ABO blood group and Rh factor distribution in population of Bhopal, Madhya Pradesh

**ABSTRACT**

Blood group system was disclosed by Karl Landsteiner, the ABO blood group system is the most vital blood group system in Transfusion Medicine. The blood group systems are also relevant in population genetic studies, researching population migration patterns as well as in solving certain medico-legal issues. This study will be carried out with an objective to provide data regarding gene frequency and distribution of ABO and RH blood groups in the population of Bhopal, Madhya Pradesh, India. Blood samples will be collected from willing individuals of Bhopal (M.P.) 180 blood samples are required for this study. Before blood sample collection we take written consent of subjects and short questionnaire based on such as an address, age, any type of diseases, medical history and sex. After blood sample collection the samples will analyze for blood group ABO and Rh factor by slide agglutination method by using Anti-A, Anti- B, Anti-D per ABO blood grouping.

**Keywords** — Transfusion medicine, Medico-legal issues and Agglutination

1. INTRODUCTION

The ABO blood group was the first human blood group disclosed in 1901 by Landsteiner followed by Rh blood group in 1941 (1, 2). In 1930, Landsteiner received the Nobel Prize in physiology and medicine for his work. At present furthermore, 30 blood groups have been described by the International Society of Blood Transfusion of which only ABO and Rh blood groups remain clinically most important (3, 4). The ABO blood grouping system consists of the A, B, and H carbohydrate antigens and antibodies against these antigens, while that of Rh is posed of D antigen (5). Therefore ABO blood grouping is based on the existence or non existence of A and B antigens on the covering of red blood cells (RBCs) and Rh grouping is based on the D antigen existence or non existence on the RBC surface (6,7). The blood group antigens are poised of genetically controlled glycoprotein and glycolipids (7). All blood group systems are inherited and mutual by all human populations but the frequency alters. Those alterations depend on the allele’s distribution, the mating system of a population, ethnic group, and race (8, 9, 10).

During the Second World War, blood and blood component transfusion has been used to correct severe anaemia, deficiency of plasma clotting factors, thrombocytopenia, immuno deficiency states, hypoalbuminaemia, and problems related to electrolytes (11, 12). Transfusion of compatible blood at least for ABO and Rh antigens reduces transfusion reaction in recipients. The ABO and Rh blood groups are also useful in clinical studies, population genetic studies, and researching population migration patterns as well as resolving certain medico-legal issues, particularly of disputed paternity cases (13). Therefore Science of the ABO and Rh blood group distribution in specific population has paramount importance in the context of transfusion medicine. Some previous studies in sub-Saharan Africa reported that blood group O and Rh + are the most frequent ABO and Rh blood groups, respectively, but the proportion varies by location (14, 15, 16, and 17).

Several researchers have been worked on the association of ABO and Rh blood groups with genetic and infectious diseases (9). Previous studies on patients of cancer and tumor (18), heart diseases (19), and parasitic and viral infections (20) indicated associations of ABO and Rh blood groups. In particular, the ABO antigens regulate cellular activities suggesting their impact on determining susceptibility and severity of certain diseases (21). It has been more than four decades since the association of ABO blood group and malaria was suggested. There is also a hypothesis that Plasmodium falciparum (P. falciparum) malaria has shaped the distribution of ABO blood groups in humans (22). Otajevwo (16) and Singh et al. (23) reported a significant
The ABO blood group is the most significant blood factor in clinical applications encompassing blood transfusions. Perception of the significance of the ABO blood group is not restricted to clinical applications; however, with present capabilities to rapidly sequence genes, the ABO blood group is also proving to be a valuable asset for determining human migration patterns and origins (27). ABO blood types are determined by cell surface markers that are characterized by a protein or lipid, which has an extension of a particular arrangement of sugars that determines each of the blood types A, B, and O as shown in figure (1) (28). Each type is identical, except that types A and B have an additional sugar: N-acetyl galactosamine (C6H15NO6) for A, and galactose (C6H12O6) for B. These sugar arrangements are part of an antigen capable of stimulating the immune system response that produces antibodies. The gene which is responsible for the specification of antigens A or B or type O located on the long arm of the ninth human chromosome (9q34.1) (29), and that of the Rh-D on chromosome one (1p34–p36) (30). An enzyme, glycosyltransferase, is the product of ABO gene, and differences in the sequence of DNA of this gene leads to enzyme polymorphisms and determine whether the enzyme attaches N-acetyl-galactosamine (Ag-A), galactose (Ag-B), or no sugar (type O).

**Fig. 1: ABO antigen. The ABO antigens differ by just one sugar at the antigen terminus. Only the carbohydrate portion of the antigen is illustrated.**

These differences are few, but not trivial. A single DNA deletion in the A-specific allele gives rise to in a truncated version of the glycosyl transferase gene product, get rid of enzymatic activity and effectively resulting in blood type O, so a type O in-individual has both alleles for the inactive glycosyl transferase (28). Almost always, an individual has the same blood group, but very infrequently, a person’s blood type changes through addition and/or suppression of an antigen, e.g. in malignancy (31) or in autoimmune diseases (32). Due to the ease of identifying their phenotypes, ABO blood groups have been used as genetic markers of populations since the differences in ABO blood groups exist, both within and among ethnicities (33), (34), and even in different areas within the small country (35).

### 2. MATERIAL AND METHODS

For the present study, the data were collected from willingly individuals of Bhopal (M.P.) total of 180 samples were collected and analyzed for ABO and Rh factor blood group system. All the necessary precautions were taken for random sampling. Three drops of the blood sample were collected by finger pricking method after the written consent of the subject, on a sterile slide. The samples were analyzed for blood group ABO and test was processed by using Anti-A, Anti- B, Anti-H per ABO and Rh factor blood grouping.

### 3. RESULTS

A total of 180 blood donors participated in the study. 103 (57.222%) were male and 77 (42.777%) were female. Donors with previously reported for malaria, chikungunya and dengue history account 6 (3.33%), 1 (0.925%) and 2 (1.11%). The most frequent ABO blood group was B positive 66 (36.66%) followed by O positive 51 (28.333%), A positive 34 (18.88%), and AB positive 24 (13.333%). The least frequent blood group was A negative 0 (0%) followed by B negative 2 (1.111%), O negative 2 (1.111%) and AB negative 1 (0.55%). Most of the blood donors are 175 (97.222%) were Rh positive while only 5 (2.777%) were Rh negative.

<p>| Table 1: Clinical history of blood donors. |</p>
<table>
<thead>
<tr>
<th>S no.</th>
<th>Variables</th>
<th>Numbers (n)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sex</td>
<td>Males</td>
<td>103</td>
<td>57.222</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>77</td>
<td>42.777</td>
</tr>
<tr>
<td>2. Previous Malaria, Chickengunia and Dengue infections</td>
<td>Malaria</td>
<td>6</td>
<td>3.333</td>
</tr>
<tr>
<td></td>
<td>Chickengunia</td>
<td>1</td>
<td>0.555</td>
</tr>
</tbody>
</table>
Calculation of allelic frequency were based on Hardy Weinberg equilibrium law that says that at equilibrium \((p + q + r)^2 = p^2 + q^2 + r^2 + 2pq + 2pr + 2qr = 1\), where \(p^2\) is the probability of \(I^A I^A\) and \(2pr\) is the probability of \(I^A i\) (thus probability of type \(A = p^2 + 2qr\), \(q^2\) is the probability of \(I^B I^B\) and \(2qr\) is the probability of \(I^B i\) (thus probability of type \(B = q^2 + 2qr\), \(r^2\) is the probability of \(ii\) (thus probability of type \(O = r^2\)) and \(2pq\) is the probability of \(IAIB\) (thus probability of type \(AB = 2pq\)).

### 3.1 Preliminary estimates were calculated manually as (36)

\[
P = 1 - \sqrt{B + O}, \quad q = 1 - \sqrt{A + O}, \quad r = \sqrt{O}
\]

\(p, q, r\) denote allele frequencies and \(A, B, O\) denote observed frequencies of blood group \(A, B\) and \(O\).

### 3.2 Calculation of allelic frequencies

Let \(p\) represent the frequency of \(I^A\)

\(q\) represent the frequency of \(I^B\)

And \(r\) represents the frequency of \(I^O\)

For \(O\) allele frequency (\(r\))

\[r^2 = \text{frequency of the O phenotype}
\]

\[r = \sqrt{0.2944}
\]

\[r = 0.5425\]

For \(A\) allele frequency (\(p\))

\[(p + r)^2 = 0.1888 + 0.5425
\]

\[p + r = \sqrt{0.1888 + 0.5425} = \sqrt{0.7771}
\]

\[p = 0.9884
\]

\[p = 0.9884 - 0.5425 = 0.4459
\]

\[p = 0.4459\]

For \(B\) allele frequency (\(q\))

\[q + r = \sqrt{0.3777 + 0.5425}
\]

\[q = \sqrt{1.1570} = 1.0756
\]

\[q = 1.0756 - 0.5425
\]

\[q = 0.5331\]

Calculation of \(D\) allele frequency \(I^O\) (\(v\))

\[u + v = 1
\]

\[v = 1 - u
\]

\[u = 0.0111
\]

\[v = 1 - 0.0111 = 0.9889
\]

\[v = 0.9889\]

Calculation of genotype frequency

\[AA = p^2 = (0.4452)^2 = 0.1982
\]

\[AO = 2pr = 2 \times 0.4452 \times 0.5425 = 0.4830
\]

\[BB = q^2 = (0.5331)^2 = 0.2841
\]

\[BO = 2qr = 2 \times 0.5331 \times 0.5425 = 0.5784
\]

\[OO = r^2 = (0.5425)^2 = 0.2943
\]

\[AB = 2pq = 2 \times 0.4452 \times 0.5331 = 0.4746
\]

\[dd = u^2 = (0.0111)^2 = 0.0001
\]

\[Dd = 2uv = 2 \times 0.0111 \times 0.9889 = 0.021
\]

\[DD = v^2 = (0.9889)^2 = 0.9779
\]

The calculated gene frequencies are 0.4459 for \(I^A\) (\(p\)), 0.5331 for \(I^B\) (\(q\)) and 0.5425 for \(I^O\). From studied population \(O\) (\(r\)) recorded the maximum frequency followed by \(B\) (\(q\)) and \(A\) (\(p\)).

### 4. DISCUSSION

The present study on ABO and Rh frequency among people in Bhopal included 180 and we reported that predominance of blood group \(B\) and allele \(O\). Pioneer substance of ABO blood group is antigen \(H\), present on the surface of the red blood cell membrane.
and most of the epithelial and endothelial cells. The allele codes for an enzyme that adds an N-acetyl galactosamine to the H antigen. The B allele which differs from the former by four amino acid changes, codes for an enzyme that add a D-galactose. The allele occurs most frequently in modern humans and carries a human specific inactivating mutation which produces a non-functional enzyme and thus the H antigen remains with further modifications on the surface of the cells. (37)

Results of ABO blood group distribution among people of Bhopal were close to studies from Northern India, Rajasthan, neighbouring Pakistan and Bangladesh with B group predominance but O group followed closely behind. We can say that in these areas B ≥ O>A>AB [Table 2].

Table 2: ABO and Rh phenotype among blood donors of Bhopal

<table>
<thead>
<tr>
<th>S no.</th>
<th>Blood Group</th>
<th>Rh +ve Frequency (%)</th>
<th>Rh - ve Frequency (%)</th>
<th>Total Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>34</td>
<td>18.88</td>
<td>34</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td>66</td>
<td>36.66</td>
<td>68</td>
</tr>
<tr>
<td>3</td>
<td>O</td>
<td>51</td>
<td>28.33</td>
<td>53</td>
</tr>
<tr>
<td>4</td>
<td>AB</td>
<td>24</td>
<td>13.33</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>175</td>
<td>97.2</td>
<td>180</td>
</tr>
</tbody>
</table>

Behra and Rajshre (2013) also showed that blood group B predominance from central India. Kruti A (2016) also reported similar results in Gujrat population which shows B (34.43%) followed by O (32.26%), A (24.35%) and the least prevalent blood group was AB (8.94%). Gautam et al (2012) also reported similar results the frequency of B blood group is highest with percentile frequency of 0.361 and lowest AB blood group with percentile frequency of 0.095 in Sagar district of Madhya Pradesh.

When data across the world is compared blood group distribution frequencies for A, B, O and AB blood group vary among different parts of the world (Table 3). Although blood group B is the most common blood group in the present study, allele B is the least common allele among the world population with only 22% prevalence. Blood group B has its highest frequency in northern India and central Asia. Comparison of results of the present study with that of some other populations is shown in Table 3. Blood group O is the most common phenotype globally with parts of Africa and Australia showing highest frequency. Blood group A is most common in northern and central Europe.

Table 3: Distribution of ABO phenotype in different parts of India and Neighbouring Countries.

<table>
<thead>
<tr>
<th>Study</th>
<th>A (%)</th>
<th>B (%)</th>
<th>O (%)</th>
<th>AB (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present Study</td>
<td>18.88</td>
<td>37.77</td>
<td>29.44</td>
<td>13.88</td>
</tr>
<tr>
<td>Sagar (M.P) (39)</td>
<td>21.9</td>
<td>36.1</td>
<td>32.5</td>
<td>9.5</td>
</tr>
<tr>
<td>Bangalore (40)</td>
<td>23.85</td>
<td>29.95</td>
<td>39.81</td>
<td>6.37</td>
</tr>
<tr>
<td>Kashmir (41)</td>
<td>22.95</td>
<td>32.05</td>
<td>38.43</td>
<td>6.55</td>
</tr>
<tr>
<td>Rajasthan (42)</td>
<td>22.2</td>
<td>36.4</td>
<td>31.7</td>
<td>9.4</td>
</tr>
<tr>
<td>South India (43)</td>
<td>25.74%</td>
<td>27.86%</td>
<td>39.76%</td>
<td>6.64%</td>
</tr>
<tr>
<td>North (Lucknow) (44)</td>
<td>21.38</td>
<td>39.92</td>
<td>29.27</td>
<td>9.43</td>
</tr>
<tr>
<td>Uttarakhand (45)</td>
<td>28.70</td>
<td>32.70</td>
<td>28.70</td>
<td>10.53</td>
</tr>
<tr>
<td>Western Ahmedabad (46)</td>
<td>21.94</td>
<td>39.40</td>
<td>30.79</td>
<td>7.86</td>
</tr>
<tr>
<td>Eastern Ahmedabad (47)</td>
<td>23.30</td>
<td>35.50</td>
<td>32.50</td>
<td>8.80</td>
</tr>
<tr>
<td>Maharstra (Loni) (48)</td>
<td>28.38</td>
<td>31.89</td>
<td>30.99</td>
<td>8.72</td>
</tr>
<tr>
<td>Neighbouring countries</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bangladesh (49)</td>
<td>23.51</td>
<td>39.8</td>
<td>27.6</td>
<td>9.2</td>
</tr>
<tr>
<td>Pakistan (50)</td>
<td>21.20</td>
<td>36.16</td>
<td>34.14</td>
<td>9.05</td>
</tr>
<tr>
<td>Nepal (51)</td>
<td>34.00%</td>
<td>29.00%</td>
<td>32.50%</td>
<td>4.4%</td>
</tr>
</tbody>
</table>

Fig. 1: Representation of ABO and Rh factor distribution in Bhopal population
5. CONCLUSION
We conclude that blood group B positive 66 (36.66%) is most frequent blood group in Bhopal population followed by O positive 51 (28.333%), A positive 34 (18.88%), and AB positive 24 (13.333%). The least frequent blood group was A negative 0 (0%) followed by B negative 2 (1.111%), O negative 2 (1.111%) and AB negative 1(0.55%). Most of the blood donors are 175 (97.222%) were Rh positive while only 5 (2.777%) were Rh negative.

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