African Journal of Basic & Applied Sciences 11 (1): 01-10, 2019
ISSN 2079-2034

DOI: 10.5829/idosi.ajbas.2019.01.10

Allelic and Genotypic Frequencies of ABO and Rh (D) Blood Groups among Blood Donors in Bale Zone, South East Ethiopia

Mindaye Regasa and Temesgen Bedassa Gudeta

Department of Biology, Madda Walabu University, P.O. Box: 247, Robe, Ethiopia

Abstract: Each series of blood groups in human is under the control of genes at a single locus. The Frequencies of genotypes and alleles of the ABO and Rh (D) blood group system vary worldwide and are not found in equal numbers even among ethnic groups. This study was aimed at getting information on the frequencies of alleles, phenotypes and genotypes of ABO and Rh (D) blood group systems among blood donors of Bale zone, Southeastern Ethiopia. A retrospective study was carried out on 5485 blood donors during a period of three year from 1st January 2014 to 31st December 2016 in Goba Blood Bank of Bale Zone. Each sample of donors was tested for ABO and Rhesus group status using antisera combined slide and tube method. Phenotype O was the most frequent while blood group AB was the least frequent in the whole sample. The O, A, B and AB blood groups percentage, were as follows: 41.7, 27.3, 25.5 and 5.5%, respectively. Rhesus factor records: 94.88% for Rh^+ and 5.12% for Rh^-. For the frequencies of ABO/Rh blood groups: O+ was found to be the most common (39.31%), followed by A^+ (25.98%), B^+ (24.39%) and AB^+ (5.2%), whereas among the Rh negative subjects, blood group O^- was the most frequent (2.42%), followed by groups A^- (1.31%), B^- (1.08%) and AB^- (0.31%). The allele frequencies of ABO and Rh blood groups were calculated by Hardy-Weinberg equation and found to be: 0.6497, 0.1806 and 0.1697 for I^O, I^A and I^B, respectively. The Rh allelic frequencies were 0.7737 for D and 0.2263 for d, respectively. The calculated Chi-Square value for total studied population was 5.10 with $P<0.05$ with 3 degrees of freedom. This demonstrates that there is genetic variability and polymorphism as regards ABO and Rh blood group among the population sampled.

Key words: ABO Blood Groups · Allele · Bale Zone · Frequency · Genotype · Phenotype · Retrospective · Rh Blood Groups

NTRODUCTION

The blood plays more roles than one might expect, it is involved in respiration, nutrition, waste elimination, thermoregulation, immune defense, water and acid base balance and internal communication [1-3]. Most adults have 4 to 6 liter of blood containing Erythrocytes (Red blood cells), sLeukocytes (White blood cells) and platelets [4, 5]. The classification of blood into groups is based on the presence or absence of inherited antigenic substances on the surface of red blood cells, RBCs [27-30]. Some of these antigens are also present on the surface of other types of cells and body secretions like saliva, sweat, tear, urine, semen, serum etc, which are used in forensic investigations [6]. Several of these RBC surface antigens that stem from one allele (Or very closely linked genes) collectively form blood group system [29]. Blood groups are genetically determined and exhibit polymorphism in different populations [7]. Each blood group system is represented by definite antigens found on the surface of red blood cells, Fig. 1. The popular blood grouping systems are ABO blood group system, Rhesus blood group system, MNS system, Kell system, Lewis system, etc. However, ABO blood group and Rhesus blood group systems are the most common in human [3, 8]. The ABO and Rhesus (Rh) blood group antigens are hereditary characters and are useful in population genetic studies, researching population migration patterns, as well as resolving certain medico-legal issues, particularly of disputed paternity and more importantly in compatibility test in blood transfusion practice [3, 4, 9, 10, 29].

Corresponding Author: Temesgen Bedassa, Department of Biology, Madda Walabu University, P.O. Box: 247, Robe, Ethiopia. Tel: +251911785364, E-mail: tasgabifenet@gmail.com.

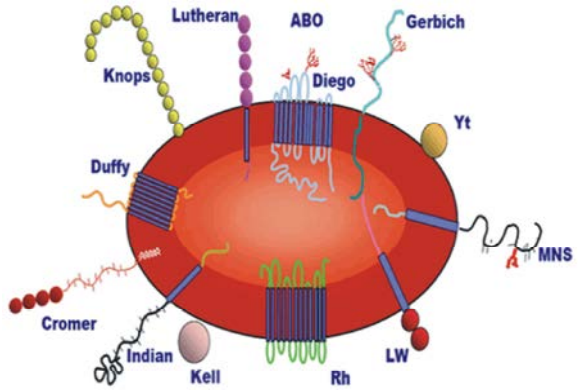

Fig. 1: Schematic representationof clinically significant blood group antigens; Source: Wester *et al*. [15]

According to the ABO blood group system, there are four different kinds of blood groups: A, B, AB and O. Blood group A, has A antigens on the surface of RBCs and B antibodies in blood plasma; blood group B, has B antigens on the surface of RBCs and A antibodies in blood plasma; blood group AB, has both A and B antigens on the surface of RBCs and no A or B antibodies at all in blood plasma and blood group O, has neither A nor B antigens on the surface of RBCs but it has both A and B antibodies in blood plasma [11]. The ABO blood group system is governed by a single gene (The ABO gene) with three alleles (I^A, I^B and I^O) of which I^A and I^B alleles are co-dominant but both of them are dominant over the recessive alleles I^O in intra allelic interaction [12]. The Rh system is one of the most polymorphic of the human blood groups. Many people also have a so called Rh factor on the red blood cells surface. This is also an antigen and those who have it are called Rh+. Those who haven't are called Rh-. A person with Rh- blood does not have Rh antibodies naturally in the blood plasma; as one can have A or B antibodies, for instance. But a person with Rh- blood can develop Rh antibodies in the blood plasma if he or she receives blood from a person with Rh+ blood, whose Rh antigens can trigger the production of Rh antibodies. A person with Rh+ blood can receive blood from a person with Rh- blood without any problems [13, 14]. More than 400 antigens have been genetically identified; five are the most common known as D, C, c, E and e. The Rh is genetically complex but it is simply described in terms of a single pair of alleles, D and d. An Rh positive (Rh+) person has DD and Dd and Rh negative (Rh-) have dd. The Rh blood groups rank with ABO blood groups in clinical importance because of their relation to hemolytic disease of the new born (HDN) and their importance in blood transfusion [7, 12, 15, 27].

The need for blood group prevalence studies is multipurpose, as besides their importance in evolution, their relation to disease and environment is being increasingly sought in modern medicine [16, 30]. Estimates of gene frequencies provide very valuable information on the genetic similarity of different populations and to some extent on their ancestral genetic linkage, despite the cultural and religious differences of the different populations [17]. It is, therefore, imperative to have information on these blood groups in terms of allelic, genotypic and phenotypic frequencies in any population of a given area. Blood grouping has improved with the advent of monoclonal antibodies and the automation of testes. Although different advanced techniques, such as micro plate method, PCR based typing, mini sequencing analysis, fluorescent immune micro plate technique, sandwich ELISA method, etc… are available for ABO genotyping, the Manual (Serological) method has its own significance not only in blood typing but also measuring its genotypic frequency by Hardy-Weinberg law [6, 7 & 18]. The ABO and Rh blood group alleles vary worldwide and are not found in equal frequencies even among the same ethnic groups. For example, among African-Americans, the distribution of ABO blood group is type O is 46%; A, 27%; type B, 20%; and type AB, 7%. Among Caucasians in the United States, the distribution of type O is 47%; type A, 41%; type B, 9% and type AB, 3%. Also, among Western Europeans, type O is 46%; type A, 42%; type B, 9% and type AB, 3% [4, 10].

As it is described above, different countries of the world have had well organized documents on the frequency of alleles, phenotypes and genotypes of ABO and Rh D blood groups. This made the information available for the purpose of blood transfusion and other blood related activities to reduced corresponding problems. In most parts of Ethiopia, including the present research site, Bale zone, of different districts, there was no prior study of this type and literature that provides information. So, this study is significant in coming up with document that shows the phenotypic, genotypic and allelic frequencies of ABO and Rh D blood groups based on the available retrospective data that could serves as a base line information in creating awareness. It can also be important to generate data to be used as a reference in the future for different purposes by health planners and other researchers. Therefore, the objectives of this study were specifically:

- To determine the distribution of ABO and Rh (D) blood group phenotypes among blood donors of Bale zone.

- To estimate the allelic frequency of ABO and Rh (D) blood groups among blood donors of Bale zone.
- To quantify genotypic frequency of the ABO and Rh (D) blood groups among blood donors of Bale zone.
- To check if the blood donor population is at Hard-Weinberg law of genetic equilibrium.

MATERIALS AND METHODS

The current study was conducted based on the retrospective data of Goba Blood Bank stocked over a period of three years, from 1st January 2014 to 31st December 2016.

Study Design: A Blood bank-based, quantitative retrospective study design supplemented with qualitative description was conducted using three years retrospective data to identify the general distribution, genotypic and allelic frequencies of ABO and Rh (D) blood groups among blood donors of Bale zone, South-East of Ethiopia.

Study Population and Sampling Technique: Although Goba Blood Bank is working on six administrative zones of the country, the data associated with Bale zone alone was the main concern of this study for ease management of the work. The data of sample donors of either sex were selected purposively so as to exclude donors other than Bale Zone. As a result, the sample consisted of all the donors of the target zone recorded on the registration book stratified along three consecutive period lines, 2014, 2015 and 2016. All the donors with age between 18-60 years, hemoglobin more than 12.5 g% and body weight above 50Kg were included in the study. The donors those donated their blood repetitively and recorded more than once on the register book were considered only once for the study.

Inclusion and Exclusion Criteria

Inclusion Criteria: Subjects considered for this study must be blood donors from Bale Zone and must have donated their blood to the blood bank within the period under study.

Exclusion Criteria: Donors whose their history showed other than Bale Zone, donors infected by blood borne diseases were avoided and those donated their blood to the blood bank out of the study period were excluded.

Method of Data Collection: Checklist was prepared to collect data regarding frequency of ABO and Rh groups of the screened donors from registration books of Goba blood bank from 1st January 2014 to 31st December 2016. All the data recorded on the registration book were stocked from donors' blood samples collected by qualified laboratory technicians of the Blood Bank following the standard clinical procedure with sterilized needle, slides and chemicals like Anti- A, Anti-B and Anti–D. The registration book of the blood bank was also assessed to collect socio-demographic and other useful data to determine the gene frequency of ABO blood group system and Rh (D) factor. All the required data from the registration book of the blood bank was recorded.

Data Analysis: The genetic structure of a population is determined by the total of alleles (The gene pool) from the collected data. In the case of sexually interbreeding individuals the structure is also characterized by the distribution of alleles in to genotypes. The genetic structure can be described in terms of allelic and genotypic frequencies [10, 11 & 30]. When two alleles, for example, p and q are present at a locus, based on the Hardy-Weinberg principle at equilibrium the frequencies of the genotypes become $p^2 + 2pq + q^2 = 1$, which is the square of the allelic frequencies $(p + q)^2$. This is a simple binomial expansion and this principle of probability theory can be extended to any number of alleles that are inherited two at a time into a diploid zygote. For this study three alleles were computed (A, B and O), with frequencies equal to p, q and r, respectively. The three alleles of ABO blood group which are I^A, I^B and I^O were represented as p, q and r, respectively in which p is the frequency of allele A, q was the frequency of allele B and r was the frequency of allele O. The frequencies of the genotypes at equilibrium are computed by trinomial expansion as: $(p+q+r)^2 = p^2$ (AA) + 2pq (AB) + q^2 (BB) + 2pr (AO) + 2qr (BO) + r^2 (OO) [16, 19- 21].

Modified Hardy-Weinberg equation with more than two alleles was used to calculate both genotypic and allelic frequencies of ABO blood groups from phenotypic frequencies [5]. In this study, first, the distributions of blood groups among blood donors were expressed in percentage and frequencies. Gene frequency was calculated considering two alleles at the same locus for Rh system and three alleles at the same locus for ABO using standard formulae of population genetics.

- Formula for Phenotypic frequency determination of ABO and Rh (D) blood groups

$$Obderved\ percentage\ frequency = \frac{Observed\ number}{Total\ number} x100$$

Formula for the calculation of allelic frequency:

Allelic frequency determination of ABO and Rh D blood groups frequency of the three ABO blood group alleles (p, q and r) was determined as follows:

$r = \sqrt{O}$
$p = 1 - \sqrt{B+O}$
$q = 1 - \sqrt{A+O}$

A correction factor (d) was calculated accordingly as: $d = 1 – p – q – r$. The final allele frequencies were then calculated as follows:

$p1 = p (1 + d /2);$
$q1 = q (1 +d /2);$
$r1 = (r +d / 2) (1 + d/ 2)$

Frequencies of the two Rh (D) blood group alleles (p and q) were determined as follows:

$q = \sqrt{Rh-}$
$P = 1 – q$

Formula for genotypic frequency determination of ABO and Rh D blood groups.

The genotypic frequencies of ABO blood groups are calculated as follows:

P^2 is the frequency of genotype I^AI^A,
q^2 is the frequency of genotype I^BI^B,
2pq is frequency of genotype $I^AI^{B,}$
2pr is frequency of genotype I^AI^O,
2qr is the frequency of genotype I^BI^O
r^2 is the frequency of genotype I^OI^O

Formula for the genotypic frequencies of Rh (D) blood groups are calculated as follows: $(D+d)^2$.

Genotype $DD = p^2$,
Genotype Dd = 2pq,
Genotype $dd = q^2$

- Expected phenotypic frequencies (Ef) were calculated as:

- Ef = Genotypic frequency X number of total sample
- For A blood group Ef = frequency of (AA + AO) X number of total sample
- For B blood group Ef = frequency of (BB + BO) X number of total sample
- For AB blood group Ef = frequency of AB X number of total sample
- For O blood group Ef = frequency of OO X number of total sample

Statistical Method to Test the Goodness of Fit of the Genetic Data: Chi square test was used to compare observed allelic and genotypic frequency distribution of blood group ABO and Rh antigens to that expected under Weinberg Hardy Weinberg equilibrium. This is to indicate the existence of genotypes frequency within a population and whether they are based on a valid definition of alleles and randomly mating sample. Hardy Weinberg assumes that a stable population of adequate size without selective pressure and used in human genetic studies as a guide to data quality by comparing observed genotype frequency to those expected within a population [1, 22, 28]. A p-value less than or equal to 0.05 were taken as statistically significant. The numbers of degrees of freedom was calculated by subtracting one from the number of studied classes (blood groups). Observed and expected genotype frequencies of Hardy Weinberg were calculated on the basis of genotypic frequency and Chi-square test was done to test the independence and the goodness of fit for genotypic frequency [22, 30]. Chi-square test (X^2) was calculated by the following formula.

RESULTS AND DISCUSSION

In this study there were differences in frequency distribution of the ABO and Rh (D) blood group phenotypes in study population. Blood group O has the highest frequency with 41.7% while blood group AB has the lowest frequency 5.5%. Regarding Rh blood group Rh^+ has higher percentage frequency while Rh^- has lower percentage, Rh+ 94.88% and Rh- 5.12% respectively, Table 1.

As it is illustrated in Table 1 and depicted in Fig. 2, blood group O has the highest frequency 2289 (41.7%) while blood group AB has the least frequency 302 (5.5%) in studied total population. The frequency of blood group O and AB were 41.7% and 5.5% respectively. This finding is in agreement in population of south west Ethiopia, at Gilgel Gibe Field Research Center, the frequency of O, A, B and AB phenotypes is 42, 31, 21 and 6% respectively among a total of 1965 study participants [10]. Among Sidama ethnic group (Ethiopia), the distribution is type O, 51.3%; type A, 23.5%; type B, 21.9% and type AB, 3.3% [5]. Among Ethiopian blood donors, the frequency of type O is 40%; type A, is 31%; type B, is 23%; and

Table 1: Phenotypic distribution of ABO and Rh blood groups among blood donors of Bale zone, in the years 2014 - 2016 at Goba Blood Bank, Ethiopia

	ABO blood Grouping System						Rh (Rhesus) Blood grouping system		
Study Period at Goba Blood Bank	O	A	B	AB	Total	Sex	Rh+ve	Rh-ve	Total
2014	799 (41.5)	530 (27.5)	494 (25.7)	102 (5.3)	1925 (100)	Male	1168(60.68	42(2.18)	1210(62.86)
						Female	680 (35.32)	35(1.82)	715(37.14)
						Total	1848 (96)	77(4)	1925(100)
2015	748 (41.6)	480 (26.7)	467 (25.9)	105 (5.8)	1800 (100)	Male	1105(61.4)	63(3.5)	1168(64.9)
						Female	592(32.9)	40(2.2)	632(35.1)
						Total	1697(94.3)	103(5.7)	1800(100)
2016	742 (42.1)	487 (27.6)	436 (24.7)	95 (5.4)	1760 (100)	Male	1059(60.17)	60(3.4)	1119(63.6)
						Female	600(34.09)	41(2.33)	641(36.4)
						Total	1659(94.26)	101(5.74)	1760(1000
Total	2289 (41.7)	1497 (27.3)	1397 (25.5)	302 (5.5)	5485 (100)	Male	3332(60.75)	165(3)	3497(63.8)
						Female	1872(34.13)	116(2.11)	1988(36.2)
						Total	5204(94.88)	281(5.12)	5485(100)

Value in parentheses represent phenotype percentage occurrence

Table 2: Phenotypic frequency of combined ABO and Rh blood groups systems among blood donors of Bale zone for the years 2014 – 2016 at Goba Blood Bank, Ethiopia

		Frequency of ABO Blood Types				
Study site/Period	Rh blood group	O	A	B	AB	Total Frequency %
Goba Blood Bank (2014-2016)	Rh+Positive	2156(39.31)	1425(25.98)	1338(24.39)	285(5.2)	5204(94.88)
	Rh-Negative	133(2.42)	72(1.31)	59(1.08)	7(0.31)	281(5.12)
	Total	2289(41.7)	1497(27.3)	1397(25.5)	302(5.5)	5485(100)

Value in parentheses represent phenotype percentage occurrence

Based on the present study ABO/Rh blood groups frequencies in the studied population blood group ORh+ was found to be the most common (39.31%), followed by groups ARh+ (25.98%), BRh+ (24.39%) and ABRh+ (5.2%), whereas amongst the Rh negative subjects, blood group ORh- was the most frequent (2.42%), followed by groups ARh- (1.31%), BRh- (1.08%) and ABRh- (0.31%), (Table 2)

type AB, is 6 % [9]. Therefore, the results of this study are in agreement with the data from previous studies in Ethiopia populations. Least phenotypic frequencies of AB blood group was observed in the study done by [27] on ABO, RH phenotypes and kell blood groups in an Egyptian population.

ABO and Rh Genotype and Allele Frequency: Allelic frequencies showed a high frequency of the allele I^O over I^A and I^B alleles in the order of (I^O> I^A> I^B) in study population, Table 3. The allelic frequencies were obtained in order of I^O = 0.6497, I^A=0.1806 and I^B= 0.1697; whereas in the case of Rh blood group allelic frequencies of the dominant allele D and the recessive allele d were 0.7737 and 0.2263 respectively. The genotypic frequency ABO and Rh blood group in study population was calculated from the allelic frequency by Hardy-Weinberg equation and estimated as the highest frequency in genotype I^OI^O and the lowest is I^BI^B with 0.4221 and 0.0288 respectively as indicated in Table 3. The genotypic frequency of heterozygous Rh+ (Dd) also calculated using the Hardy-Weinberg equation, the heterozygous Rh+ (Dd) found to be 0.3502 and the homozygous genotype DD and dd calculated as 0.5986 and 0.0512 respectively in study population (Table 3).

The Chi-Square for the Goodness of fit of ABO and Rh Blood Group Distribution: The chi-square tests for study population were calculated based on the expected and observed results from the findings. It is very important to know whether the study population in Hardy-Weinberg equilibrium or not. The chi-square tests in ABO blood distribution for study population were calculated from the expected and observed values. The ABO blood group distribution is compared with the calculated expected value by using the Chi-square test at P value <0.05, 95% confidence level.

In Table 4, the calculated Chi-Square value for total study population is 5.10 which has the P value is < 0.05 with 3 degrees of freedom. This means that there is no significant difference between values expected for the distribution of ABO blood group and observed for total

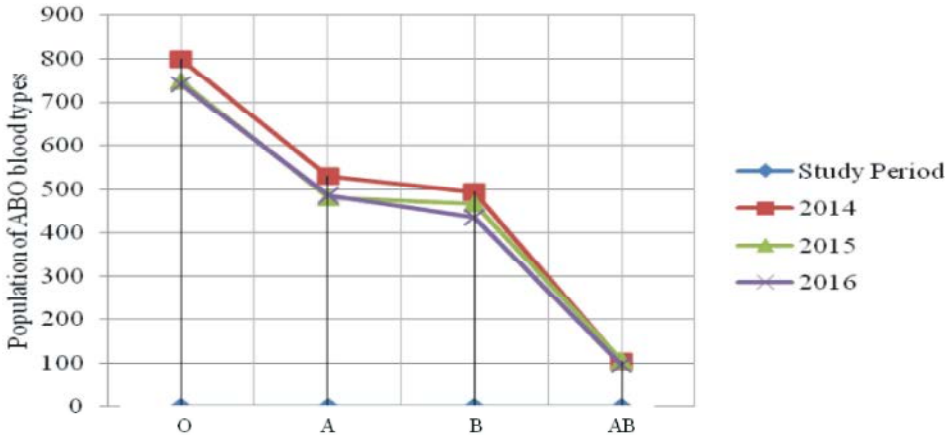

Fig. 2: ABO blood group population trend across the study year (2014-2016)

Table 3: Genotypic and Allelic frequencies of combined ABO and Rh blood groups among blood donors of Bale zone for the years 2014 – 2016 at Goba Blood Bank, Ethiopia

Study site (Period)	Blood group	Gene (Allele)	Allelic Frequency	Genotype	Genotypic Frequency	Phenotype	Phenotypic Frequency
Goba Blood Bank (2014-2016)	ABO	O	0.6497	OO	0.4221	O	0.417
		A	0.1806	AA	0.0326	A	0.273
		B	0.1697	AO	0.2342	A	
				BB	0.0288	B	0.255
				BO	0.2205	B	
				AB	0.0613	AB	0.55
	Rhesus	D	0.7737	DD	0.5986	Rh+ve	
		d	0.2263	Dd	0.3502	Rh+ve	0.9488
				dd	0.0512	Rh-ve	0.0512

Table 4: Observed and Expected Numbers and Frequencies of ABO and Rh blood groups among blood donors of Bale zone for the years 2014 – 2016 at Goba Blood Bank, Ethiopia

	ABO Blood System				Rh Blood System				
ABO Blood group	Observed number	Observed frequency	Expected number	Expected frequency	Rh(D) Blood group	Observed number	Observed frequency	Expected umber	Expected frequency
O	2289	0.417	2315.22	0.422	$Rh(D)^{+ve}$	5204	0.948	5204.17	0.949
					$Rh(D)^{-ve}$	281	0.512	280.83	0.051
A	1497	0.273	1466.14	0.267	Total	5485	1	5485	1
B	1397	0.255	1367.41	0.250	$\chi^2 = 0.00011$, $p < 0.05$				
AB	302	0.55	336.23	0.061					
Total	5485	1	5485	1					

$\chi^2 = 5.10$, $p < 0.05$

study population. The calculated Chi-Square value of Rh blood group is 0.0001 for study population. Hence the overall significance level of the research is acceptable at P value < 0.05% and there is no significant in difference between values obtained for study population. Comparison of Expected and observed values of Rh blood groups distribution in study populations (Table 4) reported that in both Rh positive and Rh negative individuals the observed and expected values are nearly the same. This is also illustrated by Figure 3.

When compared with other reports from similar studies, the results of this study are also consistent with previous findings from other parts in Caucasians in the United States, the distribution is type O, 47%; type A, 41%; type B, 9%; and type AB, 3%. Among African American, the distribution is type O, 46%; type A, 27%; type B, 20%; and type AB; 7%. Among Western Europeans, 42% have group A, 9% group B, 3% group AB and the remaining 46% group O [20, 21, 23].

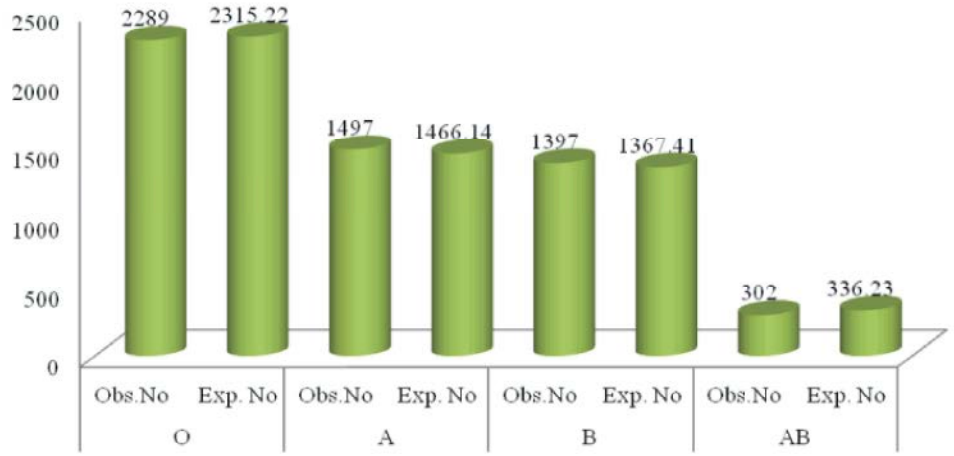

Fig. 3: Observed number (Obs. No) vs. expected number (Exp. No) of the ABO blood group among individuals at Goba Blood Bank in the year 2014-2916.

This study has shown that Rh- positive has the higher percentage frequency while Rh negative has the lower percentage frequency in study population of Bale zone. The frequency of Rh (D) positive blood group was 94.88% and Rh negative 5.12%. These results are consistent with findings of the research carried out on Hematoimmunological profile at Gilgel Gibe Field Research Centre southwest Ethiopia [10]. Again, the findings of this study are in agreement with report from previous similar studies in different parts of the world where the RhD positive was found to be higher in the population sampled than the RhD negative [18, 26]. RhD negative blood group was documented as 5.5% in south India, 5% in Nairobi, 4.8% in Nigeria, 7.3% in Lahore, 7.7% in Rawalpindi. About 95% of African-Americans are Rh-positive [10, 21, 25]. The Rh factor in the study area, 94.88% was Rh positive and 5.12% were Rh negative from the total observed populations. This result is also in line with the study carried out by [26, 28] on ABO and Rh (D) blood groups distribution in the population of Mexican and among selected tribes in Adamawa state of Nigeria respectively.

Allele frequencies of ABO blood groups among blood donors in Bale zone were frequencies of alleles I^A, I^B and I^O were calculated 0.6497, 0.1806 and 0.1697 respectively according to the modified Hardy-Weinberg Law of equilibrium. The order of allele frequencies of ABO blood group among study population in Bale zone were $I^O > I^A > I^B$. Previous studies among various part of the world population have documented similar pattern of allelic frequencies. For instance, studies by in Ogbomoso, South-west Nigeria and in Ilorin, Kwara State of Nigeria all found the allelic frequencies to occur in $I^O > I^A > I^B$ order [18, 26].

The allelic frequencies of Rh (D) blood group were calculated according to the Hardy-Weinberg equation. The frequency of allele D and d are found to be 0.7737 and 0.2263 respectively in study population of Bale zone. This shows that allele D has higher frequency than allele d. This result also agrees with many studies where Rh positive has higher incidence than Rh negative in different populations and ethnic groups.

The genotype frequencies of ABO blood groups among blood donors in Bale zone were frequencies of $I^OI^O = 0.4221$, $I^AI^A = 0.0326$, $I^AI^O = 0.2342$, $I^AI^B = 0.0613$, $I^BI^B = 0.0288$ 0.0269 and $I^BI^O = 0.2205$. The frequency of the genotypes for Rh blood group among blood donors in Bale zone were 0.5986 for I^DI^D, 0.3502 for I^DI^d and 0.0512 for I^dI^d. Most of the A and B blood types are heterozygous dominant (AO and BO respectively) in study population of Bale zone for this study and also it agrees with the finding of the study done by [24] which showed the predominance of O allele may also be as a result of the fact that many A's and B's may have been heterozygous system, the frequency of heterozygous Rh (Dd) obtained for this study was 0.3502, in study population of Bale zone and the homozygous Rh genotype (DD) had the highest frequency 0.5986 and Rh (D) with homozygous recessive (dd) were with the frequency 0.0512 which is equal to population with Rh factor. The calculated Chi-Square value for ABO blood group in Bale zone populations were 5.10 which has the P value is less than

0.05 and with 3 degrees of freedom. This means that there is no significant difference between values expected for the distribution of ABO blood group and observed for total populations in Bale zone. The calculated Chi-Square value of Rh blood group is .00011 for study populations in Bale zone (Table 4). Hence the overall significance level of the research is acceptable at P value < 0.05% and there is no significant in difference between values obtained for study populations in Bale zone.

CONCLUSIONS AND RECOMMENDATIONS

The distributions of ABO and Rh blood groups of this study have similar trends with the data of previous studies in Ethiopian population and with most population of the world. In ABO blood group system in studied population, O blood group record the highest frequency followed by blood groups A, B and AB in this order, while the Rh+ the highest rhesus phenotype frequency. These results are in accordance with those Bale zone population blood donors in Goba Blood Bank.

The data from this study provides information on the genetic variability and polymorphism of the blood group and rhesus antigens among the population in Bale zone. This information would be useful to the population geneticists and to the clinicians, especially in the planning of blood transfusion program since they play integral role of the genetic profile of the Ethiopian population.

The study has a significant implication regarding the management of blood bank and transfusion services in the area. Knowledge of blood group distribution is also important for clinical studies, for reliable geographical information and for forensic studies in the population. Such studies need to be carried out at all the zonal and the regional levels of Ethiopia.

Recommendations: The data generated would be helpful as a base for researchers who are interested to conduct blood frequency related studies type of study in Bale zone the population.

The sample size used to conduct this study was small and may not represent the number of population in the zone. Therefore, it is advisable to use larger sample size to obtain more accurate data regarding the pattern of distribution on these blood groups.

As it was mentioned under the description of the study area of this research, the Blood Bank of Goba town is working on six zonal areas of the country namely: Bale, West Arsi, West Guji, East Guji, Borena and Shashamane town. However, this study dealt with only blood donors of Bale Zone. Therefore, farther research must be conducted on the rest of the zonal units controlled under Goba blood bank.

Conflicts of Interest: The authors declare that they have no conflicts of interest.

ACKNOWLEDGMENTS

The authors acknowledge the financial assistance provided by Ethiopian Ministry of Education to Mindaye Regassa for pursuing his Master of Science studies in Biology. The authors gratefully acknowledge Madda Walabu University for providing necessary support.

REFERENCES

1. Raja, K.A., G.H. Dobariya, C.A. Unagar, A.N. Pandya, J.N. Patel and S.N. Wadhwani, 2016. 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., 4: 5377-5381.
2. Sharma, D.C., R. Sunita, S. Iyenger, B. Jain and S. Sao, 2013. Prevalence and distribution of ABO and Rh-D antigens along with its subgroups & rare types in Greater Gwalior Region. Open J. Blood Dis., 3: 69-73.
3. Mollison, P.L., 1994. The genetic basis of the Rh blood group system. Transfusion, 34: 539–41.
4. Kassahun Tesfaye, Yohannes Petros and Mebeaselassie Andargie, 2014. Frequency distribution of ABO and Rh (D) blood group alleles in Silte Zone, Ethiopia. The Egyptian Journal of Medical Human Genetics, 9(2): 2-5.
5. Tewodros Zerihun, Abraham Degarege and Berhanu Erko, 2011. Association of ABO blood group and Plasmodium falciparum malaria in Dore Bafeno Area, Southern Ethiopia. Asian Pacific Journal of Tropical Biomedicine, 1(4): 289-294.
6. Lekha, M., Archana Shetty and Vijaya Chowdappa, 2016. Distribution of ABO, Rhesus Blood Groups, Transfusion Transmitted Diseases and Adverse Donor Reactions in Blood Bank of Sapthagiri Tertiary Care Hospital, India: A Five Year Study. National Journal of Laboratory Medicine, 10: 1-4.
7. Jaff, M.S., 2010. ABO and rhesus blood group distribution, in Kurds. Journal of Blood Medicine, 1: 143-146.

8. Behra, D. and D. Joshi, 2013. Distribution of ABO blood group and Rh factor in Western Rajasthan. J Med Res., 3: 73-5.
9. Tibebu Mokonnin, 1998. The Blood Bank Manual, Ethiopian Red Cross society, National Blood Transfusion Service, Addis Ababa, pp: 54-63.
10. Abraham Haileamlak, Ayalew Muluneh, Fessahaye Alemseged, Fasil Tessema, Kifle Woldemichael, Makonnen Asefa, Yoseph Mamo, Solomon Tamiru and Gemeda Abebe, 2012. Hematoimmunological profile at Gilgel Gibe Field Research Centre southwest Ethiopia. Ethiopian Journal of Health Science, 22(1): 39-50.
11. Fekadu, A.A., 2015. Distribution of ABO and Rh Blood Groups Among Students of Some Ethnic Groups at Dilla University, Ethiopia, International Journal of Genetics and Genomics, 3(1): 8-19.
12. Fareed, M., Hussain, Ruqaiya, Shah, Ahsana, Afzal, 2014. A1A2BO and Rh gene frequencies among six populations of Jammu and Kashmir, India. Transfusion and nApheresis Science, 50(2): 247.
13. Eweidah, M.S., 2011. Distribution of ABO and Rhesus (RHD) blood groups in Al-Jouf Province of the Saudi Arabia; Anthropologist, 13(2): 99-102.
14. Enosolease, M.E. and Bazuaye G.N., 2008. Distribution of ABO and Rh- D blood groups in the Benin area Of Nigeria-delta implication for regional blood transfusion. Asian J. Transfuse Sci., 2(1): 3-5.
15. Wester, E.S., J.R. Storry and M.L. Olsson, 2011. Characterization of Jk (a+ (weak)): a new blood group phenotype associated with an altered JK*01 allele. Transfusion, 51(2): 380-92.
16. Agrawal, A., A.K. Tiwari, N. Mehta, P. Bhattacharya, R. Wankhede, S. Tulsiani and S. Kamath, 2014. ABO and Rh (D) group distribution and gene frequency; the first multicentric study in India. Asian J Transfus Sci., 8(2): 121-5.
17. Giri, P.A., S. Yadav, G.S. Parhar and D.B. Phalke, 2011. Frequency of ABO and Rhesus blood groups: A study from a Rural Tertiary Care Teaching Hospital in India. International Journal of Biological Medical Research, 2(4): 988 -990.
18. Iyiola, O.A., O.O. Igunnugbemi, U.A. Raheem and A.T. Anifowoshe, 2011. Gene frequencies of ABO and Rh (D) blood group alleles in Ilorin, North-Central Nigeria, World Journal of Biological Research, 4(2): 633-743.
19. Hanania, S., D. Hassawi and N. Irshaid, 2007. Allele frequency and molecular genotypes of ABO blood group system in a Jordanian population. J. of Medical Science, 7: 51-58.
20. Apecu, R.O., Edgar M. Mulogo, F. Bagenda and A. Byamungu, 2016. ABO and Rhesus (D) blood group distribution among blood donors in rural south western Uganda: a retrospective study. BMC Res. Notes, 9: 513.
21. Farhud, D.D. and M. Zarifyeganeh, 2013. A brief history of human blood groups. Iranian Journal of Public Health, 42(1): 01-06.
22. Chakraborty, S., 2011. Genetic analysis on frequency of alleles for Rh and ABO blood group systems in the Barak Valley Populations of Assam .Science Biological, 2(2): 31-34.
23. Talukder, S. and R. Das, 2010. Distribution of ABO and Rh blood groups among blood donors of Dinajpur district of Bangladesh. Dinajpur Med Col J., 3: 55-8.
24. Bakare, A.A., M.A. Azeez and J.O. Agbolade, 2006. Gene frequencies of ABO and rhesus blood groups and hemoglobin variants in Ogbomosho, South West Nigeria; African Journal of Biotechnology, 5(1): 224-229.
25. Chavhan, A., S. Pawar and M. Baig, 2010. Allelic frequency of ABO and Rh D blood group among the Banjara backward caste of Yavatmal District, Maharashtra, India, Nature Proceedings, 5(1): 65-76.
26. Adrián C.R., C.R. Abraham, A.C. José, A.L.M. Mario, J.A.M. Francisco, K.C.Z.T.G.O.E. Cinthia, L.S. Nidia, M.G.L. Alma, V.R. Jorge, M.A. Héctor Flores-Villaseñor, Secundino, J.M.G. Jesús and A.F. Jonathan, 2018. Blood Groups Distribution and Gene Diversity of the ABO and Rh (D) Loci in the Mexican Population, BioMed Research International, vol. 2018, Article ID 1925619, pp: 11. https://doi.org/10.1155/2018/1925619.
27. Swelem, O., F. Goubran, S. Younis and N. Kamel, 2018. ABO, RH phenotypes and kell blood groups frequencies in an Egyptian population. Hematol Transfus Int. J., 6(2): 71-75.
28. Etim, E.A., J.O. Akpotuzor, A.C. Ohwonigho A.A. and Francis, 2017. Distribution of ABO and rhesus blood groups among selected tribes in Adamawa State, Nigeria. Hematol Transfus Int J., 4(6): 149-152.

29. Ohiengbomwan, O.T., N.L. Idemudia, O. Owoicho and A.A. Adeyanju, 2018. Gene Frequencies of Haemoglobin Genotype, ABO and Rhesus Blood Groups among Students Population of a Private University in Nigeria-Implications for Blood Banking. Int. J. Life. Sci. Scienti. Res., 4(4): 1851-1857.

30. Abass Toba Anifowoshe, Olubukola Abibat Owolodun, Kehinde Monica Akinseye, Oluyinka Ajibola Iyiola and Bolaji Fatai Oyeyemi, 2017. Gene frequencies of ABO and Rh blood groups in Nigeria: A review. The Egyptian Journal of Medical Human Genetics, 18: 205-210. https://doi.org/10.1016/j.ejmhg.2016.10.004.