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Frequency of ABO blood groups and RH factor: a case study

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Abstract

A random case study was carried out from February, 2018 to January, 2019 to see the different frequencies of blood group among different people regardless the community and age group in Assam and Arunachal Pradesh of N.E. India including the students coming from different places of the two states for the INSPIRE Science Camp in Arunachal University of Studies organized in 1-5 February, 2018 sponsored by Department of Science & Technology (DST). A scientific procedure was followed for detecting the blood group accurately which includes the primary data of this study; on the other hand secondary data were collected by interview process of the people who already had a medical test for blood group. A total of 2410 data (individuals) were considered and in the study O blood group was found to be dominant (45.23%) and AB blood group was the least common one (7.05%). On the other hand in case of Rh factor, positive blood group was quite common (96.68%) and negative was found very rare (3.32%). These showed that the frequency of blood groups were different in from each other causing the biodiversity in gene level i.e. blood group polymorphism occurs as a case of natural selection.

Keywords: *biodiversity, blood group, dominant, natural selection, Rh factor.*

Introduction:

Human blood groups are interesting subject of study in Human Genetics which shows multiple allelesim thereby showing polymorphisms. Polymorphism is a natural occurrence which is related to biodiversity, genetic variation and adaptation (Dobzhansky and Theodosius, 1970). The ABO blood group system is the most common blood group system in human being and the blood groups are named after some natural antigens present on the RBC's surfaces. It was the first reported and studied genetic polymorphism in human being. In various circumstances a person needs to receive blood from other persons for which proper identification of blood group of both the recipient and donor are needed to avoid agglutination reaction. Blood transfusions were first attempted around 1600 by transfusing animal blood into humans which proved disastrous but Karl Landsteiner in 1900, at the University of Vienna discovered why some blood transfusions were successful while others could be deadly. He discovered the ABO blood group system by mixing the red cells and serum of each of his staff and demonstrated that the serum of some people agglutinated the red cells of other (Landsteiner and Wiener 1940). From these early experiments, Landsteiner identified three types, called A, B and C (C was later to be re-named O for the German "Ohne", meaning "without", or "Zero", "null" in English). The fourth less frequent blood group AB, was discovered a year later. Landsteiner received the Nobel Prize in 1930 in physiology and medicine for his work.

ISSN 22772723 (P) 22772726 (O)

There is a history of severe blood transfusion reaction showing agglutination due to mismatched blood regarding Rh factor in which negative woman was transfused with positive blood after she gave birth to stillborn child suffered in erythroblastosis fetalis (Levine and Stetson, 1939). The Rh factor (D antigen) was 1st isolated in 1940 by Karl Landsteiner and his student Wiener in the blood of Rhesus monkey and so it is known as Rhesus factor (Rh factor). The parson carrying the Rh factor or RhD antigen is called RhD positive (Rh $^{+ve}$ or simply positive) and who does not carry it is called Rh D negative (Rh^{-ve} or simply negative). Incompatibilities of blood groups transfusion lead to the agglutination of RBC, which also crack and its contents leak out in the body. The red blood cells contain hemoglobin which becomes toxic when outside the cell. This can have fatal consequences for the patient. The incompatibility of Rh factor may lead to HDN (Hemolytic Disease of Newborn), resulting in severe anemia or death of child before or after birth.

Materials and Methods:

The primary data (blood samples) were collected from different peoples of different religions, including the students from different schools of Arunachal Pradesh and Assam coming for the INSPIRE Science Camp in Arunachal University of Studies organized in 1-5 February, 2018 sponsored by Department of Science & Technology (DST), Ministry of Science & Technology, GOI. The secondary data were collected by interview process in different parts of Assam and Arunachal Pradesh. The study period was from February, 2018 to January, 2019.

Materials required were:

a. Monoclonal Antibodies (Anti-A, Anti-B and Anti-D), b. Ice tray, c. Blood Lancet, d. Alcohol swabs,
e. Tooth picks f. sterile cotton balls and g. clean glass slides and h. microscope.

The procedure (steps) followed was as follows:

a. Keep ready the monoclonal antibodies on an Ice tray.
b. With a glass marker mark on the three depressions of a glass as A, B and D respectively
c. Using alcohol swab rub at the finger tip (preferably left ring finger)
d. With sterilized Lancet prick the finger tip
e. Make a drop of blood fall on the three depressions of glass slide marked as A, B and D respectively.
f. Use a cotton ball at the tip of finger to stop blood flow.
g. Put a drop of Anti-A (blue) on the slide marked as A and mix it with a separate tooth picks
h. Put a drop of Anti-B (yellow) on the slide marked as B and mix it with a separate tooth picks
i. Put a drop of Anti-D (colorless) on the slide marked as D and mix it with a separate tooth picks
j. Wait for a few minutes to observe the result under a microscope.

Observation and conclusion drown were:

1. If blood clumps in the spot marked as A = blood group will be "A"
2. If blood clumps in the spot marked as B = blood group will be "B"
3. If blood clump both in the spots marked as A and B= blood group will be "AB"
4. If no blood clump both in the spots marked as A and B = blood group will be "O"
5. If blood clumps in the spot marked as D = Rh will be "+ve"
6. If no blood clump in the spot marked as D = Rh will be "–ve"

ISSN 22772723 (P) 22772726 (O)

The principle behind the result is that same type of antibody and antigen can't exist together, if come in contact the agglutination or clumping occurs. So A blood group can't donate blood to B or O but to its own type and AB (as it has no antigen on the RBC's surface to fight against, so called universal recipient); O have no antigen on the RBC's surface so can donate blood to all the blood groups, but can't receive blood from other types except its own type (as it has both the antibody in his plasma), so this type is universal donor (Table1)

Table1: Types of human blood groups.

Sl. No.	Blood groups (phenotype)	Antigen present on R.B.C.s surfaces	Antibodies present in plasma	Can give blood to groups	Can receive blood from	Genotype
1.	O	None	Anti- A and Anti- B	O, A, B, AB	O	I^OI^O
2.	A	A	Anti- B	A, AB	O, A	$I^A I^A$ or I^AI^O
3.	B	B	Anti- A	B, AB	O, B	I^BI^B or I^BI^O
4.	AB	AB	None	AB	O, A, B, AB	$I^A I^B$

It is an example of multiple allele inheritance concerning three alleles – I^A, I^B and I^O located on the chromosome no. 9. So the A blood group has two possible combinations of genes or genotypes of $I^A I^O$ or $I^A I^A$; the B blood group has two possible combinations of $I^B I^O$ or $I^B I^B$; AB has only one combination of I^AI^B, whereas O has also one combination of $I^O I^O$, which indicate that A and B blood groups are co-dominant and O is recessive to both of A and B (Table 1). If we know the blood groups of the parents then the probable blood group of their children can be detected easily (Table 2), which is also helpful for solving the paternal dispute.

Table 2: Blood groups parents and the probable blood group of their children

Sl. No.	Blood groups of parents	Possible blood groups of children
1.	A & A	A & O
2.	A & B	A, B, AB & O
3.	A & AB	A, B & AB
4.	A & O	A & O
5.	B &B	B & O
6.	B &AB	A, B & AB
7.	B & O	B & O
8.	AB &AB	A, B & AB
9.	AB&O	A & B
10.	O & O	O

Results and Discussion:

Study on 2410 individuals gave the frequency of different blood groups- O>A>B>AB=45.23%>25.73%>21.99%>7.05% (Figure 1.a and 1.b). Thus, the O blood group is the most common blood group having 45.23%> and AB blood group is the least common blood group with 7.05% (Table 3 and Figure 2. a, b & c). Similar types of findings (except the A blood group was dominated by B) were recorded in the study of Periyavan *et. al.,* (2010) and Agrawal *et. al.,* (2014) conducted in various regions of India.

ISSN 22772723 (P) 22772726 (O)

Table 3: Percentage of people with different blood groups

Sl. No.	Blood groups	No. of individuals and %
1.	O	1090=45.23%
2.	A	620=25.73%
3.	B	530=21.99%
4.	AB	170=7.05%
5.	Rh + ve	2330=96.68%
6.	Rh - ve	80=3.32%

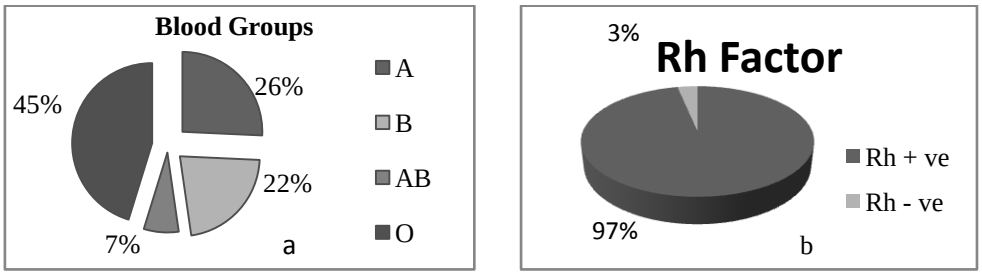

Figure 1. a and b showing blood group and Rh factor frequencies

According to Ford (1940), "Genetic polymorphism is the simultaneous occurrence in the same locality of two or more discontinuous forms in such proportions that the rarest of them cannot be maintained just by recurrent mutation or immigration".

Figure 2. a, b & c: Blood Group testing in the INSPIRE Science Camp in Arunachal University of Studies organized in 1-5 February, 2018 (sponsored by DST, Ministry of Science & Technology, GOI.)

The natural selection is a process that is responsible for elimination of the bad allele from a population, but the natural selection never eliminated the different blood groups polymorphisms from human populations and the reason was discussed by various researchers after the disease statistics. As for instances, there are various degrees in susceptibility of disease cholera caused by the *Vibrio cholerae* by the four different blood groups are: O is most susceptible, AB is most resistant, A is more resistant than B (Harris *et. al.,* 2005). Although O group have a greater life expectancy than other three types of blood groups, but highly prone to *Helicobacter pylori* causing the disease peptic ulcers (Aird *et. al.,* 1954 and Clarke *et. al.*, 1955). According to Bjorkholm *et. al.,* (2001) it has established colonies in the stomachs of approximately one –half the world's population. According to Rosenberg *et. al.* (1983) there is significant risk factor for myocardial infarction of A group in women younger than 50 years. According to the survey of Shimizu *et. al.* (2004) the percentage of ABO blood group in people older than 100 years living in Tokyo were A =34.2%, B =29.4%, O =28.3 and AB=8.2%.

The negative blood group is very rare with comprising only 3.20% of the total samples (Table 3). All over the world the negative blood group is reported in very less frequencies which

ISSN 22772723 (P) 22772726 (O)

may be due to RHD deletion or alternation. A female with negative blood group has disadvantage if she marries a person with positive blood group as the positive blood group fetus can develop the HDN, but modern medicine developed the preventive strategy to cope up with the disorder of mismatch blood groups. A number of studies have been done by various researchers to understand the reason of this polymorphism *i.e.* Novotna and Havlicek *et. al.,* (2008) studied on *Toxoplasma* and reaction time: role of toxoplasmosis in the region, preservation and geographical distribution of Rh blood group polymorphism and demonstrated that heterozygous men were protected against infection with the common protozoan parasite *Toxoplasma gondii*. Their results suggest that the balancing selection favoring heterozygotes could explain the origin and stability of the RhD polymorphism. Flegr (2007, 2013) and Flegr *et. al.,* (1994, 2002) studied extensively on *Toxoplasma* and its affect on human behavior, personality, hormonal effect etc.

Conclusion:

The genetic frequencies of ABO blood group and Rh factor within different populations may vary; but they remain constant from generation to generation within population due to the fact that none of the alleles- I^A, I^B and I^O for these blood groups has a selective advantage over the other which results a balanced selection. A combination of selection against infectious diseases (*e.g.* plague and smallpox) and genetic drift and founder effects in small populations may ultimately explain the allele frequencies observed today. Besides blood transfusion, the blood groups have an important application in solving paternal dispute and have many forensic applications. For common people blood group concept is a very famous and peculiar one, as in every document the blood group must be mentioned and there are very low frequencies of peoples are found in societies who don't know their blood groups.

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