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Original Article

Pattern of ABO and Rhesus Blood Group Distribution among Second Year Medical Students of Arsi University, Southeast Ethiopia

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ABSTRACT

Background and Aim: The genetics, inheritance patterns and disease susceptibility of blood group antigens, which are hereditary in nature, are crucial for transfusion safety. The purpose of the present study was to determine the frequency and distribution of both ABO and Rhesus blood types among second year medical students of Arsi University. **Methodology:** All second-year medical students at Arsi University participated in a cross-sectional study that was institutionally based. A structured questionnaire and a data collection sheet were used to obtain the socio-demographic data and blood group types of study participants. The blood samples were obtained by standard procedures and subjected to determination of ABO and Rhesus blood group using anti-sera by combined slide and test tube method. Each sample was tested for ABO and Rhesus status. The collected data were double entered into Epi-data version 3.1 and exported into SPSS version-22 for analysis. Descriptive statistics was used to calculate percentage frequencies of blood phenotype. The genotypic and allelic frequencies of the blood groups were calculated from the observed phenotypes under the assumption of Hardy-Weinberg equilibrium. **Results:** In the present study, one questionnaire was rejected for incompleteness, resulting in a response rate of 98.89%. The respondents had a mean age of 21.38 years (SD±0.898) and were mainly female (58.4%). The distribution of ABO blood group was; blood group O (39.3%); blood group A (31.5%); blood group B (24.7%) and blood group AB (4.5%). The proportions of Rhesus (D) positive and Rhesus (D) negative were 84.3% and 15.7%, respectively. **Conclusion:** The current study revealed that blood group O is the most frequent blood group among the ABO blood group system with dominant Rh positivity. This study along with other similar studies in other regions of the country will be useful for health planners to face medical emergencies.

Keywords: Blood group, RhD group, ABO blood group, Medical Students, Arsi University.

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INTRODUCTION

All blood was thought to be the same up until the discovery of the ABO blood group more than a century ago and the catastrophic effects of blood transfusions were not known.[1] The International Society of Blood Transfusion today recognizes 30 human blood group systems, with the ABO and Rhesus (Rh) being the most significant in clinical practice.[1,2] Karl Landsteiner, an immunologist from Austria, discovered the ABO blood group system, the first human blood group system, in 1901. Later, in 1941, Landsteiner and Wiener defined the Rh system, the second most significant blood group system after the ABO system.[3,4]

The ABO gene (OMIM: 110300) is a gene that encodes for one of the three variant alleles (I^A, I^B and I^O) of the ABO blood group system and is located on the long arm of chromosome 9 (9q34).[5,6] The α1,3-GalNAc-transferase and/or α1,3Gal-transferase enzymes that the I^A and I^B alleles encode catalyze the transfer of various carbohydrates onto the H antigen to generate I^A and/or I^B (glycosyltransferase) antigens.[5,7] Because the O allele does not produce active glycosyltransferase, neither I^A nor I^B antigens are produced.[5] In an intra-allelic interaction in a diploid state, the dominant alleles I^A and I^B are both dominant over the recessive allele I^O.[8] The ABO system categorizes all human blood into one of the four groups (phenotypes) A, B, AB, or O with six genotypes, namely, OO (type O), OA (type A), OB (type B), AA (type A), BB (type B) and AB (type AB).[6] The ABO system is determined by the presence of red blood cell antigens, an, antigen A (group A), antigen B (group B), or both anti (type AB).[9]

Due to the prenatal hemolytic syndrome and its significance in subsequent transfusions for Rh negative people, once they

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develop Rh antibodies, the Rh system has become the second most significant blood group system.[10] There are currently more than 50 antigens in the Rh blood group system, although D, C, E, c and e are the main Rh antigens of medical significance.[11] It is controlled by a gene having two alleles (D and d) on the short arm of chromosome 1.[8] Rhesus-positive individuals (Rh^+)(DD or Dd genotype) are those having the D antigen on their red blood cells, whereas Rh^- individuals are those with the D antigen absent from their red blood cells (dd genotype).[12] Transfusion responses can occur if an Rh^- person receives an Rh^+ transfusion because the receiver develops anti-D. Contrary to the ABO blood group, Rh antigens never give rise to spontaneous antibodies and large amounts of antibodies must be produced by repeated exposure to trigger a transfusion reaction.[13]

The advancement of blood banking services and transfusion medicine has greatly benefited from the identification of the ABO and Rh blood groups. They are helpful in population genetic studies and settling medical and legal disputes like parentage claims.[14] ABO blood group has also been linked in some studies to a number of pathological conditions. For instance, blood group A individuals have been found to have a higher prevalence of stomach cancer and blood group O individuals have been found to be more susceptible to malaria infection than non-O blood group individuals.[15,16] Additionally, a genetic marker for obesity and one of the best predictors of the country's suicide rate are the ABO blood group system.[17]

ABO and Rhesus blood group systems are the same across the board for all human populations, albeit they vary in terms of frequency and distribution of particular kinds among various racial, ethnic, socioeconomic and geographic groups.[18-20] ABO and Rhesus blood group distribution in the British is as follows: type A: 42%; type B: 8%; type O: 47%; type AB: 3%; Rh^+: 83%; and Rh^-: 17%.[21] In Caucasians in the US, the ABO and Rhesus distribution is as follows: type A: 41%; type B: 9%; type O: 46%; type AB: 4%; Rh^+: 85%; and Rh^-: 15%.[21] The distribution in Malaysia is as follows: type A: 24.9%; type B: 30.2%; type O: 38.3%; type AB: 2.8%; Rh^+: 98.4; and Rh^-: 1.6%.[22] Type A blood makes up 43.8% of the population in Turkey, followed by type B (16.2%), type O (30.8%), type AB (9.2%), Rh^+ (86.0%) and Rh^- (14.0%).[23] According to records, blood group O was the most prevalent in Uyo, Nigeria, accounting for 56.10% of all cases. Blood groups A (25.07%), B (16.4%) and AB (2.45%) were next, followed by Rh^+ (96.7%) and Rh^- (3.30%), respectively.[24] The frequency of the A, B, AB and O blood groups among students at Ladoke Akintola University in Ogbomosho was 21.30, 22.73, 2.85 and 53.12%, respectively. 93.32% of them were Rhesus positive, while 6.68% were Rhesus negative.[16] The results from students at Nasarawa State University showed that blood group O made up 45% of the population, followed by blood groups A (25.5%), B (25%) and AB (3.5%). In Kaduna, a city in the northwest of Nigeria, type A was 21.3%, type B was 24.3%, type AB was 5.2% and type O was 49.2%.[25] Additionally, Rh^+ was 94% and Rh^- was 6%. Additionally, blood group distribution among 160,431 people in Benin, the Niger Delta region of Nigeria and Benin revealed phenotypes A, B, AB and O as 23.72, 20.09, 2.97 and 53.22 percent, respectively.[14] According to a study done in Mogadishu, Somalia, blood groups O and Rh^+ predominated with the following blood groups: O group (60.30%), group A (26.50%), group B (11.27%), group AB (1.93%), Rh^+ group (96.49%) and Rh^- group (3.43%).[26] Fekadu[27] stated that type O made up 40% of the general Ethiopian population's ABO blood group distribution, followed by type A (31%), type B (23%) and type AB (6%). The frequencies of O (41.0%), A (24.5%), B (21.3%) and AB (5.2%) as well as 92.06% Rh^+ and 7.94% Rh^- were reported by Kassahun *et al*. in the Silte zone of Ethiopia.[28] The proportion of ABO blood groups among the Sidama ethnic group in Ethiopia is type O (51.3%), type A (23.5%), type B (21.9%) and type AB (3.3%).[29] Similar to this, Teklu and Shiferaw reported that O (43.0%), A (32.0%), B (21.5%) and AB (3.5%) were also prevalent.[30]

The most crucial blood group systems in terms of clinical importance continue to be the genetically determined ABO and Rh systems.[31,32] Calling the patient's loved ones is the only reliable option when an urgent need for blood donation arises. The most horrifying information to learn is that the majority of these people do not know their blood types, regardless of how long it takes to obtain them. Due to the present emergency, it is crucial for everyone to be aware of their blood type, especially young people, to facilitate blood transfusions. ABO and Rh phenotypic frequencies in various populations have been well researched. However, the problem is greater in developing countries, especially in resource-limited countries like Africa, as the lack of awareness and typing antisera as well as the associated costs and logistics were a serious concern.[33,34] Even if some studies on the blood groups have been conducted in Ethiopia, there is no any research done to give full information about the distribution of blood group in the study area i.e., Southeast Ethiopia. Hence, the present study was carried out to determine the distribution of ABO and D blood groups among 2nd year medical students of Arsi University, Southeast Ethiopia.

METHODOLOGY

Study Design and Population

Institutional based cross-sectional study design was conducted at Arsi University from June 03 - 20, 2022, among all 2nd year undergraduate medical students. All medical students in Arsi University at the time of the study were eligible to participate except for severely ill students. Arsi University College of Health Sciences focuses on educating and/or training competent and ethical health professionals for the contribution of paramount in national GDP, particularly the health of the whole community in the growing manufacturing industry, at all levels.[35] The medical curriculum of the School of Medicine at Arsi University takes

six years in which students stay three years in the preclinical and three years on clinical practice.[35]

Ethics Approval And Consent To Participate

The study received ethical approval from the Research Ethics Committee of Arsi on March 15, 2022 (Serial Number: 0106774; IRB NO:00012098; FWA NO:00018699). Approval to use the records was obtained. Confidentially of the collected data was ensured.

An ethical support letter was obtained from Arsi University's ethical board. Informed consent was secured and participation was totally voluntary. The confidentiality was kept anonymous. Of the ninety (90) students learning 2nd year undergraduate medical students at Arsi University, eighty nine agreed to take part.

Procedure

The sociodemographic data was collected by self-administering questionnaire and it comprises age, gender, marital status, residence, income, religion and ethnicity. Furthermore, the ABO and Rh phenotypes were determined by standard serology methods. A drop of blood was taken from their fingertips using a lancet under aseptic precautions. Blood group was determined by slide haemagglutination technique. 2.5% suspension of red blood cells was prepared in normal saline (0.85g/dl sodium chloride in distilled water) preparation method given below. One drop of blood will be mixed with 1 ml of normal saline in a test tube. This provided the red cell suspension. On one half of the glass slide, one drop of Anti-A human polyclonal or murine monoclonal blood grouping serum was placed. On the other half a glass slide, one drop of Anti-B (yellow colour) human polycolonal or murine monoclonal blood grouping serum was placed. Using a Pasteur pipette, one drop of red blood cell suspension was added to each half of the side. On a separate applicator, the serum was well mixed back and forth and observed for agglutination and it was confirmed under a low power objective. Similarly, for Rhesus D typing, a drop of anti-D serum was placed in a clean labeled tile, mixed with a drop of blood and watched for agglutination. Results of agglutination were recorded immediately for ABO blood group and after 2 min for Rh.

Statistical Analysis of Data

The questionnaire was pretested on 5% randomly selected undergraduate paramedical students of Arsi University. Data were checked for completeness daily. To be edited and cleaned, the collected data were double entered into Epi-data version 3.1 and exported into SPSS version-22 for analysis. Incomplete and inconsistent data were excluded from the analysis. The data were processed by using descriptive analysis and analytical methods, including frequency distribution, cross-tabulation and summary measures. Descriptive statistics was used to calculate frequencies of the phenotype of the blood ABO and Rh blood groups and results were reported as frequencies and percentages. Allelic frequencies of ABO and Rh blood groups (I^A, I^B, I^O, I^D and I^d) were calculated using Hardy-Weinberg formula using the following equations.[36] The three alleles of ABO blood groups, i.e., I^A, I^B and I^O and their frequencies were represented by p, q and r, respectively. The frequencies were calculated as follows:

$$r=\sqrt{O}=\text{Allele } I^O$$

$$p=1 - \sqrt{B + O}=\text{Allele } I^A$$

$$q=1 - \sqrt{A + O}=\text{Allele } I^B$$

Therefore, the genotypic frequencies are represented as:

$$(p + q + r)^2=p^2 + 2pq + q^2 + 2pr + 2qr + r^2=1 \text{ and } p + q + r=1$$

Where, p^2 is the genotypic frequency of I^AI^A, q^2 is the genotypic frequency of I^BI^B, 2pq is the genotypic frequency of I^AI^B, 2pr is the genotypic frequency of I^AI^O, 2qr is the genotypic frequency of I^BI^O and r^2 is the genotypic frequency of I^OI^O as cited in Hanania *et al.*[37]

The frequencies of the Rh blood group allele, D (dominant allele) and d (recessive allele) were determined as:

$$q=\sqrt{Rh-}=\text{Allele d}$$

$$P=1 - q=\text{Allele D}$$

The Rh blood (D) group genotypic frequency was calculated from the allelic frequency under the assumption of Hardy-Weinberg equilibrium as follows:

$$DD + 2Dd + dd=1$$

Where,

Genotype $DD=p^2$

Genotype $Dd=2pq$

Genotype $dd=q^2$

Chi-square (χ^2) test ($p<0.05$) was used to check whether the observed and expected frequency distributions of the ABO blood groups and Rh factor were in the Hardy Weinberg equilibrium or not. Odds ratios were calculated and statistical significance was accepted at $p<0.05$.

$$\chi^2 =\Sigma (Of - Ef)^2 / Ef$$

Where,

Of=Observed frequency;

Ef=Expected frequency

Expected phenotypic frequencies for each blood group were calculated as:

A blood group Ef=frequency of (AA + AO) X number of total samples,

B blood group Ef=frequency of (BB + BO) X number of total sample,

AB blood group, Ef=frequency of AB X number of total samples,

O blood group Ef=frequency of OO X number of total sample,

RESULTS

Sociodemographic Characteristics

From a total of 90 medical students who received the questionnaire, 89 completed the survey, yielding an overall response rate of 98.89%. Age of the study sample ranged between 20 and 24 years with the mean (SD) of 21.38±0.898 years. In the present study, most respondents were female with a frequency of 52 (58.4%), single in marital status with a frequency of 86 (96.6%), living in campus with a frequency of 87 (97.8%) and had a monthly income of ≤1000 ETB with a frequency of 68 (76.4%) (Table 1). Regarding their religion and ethnicity, 42 (47.2%) were Orthodox believers and 73 (82.0%) were Oromo, respectively.

Distribution of ABO and Rh Blood Groups

According to the present study, in the ABO blood group system, type O was the most prevalent (39.3%), followed by type A (31.5%), type B (24.7%) and type AB was the least frequent (4.5%) in the order O>A>B>AB. Regarding Rh factor, most of the participants were found to be Rh^+ (84.3%) (Table 2).

With respect to the rhesus blood group system, among the population studied, blood group O^+ was the most common with a frequency of 31 (34.8%), followed by A^+ with a frequency of 23 (25.8%), then B^+ 19 (21.3%) and AB^+ 2 (2.2%), whereas among the rhesus negative students, blood group A^- was the most frequent 5 (5.6%), blood group O^- 4 (4.5%) and B^- were 3 (3.4%) each while blood group AB^- was 2 (2.2%) (Table 3).

Table 1: Sociodemographic characteristics in relation to gender, AU, n=89.

Sociodemographic Variables		Male	Female	Total (n=260)
Age	20 - 21 years	12 (20.7)	46 (79.3)	58 (100.0)
	22 - 24 years	25 (80.6)	6 (19.4)	31 (100.0)
Current Marital Status	Single	36 (41.9)	50 (58.1)	86 (100.0)
	Married	1 (33.3)	2 (66.7)	3 (100.0)
Monthly Income	≤ 1000 ETB	31 (45.6)	37 (54.4)	68 (100.0)
	> 1000 ETB	6 (28.6)	15 (71.4)	21 (100.0)
Residency	Non-dormitory	0 (0.0)	2 (100.0)	2 (100.0)
	Dormitory	37 (42.5)	50 (57.5)	87 (100.0)
Religion	Orthodox	12 (28.6)	30 (71.4)	42 (100.0)
	Muslim	9 (64.3)	5 (35.7)	14 (100.0)
	Protestant	16 (51.6)	15 (48.4)	31 (100.0)
	Others[¥]	0 (0.0)	2 (100.0)	2 (100.0)
Ethnicity	Oromo	35 (47.9)	38 (52.1)	73 (100.0)
	Amhara	0 (0.0)	5 (100.0)	5 (100.0)
	Sidama	1 (33.3)	2 (66.7)	3 (100.0)
	Gurage	1 (20.0)	4 (80.0)	5 (100.0)
	Others[††]	0 (0.0)	3 (100.0)	3 (100.0)

[¥]Catholic, Waqefatta, Faith and Pagan. [††]Silte, Harari and Kambata. ETB=Ethiopian Birr. Current exchange rate: $1USD=52.64 ETB.

Table 2: The phenotypic frequency distribution of ABO of blood groups among 2nd year medical students of Arsi University based on Rh blood group, n=89.

Variables		Blood type				Total n (%)
		Type A n (%)	Type B n (%)	Type AB n (%)	Type O n (%)	
Rh factor	Positive	23 (82.1)	19 (86.4)	2 (50.0)	31 (88.6)	75 (84.3)
	Negative	5 (17.9)	3 (13.6)	2 (50.0)	4 (11.4)	14 (15.7)
Total N (%)		28 (31.5)	22 (24.7)	4 (4.5)	35 (39.3)	89 (100.0)

Allelic Frequencies of ABO and Rh (D) Blood Groups

In the present study, the allelic frequencies of the ABO blood group of r (I^O), p (I^A) and q (I^B) were 0.63, 0.20 and 0.16, respectively (I^O>I^A>I^B) while the allelic frequencies of the Rh blood group of D and d were 0.60 and 0.40, respectively. Genotypic frequency of I^OI^O was the most (0.40) frequent while that of I^BI^B was the least (0.03) frequent (Table 4).

Observed and Expected Frequencies of ABO Blood Group and Rh Factor

In the present study, the observed and expected frequencies of individuals having ABO and Rh blood were not significantly different in both blood systems (goodness-of-fit x^2 for ABO=1.012, df=3 and for Rh=0.0041, df=1; p<0.05) (Table 5).

DISCUSSION

Distribution of ABO and Rh Blood Groups

There are currently 35 systems made up of around 700 human blood group antigens.[38] The ABO and Rh(D) systems are the most crucial among them. For a better understanding of human heredity and migratory patterns, researchers are looking into the ABO and Rh blood group antigens. Additionally, the therapeutic and practical value of these blood group systems is significant. They undergo routine screenings in the fields of forensics, paternity testing, legal medicine and transfusion and transplantation.[39] The ABO blood system is known to be linked to a variety of cancers, including those of the skin,[40] pancreatic,[41,42] ovarian, gastric,[43] and epithelial origin,[44,45] as well as other non-communicable disorders such ischemic heart disease,[46] and diabetes mellitus.[47]

Following the initial suggestion 48 years ago, the connection between malaria and the ABO blood group is one of the infectious diseases that is rapidly being acknowledged.[48-50] Due to the close connection between transfusion medicine and organ transplants, the research of blood types is also essential to clinical practice.[51] It is difficult for blood banks to obtain enough blood units, especially for the blood types that are less common.[52]

According to the study's findings, the blood groups were most frequently distributed in the following order: O>A>B>AB, which is consistent with earlier research done in other countries, including Ethiopia. 46% of the USA population displayed group O, 41% group A, 9% group B and 4% group AB.[53] In addition, type O is represented by 46% of Western Europeans, type A by 42%, type B by 9% and type AB by 3%.[54] In the Mexican population, there is a very high prevalence of type O (61.82%), type A (27.43%), type B (8.93) and type AB (1.81%), as well as 95.58% Rh^+ (52). The O>A>B>AB blood group distribution was the norm throughout most of China.[55] In a study on Nepalese medical students, type O (34.87%), type B (30.17%), type A (28.17%), type AB (6.79%) and Rh+ (95.38%) were discovered.[56]

Group O makes up 52% of the population in Saudi Arabia, whereas Group A makes up 25%, Group B makes up 19% and Group AB makes up 4%.[57] In Iran, blood group O is the most prevalent blood type (41.16%).[58] In Port Harcourt, among students of African origin, among students in the Niger Delta and among the Yoruba and Hausa ethnic groups, in five zones of Nigeria and in Ibadan, respectively, the prevalence of ABO blood

Table 3: Distribution of ABO and Rhesus blood group systems among 2nd year medical students of Arsi University based on Rh blood group, n=89.

Blood group	Frequency	Percent
A^+	23	25.8
B^+	19	21.3
AB^+	2	2.2
O^+	31	34.8
A^-	5	5.6
B^-	3	3.4
AB^-	2	2.2
O^-	4	4.5
Total	89	100.0

Table 4: Allelic and genotypic frequencies of ABO and Rh blood groups among 2nd year medical students of Arsi University, n=89.

Allele	Frequency	Genotype	Frequency	Percentage	Phenotype
O (r)	0.63	I^OI^O	0.40	40%	O
A (p)	0.20	I^AI^A	0.04	4%	A
		I^AI^O	0.25	25%	A
B (q)	0.16	I^BI^B	0.03	3%	B
		I^BI^O	0.21	21%	B
		I^AI^B	0.07	7%	AB
D	0.6	DD	0.36	36%	Rh (D)+
		Dd	0.48	48%	Rh (D)+
d	0.4	dd	0.16	16%	Rh (D)-

p^2 is the genotypic frequency of I^AI^A, q^2 is the genotypic frequency of I^BI^B, 2pq is the genotypic frequency of I^AI^B, 2pr is the genotypic frequency of I^AI^O, 2qr is the genotypic frequency of I^BI^O and r^2 is the genotypic frequency of I^OI^O. Genotype DD=p^2, Genotype Dd=2pq and Genotype dd=q^2.

Table 5: comparison between observed and expected frequencies of the ABO blood group and Rh factor among 2nd year medical students of Arsi University, n=89.

ABO Blood group and Rh factor	Observed number (o)	Expected number (e)	Difference (d)	d^2/e	χ^2
Type A	28	25.81	2.19	0.185	1.012
Type B	22	21.36	0.64	0.019	
Type AB	4	6.23	-2.23	0.798	
Type O	35	35.60	-0.60	0.010	
Rh^+	75	74.76	0.24	0.0001	0.0041
Rh^-	14	14.24	-0.24	0.0040	

Expected phenotypic frequencies for each blood group were calculated as:A blood group Ef=frequency of (AA + AO) X number of total samples,B blood group Ef=frequency of (BB + BO) X number of total samples,AB blood group, Ef=frequency of AB X number of total samples,O blood group Ef=frequency of OO X number of total samples,Rh^+ blood group Ef=frequency of (DD + Dd) X number of total samples,Rh^- blood group, Ef=frequency of dd X number of total samples.

groups followed a pattern of prevalence (AB<B<A<O).[59-61] Like in Egypt, blood group O is the most common.[62] Similar research also revealed that O was the blood group that was most common while AB was the blood group that was least common in Kenya, Uganda, Mauritania and Ethiopia.[63-66] Blood group O was reported to be the most common disease (41.0%), followed by A (24.5%), B (21.3%) and AB (5.2%) in the Silte zone of Ethiopia.[28] The proportion of ABO blood groups among the Sidama ethnic group in Ethiopia is type O (51.3%), type A (23.5%), type B (21.9%) and type AB (3.3%).[29] Teklu and Shiferaw[30] in a similar vein, noted the preponderance of O (43.0%), A (32.0%), B (21.5%) and AB (3.5%). Fekadu.[27] found that type O made up 40% of the total Ethiopian population, followed by type A (31%), type B (23%) and type AB (6%).

In the current investigation, the relative frequencies of ABO and Rhesus blood types did not differ from the national trend of O>A>B>AB. Research conducted in India[67] and Pakistan[68] showed blood group B was the most prevalent, followed by blood groups O, A and AB, in contradiction to the current study. Khan *et al.*[69] revealed the prevalence pattern of B>A>O>AB in a study conducted in the Bannu region of Pakistan. According to Khattak *et al.*[20] the percentage frequencies of B (32.40%), O (29.10%), A (27.92%) and AB (10.58%) were found in Pakistan's Swat district. The majority of investigations in Bangladesh and India have revealed the typical Asian distribution pattern of B>O>A>AB.[9] The most common blood type was B (36.6%), which was followed by O (35.5%), A (21.4%) and AB (7.0%). These blood types showed the same trend of frequency as over the entire Indian subcontinent (B≥O>A>AB).[69] There is regional variation, although; according to some studies, blood group B predominates in Western and Central Africa, whereas blood group O predominates in Eastern and Southern nations.[70-72] In contrast, a different study conducted in Nepal by Pramanik *et al.*[19] discovered that blood group A is the most prevalent, followed by blood groups O, B and AB. Similar to this, a few European countries also displayed the A>O>B>AB pattern.[9] The current discovery also differs from earlier findings on the Guinean population, where the population's frequencies for genes A, B and O were 14.70, 15.48 and 69.83, respectively.[73] These regional differences may be explained by genetic mapping and the varying origins of diverse ethnic groups and more specifically due to different sample sizes.

The least common blood group in the world's population, according to all research listed and the current study included, is AB. O is the blood type with the highest prevalence in Britain, whereas AB has the lowest.[72] Blood group AB (3.4%) was the least common, according to data from Saudi Arabia, although blood group O (56.8%) was more common.[74] While most Africans, Americans, Australians and English people display an O>A>B>AB pattern of ABO phenotypes, most Asians typically have a B>O>A>AB pattern.[75]

It is advantageous that blood type O has a higher dispersion than was seen in this study. According to Lemu *et al.*[76] there is a theory that group "O" phenotypes are more prevalent than non-"O" phenotypes in malaria endemic locations. The indigenous blood type "O" seems to have fared better in terms of surviving acute malaria. On the other side, both Rh-negative and "O" phenotypes may have aided in the spread of malaria in the region as asymptomatic carriers predominated, perhaps as a result of their resistance to the disease, which demonstrated the advantages of the phenotypes. Because studies have indicated that blood type O individuals may not have erythrocytes that are ideal for the creation of rosettes by *Plasmodium falciparum*, the predominance of the O group may therefore be protective against malaria. Additionally, the higher incidence of "O" blood provides benefits, including the potential for emergency blood transfusions because blood group O is a universal donor (lacking both A and B antigens), making it easily accessible. This might be considered as a good input for blood bank services for efficient blood management and secure blood transfusion procedures.[76]

The majority of second-year students at the College of Health Science at Arsi University had Rhesus positive blood in the current study, which is consistent with the vast majority of research done around the world.[77-80] Rh-negative phenotypic frequency varies considerably amongst populations. The Rh-negative phenotype is

less prevalent in Asia and Africa. For instance, statistics indicate that only 1% of people in Madagascar[81] and 6% of people in Nigeria[82] are Rh-negative. Rh negative was also found to be between 0.6% and 8.4% in different parts of India.[83] Less than 1% of people are Rh-negative in China,[84,85] Indonesia,[86] and Japan.[87] Western countries like the United States[53] and Britain,[88] on the other hand, have Rh factor negative of 17 and 15%, respectively, which is closer to the results of the present study. 29% of the population in one area of Saudi Arabia, according to a research, is Rh negative.[89]

Apart from Saudi Arabia, the High Atlas Range in Morocco has unique communities with Rh-negative rates of roughly 29%, which is the highest reported prevalence of Rh-negative phenotypes.[81] The results of the present study revealed that the frequency of Rh- was very low and the scenario may imply the shortage and difficulty of getting it when required from blood banks and to meet the patient's needs. Accordingly, Lemu *et al.*[76] reported that the Rh- blood group is uncommon in many populations, which implies that it is scarcely available in blood banks. As a result, populations where the Rh- negative blood group is more prevalent may be approached and people are encouraged and persuaded to donate blood to increase the availability of this blood group in blood banks.

The prevalence of the Rh factor in the current study is in line with earlier investigations carried out in various regions of Ethiopia. For instance, in Jimma city, 93% of blood donors were Rh+ and 7% were Rh-[30] and Kassahun *et al.*[28] found that in the Silti zone, 92.06% of donors were Rh+ and 7.94% were Rh-.

Allelic Frequencies of ABO and Rh (D) Blood Groups

The findings of Kassahun *et al.*[28] in a related study carried out in the Silte zone of Ethiopia were remarkably comparable to those of the present study in terms of the allelic frequencies of O, A, B; D and d; and Rh factors. According to their research, O (r), A (p) and B (q), D and d allelic frequencies were 0.65, 0.19 and 0.15, 0.72 and 0.28, respectively. Furthermore, they discovered that whereas 7.94% were Rh^-, 92.06% were Rh^+.[28] In accordance with the findings of other research carried out in Oromia National Regional State, the pattern of allelic frequencies in the current study was similarly consistent. For instance, the frequency of I^A in the Arsi clan is 0.19, I^B 0.16 and I^O 0.65, whereas it is 0.21, I^B 0.16 and I^O 0.63 in the Guji clan and 0.22, I^B 0.15 and I^O 0.63 in the Borena clan.[90] The genotype I^OI^O was the most prevalent (41.3%) among the six distinct genotypes. The fact that blood groups A and B (I^AI^O and I^BI^O) both possess O alleles in their heterozygous state, in addition to the homozygous I^OI^O, may be the cause of the I^O allele's preponderance. Allelic frequencies of p (0.154), q (0.249), r (0.591), D (0.676) and d (0.324) have been observed across the entire Indian subcontinent[90] and these allelic frequencies differ from those found in the current study, which had O (r) values of 0.64, A (p), 0.21, B (q), 0.15, D was 0.73 and d values of 0.27. Over allele d, allele D has dominance. Regarding patient safety, it its critical to maintain a sufficient supply of Rh-positive blood. Identification of the Rh blood group system is crucial to preventing the condition known as erythroblastosis fetalis, which frequently develops when a Rh negative (Rh^-) mother is carrying a Rh positive (Rh^+) fetus.[91,92] Additionally, localised data on the prevalence of the Rh blood type, among other things, is needed for expanding literature on the relationship between blood groups and the aetiology of cancer.[93] According to the present study's findings, there was no appreciable discrepancy between the observed and anticipated values for the distribution of ABO blood groups. The observed and expected values for the Rh blood group did not significantly differ.

CONCLUSION

The effectiveness of any national health service depends on having current knowledge of the distribution of blood types in a given area. Blood group O was discovered to have the largest prevalence in the current study's study population, with a prevalence of 39.3%, followed by blood groups A, B and AB in that order. Rhesus positivity was found to be prevalent among students, with Rhesus negativity being identified only in small numbers. This discovery will help in the organization of healthcare, genetic counseling and the safe, effective and well-organized operation of blood transfusion services. The blood types shown on student ID cards from high school or college and driver's licences will come in very handy in cases where an emergency transfusion of blood that hasn't been cross-matched is needed. It is important to recognize the limitations of the current investigation. Our findings are constrained by a sample size that is too small to provide a reliable assessment of the frequency distribution of blood groups in the research area. Additionally, this survey was carried out with university students in Ethiopia. This could therefore prevent the results from being applied to the entire nation.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

AU: Arsi University; **ETB:** Ethiopian Birr; **GDP:** Gross Domestic Product; Rh: Rhesus; **SD:** Standard Deviation.

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