

# Estimation of Allelic, Genotypic and Phenotypic Frequencies for ABO and Rh Blood Groups Among Blood Donors at the Central Blood Bank in Benghazi, Libya

Hameda Ali Mohamed Naser El-Moghrabi<sup>1</sup>, latifa Abdel-Hafid Jweli<sup>2</sup>,  
Nadia Eldarogi<sup>3</sup>, Fatma Yousuf Mohammed Ziuo<sup>4</sup>

<sup>1,2</sup>Assistant Professor at Faculty of Arts and Sciences, Ghemins, University of Benghazi, Libya.

<sup>3</sup>Lecturer Family and Community Medicine, Faculty of Medicine, University of Benghazi, Libya.

<sup>4</sup>Associate Professor Family and Community Medicine, Faculty of Medicine, University of Benghazi, Libya.

## Abstract

**Objective:** to estimate the average of prevalence, allelic, genotypic and Phenotypic frequencies for ABO and Rh blood groups among blood donors at the Central Blood Bank (2021) in Benghazi, Libya.

**Methodology** The study of blood group determination (hem classification) and Rh factor determination was carried out between January to December 2021. Calculations for allelic frequencies, genotypic frequencies and Phenotypic frequencies were based on Hardy Weinberg equilibrium.

**Results:** Phenotype O and allele O were the most common while, the least frequent was Phenotype AB and allele B. More than 86% population of this study is Rh positive.

**Keywords:** Blood groups, Rhesus, alleles frequencies, gene frequencies, Phenotypic frequencies, Hardy–Weinberg equilibrium .

## Introduction

The two most important and common classifications of blood group of human beings are the ABO and the rhesus factor (Hoffbrand, Pettit and Moss, 2001). The ABO locus has three main phenotypes, A, B, and O, with the combination of glucosyltransferases encoded by different alleles determining the A, B, AB, or O blood group phenotype (Landsteiner , 2001 ., Crow ,1993 ).The genes of ABO and Rh (D) are located on chromosome nine and one respectively ( Avent and Reid , 2000 ., John ,1996) .The study of blood grouping is very important as it plays an important role in genetics blood transfusion, forensic study, blood bank, organ transplantation and paternity test, and some groups may have association with diseases like duodenal ulcer, diabetes mellitus, urinary tract infection, Rh incompatibility and ABO incompatibility of newborn (Rehman *et al* . 2005).

**Methods:****Study Population:**

The data of this study were obtained from blood donors at the Central Blood Bank at Benghazi, Libya during year 2021.

**Determination of blood group:****Slide Method**

The slide test is relatively the least sensitive method among others for blood group determination, but due to its prompt results. This method includes a glass slide or white porcelain support is divided into three parts, as for each part, a drop of donor or recipient blood is mixed with anti-A, anti-B and anti-D separately. The agglutination or blood clumping pattern can be visually observed from which the ABO and rhesus D (RhD) type of blood can be determined. The test completes in 5–10 min and is inexpensive, which requires only a small volume of blood typing reagents (Malomgre and Neumeister, 2009).

**Statistical Analysis:**

The Hardy-Weinberg equation is a mathematical equation that can be used to calculate the genetic variation of a population at equilibrium. Allele frequencies were calculated under the assumption of H-W equilibrium and expressed as percentages. To estimate phenotypes and gene (alleles) frequencies for ABO blood type : p, q and r was assigned to allele A, B, and O respectively. Their frequencies were calculated according to Hardy-Weinberg (H-W) Law  $\{p^2 (IAIA) + 2pr (IAIO) + q^2 (IBIB) + 2qr (IBIO) + 2pq (IAIB) + r^2 (IOIO)\}$  while allele D and d in rhesus type were assigned p and q respectively and their frequencies was calculated using H-W equilibrium  $p^2 + 2pq + q^2 = 1$  (Klug *et al.*, 2006 ., Anifowoshe *et al.*, 2015 ).

Chi-square test was used to compare observed allelic and genotypic frequency distributions of the blood group and Rh antigens that expected under the H-W equilibrium (Klug *et al.*, 2006., Klug *et al.*, 2012., Saadat, 2015). P values <0.05 were considered statistically significant.

**Results**

Total number of 31712 individuals were collected from blood donors at the Central Blood Bank in Benghazi, shown (Table 2) phenotype O is the most common blood group 12563 (39.6158 %), followed by blood group A 10669 (33.6434%), blood group B 6253 (19.718%) and blood group AB 2227 (7.0225%). The Rh D positive blood group were 27500 (86.7179%) while Rh D negative blood group were 4212 (13.282 %). Allelic frequencies of the ABO blood groups included O (0.6294117751), A (0.2265048914), B (0.1440833335), and D (0.63555546907) and d (0.3644453093) for Rhesus D positive and Rhesus d negative respectively. The genotypic frequencies were reported (0.3961591826), (0.0513044658), (0.020760007), 0.2851296915 (0.1813754934) ,(0 . 0652711596 ) for OO, AA, BB, AO, BO and AB respectively. The phenotypic were (0.3364601315) (0.2021355004), (0.3961591826), (0.0652711596), (0. 86717961630) and (0.1328203835) for, A, B , O, AB, DD+2Dd , dd respectively .

**Table 1: Distribution of ABO blood group phenotypes among blood donors at Central Blood Bank of Benghazi, Libya, 2021**

B G	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept.	Octo	Nov	Dec
O +	877	1045	1097	727	935	983	835	967	703	870	886	771
O -	147	151	233	117	148	151	143	150	140	158	164	115
A+	798	840	890	710	825	837	711	804	724	723	822	679
A-	92	118	107	80	130	129	99	135	83	98	114	121
B+	409	451	511	384	579	623	446	466	426	401	411	388
B-	52	61	64	55	72	85	30	73	62	70	72	62
AB+	152	182	167	134	165	194	186	161	119	134	129	163
AB-	21	21	28	18	25	35	36	27	36	24	24	46
<b>Total</b>	<b>2548</b>	<b>2869</b>	<b>3087</b>	<b>2225</b>	<b>2879</b>	<b>3035</b>	<b>2486</b>	<b>2783</b>	<b>2353</b>	<b>2478</b>	<b>2622</b>	<b>2345</b>

**Table. 2: Prevalence of ABO and Rh blood group distribution at the Central Blood Bank of Benghazi, Libya, 2021**

Rh-D phenotypes and ABO blood group phenotypes											Total
Blood group	O+	O-	A +	A-	B+	B-	AB+	AB-	Rh+	Rh-	31712
No.	10756	1807	9363	1306	5495	758	1886	341	27500	4212	
%	33.9177	5.6981	29.5251	4.1183	17.3278	2.290	5.947	1.0753	86.7179	13.282	
%	O		A			B		AB			
39.6158 %			33.6434 %			19.718%		7.0225 %			

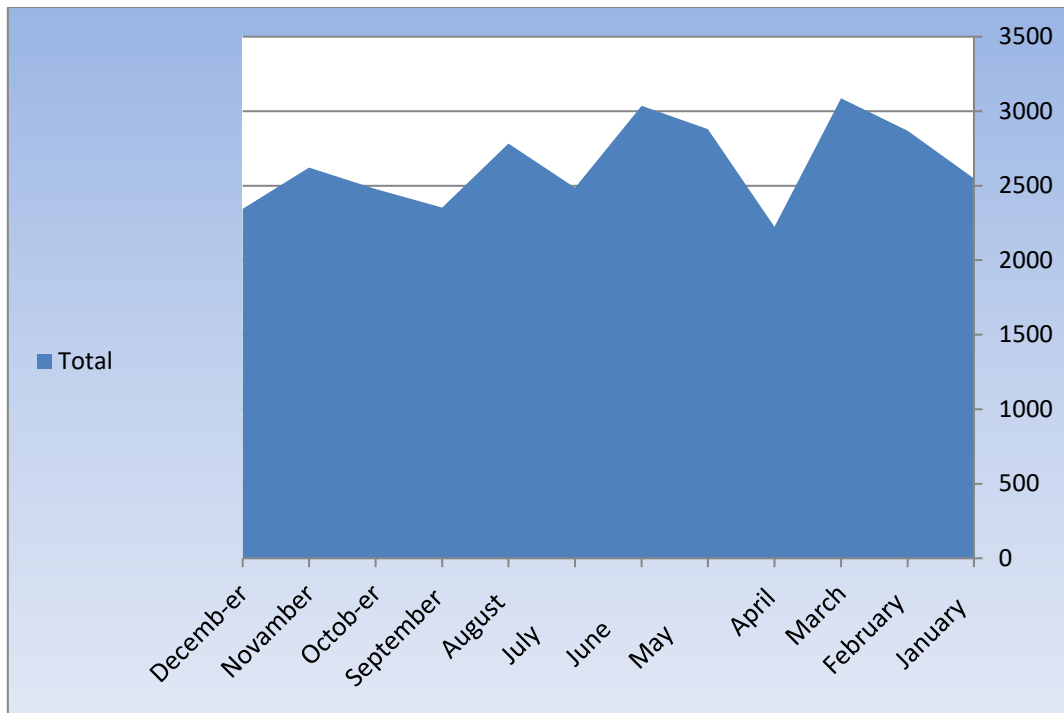


Figure 1: Ppattern of The number of blood donors at the Central Blood Bank of Benghazi during months in the year 2021.

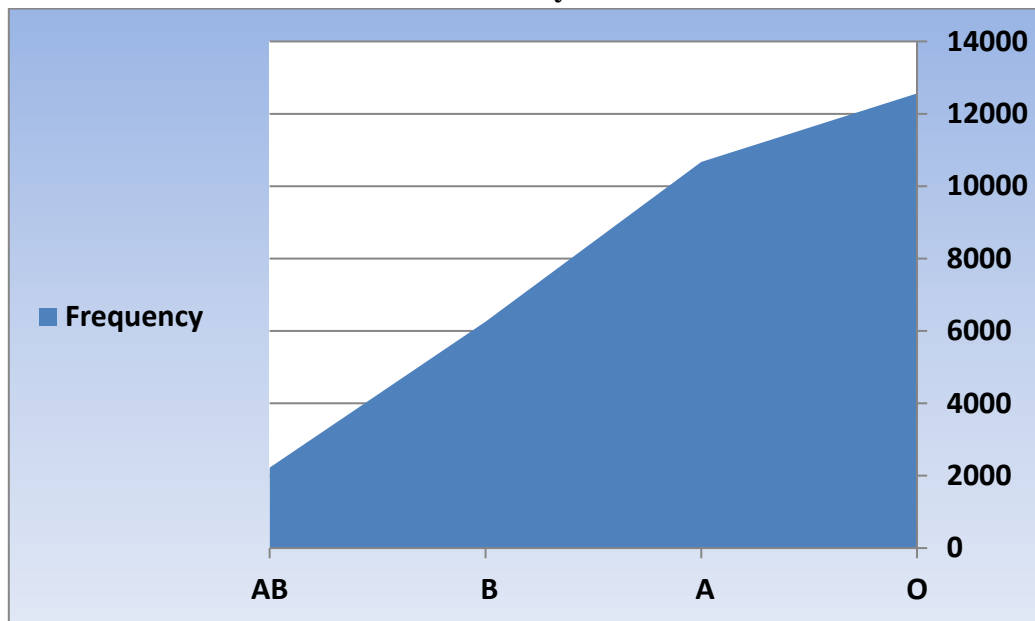
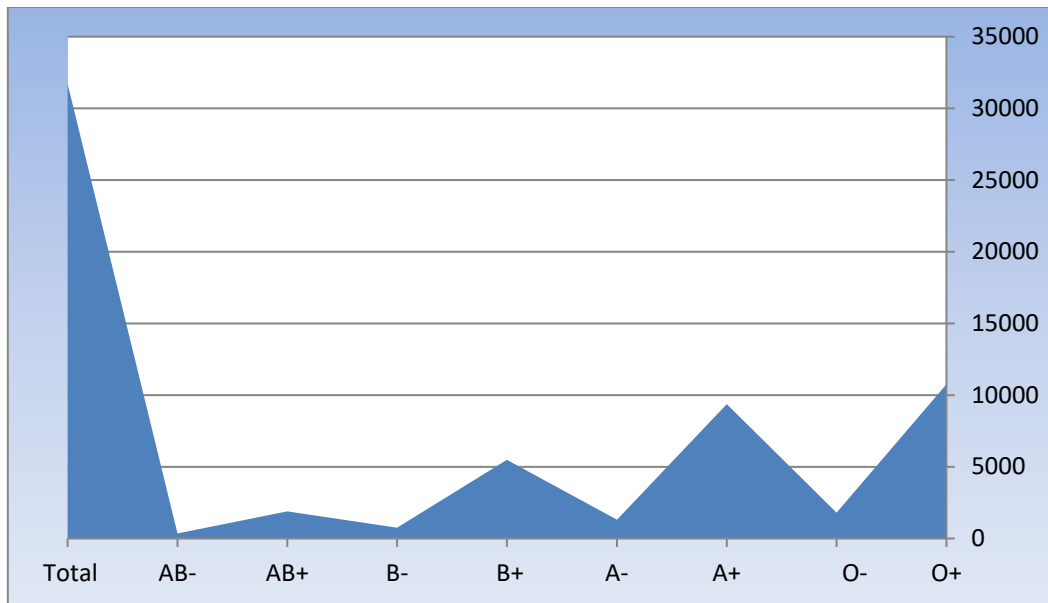


Figure 2: Distribution of ABO blood group at the Central Blood Bank of Benghazi , Libya 2021.



**Figure 3: Distribution of ABO and Rh blood groups at the Central Blood Bank of Benghazi, Libya 2021.**

**Table 3: Allelic frequencies of ABO and Rh blood groups at the Central Blood Bank of Benghazi, Libya 2021**

Year	Number donors	blood	Phenotype	Allele	Allele Frequency
2021	10669		A	IA	0.2265048914
	6253		B	IB	0.1440833335
	2227		AB		
	12563		O	IO	0.6294117751
	27500		Rh+	D	0.63555546907
	4212		Rh-	d	0.3644453093

**Table 4: Genotypic frequencies of ABO and Rh blood groups among donors from Blood Donors at the Central Blood Bank of Benghazi, Libya 2021.**

Blood Group	Genotypic frequencies of ABO and Rh blood groups		
	A	AA	p2
	AO	Pr 2	0.2851296915

B	BB	q <sup>2</sup>	0 . 020760007
	BO	2qr	0 .1813754934
AB	AB	2pq	0 .0652711596
O	O	r <sup>2</sup>	0 .3961591826
Rh +ve	DD	p <sup>2</sup>	0 .4039297649
	Dd	Pq <sup>2</sup>	0 .4632498514
Rh –ve	dd	q <sup>2</sup>	.13282038350.

**Table 5: Phenotypic frequencies of ABO and Rh blood groups among donors from Blood Donors at the Central Blood Bank of Benghazi, Libya 2021**

Blood Group	Phenotypic frequencies of ABO and Rh blood groups		
A	AA+2AO	p <sup>2</sup> + 2pr	0 .3364601315
B	BB+2BO	q <sup>2</sup> +2qr	0 .2021355004
AB	AB	2pq	0 .0652711596
O	OO	r <sup>2</sup>	39615918260.
Rh +ve	DD+2Dd	p <sup>2</sup> + 2pq	0 .8671796163
Rh –ve	dd	q <sup>2</sup>	.13282038350

**Table 6: Observed and expected number of ABO and Rh blood group among blood donors at the Central Blood Bank of Benghazi, Libya 2021.**

ABO blood group	Observed	Expected	Rh system	Observed	Expected
			Blood group		
Blood group	Observed	Expected		Observed	Expected
O	12563	12563	Rh(D)+ve	27500	27500
A	10669	10669			
B	6253	6410	Rh(d)-ve	4212	4212
AB	2227	2070			
Total	31712		Total	31712	31712

goodness-of-fit $X_3^2$ for ABO =15.7 , df=3, P < 0.05).	goodness-of-fit $X_1^2$ for Rh= 0.000 , df =1, P<0.05).
--	---

## Discussion

This study investigated the blood group prevalence, the allelic frequencies, genotypic frequencies and Phenotypic frequencies of ABO and Rh (D) blood group systems among blood donors at the Central Blood Bank in Benghazi, Libya. The result of current study about the blood group prevalence sequence is ( O > A > B > AB) shown (Table 2 and Figure 2), the result of this study agrees with the study at the Central Blood Bank for three consecutive years ( El-Moghrabi *et al.* , 2021 ) and other local, Arab and international studies (Salih *et al.*, 2005)., (Fayrouz, Farida and Irshad, 2012).,( Noor and Eldin, 2013)., (Saad, 2016)., (Ameigal and Ageel, 2019) ., (El-Moghrabi *et al.*, 2020). our results is different from the blood group prevalence sequence reported from different regions of the world ( Rajshee and Raj, 2013 ., Khan *et al.*, 2009) ., Kuku *et al.*, 2004 ., Hanania *et al.*, 2007 ., Shrivastava, Gahine and Kapse , 2015 ).

Overall the group O+ was the most common at 33.9177 % while, AB- was the least frequent at 1.0753 % among blood donors at the Central Blood Bank shown (Table 2) .The Rh (D) positive was the most common at 86.7179 % while the Rh (D) negative was the least frequent at 13.282% shown (Table 2) , the result of this study agrees with the study at the Central Blood Bank for three consecutive years ( El-Moghrabi *et al.* , 2021 ) which similar to previous studies in Libya and different regions of the world (El-Moghrabi *et al.* , 2020 ., Pramanik & Pramanik,2000., Pramanik and Adhikari , 2006 ., Apecu *et al.*, 2016., Ilyas , Iftikhar & Rasheed , 2013 ., Ghobadian *et al.* , 2014 ., Olaniyan *et al.*, 2013 ., Nazli *et al.* , 2015., Kuku *et al.* , 2004 ).

The overall the allele O was highest in this study and all population in the world .Allelic frequencies of ABO in this study were (O > A > B ) (Table 3) , a similar result was obtain from a study by (El-Moghrabi *et al.* , 2020., El-Moghrabi *et al.* ,2021 ., Anifowoshe *et al.* , 2015 ., Hanania, Hassawi and Ihaidrs, 2007)., Iyiola , Igunnugbemi and Belloa ,2012., Matough *et al.*,2019 .,Tesfaye, Petros and Andargie , 2014 ). Allelic frequencies of Rh blood groups in this study were ( D > d ) shown (Table 3) , the allele D was the most common in general studies in the world . Rh-positive is commonest while Rh-negative is the rarest blood group in the world.

The homozygous types were as follows: OO (0.3961591826) , AA (0.0513044658) and BB( 0.020760007 ). The heterozygous types were AO(0.2851296915 ) , BO (0.1813754934 ) , shown (Table 4).

(0 .0652711596)and AB Genotypic frequencies of OO were the most common while the genotypic frequencies of BB were the least frequent among blood donors at the Central Blood Bank (2021) shown (Table 4) , the result of this study agrees with a study done by ( El-Moghrabi *et al.* , 2021) .

Chi-square test was used to compare observed and expected number of ABO and Rh blood group to that expected under the H-W equilibrium among blood donors at the Central Blood Bank in Benghazi, Libya differ significantly from those expected under Hardy–Weinberg equilibrium (goodness-of-fit  $X^2$  for ABO =15.7 , df=3, P<0.05). Proportion and incidence of Rh blood antigens was not significantly differ from those expected under Hardy–Weinberg equilibrium (goodness-of-fit  $X^2$  for Rh= 0.000 , df =1, P<0.05) shown ( Table 6 ).

## Conclusion

The ABO blood groups, there are A, B, O, and AB blood types. They are due to three alleles, IA, IB, and IO, with IAIA and IAIO having blood group A with IBIB and IBIO having blood group B with IAIB having blood group AB and with IOIO having blood group O.

## References

1. Ameigal, S. D. and Ageel, A. A. (2019). A cross sectional preliminary study on the prevalence of ABO and rhesus blood groups in Bani Waleed City, Libya. Libyan international medical university. 4 (2): 56-61.
2. Anifowoshe, A. T., Oyeyemi, B. F., Iyiola, O. A., Ahmed, I. O., Akinseye, K. M. and Akinsowon, A. J. (2015). Gene Frequencies of ABO and Rh (D) Blood Group Alleles in Minna, North Central Nigeria. Nig. J. Pure & Appl. Sci. Vol. 28 2644 – 2657.
3. Apecu, R.O., Mulogo, E.M., Bagenda, F. and Byamungu, A. (2016). ABO and Rhesus (D) blood group distribution among blood donors in rural South Western Uganda: a retrospective study. BMC research notes. 21;9(1):513.
4. Avent, N.D. and Reid, M.E. (2000). The Rh blood group system: a review. Blood 95: 375-387.
5. Crow, J.F. (1993). Felix Bernstein and the first human marker locus. Genetics. 133:4-7.
6. El-Moghrabi, H. A., Al-Drussi, I., Jwieli, L. A. and El-Brghty, Khalil. (2020). Gene Frequencies of ABO and Rh (D) Blood Group Alleles in two Different Regions at the Northeastern of Libya. GSJ. 8. (12), 1542-1554.
7. El-Moghrabi, H. A. M. N., Jwieli, L. A., Elramli, N. A., Fator, A. F., El-Brghty, K. (2021). A Comparative Study of Prevalence, Phenotype and Genotype of ABO and Rh (D) Factor among Blood Donors from the Central Blood Bank in Benghazi Libya. International Journal of Science and Research (IJSR). Volume 10 Issue 9.
8. Fayrouz, I. N., Farida, N. and Irshad, A. H. (2012). Relation between fingerprints and different blood groups. J Forensic Leg Med. 19 (1): 18-21.
9. Ghobadian, Z., Sayemiri, K., Zeinali, M. and Sajjadi, S.M. (2014). Distribution of ABO and Rh blood groups in a major ethnic group of the West Iran, the Kurdish population. Asian Journal of Medical Sciences. 5(3):26-9.
10. Hanania, S.S., Hassawi, D.S. and Irshaid, N.M. (2007). Allele Frequency and Molecular genotypes of ABO blood group system in a Jordanian Population. J. Med. Sci. 7(1):51-58.
11. Hoffbrand, A.V., Pettit, J.E. and Moss, P.A.H. (2001). Essential Haematology, 4th edition, Blackwell Science Ltd (UK). 307-310.
12. Ilyas, M., Iftikhar, M. and Rasheed, U. (2013). Frequency of ABO and Rh Blood groups in Gujranwala (Punjab). Pakistan. Biologia (Pakistan). 59(1):107-114.
13. Iyiola, O.A., Igunnugbemi, O.O. and Bello O.G. (2012). Gene frequencies of ABO and Rh(D) blood group alleles in Lagos, South-West Nigeria Ain Shams University, The Egyptian Journal of Medical Human Genetics. (13) 143-153.
14. John, D.R. (1996). Technical Manual of American Association of Blood Banks. In: Blood group and genetics (12th edn), American Association of Blood Banks. USA. pp.173-261.
15. Khan, M.I., Micheal, S., Akhtar, F., Naveed, A., Ahmed, A. and Qamar, R. (2009). Association of ABO blood groups with glaucoma in the Pakistani population. Can J Ophthalmol. 44:582-586.



16. Klug, W.S., Cummings, M.R. and Spencer, C.A. (2006). Concept of Genetics 8th Edition Published by Pearson Education Inc.
17. Klug, W.S., Cummings, M.R., Spencer, C.A. and Palladino, M.A. (2012). Concept of Genetics. 10th ed. Pearson Education Inc.
18. Kuku, I., Kaya, E., Erkurt, M.A., Dikilitaş, M., Yıldız, R., Orhan, M., Görgel, A. and Aydoğdu, I. (2004). Malatya ve Çevresi ABO ve Rh Kan Grubu Dağılımı. İnönü Üniversitesi Tıp Fakültesi Dergisi. 11(4):213-215.
19. Landsteiner, K. (2001). Agglutination phenomena of normal human blood. Wien Klin Wochenschr. 113:768–769.
20. Matough, F. A., Alhoderi, J., Abdulkader, A., Abdullsalam, J. and Alwahaibi, N. (2019). The frequency of ABO and Rhesus blood groups phenotypes, genotypes from Sebha city of Libya. Journal of Pure Applied Sciences, V 18 (1).
21. Nazli, R., Haider, J., Khan, M.A., Akhtar, T. and Aslam, H. (2015). Frequency of ABO blood groups and RhD factor in the female population of District Peshawar. Pak J Med Sci. 31(4):984-86.
22. Olaniyan, T.O., Ajibola, B.M., Rasong, H., Dare, B.J. and Shafe, M.O. (2013). Blood Group and Rhesus Factor Pattern among Indigenes of FCT. Abuja, Nigeria. J Community Med Health Educ. 3(3). Rehman, A. K.M., Ashraf, M., Malik, S., Saeed, M. A. Rafique A, et al. (2005). ABO and Rhesus blood groups in Pakistan population. Professional Medical Journal. 12(4):368-371.
23. Rajshree, B. and Raj, J.Y. (2013). Distribution of ABO blood group and Rh(D) factor in western rajasthan. National Journal of Medical Research, 3(1):73-75.
24. Saadat, M. (2015). Estimation of allelic frequencies for ABO and Rh blood groups. The Egyptian Journal of Medical Human Genetics. Ain Shams University, Egypt.
25. Saad, K. A. O. (2016). Distribution of ABO Blood Groups And Resus Factor (RH) in ALBIYDA, Libya. Journal of Medical and Dental Science Research. 3 (9): 28-31.
26. Salih, K., Abdrhman, O. M., Irhuma, A. A., Elgadi, B. and Abd El Latef, M. H. (2005). Anthropological studies among Libyans of Fazzan Province: ABO and Rh Systems. Journal for Medical Sciences, 4 (1), Sebha University, Sebha, Libya.
27. Shrivastava, S., Gahine, R. and Kapse, V. (2015). ABO, Rhesus Blood Group And Allele frequency in and around Raipur (chattisgarh state), INDIA, Int J Cur Res Rev. Vol 7. Issue 17.
28. Tesfaye, K., Petros, Y. and Andargie M. (2014). Frequency distribution of ABO and Rh (D) blood group alleles in Silte Zone, Ethiopia. Egypt J Med Hum Genet. 16 (1).
29. Pramanik, T. and Pramanik, S. (2000). Distribution of ABO and Rh blood groups in Nepalese medical students: a report. East Mediterr Health J. 6 (1):156-8.
30. Pramanik, T. and Adhikari, P. (2006). Trend of blood group distribution among the different ethnic groups of Kathmandu Valley. Nepal Med Coll J. 8 (4):248-9.