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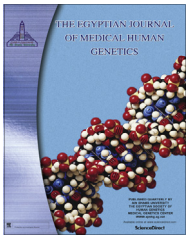

ORIGINAL ARTICLE

Frequency distribution of ABO and Rh (D) blood group alleles in Silte Zone, Ethiopia

Kassahun Tesfaye, Yohannes Petros, Mebeaselassie Andargie *

Biology Department, College of Natural and Computational Sciences (CNCS), Haramaya University, P.O. Box: 138, Dire Dawa, Ethiopia

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KEYWORDS

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Abstract *Background:* Frequency distribution of blood groups is important as it is used in modern medicine, genetic research, anthropology, and tracing ancestral relations of humans. The ABO and Rh blood groups are the most important blood groups despite the long list of several other blood groups discovered so far.

Aim of the study: To study and document the frequency of ABO and Rh (D) blood groups in three ethnic groups of Silte Zone, Ethiopia.

Subjects and methods: ABO and Rh (D) typing was carried out during 2012 and a total of 441 students from both genders were randomly selected from Silte Secondary and Preparatory School, SNNPR, Ethiopia. Finger prick blood samples from both genders were tested for ABO and Rh (D) blood groups by the open slide test method. A drop of each of the antisera, anti-A, anti-B and anti-D was added and mixed with each blood sample and rocked gently for 60 s to observe agglutination.

Results: The blood group "O" was predominant (36.73%, 40.14%, 46.26% in Sodo, Silte and Meskan ethnic groups, respectively) in all the Rh positive subjects whereas blood group "A" was predominant (5.4%) in the Rh negative subjects only in the Sodo ethnic group among the three ethnic groups. The percentage of Rh (D) positive and negative subjects was 91.16%, 93.19%, 91.84% and 8.84%, 6.81%, 8.16% in Sodo, Silte and Meskan ethnic groups, respectively.

Conclusion: The frequency of ABO blood groups in both Rh positive and negative subjects among the three ethnic groups of the Silte Zone, Ethiopia was O > A > B > AB, except in the Sodo ethnic group where the blood group A was the commonest among Rh negative subjects.

1. Introduction

Blood is the most important body fluid, which is responsible for circulation of important nutrients, enzymes, and hormones all across the body, besides the most critical substance, oxygen. The ABO blood group system is widely credited to have been discovered by the Austrian scientist Karl Landsteiner, who

Abbreviations: Rh, Rhesus.

* Corresponding author.
E-mail address: mebhel@yahoo.com (M. Andargie).

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found three different blood types in 1900 [1]. He described A, B and O blood groups for which he was awarded the Nobel Prize in 1930. Alfred Von Decastello and Adriano Sturli discovered the fourth type AB, in 1902 [2]. The classification of blood groups into type A, B, AB and O in ABO system, Rh-positive and Rh-negative in Rh system is based on the presence or absence of inherited antigenic substances on the surface of the red blood cells. The antigens may be proteins, carbohydrates, glycoproteins, and glycolipids depending on the blood group system [3].

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 medicolegal issues, particularly of disputed paternity and more importantly in compatibility test in blood transfusion practice. 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 [4–7]. Percentages of people belonging to these blood groups are different in different communities. Distribution of these blood groups is also different in different races. The frequencies of ABO blood groups vary from one population to another and time to time in the same region. The knowledge of distribution of ABO and Rhesus (Rh) blood groups at local and regional levels is helpful in the effective management of blood banks and safe blood transfusion services [8]. Thus, this shows that the need for estimates of blood group and gene's frequency studies is multipurpose and provides 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 two populations [9]. There have been no known data of the distribution pattern and frequency of ABO and Rh blood groups from Silte Zone, SNNPR, Ethiopia. This study aims at providing information on the distribution pattern of the phenotypes and genotypes, and the gene frequencies of these genetic variants in this region.

2. Subjects and methods

The study design was approved by the Research Ethics Committee, College of Science, Haramaya University, Dire Dawa, Ethiopia. A total of 441 subjects of both sexes from Silte Secondary and Preparatory school were randomly selected and included in this study. The students were divided into 3 major ethnic groups i.e., Sodo, Silte and Meskan. Informed consent was granted prior to the sample collection. Blood samples were collected fresh without any anti-coagulant by finger prick with sterile lancet using an open slide method of testing ABO blood types and Rh (D) factor [10]. Before pricking the bulb was sterilized with alcohol swab, compressed and pricked slightly with the help of lancet, the oozed blood was placed on a clean slide at three places over a glass slide and to each blood drop placed at separate places a drop of anti-sera (anti-A, anti-B and anti-D) (manufactured by Tulip Diagnostics (P) Limited, Old Goa, India) was added and separately observed for the agglutination. The grouping was done by antigen-antibody agglutination test.

Allele frequencies were calculated under the assumption of Hardy–Weinberg equilibrium and expressed as percentages. Chi-square test was used to compare observed allelic and genotypic frequency distributions of the blood group and Rh antigens to that expected under the Hardy–Weinberg.

3. Results

3.1. Frequency of ABO and Rh blood grouping

The four hundred and forty one (441) Secondary and Preparatory school students selected randomly consist of 255 males and 186 females between ages 18 and 20. There are differences in frequency distribution of the blood group (ABO) among the ethnic groups of the students. Blood group O has the highest frequency while blood group AB has the lowest frequency (Table 1). Blood group O is highly distributed in the Meskan ethnic group than Silte and Sodo ethnic groups. The frequency of blood group A is higher in Sodo than Silte and Meskan ethnic groups and blood group B is dominant in the Sodo ethnic group than Silte and Meskan. Blood group AB has equal frequency in the three ethnic groups.

The variations in the frequency distribution of Rh-positive and Rh-negative among the three ethnic groups followed the same pattern as shown in Table 2. The percentage of distribution of the ABO blood group and ethnic groups varies significantly based on the Rh blood group (Table 3). The ABO blood group distribution based on Rh in Sodo and Silte is the same in blood group A with Rh positive (26.53%) but in Meskan the percentage of blood group A is reduced to 20.41% of the total population. As it is indicated in Table 3, blood group AB with Rh positive has a small percentage distribution in the three ethnic groups than blood group A and B. Blood group O with Rh positive of Sodo was 36.73% and that of the Silte was 40.14% which is higher than the Sodo ethnic group and 46.26% for the Meskan ethnic group. So, blood group O with Rh positive is dominant in the Meskan ethnic group. As compared to the other blood groups, blood group O with Rh positive percentage distribution varies significantly in the three ethnic groups. However, the percentage distribution of Rh negative is very small or rare in the three representative groups.

Table 1 Phenotypic distribution of ABO blood group system among students of the three ethnic groups at Silte Zone, Ethiopia.

Ethnic groups	Blood type frequency distribution				Total
	Type A	Type B	Type AB	Type O	
Sodo	47(31.97%)	38(25.85%)	8(5.44%)	54(36.74%)	147(100%)
Silte	42(28.57%)	34(23.13%)	8(5.44%)	63(42.86%)	147(100%)
Meskan	35(23.81%)	31(21.09%)	8(5.44%)	73(49.66%)	147(100%)
Total	124(28.11%)	103(23.35%)	24(5.44%)	190(43.08%)	441(100%)

Table 2 Phenotypic distribution of Rhesus factor blood group among students of the three ethnic groups at Silte Zone, Ethiopia.

Ethnic groups	Rhesus system		Total
	Rh positive	Rh negative	
Sodo	134(91.156%)	13(8.843%)	147(100%)
Silte	137(93.197%)	10(6.8%)	147(100%)
Meskan	135(91.84%)	12(8.16%)	147(100%)
Total	406(92.06%)	35(7.94%)	441(100%)

3.2. Estimation of ABO blood group and Rh (D) alleles

The overall allelic frequencies among students of each ethnic group as it was calculated using the extension of the Hardy–Weinberg law were 0.65, 0.19 and 0.15 for O, A and B alleles, respectively (Table 4). On the rhesus status, 92.06% were Rh +ve while 7.94% were Rh −ve. This gave the allelic frequencies as 0.72 and 0.28 for D and d alleles, respectively.

Figs. 1 and 2 represent comparison between observed and expected values for both ABO blood group and Rh factor of the three ethnic groups, respectively. The observed frequency for Rh positive was 91.2%, 93.2%, and 91.8% and the expected was 94.6% for Sodo, Silte and Meskan ethnic groups, respectively; while the observed frequency for Rh negative was 8.8%, 6.8%, and 8.2% and the expected value was 5.4% for Sodo, Silte and Meskan ethnic groups, respectively.

We found that the distribution and proportion of individuals having ABO blood antigens did not differ from those expected under Hardy–Weinberg equilibrium for Sodo and Silte ethnic groups (goodness-of-fit χ^2 for ABO = 1.54,

Table 3 ABO blood group frequency among students of each ethnic group based on Rh blood group system.

Ethnic groups	Rh blood group	Blood types				Total
		A	B	AB	O	
Sodo	Positive	39(26.53%)	33(22.47%)	8(5.44%)	54(36.73%)	134(91.16%)
	Negative	8(5.44%)	5(3.42%)	0(0%)	0(0%)	13(8.89%)
Silte	Positive	39(26.53%)	32(21.77%)	7(4.76%)	59(40.14%)	137(8.89%)
	Negative	3(2.04%)	2(1.36%)	1(0.682%)	4(2.72%)	10(6.8%)
Meskan	Positive	30(20.41%)	29(19.732%)	8(5.44%)	68(46.26%)	135(91.84%)
	Negative	5(3.4%)	2(1.36%)	0(0%)	5(3.40%)	12(8.16%)
Total	Positive	108(24.49%)	94(21.32%)	23(5.22%)	181(41.042%)	406(92.06%)
	Negative	16(8.88%)	9(2.04%)	1(0.23%)	9(2.04%)	35(7.94%)
						441(100%)

Table 4 Gene frequencies of ABO and Rh blood group alleles among students of the three ethnic groups at Silte Zone, Ethiopia.

Ethnic groups	Gene (allele)	Frequency	Genotype	Frequency	Phenotype	Frequency (%)
Sodo	O(r)	0.6060	OO	0.3673	O	36.73
	A(p)	0.2230	AA	0.0497	A	4.97
	B(q)	0.1712	AO	0.2699	A	26.99
			BB	0.0293	B	2.93
			BO	0.2293	B	22.93
			AB	0.0544	AB	5.44
	D	0.7000	DD	0.4900	Rh (D) +ve	49.00
			Dd	0.4220	Rh (D) +ve	42.20
	d	0.2970	dd	0.0900	Rh (D) −ve	9.00
Silte	O(r)	0.6546	OO	0.4285	O	42.85
	A(p)	0.1900	AA	0.0361	A	3.61
	B(q)	0.1553	AO	0.2496	A	24.96
			BB	0.0535	B	5.35
			BO	0.1778	B	17.78
			AB	0.0544	AB	5.44
	D	0.7150	DD	0.5100	Rh (D) +ve	51.00
			Dd	0.4200	Rh (D) +ve	42.00
	d	0.2850	dd	0.0820	Rh (D) −ve	8.20
Meskan	O(r)	0.7047	OO	0.4966	O	49.66
	A(p)	0.1524	AA	0.0232	A	2.32
	B(q)	0.1429	AO	0.2148	A	21.48
			BB	0.0204	B	2.04
			BO	0.1905	B	19.05
			AB	0.0544	AB	5.44
	D	0.7150	DD	0.5100	Rh (D) +ve	51.00
			Dd	0.4010	Rh (D) +ve	42.00
	d	0.2850	dd	0.0812	Rh (D) −ve	8.20

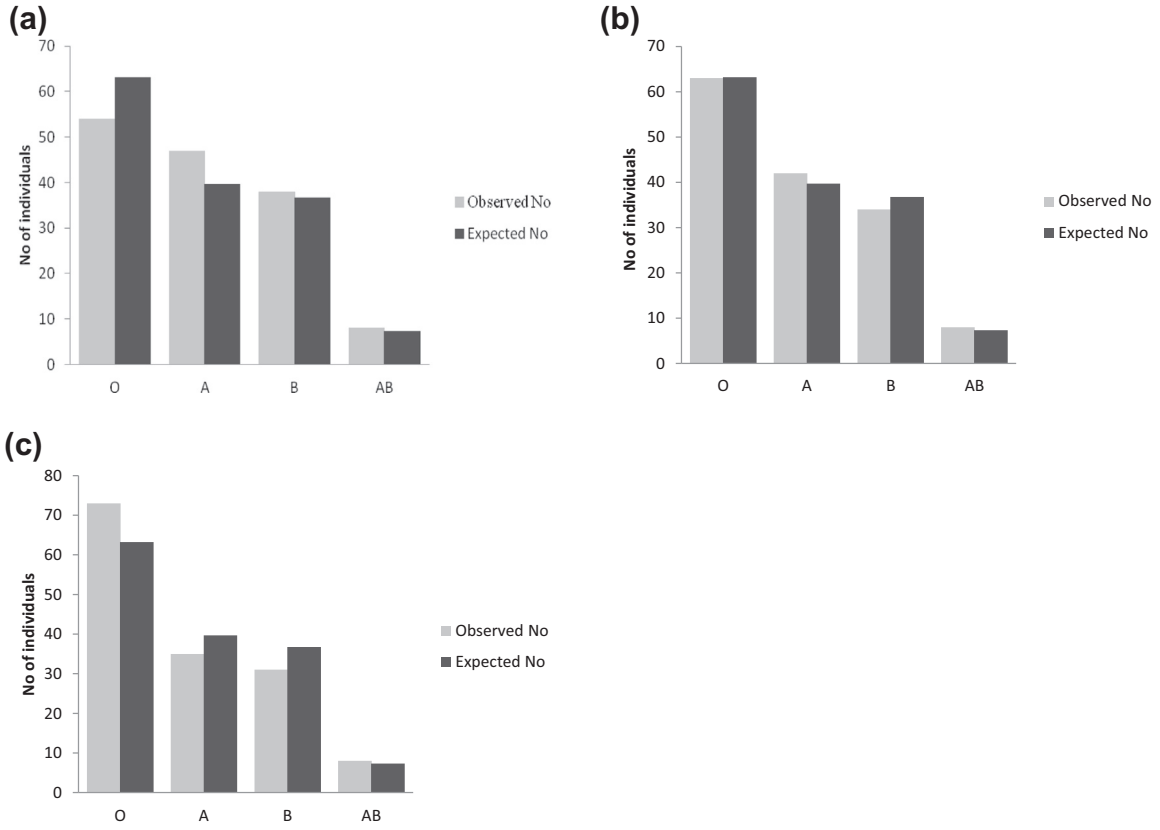

Figure 1 Observed (Obs.) vs expected (Exp.) frequencies of the ABO blood group among the three ethnic groups: (a) Sodo; (b) Silte; (c) Meskan.

df = 3, $P < 0.05$; goodness-of-fit χ^2 for ABO = 0.393, df = 3, $P < 0.05$) which is statistically insignificant with the values reported for Ethiopia, however; the distribution and proportion of individuals having ABO blood antigens differ from those expected under Hardy–Weinberg equilibrium for the Meskan ethnic group (goodness-of-fit χ^2 for ABO = 3.054, df = 3, $P < 0.05$). This value shows a greater deviation from the population of Ethiopia as a whole but the difference is not significant. The distribution and proportion of individuals having Rh blood antigens for all the three ethnic groups did not differ from those expected under Hardy–Weinberg equilibrium (goodness-of-fit χ^2 for Rh = 3.13, df = 1, $P > 0.05$; goodness-of-fit χ^2 for Rh = 0.60, df = 1, $P > 0.05$; goodness-of-fit χ^2 for Rh = 1.54, df = 1, $P > 0.05$ for Sodo, Silte and Meskan, respectively) which is statistically insignificant.

4. Discussion

Due to its medical importance in relation to different diseases, pursuing a line of investigation on the ABO and Rh blood group systems has been of significance for years. It is well known that these blood group systems are of great importance in blood transfusion and organ transplantation [11], and has a paramount importance that the donor blood cells match those of the recipient; otherwise, donor blood cells may be destroyed by antibodies present in the plasma of the recipient. Furthermore, the susceptibility to several diseases has been associated with the ABO phenotype, but such correlation remains controversial [12,13].

In this study, blood group O is highly distributed in the Meskan ethnic group than Silte and Sodo ethnic groups. The frequency of blood group A is higher in Sodo than Silte and Meskan ethnic groups and blood group B is dominant in the Sodo ethnic group than Silte and Meskan. Blood group AB has equal frequency in the three ethnic groups. In line with our report, previous studies conducted by Nwauche and Ejele as well as Flausi and his colleagues showed that there are variations in the ABO blood group among different ethnic groups [14,15]. Gene frequencies with respect to ABO system for the present study can be shown with a general formula O > B > A > AB which does not seem to deviate from the studies carried out previously in different parts of the world. [3,14] reported that blood group O was the most common blood group and blood group AB was the least common blood group in different ethnic groups. The findings from this study are in accordance with the aforementioned studies that also reported AB as the least prevalent blood group [3,16–19]. Thus, the gene segregation for ABO systems always followed a particular pattern for its distribution in different ethnic groups with exceptional cases. However, in the studies conducted on Nepalese medical students by Pramanik and Pramanik [16] and on a report by Tomilin and Gurtovaia [20] on a population of the Russian Federation, A was the most prevalent blood group. Similarly [21], reported that blood group B was the most prevalent one in Bannu region in Pakistan. Such contradictions are probably due to immensely different sample sizes,

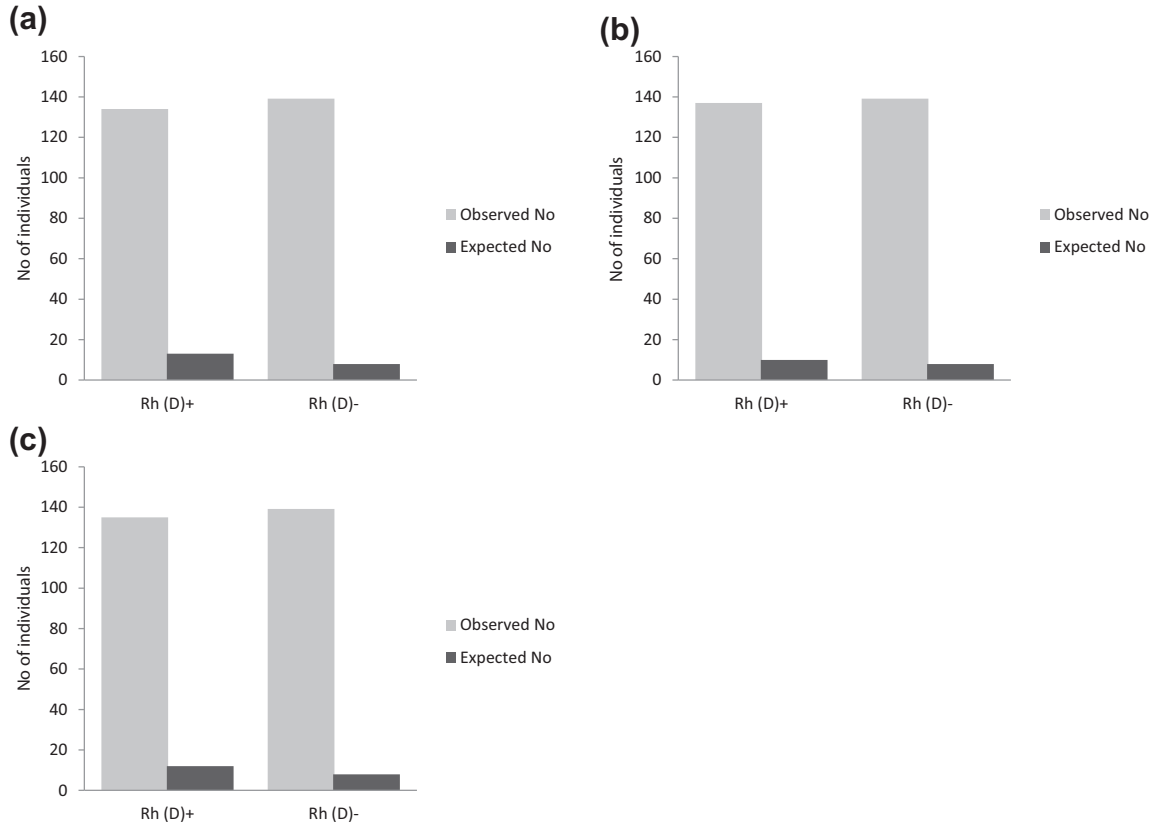

Figure 2 Observed (Obs.) vs expected (Exp.) frequencies of Rh Blood groups among the three ethnic groups: (a) Sodo; (b) Silte; (c) Meskan.

geographical environments and ethnic groups in the study populations. Moreover, it shows that specific ABO blood groups might be distributed in different regions of the world.

Most antigens from the blood group Rh are weak and do not really elicit antibody production. The exception is the D antigen, which is strong and is likely to cause transfusion problems. Thus, the classification of being Rh+ or Rh− is dependent on the presence of this particular antigen [22]. As such, this blood group is considered to be a case of single gene inheritance with dominance. On the Rhesus factor, this study further confirmed that Rh+ has the highest percentage frequency while Rh− has the lowest percentage frequency in all the three ethnic groups as observed in previous studies among different ethnic groups [15,23,24]. The current as well as the previous findings confirmed the trend of the relatively low incidence of rhesus negativity in the African population. However, we observed that our results differ from the study conducted by Yousaf and his colleagues [25] among Bahawalpur division of Pakistan population where the subjects were exclusively Rh (D) positive. We also need to stress that we did not come across any previous studies on this subject where there was a higher proportion of Rh (D) negative in the sampled population at all.

The relevance of having knowledge about the blood group systems among different ethnic groups in any population is enormous. The types of information obtained from the findings are useful for genetic information, genetic counseling, medical diagnosis as well as general and physiological wellbeing of individuals in a population. We report in this paper the blood type frequencies for multiple blood groups of a regional population in Silte Zone, Ethiopia. No significant differences were found in the ABO and Rh blood groups' frequency distribution compared to the national data. All the three ethnic groups are in Hardy–Weinberg equilibrium in general, but in the Silte ethnic group the equilibrium is much stronger than the other two and the least was observed in the Meskan ethnic group. Furthermore, the data generated in this study would be helpful to the researchers in the field of population genetics to explore the factors responsible for the observed distribution patterns of these genetic markers in this part of central Ethiopia or even to east Africa.

5. Conclusion

We believe that data from this study have provided information on the genetic variability and polymorphism of the blood group and rhesus antigens among the population in Silte Zone, Ethiopia. This information would be useful to the geneticists and to the clinicians especially in the planning of blood transfusion programmes since they play an integral role in the genetic profile of the Ethiopian population.

Declaration of conflicting interests

The authors declare no conflicts of interest. There is no financial and personal relationship with other people or organiza-

tions that could inappropriately influence this work. The authors declared no potential conflicts of interests with respect to the authorship and/or publication of this article.

Human and Animal Rights

The work described in this article has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki).

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