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Distribution of the ABO Blood Group and Rhesus Factor among Cuttington University Undergraduate Students

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Abstract: ***Karl Landsteiner made a very vibrant discovery in blood transfusion in the early twentieth century. He showed that when you are cross-testing one blood sample with another, some samples would mix successfully without visual signs of feedback, on the other hand, others would react strongly, causing agglutination. He observed that the agglutination was due to the existence of an antigen on the red cells and an antibody in the serum, thus, the ABO blood group was introduced. The basic blood groups of ABO system are, A, B, AB, and O. In this study, we investigated the prevalence of ABO Blood Group System amongst Cutting ton University Undergraduate Students. Using the blood from a prick on the finger of each student along with the ABO reagents, we determined each student`s blood type along with their respective Rh factor. The genotypic frequencies of the blood types we also calculated in percentages and decimal points. The result shows that the O blood type is the most prevalent, followed by B, A and AB (i.e. O > B > A > AB). We further predicted the population's genotypic frequencies using its allele frequencies in line with Hardy–Weinberg Principle. The result shows that, $ii>I^Bi>I^Ai>I^AI^B>I^BI^B>I^AI^A$ (ie. OO>BO>AO>AB>BB>AA) in a population of 321 undergraduate students. The data further revealed that the Rh factor accounted for 98.8% Rh(+) and 1.2% Rh(-).***

Keywords: ABO Blood group, Hardy–Weinberg principle, Rh factor, Genotype, Phenotype

1. Introduction

One of the most important fluids in the human body, which aids in the circulation of nutrients, oxygen, hormones and enzymes, is blood. Even though there is one blood with the same functions in humans, there are different blood group systems. One of them is the ABO blood group system, which has three carbohydrate antigens known as A, B, and O. The O antigen sequence is terminal disaccharide Fucα1-2Galβ-, A is terminal trisaccharide N-acetylgalactosamine (GalNAc)α1-3[Fucα1-2]Galβ-, and B is terminal tri- saccharide Galα1-3[Fucα1-2]Galβ-. The O gene encodes an inactive enzyme, while A and B genes code A and B glycosyltransferases respectively[1]. They are determined by the presence or absence of certain antigens (substances that can trigger an immune response if they are foreign to the body)on the surface of red blood cells[2].

Since some antigens can trigger a patient's immune system to attack the transfused blood, safe blood transfusions depend on careful cross-matching and accurate blood typing which aids in the reduction of intravascular hemolysis [3]. About 19 blood group systems with more than 200 antigens have been discovered in the human body, among which is the ABO blood group[4].

In 1900, Physician Karl Landsteiner first described the ABO blood group, and it is now serving as the beginning of blood banking and transfusion medicine along with the Rhesus factor system (recognized in 1939)[5]. During blood transfusion, the isoantibodies must be taken into consideration. Individuals with blood group O and B have anti-A isoantibodies, O and A individuals have anti-B isoantibodies, while O individuals have both anti-A and anti-B isoantibodies. On the other hand, individuals with blood group AB do not have anti-A and anti-B isoantibodies[1].

The ABO blood group accounts for four different blood types (A,B,AB, and O) which can be determined by the presence of antigens on their surfaces and agglutinins[6]. The Rh factor when tested for, along with each blood type, can be positive (+ve) or negative (-ve), thus, accounting for the 8 most common blood types (A+, A-, B+, B-, O+, O-, AB+, AB-)[7]. The ABO blood group is followed by the Rhesus blood group system, which is linked to the haemolytic disease of the newborn. It has alleles 'D' and 'd' and can be located on the short arm of chromosome one.

Genetically, the blood types can be read from a phenotypic point as (A, B, AB and O) and from a genotypic point as (AA=A, AO=A, BB=B, BO=B, AB=AB and OO=O). The genotypic reading shows that blood type O is recessive while A and B alliles are co-dominant. At the same time, all non-O blood types are dominant to O[8].

It has been reported that blood group O (a genetically recessive trait) is the most prevalent among the different ABO blood types, followed by A, B, and AB. Unlike the blood types A, B, and AB, which are known to be heterozygous or homozygous dominant, individuals with blood type O have basic resistance to few disorders or infections as well as some high motility or severe disease conditions[3][4].

Generally, diseases like malaria, smallpox, virus, influenza virus, cholera, and plague, are known to have a strong relationship with the ABO blood group [11][12]. Pancreatic cancer has been known to be inversely associated blood type O while individuals with A, B, and AB blood types are inversely related to non-melanoma skin cancer[13]**.** In line with SARS-CoV-2 and malaria, majority of the positive individuals are more likely to have non-O blood group than blood type O [14][15].

The trend of ABO blood type is almost or always in the same ratio among people in different regions. For example, the Caucasians in the United States, the African American, Western Europeans, the people of Ghana and the Ogbomosoof Oyo State, Nigeria have the following order; O>A>B>AB, table 1, [4,][8]. Some regions also have different blood type (A or B) proving to be predominant among students. The AB blood type which has no relationship with O is almost always appearing to be the least [16].

From a common ancestor, humans in general share the same blood group system but differ only in the frequencies. The frequencies of the alleles and the mating system account for the genotypic and phenotypic frequencies in different population[17].

No study has been done in Liberia to access the frequency of the ABO blood types and Rh factor along with the genotypic frequencies among university students. Considering the importance of this information for Liberian and other researchers, this study was conducted.

Table 1: Comparison of the ABO blood type frequency in different countries

Country	Frequency of Blood type			
	A	B	AB	O
Cuttington University, Liberia	15.9%	21.2%	6.5%	56.4%
Caucasians, United States	41%	9%	3%	47%
African American	27%	20%	7%	46%
Western Europeans	42%	9%	3%	0.46%
Ogbomoso, Oyo State, Nigeria	22.9%	21.3%	5.9%	50%
Winneba, Ghana	23.5%	17.5%	3%	56%

2. Method

The research took into consideration 321 students of Cuttington University undergraduate programs, in Suakoko, Bong County. The testing took place in the Biology Laboratory of the Emmet A. Dennis College of Natural Sciences.

The prospective part of the study, ABO blood group tests was carried out for the selected sample group, using ABO regent, blood lancet, alcohol swap, slide sample wells etc. In brief, randomly selected students from different colleges were taken to the Biology laboratory for blood typing.

While in the laboratory, each student hand was dangled down to increase the flow of blood in the fingers. Using 70% alcohol, the middle fingertip was cleaned, and pierced with a sterile lancet, and gently massaged to increase the flow of blood. Using a slide containing three cavities, labeled A, B, and D, a drop of blood was placed in each cavity. The Labels A, B and D represent antiserum A, B, and anti RhD respectively. Finally, one drop of antiserum was added to each cavity respectively and mixed using a fresh mixing stick. Within 30 seconds, each mixture was observed for agglutination or not, and result was read as indicated in figure 1 and figure 2.

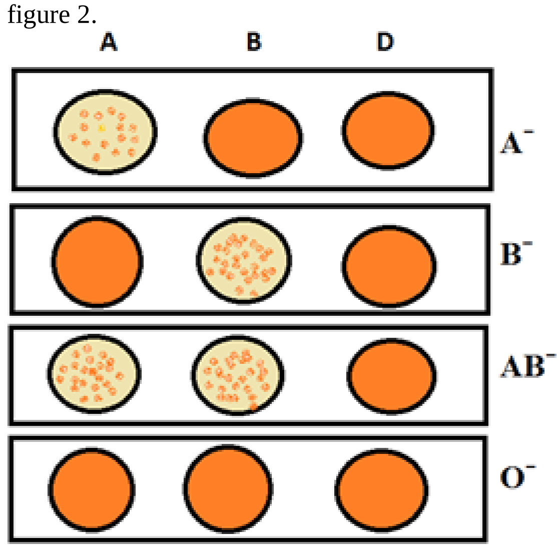

Figure 1: Blood type A, B, AB, and O (-ve)

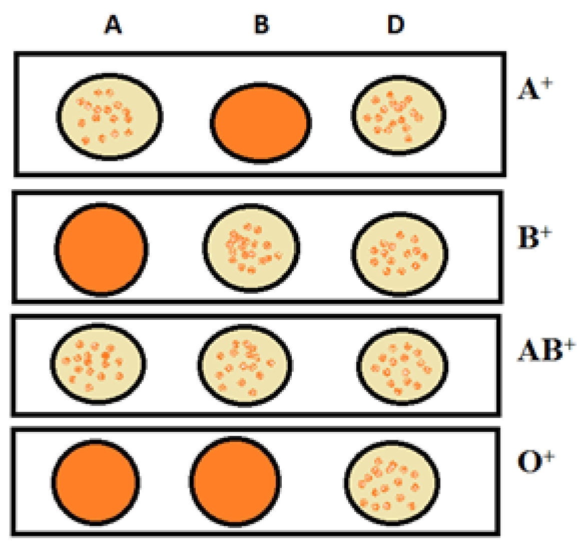

Figure 1: Blood type A, B, AB, and O (+ve)

From figure 1 and figure 2, a slide reads ‘A’ because cavity A agglutinated after being mixed with Anti A reagent, thus, blood group A. It reads B because cavity B agglutinated after being mixed with Anti B reagent, thus, blood group B. It reads AB because cavities A & B agglutinated after being mixed with Anti A & B reagents, thus, blood group AB. It reads O because cavities A & B never agglutinated after being mixed with Anti A & B reagent respectively, thus, blood group O. For figure 1, all of the blood types expressed –ve Rh factors because cavity D did not agglutinate when and individual's blood types was mixed with Anti RhD reagent. On the other hand, all of the blood types expressed +ve Rh factors because cavity D agglutinated when individual's blood types was mixed with Anti RhD reagent in figure 2.

3. Result and Discussion

Table 2: Distributions of Rh factors and ABO Blood Type among respondents

Blood type/Rh factor	A		B		AB		O		Total	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Positive	23	27	39	28	6	13	91	90	159	158
Negative	1	-	-	1	-	2	-	-	1	3
Total (%)	51 (15.9%)		68 (21.2%)		21 (6.5%)		181 (56.4%)		321 (100%)	

Tables 2 depict a combination of Rh factors and the different blood types associated with respondents. Of the total individuals tested, 317persons representing 98.8% were Rh Positive while four (4) persons representing 1.2% were Rh negative. On the other hand, 51 (24 males, 27 females), 68 (39 males, 29, females), 21 (6 males, 15, females), and 181 (91 males, 90 females) were tested to be A, B, AB and O respectively. Additionally, the population constituted 160 males and 161 females.

Table 3: Frequency of blood phenotype and estimated genotypic frequency

			Estimated frequency of blood genotype								
Blood type	Population	Frequency of blood phenotype	P	P2	2pr	q	q2	2qr	2pq	r	r2
A	51	0.16	0.10	0.01	0.15						
B	68	0.21				0.15	0.02	0.23			
AB	21	0.07							0.03		
O	181	0.56								0.75	0.56
Total	321	1									

The above table shows the chance (probability) of obtaining specific genotype among the different blood types. It is known that an individual with a specific blood type has a defined genotype, i.e. A→(I^AI^A / I^Ai) , B→(I^BI^B / I^Bi), AB→ (I^AI^B), while O→(ii). Considering this factor, there must be an estimated frequency of specific allele in a given population. In line with the Hardy–Weinberg equilibrium, the sum of the phenotypic frequency must be equal to one (1), the sum of A,B and O (p,q,r, respectively) must be equal to one (1), while the value of $(p+q+r)^2$ must be equal to one (1). It is worth noting that I^AI^A→p^2, I^Ai→2pr, I^BI^B→q^2, I^Bi→2qr, I^AI^B→ 2pq while ii→r^2, reading from a genotypic point.

From our prediction, 1% of the students were known to have a genotype of AA, 15% were AO, 2% were BB, 23% were BO, 3% were AB, while 56% were OO. Additionally, the percentages of A,B and O within the given population were 10%, 15% and 75% respectively.

Table 4: Comparison of Genotypic frequencies between Ethiopia[17] and Liberia

Country/Genotype	O	OO	A	AA	AO	B	BB	BO	AB
Liberia	0.75	0.56	0.1	0.01	0.15	0.15	0.02	0.23	0.03
Ethiopia	0.62	0.39	0.23	0.05	0.29	0.15	0.02	0.18	0.07

From the above table, it can be understood that the alleles frequencies in decreasing order for Liberia and Ethiopia can be written as: (O>B>A and O>A>B; OO> BO>AO>AB>BB>AA and OO>AO>BO>AB>AA>BB, respectively). Considering the result, the frequency of the recessive alleles (O) and the frequency of individuals with the recessive genotype (OO) for both countries have the highest frequencies. The frequencies of the dominant alleles (the individuals with the dominant genotypes), and the individuals with the heterozygous genotypes vary slightly for the two countries.

4. Conclusion

The purpose of this research was to carry out an Investigation into The ABO Blood Group System Amongst Cuttington University Students in Suakoko, Bong County.

The ABO Blood Group System or ones blood type is a very important to be known as an individual. One may consider donating blood to a sick relative who is highly in need of blood, in this case, knowledge on ones blood type can save time for compatibility testing. It was deduced from this research that the O blood type and RhD (+ve) dominated among the respondents. At the same time, AB blood type and RhD (-ve) was known to be the least. Taking into consideration the different genotypes, the individuals with genotype OO dominated in percentage followed by genotype AO. The genotypes with the least percentages were AA followed by BB. This result is also in line with a study conducted in **Population of Adet and Merawi, Ethiopia Table 1** [17]**.**

5. Future Scope

Today, a relative of an individual can go short of blood and need urgent blood transfusion. The best person to obtain such blood from is a relative. Anyone can be said relative; therefore, knowing ones blood type will reduce the time of screening for compatible donor. We therefore recommend that a research of such be done for all university students who do not know their blood types as well as no university students. Additionally, the ABO blood type should be done along with associated disease condition.

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