Table 5.

**Table 3: Distribution of ABO blood group with Rhesus factors with respect to gender**

| Blood group | Cases (%) | Total cases | 95% CI Prevalence rate |
|-------------|------------|-------------|------------------------|
| A positive  | 2620 (28.7) | 189 (25.2) | 2809 28.42 27.5-29.3 |
| B positive  | 2702 (29.6) | 238 (31.7) | 2940 29.75 28.9-30.7 |
| AB positive | 1020 (11.2) | 71 (9.5)   | 1091 11.04 10.4-11.7 |
| O positive  | 2280 (25.1) | 202 (26.9) | 2402 24.30 23.5-25.2 |
| A negative  | 167 (1.9)   | 17 (2.3)   | 194 1.96 1.7-2.26   |
| B negative  | 179 (2.0)   | 12 (1.6)   | 191 1.93 1.7-2.22   |
| AB negative | 59 (0.6)    | 6 (0.8)    | 65 0.66 0.52-0.84   |
| O negative  | 176 (1.9)   | 15 (2.0)   | 191 1.93 1.7-2.22   |

CE: Confidence interval

**Table 4: ABO system and Rh phenotype allele distribution in different studies**

| Authors          | Year | I^A | I^B | I^O | I^D | I^d |
|------------------|------|-----|-----|-----|-----|-----|
| Present study    | 2017 | 0.2403 | 0.2475 | 0.5122 | 0.7452 | 0.2548 |
| Raja et al.[11]  | 2016 | 0.1844 | 0.2477 | 0.5679 | 0.7794 | 0.2206 |
| Suresh et al.[13] | 2015 | 0.1398 | 0.2148 | 0.6454 | 0.7321 | 0.2679 |
| Agrawal et al.[17] | 2014 | 0.1653 | 0.2254 | 0.6093 | 0.7679 | 0.2321 |
| Sidhu[19]         | 2003 | 0.1710 | 0.2700 | 0.5590 | 0.8360 | 0.1640 |

**Table 5: ABO and Rh phenotype comparison between national and international level studies for the year 2016 onwards**

| Author                | Sample size | A     | B     | AB   | O    | Blood group (%) |
|-----------------------|-------------|-------|-------|------|------|-----------------|
| Indian studies        |             |       |       |      |      |                 |
| Srinagar, Uttarakhand | Present study | 9883  | 30.39 | 31.68 | 26.24 | 11.70 | 93.51 | 6.49 |
| Andhra Pradesh[21]   | Bhavani et al. | 6942  | 20.00 | 35.80 | 36.90 | 7.30  | 96.28 | 3.72 |
| Jharkhand[16]         | Singh et al. | 2055  | 22.09 | 35.15 | 34.73 | 8.03  | 96.46 | 3.54 |
| Delhi[17]             | Kaur et al. | 15,446| 22.60 | 37.80 | 29.50 | 10.10 | 94.47 | 5.53 |
| Madhya Pradesh[18]    | Mehta and Mehta | 800   | 25.63 | 39.25 | 28.63 | 6.50  | 94.88 | 5.12 |
| Uttarakhand[17]       | Kaur et al. | 6350  | 23.40 | 35.60 | 29.50 | 11.40 | 94.55 | 5.45 |
| Karnataka[19]         | Anushree et al. | 1959 | 21.40 | 34.80 | 38.80 | 5.00  | 97.10 | 2.90 |
| Assam[20]             | Islam Barbhuiya et al. | 334   | 21.60 | 29.30 | 44.30 | 4.80  | 98.50 | 1.50 |
| International studies |             |       |       |      |      |                 |
| Ethiopia[21]          | Zeriun and Bekele | 6922  | 31.90 | 21.50 | 43.10 | 3.50  | 92.80 | 7.18 |
| Uganda[22]            | Apecu et al. | 23,504| 25.00 | 20.39 | 50.36 | 4.25  | 97.97 | 2.03 |
| Libiya[23]            | Saad        | 1306  | 31.17 | 23.43 | 37.44 | 8.96  | 83.92 | 16.07 |
| Iran[24]              | Torabizade Maatoghi et al. | 29,922| 28.48 | 24.71 | 40.21 | 6.60  | 92.38 | 7.62 |
| Iraq[25]              | Saleh and Abood | 1268 | 23.11 | 21.45 | 48.03 | 7.41  | 88.56 | 11.44 |
| Bangla Desh[26]       | Verma et al. | 937   | 26.57 | 34.15 | 29.67 | 9.61  | 90.82 | 9.18 |

**Conclusion**

The present study concludes that the most common blood group is “B” and “AB” is the least common among the donors in the region of Garhwal hills at Srinagar, Uttarakhand, India. Rh positive were 93.51% and Rh negative were 6.49%. Awareness about donation of blood has to be created in order to increase the number of female donors. The data obtained in our present study when read in context of several other studies of different regions of India and abroad may be useful in policy making and policy implementation to face the future health challenges.

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**Conflicts of interest**

There are no conflicts of interest.
References

1. Behra R, Joshi YR. Distribution of ABO blood group and RH (D) factor in Western Rajasthan. Natl J Med Res 2013;3:73-5.
2. Eweidah MH, Rahman S, Ali H, Dhas Al-Shamary AM. Distribution of ABO and Rhesus (RHD) blood groups in Al-Jouf province of the Saudi Arabia. Anthropologist 2011;13:99-2.
3. Blaney K, Howard P. Basic and Applied Concepts of Blood Banking and Transfusion Practices. 3rd ed. Mosby; Elsevier Inc.; 2013.
4. Sharma DC, Sunita R, Iyenger S, Jain B, Sao S. Prevalence and distribution of ABO and Rh-D antigens along with its subgroups & rare types in Greater Gwalior Region. Open J Blood Dis 2013;3:69-73.
5. Pourazarr A. Red cell antigens: Structure and function. Asian J Transfus Sci 2007;1:24-32.
6. Worlledge S, Ogiemudia SE, Thomas CO, Ikoku BN, Luzzatto L. Blood group antigens and antibodies in Nigeria. Ann Trop Med Parasitol 1974;68:249-64.
7. Gadwalkar S, Kumar NS, Ravidhar. Distribution of blood groups in and around Bellary, Karnataka. Indian J Clin Pract 2008;24:247-50.
8. Negi SS. A Historical township. In: Souvenir of 20th Convention of Indian Association of Sedimentologist. Srinagar; 2003. p. 1-29.
9. Census of India 2001: Data from the 2001 Census, Including Cities, Villages and Towns (Provisional). Census Commission of India. Archived from the Original; 2004. Available from: https://en.wikipedia.org/wiki/Census_town. [Last retrieved on 2008 Dec 01].
10. Sutton HE. An Introduction to Human Genetics. 3rd ed. Philadelphia USA: Saunders College; 1980. p. 592.
11. Raja KA, Dobariya GH, Unagar CA, Pandya AN, Patel JN, Wadhwani SJ. Frequency and distribution of ABO and Rh blood groups among blood donors in tertiary care hospital of South Gujarat, India. Int J Res Med Sci 2016;4:5377-81.
12. Suresh B, Sreedhar Babu KV, Chandra Mouli P, Arun R, Jothbai DS. Distribution of ABO and rhesus (D) blood group antigens among blood donors at a tertiary care teaching hospital blood bank in South India. J Clin Res Sci 2015;4:129-35.
13. Agrawal A, Tiwari AK, Mehta N, Bhattacharya P, Wankhede R, Tulsiani S, et al. ABO and Rh (D) group distribution and gene frequency; the first multicentric study in India. Asian J Transfus Sci 2014;8:121-5.
14. Sidhu S. Distribution of the ABO groups and Rh (D) factor among the scheduled caste population of Punjab Anthropopol 2003;5:203-4.
15. Bhavani C, Sujeve Swapna R, Neeraja M, Sravani P, Chaitanya B. Distribution of ABO blood groups and Rh (D) factor in and around Anapatpuram, Andhra Pradesh. Int J Med Res Rev 2016;4:372-5.
16. Singh A, Srivastava RK, Deogharsha KS, Singh KK. Distribution of ABO and Rh types in voluntary blood donors in Jharkhand area as a study conducted by RIMS, Ranchi. J Family Med Prim Care 2016;5:631-6.
17. Kaur D, Doda V, Kandwal M, Parmar I. ABO Rh (D) blood group distribution among whole blood donors at two different setups of tertiary care hospitals in North India. Int J Community Med Public Health 2016;3:2806-11.
18. Mehta AA, Mehta AA. Frequency distribution of ABO blood group and Rh factor in Bhanpur. Bhopal Sch Acad J Biosci 2016;4:106-9.
19. Anushree CN, Sujatha R, Patil SB, Jaya Prakash HT. Distribution pattern of ABO grouping and Rhesus typing among blood donors: A study from a tertiary care teaching hospital blood bank of Dr. BR Ambedkar Medical College, Bangalore. Indian J Pathol Oncol 2017;48:11.
20. Islam Barbhuiya FG, Rahman M, Ahmed SA. Frequency and distribution of ABO and R(h) blood groups among the Bengali Muslims of Cachar District of Assam, India. Asian J Multidiscip Stud 2016;4:2017-20.
21. Zerihun T, Bekele S. Pattern of ABO and rhesus blood groups distribution of five years survey in Jimma Town Blood Bank, South West Ethiopia. J Health Educ Res Dev 2016;4:2-4.
22. Apecu RO, Mulogo EM, Bagenda F, Byamungu A. ABO and Rhesus (D) blood group distribution among blood donors in rural South Western Uganda: A retrospective study. BMC Res Notes 2016;9:513.
23. Saad KA. Distribution of ABO blood groups and resus factor (RH) in ALBIYDA/LIBYA. J Med Dent Sci Res 2016;3:28-31.
24. Torabizade Maatoghi J, Paridar M, Mahmodian Shoushtari M, Kiani B, Nori B, et al. Distribution of ABO blood groups and rhesus factor in a Large Scale Study of different cities and ethnicities in Khuzestan province, Iran. Egyp J Med Hum Genet 2016;17:105-9.
25. Saleh SM, Aboud AS. ABO and Rh (D) blood groups’ distribution and gene frequencies in North Baghdad population – Iraq. Int J Sci Eng Res 2016;7:2-4.
26. Verma M, Prabhakar S, Daihiya B. An examination of distribution patterns of ABO and Rh-D blood group among the population of Chittagong city corporation area in Chittagong city of Bangladesh. World Acad J Community Health Epidemiol 2016;2:44-8.
27. Swamy CM, Basavaraj PB, Kavitha GU, Shashikala P. Prevalence of ABO and Rhesus blood group among blood donors. Indian J Public Health Res Dev 2012;3:106-9.
28. Deshpande RH, Wadde SK. Distribution of blood groups in blood donors in blood banks of Latur. Sch J Appl Med Sci 2013;1:276-9.