

# Reviewing Publication Discussing the Frequency of ABO and Rhesus-D Blood Groups in Saudi Arabia

Saeed M. Kabrah<sup>1\*</sup>, Arwa F. Flemban<sup>2</sup>, Asim A. Khogeer<sup>3, 4</sup>, Waleed M. Bawazir<sup>5,6</sup>

<sup>1</sup>Department of Laboratory Medicine, Faculty of Applied Medical Sciences, Umm Al-Qura University, Makkah, Kingdom of Saudi Arabia

<sup>2</sup>Department of Pathology, Faculty of Medicine, Umm Al-Qura University, Makkah, Kingdom of Saudi Arabia

<sup>3</sup>Research Department, The Strategic Planning, General Directorate of Health Affairs Makkah Region, Ministry of Health, Makkah, Kingdom of Saudi Arabia

<sup>4</sup>Medical Genetics Unit, Maternity & Children Hospital, Makkah Healthcare Cluster, Ministry of Health, Makkah, Kingdom of Saudi Arabia

<sup>5</sup>Medical Laboratory Technology Department, Faculty of Applied Medical Sciences, King Abdulaziz University, Jeddah, Saudi Arabia

<sup>6</sup>Hematology Research Unit, King Fahd Medical Research Center, King Abdulaziz University, Jeddah, Saudi Arabia

## ABSTRACT

**Background:** Since the discovery of the blood group in 1901 by Karl Landsteiner, the ABO grouping became an essential element in blood transfusion, followed by the Rh blood group system, which was discovered in 1940 by Landsteiner and Wiener. These two systems are considered the most clinically significant blood groups due to the high immunogenicity of their antigens and the naturally occurring antibodies for the ABO system. Knowledge of the ABO and Rh blood groups distribution is necessary to recruit voluntary blood donors. Additionally, building an effective management unit inventory at both the regional and national levels is also required. Identifying these blood groups, ABO and Rh antigens, are vital for planning effective strategies for transfusion.

**Objective:** This study aims to review the literature on the distribution and frequency of ABO and Rh blood groups in Saudi Arabia and critically assess several standards followed by the selected research, including the sample size, represent ability of the Saudi Arabian population, and the availability of ethical approval.

**Materials and Methods:** A computerized systematic literature search was conducted among the PubMed and google scholar search engines using the following keywords: ABO blood group, RhD blood group, Saudi Arabia, and worldwide, to determine the distribution of ABO and RhD blood groups in Saudi blood donors.

**Results and Conclusion:** 32 publications were included in the current study, and the results indicated that most of the blood donors in Saudi Arabia were male. The most common blood group phenotype was O (51+8%), followed by A (27+4%), B (18+8%), and AB (4+2%). The majority of the blood donors were RhD positive (92+2%). The Frequency of ABO and Rh blood groups in this study were similar to the worldwide incidence. However, there was an insignificant difference between the researches. For these reasons, producing publications on blood groups should be considered and corroborated by the Saudi health authorities on a large scale.

**Key words:** ABO, Blood Group, Saudi Arabia

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**Corresponding author:** Saeed M Kabrah  
**e-mail** ✉: smkabrah@uqu.edu.sa  
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## INTRODUCTION

Blood bank service is a central part of the health service in Saudi Arabia. Daily, erythrocyte units are produced to meet the demands of surgical and emergency cases. There is increasing demand for the universal blood types (O negative) as well as all the rare blood types including A negative, B negative and AB negative. There is a growing

concern regarding the supply of those blood types, especially during emergencies [1]. Thus, it is imperative to continuously improve blood donation strategies based on informed statistical analysis of the needs. One of the strategies is to encourage current donors to continue to donate. To inform prospective changes to blood donation policies and strategies, research and evidence is required to make the essential changes to these policies and strategies [2].

Modelling and future predictions suggest that within the next 10 years blood availability will increase to cover the escalating demand of the growing population [3]. This

increase in blood supply meets many challenges and requires new approaches of maintaining future donors, and careful selection of the high demand blood groups. Furthermore, blood stock management across healthcare providers is paramount to minimise waste [2].

For correct planning and implementation of policies in Saudi Arabia, it is important to be able to determine the frequency and distribution of blood types in the country. Having sufficient knowledge of blood groups availability and distribution will aid in planning stocks and transportation of blood products in blood banks region. Several studies also showed an association between blood groups genetic and infectious diseases. More recently, several studies showed there were associations between blood groups and cancer [4]. In addition to improving the quality and safety of healthcare services provided to patients by reducing many preventable deaths. The frequency of these blood groups varies in the population due to various factors, including race, socioeconomic, marriage, and ethnic groups. Such studies require surveying a large sample size that is representative for the population which include blood donors, patients, and volunteering individuals. Additionally, adhering to the country policies and research governance is essential. Such governance ensures participants security and minimal errors in data including repetition and inaccuracies of sources. Ethical approval from a governmental authority provides validity of the accuracy and sensitivity of the data presented.

Several researchers worked on determining the frequency of ABO and Rh blood groups in Saudi Arabia regions and others restricted their findings on local organisations (Table 1). The standards of those published data vary from study to study. Also, ethical approvals are often overlooked in the selected research.

Therefore, this study aims to review the published work regarding the distribution and frequency of ABO and RhD blood groups in Saudi Arabia and critically assess several standards of the previously published work in terms of sample size, representability of the Saudi Arabian population, and ethical approval. Subsequently, the overall frequency and distribution of ABO and Rh groups in the Saudi Arabian population will be compared to other countries.

### METHODOLOGY

A computerized systematic literature search was conducted among the PubMed and google scholar search engine using the following keywords: ABO blood group, RhD blood group, Saudi Arabia, and worldwide, to determine the distribution of ABO and RhD blood groups among the blood donors in Saudi Arabia and worldwide.

The retrieved publication list was reviewed manually to identify additional eligible studies published in the English language. The selection of publications for inclusion was performed with the last search in September 2019.

### Literature search strategies

Articles available in PubMed, Web of Science, and Google Scholar were searched using the terms ("ABO blood type" OR "ABO blood group" OR "Rh blood type" OR "Rh blood group" OR "blood type" OR "blood group") AND ("Saudi Arabia" OR "Saudi" OR "KSA") in June, 2019. Language, date of publication, study design, age, gender, and geography were not restricted. All manuscripts were combined after removing the duplicates, then titles and abstracts of articles were screened, and full contents of eligible articles were reviewed. Articles were screened by authors independently using eligibility criteria for the review.

### ELIGIBILITY CRITERIA

All published original studies of any design except review studies that discussed the importance of ABO, and RhD blood group frequency were included. Moreover, studies were excluded from meta-analysis when they lacked sufficient data to estimate the frequency of ABO and Rh data.

### DATA COLLECTION

For each study, the following information were extracted, the study location, study year, sample size, study design, gender, prevalence of ABO and Rh blood group, participant types, study period, and ethical approval. Four authors extracted data independently, and the degree of discrepancy in data extraction was minimal between the three authors. A discrepancy in the data collection was resolved by researcher consensus.

### RESULTS

Following validation of studies that were included in this study, 24 studies (Table 1) determined the frequency of major blood groups (A, B, AB, O and RhD) in Saudi Arabia. Most of the research summarised in Table 1 investigated the frequencies of blood groups at the level of cities and the rest conducted the research on the level of regions (16 and 8 studies respectively).

Also, there are 13 administrative regions in Saudi Arabia and as seen in Table 1 one study investigated the frequency of blood groups in 5 administrative regions and all others focused on one. Furthermore, the names of the administrative regions were not following the actual official names, which make the determination of the interpretation of certain regions difficult (e.g., western region can include both/either Makkah and/or Madinah administrative regions). When calculated the average frequency of blood groups showed standard deviation that ranged from 2 to 8 in most cases. Blood groups O and B showed the highest variation followed by blood group A (8 for both O and B and 4 for A) and the lowest variation was seen in the rest of blood groups (AB, Rh +ve and Rh-ve) (Table 1). It can also be noted that there was variation between the frequencies of blood groups in the same regions among two different studies as seen in Table 1B.

**Table1: Demonstrates the distribution of ABO and RhD blood groups in various regions and cities of Saudi Arabia. This table shows the distribution of ABO and RhD blood groups in various regions and cities of Saudi Arabia.**

Ref No.	City	Participants	O%	A%	B%	AB%	Rh+%	Rh-%
[5]	Arar	Pregnant	33.8	39	16.6	10.5	77	23
		Healthy Father	28.9	36.7	19.2	15.2	79/00	21
[6]	Al-juof	Healthy population	39.8	27.5	25.5	7.3	91.2	8.8
[7]	Jeddah	Patients	38.5	34.2	24.8	2.5	96.3	3.7
[8]	Hail	Healthy population	51.3	19.2	26.2	3.3	95.5	4.5
[9]	Makkah	Blood donors and patients	48.29	29.91	17.54	4.23	92.2	7.8
[10]	Al Madinah	Blood donors	45.3	27.7	18.9	8.1	87.9	12.1
[11]	Najran	Healthy students	69.47	24.3	4.04	2.19	90.56	9.44
[12]	Jazan	Blood donors	62	27.6	8.7	1.7	95	5
[13]	Riyadh	Patients	48	27	22	3	96	4
[14]	Al Madinah	Blood donors	45.3	27.7	18.9	8.1	87.9	12.1
[15]	Riyadh	Patients	64	32	14	4	-	-
[16]	AL Madinah	Healthy population	46	31.4	16.1	6.5	-	-
[17]	Unaizah	Blood donors	46.4	24.8	23.5	5.3-	89.08	19.91
[18]	Hail	Healthy population	59.9	17.1	19.8	3.2	97.3	2.7
	Baqaa	Healthy population	41.8	23.3	30.2	4.7	95.3	4.7
	Alghazala	Healthy population	48.9	18.8	28.6	3.8	93.2	6.8
	Alhaet	Healthy population	49	19.3	28.6	3.1	93.8	6.2
	Alshinan	Healthy population	48.9	19.8	29.2	2.1	96.9	3.1
[19]	Riyadh	Patients	40.9	26.8	23	9.3	90.2	8.8
[20]	Buraidah	Blood donors	47.45	26.2	23	4	89.8	10.1
Ref No.	Region	Participants	O%	A%	B%	AB%	Rh+%	Rh-%
[21]	Makkah	Healthy population	50.95	25.71	19.52	3.8	91.91	8.09
[22]	North	Students	49.25	24.62	22.16	3.52	91.45	8.55
	East		47.62	21.43	26.79	4.16	94.05	5.95
	Middle		48.48	24.5	20.45	6.57	90.91	9.09
	West		38.2	33.9	24.9	3	91.42	8.58
	South		52.23	33.68	11.34	2.79	89.7	10.3
[23]	Southwest	Healthy population	56.8	33.4	6	3.8	92.8	7.2
[24]	Saudi Arabia	Healthy/patients	50	26.7	19	4.21	91.81	8.19
[25]	West II	Blood donors	50.1	29.7	16.01	4.12	91.31	8.63
[26]	Hail	Patients	36.9	24.8	27.1	7	95.79	4.21
		Healthy	41.7	20.8	23.7	4.9	91.2	8.8

[27]	Hail	Patients	41.4	31.5	19.81	7.2	95.5	4.5
		Healthy	46.8	24	18.23	10.93	81.76	18.23
[28]	East II	Blood donors	51	26	18	4	92	8
Average $\pm$ STD			47.48 $\pm$ 8	26.91 $\pm$ 5	20.39 $\pm$ 6	5.24 $\pm$ 3	91.77 $\pm$ 4	8.88 $\pm$ 5

Table 2 shows the sampling criteria of 24 studies summarised and presented in a chronological order. Here we noted that there are two studies conducted in the capital (Riyadh). Interestingly, only three of the studies listed the ethical approval information in their research method. Five of the studies discounted mention of the period of sample collection including studies that has gained ethical approval from a research authority. Most

of the samples included in studies compromised of males with exception of two studies that had higher female to male ratio. The sample size varied from 300 to almost 40000 with relatively lower sample size in studies that had mentioned the ethical approval. Also, nine of the studies were published in the last 10 years and only four studies published before 2010.

**Table 2: Demographic data of previous studies in various regions and cities of Saudi Arabia. This table shows demographic data of participants of previous studies in various regions and cities of Saudi Arabia.**

Reference	Region / City	Sample Size	Male%	Female%	Main Locations	Period of Sample Collection	Ethical Approval
[21]	Makkah	292	-	-	-	-	Not listed
[29]	Riyadh	859	0	100	King Khalid University Hospital	-	Not listed
[28]	East II	57196	99.7	0.3	Blood bank department t of king Fahd hospital	(1985-1989); (1995-1999)	Not listed
[22]	North	1278	100	0	Different regions of Saudi Arabia	-	Not listed
	East						
	Middle						
	West						
	South						
[5]	Arar	686	50	50	Maternity and Children Hospital in Arar city	Nov 2016 – May 2017	Listed
[7]	Jeddah	161	-	-	Faculty of Dentistry, King Abdulaziz University	-	listed
[17]	Unaizah	502	-	-	King Saud hospital	January 2017 to December 2017	Listed
[23]	Southwest	944	100	0	Asser, Jizan and Najran regions	-	listed
[12]	Jazan	30481	-	-	Blood Bank Department of King Fahd Central Hospital in Jazan	Jan 2002 - Dec 2008	Not listed
[6]	Al-juof	400	100	0	Primary Health Centres of four major cities (Sakaka, Domaht Aljandal (Domah), Al-Qurayat and Sweer).	-	Not listed
[24]	Saudi arabia	66,445	-	-	Retrospective study from different location	-	Not listed
[13]	Riyadh II	400	58	42	King Abdualziz Medical City	2013	listed
[14]	Al MAdinah	30.7	99.03	0.97	Al-Madinah blood Bank	Nov 2016 – Dec 2016	Not listed

[9]	Makkah	4930	-	-	Central blood bank Makkah city	Jan 2014 – Dec 2016	Not listed
[10]	Madinah	307	99.35	0.65	Al-Madinah blood bank	Nov 2016 – Dec 2016	Not listed
[15]	Riyadh	254	-	-	King Faisal Specialist Hospital and Research	Jan 2010 -Jun 2014	listed
[26]	Hail	832	100	0	college of medicine, at university of Hail	-	listed
[27]	Hail	440	40.26	59.74	Cardiology Department in Hail region of Saudi Arabia	-	Not listed
[16]	Almadinah	1171	49.1	50.9	Online Survey	-	Not listed
[8]	Hail	600	41.3	58.7	Hail, baqaa, alghazala, alhaet and alshinan cities	One year 2015	Not listed
[30]	Hail II	715	61.7	38.3	-	Sep 2017- May 2018	listed
[11]	Najran	593	100	0	Al-Ghad International College for Applied Medical Sciences in Najran- KSA.	-	Not listed
[25]	West II	35388	-	-	Transfusion medicine section of king Abdelaziz medical city of national guard, Jeddah	Feb 2014- Feb 2016	Not listed
[19]	Riyadh	205	56	45	Al-Farabi dental Hospital, Riyadh	-	listed
[20]	Buraidah	4590	-	-	blood bank centre of Buraidah central hospital	Mar 2017 – Dec 2018	listed
- Data is not available.							

This project included thirty-four studies divided and summarized into local Saudi data (24 articles (Table 1), and international findings (23 articles, Table.2). Moreover, local and international data has been divided into blood donors and non-donors (patients, students, and healthy population) based on study setup. Table 1 demonstrates the distribution of ABO blood group in the different regions of Saudi Arabia and categorizes it by the provinces or the origin of the tribal location of the targeted populations. All researches showed an insignificant difference between the ABO and RhD blood groups' distribution among participants; however, they highlighted that the prevalence of ABO blood group was O>A>B>AB. Additionally, the RhD positive group was the predominate group compared to the RhD negative ( $91.77 \pm 4$  and  $8.88 \pm 5$  respectively). Results indicated that the O blood group was the most common group in the Saudi population ( $51 \pm 8\%$ ). The average distribution of other ABO phenotypes was A ( $27 \pm 4\%$ ), B ( $18 \pm 8\%$ ), and then AB ( $4 \pm 2\%$ ). For Rh blood group, the frequency of RhD positive.

Demographic data of participants of the previous local studies' is summarized in Table 2 to determine the causes of variation in ABO and RhD distribution. The demographic data showed that males were the

predominant blood donors in all regions. However, the sample size varies between the studies according to the conducted project scope in a different location in Saudi Arabia. Few blood grouping studies showed a sample size of more than thousand participants. Among these studies, the highest recruitment of blood donors was nearly 38,000 from the Western region of Saudi Arabia. Simultaneously, the most recent studies showed a reduction in numbers of the targeted population with almost less than 1000 individuals. Moreover, ethical considerations such as an IRB approval have only appeared in three studies. That highlighted the variances in study protocols and experimental setup, which might be the reason for the differences in ABO and Rh distribution among the Saudi population.

The results recorded by this study were not far from other countries throughout the world (Table 3). Most of the listed countries (23 sites) showed higher O blood group occurrence, but seven countries indicated A as a high distributed blood group in their population. Similarly, the average distribution of Rh group in the Saudi population is following the international frequency with no influence of race and ethnicity.

**Table 3: The distribution of ABO and RhD blood groups in the world and various countries. This table shows the distribution of ABO and RhD blood groups in the world and various countries.**

Participants		Country	O %	A%	B%	AB%	Rh +%	Rh-%	Reference
Donor	Patients	Worldwide	41.22	29.41	23.13	6.24	93.99	6.01	[31]
		Egypt	25.9	39.4	24.1	10.6	85.7	14.4	[32]
		India	21.82	28.82	38.16	11.82	93.83	6.17	[33]
		Ghana	50	24.3	20.7	5	93.2	6.2	[34]
		Iran	37.15	37.22	17.86	7.75	91.9	8.9	[35]
		US	46.6	37.1	12.2	4.1	85.4	14.6	[36]
		Jordan	36.62	38.36	18.04	6.98	*	*	[37]
		Lebanon	38.44	37.89	19.6	4.07	85.52	14.48	[38]
Non-Donors		Pakistan	28.66	31.95	27.99	11.4	92.46	7.56	[39]
		German	41.21	43.26	10.71	4.82	82.71	17.29	[40]
	Students	Malaysia	40	25	27	8	72	28	[41]
		Ethiopia	43.08	28.11	23.35	5.44	92.06	7.94	[42]
		Nepal	34.8	34.3	27	3.9	98.6	1.4	[43]
		Sudan	52.7	23.3	13.2	10.8	98.3	1.7	[44]
	Healthy Population	Turkey	32.67	42.84	16.46	8.03	88.54	11.46	[45]
		China	30.4	30.5	29.4	9.7	98.98	1.02	[46]
		Nigeria	52.93	22.77	20.64	3.66	94.9	5.1	[47]
		Iraq	48.03	23.11	21.45	7.41	88.56	11.44	[48]
		Palestine	32.9	39.29	21.33	6.48	97.3	2.7	[49]
		Bangladesh	38.21	39.68	14.9	7.2	97.44	2.56	[50]
		Bahrain	51.75	19.9	24.43	3.93	93.56	6.44	[51]
		UAE	48.4	24	22.8	4.7	91.1	8.8	[52]
		UK	44	42	10	4	83	17	[52]

\* Blood group frequency was not mentioned

## DISCUSSION

No large-scale studies have sought to determine the frequency and distribution of the ABO and Rh on the level of the population of Saudi Arabia although some regional and city-scale studies exist. Researchers in other countries worked on determining the frequencies of the major blood groups in their countries to assist in improvement of policies and regulations of blood banks.

The general frequency pattern of the blood groups follows that of the world, O>A>B>AB and with higher Rh Positive cases. Here, we found that the variations between the frequency of the blood groups ranged from 2 for AB group, 4 for A and AB groups, and 8 for B and O blood groups. It is expected to find variation between the percentages of blood groups among geographically distributed populations within the same countries. Studies in other locations found similar variation between percentages of blood groups in India, Pakistan, Bangladesh, and the UK.

The variations between the frequencies of blood groups for studies conducted in matching locations were high. Some variation can be anticipated in the same population in the matching location which can result from variation of sample criteria and year in which the sample was collected. Previous studies concluded that their data represents the population in the region or city selected for their research. However, the samples in those studies were selected from unrelated population, e.g., one study recruited students of a large number and the other recruited donors in the hospital.

Studies that aim to improve policies of healthcare providers, especially blood banking regulations, require careful selection criteria of samples. Because if a research aims to affect a population needs to select a population that reflect its criteria. Here, we found that the selected populations in the studies failed to reflect the regions blood groups frequencies as they lack the criteria for representation. Some studies selected successful donors which reflect healthy, adult, and generally males. Others



selected students in a restricted institution which reflect specific population of the region that has capacity to educate their children in this particular institution. Also, some research selected patients admitted to specific hospital in one city. Thus, it can be concluded that the previous studies did not select participants that represent the city or region in which the study aims to estimate the frequency of blood group in. So, such studies are hardly representable for locations in which they are conducted and they cannot represent the whole country of Saudi Arabia.

Another point for consideration was that these studies could have been aiming to provide recommendations to advance blood banking services in cities and regions of geographic, political, religious or high demand. It was also noted that most studies selected regions of centres of close proximity to the institute in which they conducted the research. Also, there is clear lack of researches that was conducted in central blood banks with exception of Makkah.

Frequency and distribution of blood groups studies in populations need to be governed by the constrictions of tight and ethical bodies. Ethical boards guarantee representability, accuracy, reproducibility, protection of participant's privacy and adherence to correct research governance guidelines. Otherwise, such researches will not be of benefit at the level of populations.

### CONCLUSION

The sequence of ABO distribution among the Saudi studies is; O>A>B>AB. While the frequency of Rhesus (D) negative is inconsiderable low among the participants. Further, male participants were the predominant in all studies. Cities and regions were not evaluated evidently as the scopes of the articles were different. Similarly, the type of participant and ethical approval was not indicated correctly. For these reasons, producing publications on blood groups should be considered and corroborated by the Saudi health authorities on a large scale.

The blood bank services in Saudi Arabia need to develop innovative strategies targeting blood group determination, especially among females. This is likely to improve blood groups' evaluation in the region and improve blood management in the hospitals. This also will minimize the collection of unnecessary blood supplies from donors. Similar studies should be undertaken to determine the blood group among Saudi Arabia patients to establish an adequate blood group manufacturing. These studies would collectively provide the national blood bank services with information critical for supply forecasting and blood inventory management.

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### AUTHORSHIP CONTRIBUTIONS

All authors directly participated in this study's design, data collection and analysis, interpretation of the results, and manuscript drafting and revision.

### CONFLICT OF INTEREST DISCLOSURES

The authors declared that there is no conflict of interest in this work.

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### REFERENCES

1. Grieve R, Willis S, De Corte K, et al. Options for possible changes to the blood donation service: Health economics modelling. *Health Services Delivery Res* 2018; 6:1-62.
2. Williamson LM, Devine DV. Challenges in the management of the blood supply. *Lancet* 2013; 381:1866-75.
3. Schreiber GB, Sanchez AM, Glynn SA, et al. Retrovirus epidemiology donor study. Increasing blood availability by changing donation patterns. *Transfusion* 2003; 43:591-57.
4. Rummel SK, Ellsworth RE. The role of the histoblood ABO group in cancer. *Future Sci* 2016; 2.
5. Aljuhaysh RM, El-Fetoh NM, Alanazi MI, et al. Maternal-fetal Rhesus (Rh) factor incompatibility in Arar, northern Saudi Arabia. *Electronic Phys* 2017; 9:5908.
6. Eweidah MH, Rahiman S, Ali MH, et al. Distribution of ABO and rhesus (RHD) blood groups in Al-Jouf Province of the Saudi Arabia. *Anthropologist* 2011; 13:99-102.
7. Al Ghamdi AS. Association between ABO blood groups and severity of chronic periodontitis. *Med Sci* 2009; 16.
8. Moussa S, Al-zaylai F, Alnawmasi MO, et al. Pattern of distribution of ABO and Rhesus (RH) blood groups in hail province, Saudi Arabia. *Int J Med Health Res* 2018; 4:166-70.
9. Khan MN, Khaliq I, Bakhsh A, et al. Distribution of ABO and Rh D blood groups in the population of Poonch District, Azad Jammu and Kashmir. *EMHJ-Eastern Mediterranean Health J* 2009; 15:717-721.
10. Owaidah AY, Naffaa NM, Alumran A, et al. Phenotype frequencies of major blood group systems (Rh, kell, kidd, duffy, mns, p, Lewis, and Lutheran) among blood donors in the eastern region of Saudi Arabia. *J Blood Med* 2020; 11:59.
11. Al-Noaemi MC, Daghriri HA. The significant high prevalence of blood group A<sup>+</sup> in Yam Tribe of Najran City, the South Province of KSA. *Open Access Blood Res Trans J* 2018; 2:17-21.
12. Abdullah SM. Frequency of ABO and Rh blood groups in the Jazan region of Saudi Arabia. *Pak J Med Sci* 2010; 26:818-821.

13. Elsayid M, Aseeri YY, Saqri FA, et al. A study of prevalence of blood group of Saudi patients in King Abdulaziz Medical City-Riyadh. *Sci J Public Health* 2015; 3:559-62.
14. AlBilali AM, AlFraidy OB, AlHarbi HH, et al. The distribution of abo blood groups and rhesus factor among regular blood donors in al-madinah al-monawarah, Saudi Arabia 2016. *Int J Adv Res* 2017; 5:2917-2920.
15. Abu-Zaid A, Alsabban M, Abuzaid M, et al. ABO blood group and endometrial carcinoma: A preliminary single-center experience from Saudi Arabia. *Cureus* 2017; 9.
16. Alwasaidi TA, Alrasheed SK, Alhazmi RA, et al. Relation between ABO blood groups and obesity in a Saudi Arabian population. *J Taibah University Med Sci* 2017; 12:407-11.
17. Almainan AA, Almainan SH. Distribution and Association of hypertension, obesity, diabetes and transfusion transmitted infections with ABO and Rh blood groups in blood donors at King Saud Hospital, Unaizah, Saudi Arabia. *West Indian Med J* 2019.
18. Alzahrani FM, Shaikh SS, Rasheed MA. Frequency of ABO-rhesus blood groups in the western region of Saudi Arabia. *J King Abdulaziz University Med Sci* 2018; 25:9-13.
19. Mostafa D, Elkhatat EI, Koppolu P, et al. Correlation of ABO Blood groups and Rh factor with the severity of generalized chronic periodontitis: Across sectional study in Riyadh, Saudi Arabia. *Open access Maced J Med Sci* 2019; 7:617.
20. Alabdulmonem W, Shariq A, Alqossayir F, et al. Sero-prevalence abo and Rh blood groups and their associated transfusion-transmissible infections among blood donors in the central region of Saudi Arabia. *J Infection Public Health* 2020; 13:299-305.
21. Saha N, Bayoumi RA, El Sheikh FS, et al. Some blood genetic markers of selected tribes in Western Saudi Arabia. *Am J Phy Anthropol* 1980; 52:595-600.
22. Al-Himaidi AR, Umar MO. ABO blood group distribution among Saudi citizens related to their regional or original tribal location. *Kuwait J Sc Eng* 2002; 29:75-81.
23. Sarhan MA, Saleh KA, Bin-Dajem SM. Distribution of ABO blood groups and rhesus factor in Southwest Saudi Arabia. *Saudi Med J* 2009; 30:116-119.
24. AlSuhaibani ES, Kizilbash NA, Malik S. Heterogeneity and diversity of ABO and Rh blood group genes in select Saudi Arabian populations. *Genet Mol Res* 2015; 14:7850-63.
25. Alzahrani FM, Shaikh SS, Rasheed MA. Frequency of ABO-rhesus blood groups in the western region of Saudi Arabia. *J King Abdulaziz University Med Sci* 2018; 25:9-13.
26. Farshori MP, Al-Muzaini AY, Al-Wakid IH, et al. Frequency of distribution of abo and rhesus (Rh) blood group antigens in the female type 2 diabetes mellitus (T2DM) patients in hail region of Saudi Arabia. *Integrative Obes Diabetes* 2017; 3:1-6.
27. Farshori MP, Yasir GI, Abdulmajeed HM, et al. Frequency of expression and the distribution of ABO and Rh, blood group antigens in the myocardial infarction (MI) male patients of the Hail region in Saudi Arabia. *J Integrative Cardiol* 2017; 3:1-5.
28. Bashwari LA, Al-Mulhim AA, Ahmad MS, et al. Frequency of ABO blood groups in the Eastern region of Saudi Arabia. *Saudi Med J* 2001; 22:1008-12.
29. Talib ZA, Al-Nuaim LA, El-Hazmi MF, et al. Blood groups in Saudi obstetrics patients. *Saudi Med J* 1998; 19:260-264.
30. Alateeq FA, Aldugiemani TZ, Al-Rashdi YD, et al. The patterns of blood groups and its association with blood donation in Saudi Arabia. *Open J Preventive Med* 2018; 8:291-300.
31. <https://www.rhesusnegative.net/staynegative/>
32. Swelem O, Goubbran F, Younis S, et al. RH phenotypes and kell blood groups frequencies in an Egyptian population. *OMNIA* 2018; 6.
33. Singh S, Arora I. Frequency and distribution of ABO and rhesus (D) blood groups in district Chamba, Himachal Pradesh: A study from rural tertiary care hospital. *Int J Community Med Public Health* 2018; 5:689-92.
34. Doku GN, Agbozo WK, Annor RA, et al. Frequency of ABO/Rhesus (D) blood groupings and ethnic distribution in the Greater-Accra region of Ghana, towards effective blood bank inventory. *Int J Immunogen* 2019; 46:67-73.
35. Ghobadian Z, Sayemiri K, Zeinali M, et al. Distribution of ABO and Rh blood groups in a major ethnic group of the West Iran, the Kurdish population. *Asian J Med Sci* 2014; 5:26-9.
36. Garratty G, Glynn SA, McEntire R. Retrovirus epidemiology donor study. ABO and Rh (D) phenotype frequencies of different racial/ethnic groups in the United States. *Transfusion* 2004; 44:703-6.
37. Hassawi DS. Allele frequency and molecular genotypes of ABO blood group system in a Jordanian population. *J Med Sci* 2007; 7:51-58.
38. Tarhini M, kazan HF, Hijazi R, et al. Prevalence of principal abo and rhesus blood group systems over the entire lebanese population. *Asian J Sci Technol* 2018; 9:8440-8443.
39. Ullah S, Ahmad T. Distribution of ABO and Rh (D) blood groups in the population of District Dir Lower, Khyber Pakhtunkhwa Pakistan. *World Applied Sci J* 2015; 33:123-35.
40. Wagner FF, Kasulke D, Kerowgan M, et al. Frequencies of the blood groups ABO, Rhesus, D category VI, Kell, and of clinically relevant high-frequency antigens in South-Western Germany. *Transfusion Med Hemotherap* 1995; 22:285-290.
41. Amin MR, Susanto D, Naher L. Distribution pattern of ABO and Rh blood groups and their allelic frequencies among different ethnic groups in Malaysia. *Asian J Med Sci* 2015; 6:25-29.



42. Tesfaye K, Petros Y, Andargie M. Frequency distribution of ABO and Rh (D) blood group alleles in Silte Zone, Ethiopia. *Egyptian J Med Human Genetics* 2015; 16:71-76.
43. Sah JP, Pant DR, Shrestha V, et al. Distribution of ABO, rhesus blood groups and hemoglobin concentration among the school students of Deurali VDC, Kaski, Nepal. *Int J Pharm Bio Sci* 2013; 3:10-16.
44. Hassan FM. Frequency of ABO subgroup ABO and Rh (D) blood groups in major Sudanese ethnic groups. *Pakistan J Med Res* 2010; 49.
45. Salduz ZI, Çetin G, Karatoprak C, et al. ABO and Rh blood group distribution in Istanbul Province (Turkey). *İstanbul Med J* 2015; 16:98-100.
46. Liu J, Zhang S, Wang Q, et al. Frequencies and ethnic distribution of ABO and RhD blood groups in China: A population-based cross-sectional study. *BMJ Open* 2017; 7:e018476.
47. Anifowoshe AT, Owolodun OA, Akinseye KM, et al. Gene frequencies of ABO and Rh blood groups in Nigeria: A review. *Egyptian J Med Human Genetics* 2017; 18:205-210.
48. Saleh SM, Abood AS. ABO and Rh (D) blood groups' distribution and gene frequencies in North Baghdad population-Iraq. *Int J Sci Eng Res* 2016; 7:2-4.
49. Skaik YA, El-Zyan NR. Spectrum of ABO and Rh (D) blood groups amongst the Palestinian students at Al-Azhar University-Gaza. *Pakistan J Med Sci* 2006; 22:333.
50. Begum D, Amin MR, Khatun F, et al. Distribution of ABO and Rh blood groups among tribal population of Sylhet, Bangladesh. *J Dhaka Med College* 2011; 20:44-50.
51. Al-Arrayed S, Shome DK, Hafadh N, et al. ABO blood group and RhD phenotypes in Bahrain: results of screening school children and blood donors. *Bahrain Med Bull* 2001; 23:112-115.
52. Taha JY. Rh antigen and phenotype frequency in kalba region, UAE. *Bahrain Med Bull* 2012; 34.