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Distribution of ABO and Rh (D) Blood Groups and their Genotypes in Amran Governorate, Yemen

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ABSTRACT

Background: The ABO and Rh blood group systems are essential for blood bank inventory and blood transfusion services. Therefore, this study aimed to determine the distribution of ABO and Rh (D) blood group and their genotypes in the Amran governorate, Yemen. **Methods**: A cross-sectional study was carried out from January 2020 to December 2021, on 1949 volunteer blood donors were obtained from Amran University and the blood bank of the Maternity and childhood hospital at Amran. The ABO and RhD grouping was done by using commercially available monoclonal IgM antibodies (anti-A, anti-B, and anti-D) by slide methods. The allele and genotype frequency of the donors was determined by the Hardy-Weinberg equilibrium assumption. Descriptive statistics were analyzed using the SPSS (version 22) program. The difference between the observed and expected frequency was tested by an online Chi-square calculator. A *P*-value of <0.05 was considered statistically significant. **Results**: Out of 1949 participants; were 78.8% of hospital donors, 92.2% of males, and 63.5% of rural areas. Blood group O was the most prevalent (51.2%), followed by A (31.5%), B (13.9%), and AB (3.5%) with statistically significant differences (*P*= 0.002). The Rh (D) positive was present in 86.8% of participants and 13.2% were Rh (D) negative. Moreover, the allele frequencies were in the order of ($I^O > I^A > I^B >$ AB), where (I^O i = 0.513, I^A = 0.313, I^B = 0.138, and AB= 0.035). While the Rh(D) and d allelic were 0.868 and 0.132, respectively. Conclusion: The frequency of ABO and Rh (D) blood group and their genotypes were found to be similar to those reported from most Asian populations. This crucial information may be helpful in planning for future health challenges, particularly planning with regard to blood transfusion services.

1. Introduction:

The term blood group refers to the entire blood group system comprising red blood cell (RBC) antigens and a series of genes controlling the specificity of the blood group, which can be allelic or linked closely on the same chromosome. Currently, about 43 blood group systems containing 345 red cell antigens were recognized **[1]**. Human ABO blood-type antigens exhibit alternative phenotypes and genetically derived glycoconjugate structures that are located on the red cell surface which play an active role in the cells' physiology and pathology **[2].**

Among blood group systems identified, ABO (with blood types A, B, AB, and O) and Rhesus (with Rh D-positive or Rh D-negative blood types) are the most important in transfusion medicine. ABO blood group antigens are the most immunogenic of all the blood group antigens followed by Rh (D antigen) **[3].**

According to ABO blood group/Rhesus factor nomenclature, a person can belong to either of the following eight blood groups: A

Rh+ (A+), A Rh- (A-), B Rh+ (B+), B Rh- (B-), AB Rh+ (AB+), AB Rh- (AB-), O Rh+ (O+) and O Rh- (O-) **[4**].

The distribution of ABO and Rh blood groups are varying among different regions and races in the world. There are some factors such as geographical, ethnic, racial, and tribal variations that result in long-lasting differences in the frequency distribution of the blood groups. Also, temporal changes in the frequency distribution may also occur due to socioeconomic developments that bring new people into the population as well as the tendency to move out to other settlements **[5].**

The ABO and Rh blood group antigens are investigated Serologically or Molecular Biology Technique to Detect Blood Group Antigen Profile and understanding human inheritance and migration patterns. These blood group systems have also got vital clinical and practical significance. They are routinely screened in transfusion and transplantation, pregnancy, forensics, paternity testing, and legal medicine **[6].**

Knowledge of the distribution of the ABO-Rh blood group is helpful for the effective management of blood banks and safe blood transfusion services. Particularly, identification of the Rh system is important to avoid a potential risk of erythroblastosis fetalis **[7,8,9].** Associations between blood type and disease have been studied since the early 1900s when researchers determined that antibodies and antigens are inherited. However, due to the lack of antigens in some blood groups, there have been some contentious issues with the association between the ABO blood group and vulnerability to certain infectious and noninfectious diseases **[2, 10, 11,12].**

Up to date, there are only two studies conducted in Yemen. A study by **Al-Nahari [13]** found that the most common blood groups of ABO groups was group O (52%), B (24%), B (17%), and AB group (8%) reported among Al-Muhamasheen groups. Also, the overall picture of phenotypic frequencies of ABO blood groups was O>B>A>AB. While in Tribesmen the most common blood group was found to be group O (53%), followed by Group A (35%), group B (9%), and Group AB (3%). Frequencies of ABO groups in the Tribesmen group showed O> A > B >AB. The distribution of allele frequencies among Al-Muhamasheen was allele, O (r) (0.700897), B(q) (0.172675,) and A(p) (0.126429). While in Tribesmen allele O (r) is observed with the highest frequency (0.728918).

Moreover, another study conducted in five Yemeni provinces including Al-Jawf, Lahij, Al-Hudaydah, Abyan, and Amran by **Al-Nahari [14]** the O blood group was highly reported at 78.79% in Al Jawf, 64.62% in Lahij, 63.73% in Al-Hudaydah, 60.4% in Abyan, and 53.58% in Amran (0.73326) followed by the A blood group in Amran 34.25% (0.26375) and the lowest was in Al Jawf (23.05%). The B blood group was highly distributed at 10.29% (0.0640) in Abyan and the lowest frequency 5.07% (0.02846) was in Al-Jawf. The Rh-positive was 96.32% O>A>B>AB, and O> A>B among Rh-negative donors. The highest rate of Rh-positive was 95.93% recorded among the Al-Jawf province population. The Rh(D) and d allelic frequency was found to be 0.79826.

To date, there is a paucity of literature on the frequency and distribution of the ABO blood and Rhesus (D) blood group among the population living in Amran governorate, Yemen. Therefore, the present study amide to determine the distribution of the ABO blood and Rhesus (D) blood group among the population living in the Amran governorate

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2. Materials and Methods

Study Design, Area, and Period

This study is a cross-section study conducted at the Medical Laboratory of the Faculty of Medicine belonging to Amran University, Amran City, Yemen during the period from January 2020 to December 2021. This investigation was applied at Amran governorate located about 50 km north of Sana'a, the capital of Yemen. The experimental work was performed at the hematology laboratory at Amran University.

Study population and size

The present carried out among Medical Laboratory students, Amran University and donors who attended the blood bank belonging to Maternity and Childhood Hospital, Amran Governorate. A total of 1949 participants enrolled in this work; 414 (21.2%) were collected from the medical lab. students and 1535 (78.8%) were collected from blood bank.

Inclusion and exclusion criteria

The study subjects who were born in Amran Governorate aged between 18-70 years old, above 50 kg in weight, signed informed consent, delivered blood specimens, and met the required hemoglobin levels (males ≥13.0 g/dL; females ≥12.0 g/dL) were included. In contrast, the participants who not bore in the Amran governorate, his/her data incomplete, refused to deliver blood specimens, and didn't sign the informed consent were excluded.

Data collection

A structured questionnaire was used to collect the required data from participating individuals. The required data such as gender, age, and residential area, marital state were gathered for participating students via face-to-face interview and recorded in a questionnaire sheet.

Ethical consideration

The ethical statement for this study was permitted by Amran University Ethics and Review Committee and also confirmed by the blood bank Manager. The concept and purpose of this study were explained to the study participants and hospital administration. Moreover, informed consent was obtained from all subjects.

ABO and Rh blood groupings analysis

Blood samples were collected from a sterilized finger from each participant by using a sterile lancet and placed on a clean white in three places. In addition, a drop of antisera, anti-A, anti-B, and anti-D (DIAGAST and Diagnostic Grifols Barcelona, Spain) was added and rocked gently with each blood sample. Then, the blood groups were determined on the basis of agglutination. In case of doubt, the test was examined under a microscope, or the results were confirmed by reverse grouping using known group A and B red cells **[15]**. Data on the frequency of ABO and Rh-D blood groups were reported in simple percentages.

3. Statistical analysis

Descriptive statistics were used to calculate frequencies of the phenotype of the blood ABO and Rh blood groups and results were reported as frequencies and percentages.

The genotypic and allelic frequencies of the ABO and Rh blood groups were calculated from the observed phenotypes of ABO and Rh under the assumption of Hardy– Weinberg equilibrium **[16].**

Allelic frequency was estimated by using the Hardy–Weinberg equilibrium of quantitative genetics (15).

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:

$r = \sqrt{O}$ = Allele I^O $p = 1$

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

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

Therefore, the genotypic frequencies are represented as:

$(p + q + r)^2 = p^2 + 2pq + q^2 + 2pr + 2qr + r^2 = 1$ and $p + q + r = 1$

Where, **p2** is the genotypic frequency of $\mathbf{I^A\ I^A}$, $\mathbf{q^2}$ is the genotypic frequency of $\mathbf{I^B\ I^B}$, **2pq** is the genotypic frequency of $\mathbf{I^A\ I^B}$, **2pr** is the genotypic frequency of $\mathbf{I^A\ I^O}$, **2qr** is the genotypic frequency of I^B I^O and r^2 is the genotypic frequency of $\mathbf{I^O\ I^O}$ **(16).**

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

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

P = 1 – q = 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

Genotype DD = p2

Genotype Dd = 2pq

Genotype dd = q2

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.

$$X^2 = \frac{\Sigma\,(Of\ -\ Ef)2}{Ef}$$

Where; Of = Observed frequency;
Ef = Expected frequency.

Expected phenotypic frequencies for each blood group were calculated as:

1. A blood group Ef = frequency of (AA + AO) X number of total sample,
2. B blood group Ef = frequency of (BB + BO) X number of total sample,
3. AB blood group Ef = frequency of AB X number of total sample,
4. blood group Ef = frequency of OO X number of total sample **[16]**.

4. Results

Socio-demographic parameters

A total of 1949 specimens; 414 (21.2%) medical students and 1535 (78.8%) hospital donors to determine the prevalence ABO and Rh blood groups. It was that the male was predominant in blood donation accounting for 92.2%(1797/1949). Also, the majority of the participants lived in rural areas (63.5%). The highest rate of ABO blood group was O group (51.2%), followed by A blood group (31.5%) B blood group (13.9%), and AB blood group (3.5%). Among the total population, 86.8% were Rh (D) positive, while the rest of 13.2% were Rh (D) negative as illustrated in **Table (1).**

Table (1). Socio-demographic data, blood and Rh(D) groups among study subjects

Variables	Categories	Frequency No. (%)	*P*-value*
Population	**Student**	414 (21.2)	**0.001**
	Hospital	1535 (78.8)	
Gender	**Male**	1797 (92.2)	**0.002**
	Female	152 (7.8)	
Residence	**Rural**	1238 (63.5)	**0.000**
	Urban	711 (36.5)	
ABO blood group	**A**	614 (31.5)	**0.001**
	B	270 (13.9)	
	AB	68 (3.5)	
	O	997 (51.2)	
Rh phenotypes	**Rh positive**	1692 (86.8)	**0.042**
	Rh negative	257 (13.2)	

*** Measured by Chi square test (*P*<0.05 is considered significant)**

Distribution of Rhesus (D) groups among ABO blood groups

The overall frequency of Rhesus (D) positive groups among studied population A, B, AB, and O blood groups was 533(86.8%), 209(77.4%), 60(88.2%), and 890(89.3%), respectively. The most common Rhesus (D) negative blood type in the studied population is B with a rate of 22.6%, followed by A (13.2%), AB (11.8%), and O (10.7%) with statically significant differences (*P*=0.000) **(Table 2)**.

Table (2). Distribution of Rhesus (D) groups among ABO blood groups

ABO blood group	Rhesus (D) Positive No. (%)	Rhesus (D) Negative No. (%)	Total No. (%)	*P*-value
A	533 (86.8)	81 (13.2)	614 (31.5)	**000**
B	209 (77.4)	61 (22.6)	270 (13.9)	**000**
AB	60 (88.2)	8 (11.8)	68 (3.5)	**000**
O	890 (89.3)	107 (10.7)	997 (51.2)	**000**

Total	**1692 (86.8)**	**257 (13.2)**	**1949 (100)**	

*** Measured by Chi square test (*P*<0.05 is considered significant)**

Distribution of ABO blood groups among Residence

The current result showed that there were no statistically significant differences (*P*=0.705) between the distribution of the blood group (ABO) regarding the residency areas **(Table 3)**.

Table (3). Distribution of ABO blood groups according to residence area

Residence	A No.(%)	B No.(%)	AB No.(%)	O No.(%)	*P*-value
Urban	220 (30.9)	103 (14.5)	21(3.0)	367(51.6)	0.705
Rural	394 (31.8)	167 (13.5)	47(3.8)	630(50.9)	
Total	614 (31.5)	270 (13.9)	68 (3.5)	997 (51.2)	

*** Measured by Chi square test (*P*<0.05 is considered non insignificant)**

This result revealed that there were no statistically significant differences (*P*=0.450) between the distribution of the blood group (ABO) concerning the gender **(Table 4).**

Table (4). Distribution of ABO blood groups concerning gender

Gender	A No.(%)	B No.(%)	AB No.(%)	O No.(%)	*P*-value
Male	**572(31.8)**	**248(13.8)**	**49(2.7)**	**928(51.6)**	**0.450**
Female	**42 (27.6)**	**22 (14.5)**	**19(12.5)**	**69(45.4)**	
Total	**614 (31.5)**	**270 (13.9)**	**68 (3.5)**	**997 (51.2)**	

*** Measured by Chi square test (*P*<0.05 is considered non-significant)**

Distribution of ABO blood groups among Directorates of Amran

The distribution of blood and Rhesus (D) groups among Amran Directorates. It was found the highest rate of blood group O was in Alsoad (85.5%), A in Thebin (63.3%), B in Shehara (43.9%), and AB in kaflat Ethir (34.1%). In contrast, the lowest rate of blood group O was in Eial Soreh (33.2%), A in Almdan (6.3%), B in Maswarah (3.1%), and AB in Kamer (1.1%). Moreover, the highest rate of Rhesus (D) positive was recorded among study subjects lived in Almdan (100.0%) and Shehara (100.0%) while the lowest rate was in Hoth (72.1%). Similarly, the highest rate of Rhesus (D) negative was reported in Hoth (27.9%) and the lowest was in Sowair (3.1%) **(Table 5).**

Table (5). Distribution of blood and Rhesus (D) groups concerning Directorates

Directorate	ABO				Total	Rh positive No.(%)	Rh negative No.(%)
	O No.(%)	A No.(%)	B No.(%)	AB No.(%)			
Alsod	53 (85.5)	5(8.1)	2(3.2)	2(3.2)	62	57(91.9)	5(8.1)
Alsoad	70(77.8)	15(16.7	5(5.6)	0(0.0)	90	84(93.3)	6(6.7)
Aloshshah	24 (61.5)	12(30.8)	2(5.1)	1(2.6)	39	33(84.6)	6(15.4)
Almdan	27(84.4)	2(6.3)	3(9.4)	0(0.0)	32	32(100.0)	0(0.0)
Banisorim	42(48.8	28(32.6)	12(14.0)	4(4.7)	86	72(83.7)	14(16.3)
Thala	9(40.9)	8(36.4)	5(22.7)	0(0.0)	22	20(90.9)	2(9.1)
Eial Yasid	66(54.1)	40(32.8)	12(9.8)	4(3.3)	122	108(88.5)	14(11.5)
Tholimah	11(78.6)	3(21.4)	0(0.0)	0(0.0)	14	11(78.6)	3(21.4)
Harf sofian	28(65.1)	10(23.3)	5(11.6)	0(0.0)	43	32(74.4)	11(25.6)
Hoth	31(50.8)	18(29.5)	5(8.2)	7(11.5)	61	44(72.1)	17(27.9)
Karef	31(41.3)	39(52.0)	4(5.3)	1(1.3)	75	63(84.0)	12(16.0)
Kamer	51(54.3)	30(31.9)	12(12.8)	1(1.1)	94	86(91.5)	8(8.5)

Thebin	11(36.7)	19(63.3)	0(0.0)	0(0.0)	30	27(90.0)	3(10.0)
Redah	29(39.7)	19(26.0)	24(32.9)	1(1.4)	73	66(90.4)	7(9.6)
Shehara	18(43.9)	5(12.2)	18(43.9)	0(0.0)	41	41(100.0)	0(0.0)
Sowair	12(36.4)	11(33.3)	9(27.3)	1(3.0)	33	32(97.0)	1(3.0)
Amrnan	298(41.9)	209(29.4)	184(25.8)	21(2.9)	712	627(88.1)	85(11.9)
Eial Soreh	71(33.2)	71(33.2)	69(32.2)	3(1.4)	214	174(81.3)	40(18.7)
kaflat Ethir	14(34.1)	7(17.1)	6(14.6)	14(34.1)	41	32(78.0)	9(22.0)
Maswarah	32(49.2)	23(35.4)	2(3.1)	8(12.3)	65	51(78.5)	14(21.5)
Total	**997(51.2)**	**614 (31.5)**	**270 (13.9)**	**68 (3.5)**	**1949**	**1692(86.8)**	**257(13.2)**

Gene frequencies of ABO blood group alleles among the different ABO blood groups

The Gene frequencies of ABO blood groups alleles and allelic frequencies of the Rhesus (D) groups among the studied population according to the Hardy Weinberg Law. The allele frequencies were in the order of ($I^O > I^A > I^B >$ AB), where (I^O i = **0.513**, I^A = **0.313**, I^B = **0.138** and AB= **0.035**) **(Table 6)**. While the Rh(D) and d allelic frequencies were 0.868 and 0.132, respectively, depend on the observed phenotype, allelic and genotypic frequency of the ABO and Rh blood group was compared by using the Hardy–Weinberg equilibrium assumption **[16].**

Calculation:

- Calculation of O allele frequency I^O (r)
  r^2 = frequency of the O phenotype
  r = 0.716
- Calculation of O allele frequency $\boldsymbol{I}^{\mathrm{A}}$ **(p)**
  p = frequency of the A phenotype + frequency of the O phenotype
  $p^2+2pr+ r^2=(p + r)^2$
  p =0.909- 0.716= 0.193
- Calculation of B allele frequency I^B (q)
  q = 1− (p + r)
  q = 1− (0.193 + 0.716)
  q = 1− 0.909= 0.091
- Calculation of D allele frequency I^d (u)
  u2 = frequency of the d phenotype
  u =0.363
- Calculation of D allele frequency I^D (v)
  u+v = 1
  v = 1−u
  v = 1−0.363
  v = 0.637
- Calculation of genotypic frequency
  - AA = p^2 = 0.037
    AO = 2pr = 0.276
  - BB = q^2 = 0.008
    BO = 2qr = 0.130
  - OO = r^2 = 0.513
    AB = 2pq = 0.035
  - dd = u^2 = 0.132
    Dd = 2uv = 0.462
  - DD = v^2 = 0.406

Table (6). Gene frequencies of ABO blood groups alleles among the different ABO blood groups

Variables	Phenotype	Observed frequency (%)	Genotype	Expected frequency (%)		*P*-value
ABO blood groups	**A**	0.315	**AA** **AO**	**0.037** **0.276**	**0.313**	**0.520**
	B	0.139	**BB** **BO**	**0.008** **0.130**	**0.138**	
	AB	0. 035	**AB**	**0.035**	**0.035**	
	O	0.512	**OO**	**0.513**	**0.513**	
Total		**1.000**		**1.000**	**1.000**	
Rh (D) positive	**D positive**	0.868	**DD** **Dd**	0.406 0.462	0.868	0.570
Rh (D) negative	**D negative**	0.132	**dd**	0.132	0.132	
Total		**1.000**		**1.000**	**1.000**	

***** Measured by Chi square test (P<0.05 is considered non-significant)

5. Discussion

The knowledge of the distribution of blood groups is very important for blood banks and transfusion services which play an important role in the patient's health care **[18].** A total of 1949 specimens; were 414 (21.2%) medical students and 1535 (78.8%) hospital donors.

The present result showed that male was predominant in blood donation accounting for 92.2% when compared to female (7.8%) with statistically significant differences (P= 0.002). This finding is consistent with reports in Uganda **[5],** Jharkhand **[18]**, and Ethiopia **[19].**

The current result found that the highest rate of blood group was O blood group (51.2%), followed by A blood group (31.5%), B blood group (13.9%), and AB blood group (3.5%) with statistically significant differences (P= 0.002). This result is in line with the work of Apecu *et al*. **[5]** indicated that the distribution of ABO blood group was; blood group O (50.3%); blood group A (24.6%); blood group B (20.7%) and blood group AB (4.5%). Also, a similar study performed by Debele *et al.* **[19]** showed that O was the most prevalent blood group 44.65% followed by A (28.41%), B (21.24%), and AB (5.71%). Moreover, it was found that the blood group O was the most prevalent (61%), followed by A (27%), B (10%), and AB (2%) among students of Jazeera University in Somalia **[20].**

On contrary, some studies in India showed that it was blood group B that was the dominant one, **[21]** while studies in Iran and Europe indicated that blood group A was the predominant blood group **[22].**

The majority of Asians have a typical B > O > A > AB pattern. Some European nations on the other hand show an A > O > B > AB pattern **[23].** Blood type 'O' is 50% and higher reaching even 100% in some isolated populations **[24].** This difference in the distribution of the ABO blood group might be due to geographic, regional, and ethnic differences as well as genetic variations in the study groups.

In this finding, the overall rate of Rh(D) positive was 86.8% while the Rh(D) negative was 13.2% recorded among study participants with statistically significant differences (P= 0.042). This outcome is in line with earlier studies conducted in different countries **[5, 19, 20, 25].** A study by Al-Nahari **[13]** conducted in five Yemeni provinces showed that the phenotypic distribution and allelic frequencies of the Rh-positive blood group were recorded at 95.93% in Al Jawf 95.35% in Abyan, 94.58% in Al-Hudaydah, 93.58% in Lahij, and 91.58% in Amran. Also, about 89–95% of donors all over the world are detected as Rh-positive **[24]**.

Considering ABO and Rh blood groups altogether, the distribution of Rhesus (D) positive was higher among participants having blood group O (89.3%), followed by blood group AB (88.2%), blood group A (86.8%), and blood group B (77.4%). Whereas, most Rhesus (D) negative was among study individuals having blood group B (22.6%), followed by blood group A (13.2%), blood group AB (11.8%), and blood group O (10.7%) with statically significant differences (P=0.000). This outcome is in line with the findings from the literature **[19, 26].**

Humans share the same blood groups all over the world, although there are obviously some geographical, regional, and ethnic differences. Ensuring an adequate supply of D-negative blood is very important for patient safety **[20].**

In the present study, the gene frequency of ABO and Rh (D) genes was estimated under the standard assumption of Hardy–Weinberg equilibrium. It was found that the allele frequencies were in the order of ($I^O > I^A > I^B >$ AB), where (I^O i = 0.513, I^A = 0.313, I^B = 0.138, and AB= 0.035). While the Rh(D) and d allelic frequencies were 0.868 and 0.132, respectively. There was no significant difference between observed and expected values in the distribution of ABO blood groups. and between the Rh blood groups. This result is in accord with the results of Sadiq **[27]** in Nianwa, Iraq revealed that the allele frequencies were in the order of ($i > I^A > I^B$), where (i = 0.647, I^B =0.172, I^A = 0.194).

The distribution of allele frequencies among Al-Muhamasheen in allele O (r) is observed as

the highest frequency (0.700897) then B(q) (0.172675) and A(p) (0.126429). While in Tribesmen allele O (r) is observed with the highest frequency (0.728918) then A(p) (0.210121) and B(q) (0.060961) [**13**]

In other Region in Iraq such as Missan Province it is shown that the gene frequencies were (i = 0.5951, I^B = 0.2385 and I^A = 0.1663) **[28],** and (i = 0.3662, I^A = 0.3836 and I^B = 0.1804) in Jordon **[14]**. However, in other countries such as Bahrain and Koria, there has a different ABO spectrum in the order of (i > I^B > I^A).

Another study by Agrawal *et al*. **[29]** where found gene frequency for I_A (p), I_B (q), and i (r) was 0.1653, 0.2254, and 0.6093 respectively. Observed phenotypic frequency of A, B, O, AB and Rh (D) blood groups was 0.2316, 0.3410, 0.3456, 0.0818, and 0.9413 whereas the expected phenotypic frequency was 0.2316, 0.3402, 0.3456, 0.0826, and 0.9413, respectively.

Recently, a study in India by Patidar and Dhiman **[30]** found that the calculated allelic frequency of O = i(r), A = I_A(p), B = I_B(q), D = I_D(v), and d = I_d(u) was 0.5879, 0.1719, 0.2402, 0.7577 and 0.2423, respectively. The predominance of I^O allele may be due to the fact that blood groups A and B (I^AI^O and I^BI^O) carry O allele in their heterozygous state, in addition to the homozygous I^OI^O.

Limitation of study

This study had a number of limitations The predominance of male donors is observed might be because female donors are more likely to be excluded due to medical backgrounds, such as low hemoglobin levels, low body weight, pregnancy, or breastfeeding, lack of education, social taboo, cultural habits, lack of motivation, and fear of blood donation. Also, the fact that there is a general belief that men are healthier than women and thus are more suitable for blood don Secondly, the method used in This study to estimation the donors who weak or partial D inaccurate. This means very less frequency of the donors which may influence the results of RH groups.

6. Conclusion and Recommendations.

In conclusion, the pattern of distribution of the ABO blood groups in Amran province was O > A > B > AB. most of the participants were Rh+, The Male were higher than Female. The distribution of ABO and Rhesus (D) blood groups In Amrnan Directorates were, O is highly distributed in Alsoad , A in Thebin , B in Shehara and AB is dominant in kaflat Ethir .While the distribution of Rhesus (D) groups ,(D) Positive is highly in Almdan and (D) Negative in Hoth then Harf sofian . The allele frequencies were in the order of (I^O > I^A > I^B > AB. While the Rh (D allelic. was more than d allelic. **We recommended** Further studies in larger population in Amran province and in different zones of Yemen, by using more sensitive techniques. for more accurate distribution pattern of blood groups populations

7. References

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