Biosight 2023; 04(01): 87-98

Prevalence Of Blood Groups And Association With Ailments In Pakistani Population: A Review of The Current Literature

Saadia Saad[1*], Syed Tousif Ahmed[2], Ambrina Khatoon[3], Jawaid Ansari[4], Asaad J. Mirza[5]

1. *Department of Physiology, Baqai University, Karachi, Pakistan.*
2. *Department of Physiology, Ziauddin University, Karachi, Pakistan*
3. *Department of Research, Ziauddin University, Karachi, Pakistan*
4. *Department of Cardiology, Ziauddin Hospital, Karachi, Pakistan*
5. *Department of Operative Dentistry, Baqai Medical University, Karachi, Pakistan*

Abstract: The aim of this review is to report studies performed in Pakistan on the prevalence of blood groups among various sections of the population and their association with human diseases. Google Scholar was searched for the last 20 years based on MESH keywords mentioned below. The inclusion criteria were the studies published in the new millennium that reported either prevalence of blood groups or their association with diseases in the Pakistani population. There were 50 studies in Pakistan which fulfill the inclusion criteria. Among them, twenty- six were from Punjab, seven were from Khyber Pakhtunkhwa (KpK), six from Sindh, four from Kashmir, two from Northern areas, one from Baluchistan and 4 are review articles. This review concludes that blood group B is prevalent among Pakistani population followed by O, A and AB. Studies done in Azad Jammu Kashmir (AJK) and Gilgit- Baltistan reveal that B and A is prevalent in these areas respectively. AB is the least found group and Rh+ve is common among all studies. Moreover, this review also shows that blood groups act as a risk factor for many diseases. Therefore, Pakistani researchers are suggested to work on the genetic makeup of these blood groups to find out the cause of association with systemic ailments in the country.

Keywords: Antigen, ABO, blood donors, blood groups, Rh factor, phenotype

Received: October 04, 2022
Accepted: November 15, 2022
DOI: 10.46568/bios.v4i1.79

***Correspondence:** Sadia Saad, M.Phil scholar, Department of Physiology, Baqai University, Karachi Pakistan, Tel: 0092-0333-1268248 Email: saadia.12606@zu.edu.pk

Introduction

Regarding prevalence and distribution of blood type, it is mentioned in literature that though populations over the globe have the same ABO and Rh blood groups but they differ in prevalence and distributions of specific types among various races, ethnic groups and different populations [1, 2]. Number of studies has mentioned distribution and prevalence of blood groups among various ethnic groups, nations and populations as they hold quite a lot of importance as genetic markers to study population traits. They are also utilized in the anthropological studies to differentiate various racial groups and for forensic analysis. They also play very important role in transfusion medicine. Though thousands of publications on the prevalence of blood groups and their connection with human diseases are available in the medical literature which dates back to as early as 1917, history of publications on this issue in Pakistan is comparatively less.

Distribution of blood groups in Pakistan

In year 2000, a study was done among blood donors from Bhawalpur. Records of 34516 donors revealed that the most prevalent groups were O and B with equal prevalence followed by A and AB with 95.5% doniors Rh+ve [3].
In 2001, a study was performed with the objective to assess distribution of blood groups in people of Baluchistan. It showed that the blood group O was most prevalent followed by B, A, and AB. Rh+ve was 94.7 % [4].
In 2002, frequencies of blood group and influence of gender was assessed on prevalence of blood groups in a study in Faisalabad. Blood group B was most prevalent followed by group O, A and AB [5].
In 2003**,** a study was done to investigate frequency of blood groups in the patients suffering from thalassaemia, haemophilia, aplastic anemia and chronic renal failure undergoing dialysis. The commonest group was B, followed by O, A and AB. The Rh+ve was found in 94% [6].
In 2004, a study was conducted in Bannu, KpK. Its findings revealed that group B was most prevalent followed by A, O, AB. Females were 87.98 % Rh+ve and 12.02% Rh-ve, whereas men were 90.26% +ve and 9.74% -ve [7].Another extensive study was done to document blood group frequency among blood donors, gathering data from blood banks of all teaching hospitals situated at Bahawalpur, Faisalabad, Multan, Rawalpindi and Lahore. It found that the donors were predominantly Rh+ve .The blood groups in the order of prevalence in Rh+ve donors were B, O, A, and AB; while in Rh-ve it was O, A, B, and AB respectively [8]. One study reported the distribution of blood groups in an isolated population settled in Jamshoro, Sindh. Out of 50 individuals tested for blood groups, 80% had group A, 4% had B, 16% had O and none had AB. All of the participants were Rh+ve [9]. A study done in Bannu revealed that the B was most prevalent followed by A, O and AB. The Rh+ve was 89.23% [10].
In 2005**,** similar study done, revealed that residents of Gujrat, Punjab predominantly have group B with a high allelic frequency of O group [11]. A study was done to document the frequency of blood groups in potential male blood donors belonging to Skardu. The most shared group was A followed by B, O and AB. Rh+ve group comprised of 94.83% [12]. One study was done in Attock to determine the frequency of ABO and Rh phenotypes in different racial groups and casts in Pakistan. The authors were unable to find any statistically noteworthy difference of ABO and Rh distribution among various ethnic groups. O was the common blood group among various ethnic groups except in Arains where B was the most common and O was the least common [13]. A study done in Liaqautpur among blood donors found that blood group O was the most prevalent with majority Rh+ve [14].
In 2006, a study was undertaken with the purpose to know the prevalence of blood groups in Rawalpindi Islamabad population. It discovered that group B was most prevalent among the population followed by group O, A and AB. The Rh+ was noted as 92.45% [15]. One study was carried out to know the frequency of blood groups among Azad Jammu Kashmir residents. The distribution of blood groups was assessed as approximately 26%, 33%, 9% and 32% for A, B, AB and O, respectively. The occurrences for allele A, B and O were 0.2, 0.238 and 0.56, respectively [16].
In 2007,a study performed with the goal to determine frequency of blood groups in Mandi Bahauddin, showed preponderance of group B followed in decreasing order as O,A and AB [17].
In 2008, a study was conducted to ascertain the frequency of blood groups in Swat (KpK). Blood samples were received from 22897 Swat residents. It concluded that frequency of Rh+ve blood group was B, O, A, and AB in both the genders, whereas in Rh-ve people, the frequency of blood groups was different in males and females. O, B, A and AB was the order of frequency in males, and in females B, O, A, and AB was the order. [18].
In 2009, a study conducted to assess distribution of ABO in the population of Poonch, AJK. The blood group in the male population revealed the same trend of prevalence as for the Pakistani population as B, O, A, AB but for females the order of prevalence was different as O, B, A, AB

[19]. A study published in 2009, presented the data of a thalassemia foundation in Rawalpindi. This study included the data of healthy blood donors of the foundation visiting during 2005 to 2008. Blood group B with Rh +ve was observed as the commonest and $AB^-$was least the frequently distributed. Blood group B with Rh+ve was the most prevalent and AB was the least frequently observed blood group. Most of the donors were Rh+ve but no significant difference was noted among the genders [20]. A study was done in1^{st} year students of a private medical and dental college in Multan. It showed that group B was most prevalent among the students [21].

In 2011, a study was carried out to determine blood groups of Sahiwal population. 20,010 subjects comprising of 3,901 female and 16,109 males, were screened for blood grouping. It concluded that phenotypically B group was dominant with high allelic frequency of O [22].

In 2012, a study was conducted to document blood group distribution among the residents of Mirpur, AJK. Findings revealed a highest distribution of group B followed by A, O and AB. The majority had Rh+ve [23]. A study to find out the frequency of blood groups among the blood donors in Rawalpindi and Islamabad revealed that group B was most prevalent followed by O, A and AB [24].

In 2013, a study done in Islamabad, received same findings with blood group B as the most prevalent among the residents of Lehtar road [25]. A study was carried out to determine the frequency of blood groups among students studying at a public sector university in Mardan. According to its findings, group B was the commonest followed by blood group A, O and AB [26]. One study was done in Gujranwala to explore the frequency of blood groups and Rh factor in the inhabitants. It included 4754 blood donors' record of 04 years gathered during blood donation camps. It showed blood group B was most prevalant, followed by group O, A and AB [27]. A study conducted in five districts of Southern Punjab revealed that blood group O was predominant followed by B, A and AB [28] In 2014, a study was done to assess frequency of blood groups among blood donors in Lahore. It found that the most common group was B followed by O, A and AB while majority was Rh^+ [29].

In 2015, in lower Dir, KpK, a pilot study was done to analyze the genotypic and phenotypic distribution of blood groups. The population was ethnically comprised of Pakhtuns sharing similar culture and language. Its conclusion was that majority had group A while AB was the least prevalent [30]. Another study was conducted in Peshawar with the goal to assess frequency of blood group and Rh factor in the women of Peshawar city. According to its findings, the participants with blood group B were slightly-higher followed by A and O, with rare group AB in these females [31]. One study was undertaken among the residents of Sialkot to evaluate the distribution of blood groups. The most frequent group was B followed by O, A. and AB. Rh+ve were 91.24% [32]. A study done in Multan, showed the same trend of prevalence of blood groups as for other parts of Pakistan (B, O,A, AB).The most population was Rh+ve [33]. In Karachi, a study was conducted to assess the Rh and Kell phenotype of voluntary blood donors. This study discovered that group O was the most dominant group among donors with a frequency of 37%. This was closely followed by group B that was seen in 31% donors. Group A was in 21% donors while AB was the least found. Rh+ve was prevalent among 97% donors [34]. A study was conducted to evaluate the frequency of blood groups among the inhabitants of Rahim Yar Khan. It mentioned that group B was most frequent among both genders followed by O, A and AB. The majority of group B was Rh^+ in males. In females, blood group O was commonest with Rh+ve and blood group A was high with Rh-ve [35].

In 2016, a study was performed in a private medical college in Lahore to find the prevalence of blood groups among its students. Group B with Rh+ve was commonest and there was an association between a specific cast and blood group. In Khans and Syeds, group O+ve was most common [36]. Similar study was performed in public sector school in Lahore. It was performed to establish the frequency and gender distribution of blood groups in students of medicine. It concluded that these students had predominantly B+ve and O+ve [37]. A study was conducted

during 2012-14 to provide baseline information about distribution of blood group and Rh factor among blood donors visiting Jinnah Hospital, Lahore. It found that frequency of blood groups was B followed by O, A and AB. B was most prevalent and AB the least prevalent. Rh+ve was most predominant [38].

In 2018, a study was done to find the prevalence of blood groups among residents of Karachi. It showed that O group was the most prevalent among Karachiites followed in decreasing order by B, A and AB [39]. Another study was conducted to assess distribution of blood groups among the people of Danyore and Gilgit. In this study, group A^+ was found most prevalent while B-ve and AB-ve was the least distributed [40]. A study conducted to determine the prevalence of various blood groups and Rh factors in blood donors visiting a teaching hospital in Lahore. The sample consisted of 58.8% females and 41.2% males. The percentages of ABO and Rh blood groups among them were B+ve 40.5%, O+ ve 26.5 %, A+ ve 24.0%, AB+ve 2.8%, B-ve 5.0 %, O-ve 0.2%, AB-ve 0.5% and A-ve 0.5%.[41]. A study was undertaken with the goal to observe the prevalence of important minor blood group antigens in residents of Islamabad. It discovered the frequency of the blood group antigens among Pakistani blood donors to be statistically unlike from those individuals who belong to China and Africa [42]. A study was published with the objective to make the gender-based comparison of distribution blood groups among the medical and dental students of a private college in Lahore. The study concluded that there was statistically no significant relationship of gender with ABO and Rh blood groups [43].

In 2019, assessment of blood group distribution was done among population of AJK. A sample of 3450 subjects was analyzed for their blood groups. The most frequent group was B with 36.64% followed by O (29.33%), A (20.93%) and AB (13.1%). Majority of them were Rh+ve [44]. A study was conducted in Karachi to examine distribution of blood groups among multiple ethnic individuals visiting the hospital. O+ve was the most prevalent and AB-ve was the least blood group among the studied population [45]. A study was conducted to investigate blood group distribution in blood donors attending a large transfusion centre named AFIT, Rawalpindi. It found that group B was the most prevalent followed by O, A, and AB. Majority (89.03%) of the donors were Rh+ve [46].

In 2020, blood group distribution was assessed among female blood donors visiting some hospital in Karachi. It found that the most prevalent group among them was B while AB was the least observed and majority of them had Rh+ve [47]. Another recent research study was conducted in Karachi to demarcate ancestral association among the five major linguistic inhabitants of Pakistan using Abo phenotypes. B blood group was prevalent among all the subjects included in the study except Baluchis in which “A” blood group showed preponderance [48]. A systematic review published in Dec 2020, compiled the prevalence of ABO and Rh blood groups in the entire provinces and regions of Pakistan. According to the study, the most prevalent group in Pakistani population is B, followed by O, A and AB. Moreover, Rh+ve group is seen more common than Rh-ve [49].

A recent study done in 2021 to assess the frequency of blood group distribution in Faisalabad and Safdarabad revealed that among Faisalabad population, blood group O was more prevalent followed by group B, A and AB respectively. Blood group B was predominant among the inhabitants of Safdarabad which was followed by group O, A and AB respectively. In both places, people were predominantly Rh positive [50].

A review article published in the year 2021 concludes that in Pakistan, frequency of blood group B is 33.37%, while O is 33.14%, A is 23.99%and AB9.74%. Rh +ve is more prevalent than Rh-ve [51]. Another recent review article from the year 2022 also showed similar results of blood group B being the most prevalent and AB being the most least in Pakistani population [52].

Association of blood groups with diseases

Association of blood groups with human diseases is well documented. In an article on historical perspective, author has cited many studies describing work related to the link of ABO blood group and diseases worldwide [53]. In Pakistan, studies found on this issue are scarcely available and mentioned below.

1. Association with Heart diseases

The available literature on association between heart diseases and blood groups in Pakistani population is scarcely present. In this regard first accessible study was done in 2001 in Sindh. It was done to study relationship of blood groups with heart attack and angina pectoris. Its findings were that blood group A was most prevalent among heart attack and angina pectoris patients. These ailments in group O individuals were least [54].

Another study was done with the objective to explore the correlation between blood groups and coronary heart diseases (CHD). It concluded that among the Pakistani population, blood group A has an association with a substantially increased risk for CHD [55].

Lutfullah *et al* conducted a comparative study at Mayo Hospital, Lahore to inspect the association of blood groups in patients having ischemic heart disease (IHD).It revealed that there is no association between IHD and blood group distribution [56].

A study with the same objective was done at Punjab Institute of Cardiology, Lahore. Its findings were contradictory to Lutfullah's findings. According to this study, individuals having blood group A have significantly higher risk of developing IHD as compared to other blood groups [57].

Another study from the same institute was done to find association between blood groups, sex, age and angina pectoris. It mentioned that blood groups A and Rh-ve were significantly prevalent and AB was significantly lower in angina patients. Angina pectoris was significantly common in males and was highest in age 51-60 years [58].

A case control study carried out at Army Cardiac Centre CMH, Lahore showed that group 'A' was significantly prevalent among IHD patients [59].

A study conducted to investigate the frequency of acute myocardial infarction in various blood groups found that acute myocardial infarction was higher among patients having group O+ve followed by B+ve [60]. (See Table 1)

Table 1: Association of blood groups with heart diseases

S.No.	Year	Author	Findings
1.	Sindh, 2001	I A Akhund *et al*	Blood group A was most prevalent among heart attack and angina pectoris patients
2.	Karachi and Nawabshab, 2005	J. W. Herzig *et al*	Blood group A has a link with a substantially increased risk for CHD
3.	Lahore, 2011	Lutfullah *et al*	No association between IHD and blood group distribution
4.	Lahore, 2014	Saima Sharif *et al*	Blood group A have significantly higher risk of developing IHD
5.	Lahore, 2011	Siddiqui *et al*	Blood groups A and Rh-ve were significantly prevalent in angina
6.	Lahore, 2017	Ashraf *et al*	Group 'A' significantly prevalent among IHD patients
7.	Rawalpindi, 2020	Imran Iftikhar *et al*	Acute myocardial infarction was higher among patients having group O+ve followed by B+ve group

2. **Association with Infectious diseases**

a) Covid-19

Afshan *et al* at Army Medical College, Rawalpindi conducted a study to find out association of blood groups with COVID-19 and showed that persons having blood group A possess increased risk of the disease while group O has a lesser danger [61].

Another study from Peshawar showed that susceptibility to covid-19 was greater in blood types B and AB, whereas no association between blood types A and O were seen with covid-19 [62].
A study conducted on children in Lahore by Attia *et al* investigated the association of ABO with the severity and outcome of covid-19. The results showed that although blood group O was the most prevalent blood group, but blood group A was significantly associated with severe and critical disease in children [63].
Fazal *et al* also added to the literature and showed that the B blood group was the most frequent among covid-19 patients in Karachi, followed by O, A and AB. However, according to this study blood groups have no role in predicting the severity of the disease [64].

b) Malaria and Hepatitis

A study was conducted in three districts in Karachi; Central, East and South. It intended to search the association between blood group distribution and susceptibility to malaria and effects on platelets, (total leukocyte count) TLC, and (hemoglobin) Hb. It concluded that no significant association exists between blood groups and susceptibility to malaria or developing anemia or thrombocytopenia [65].
Shakeel *et al* conducted a study at Nishter Hospital, Multan and Shaikh Zayd Hospital, Rahimyar Khan found that there was no significant difference between blood group frequency and Rh with chronic viral hepatitis [66].
One more study assessed the frequency of Hepatitis B and C in blood donors living in Lahore and the association with blood group. It significantly found higher number of Rh+ve donors had HCV infection as compared to Rh-ve donors [67]**.** (See Table 2)

Table 2: Association of blood groups with infectious diseases

S. No.	Year	Author	Findings
1.	2016	Hira Burhan	No significant association exists between blood groups and susceptibility to malaria or developing anemia or thrombocytopenia
2.	2018	Hassan Abdullah *et al*	There was no significant difference between blood group frequency and Rh with chronic viral hepatitis
3.	2011	Saeed Anwar *et al*	Higher number of Rh+ve donors had HCV infection
4.	2020	Afshan *et al*	Blood group A possess an increased risk of the covid-19 disease
5.	2021	Fawad *et al*	Susceptibility to covid-19 was greater in blood types B and AB
6.	2021	Attia Bari	Blood group A was significantly associated with severe and critical disease in children
7.	2021	Fazal Rehman *et al*	B blood group was the most frequent among covid-19 patients

3. Association with Dyslipidemia

A study conducted by Shamim and Ihtesham in NWFP to find the possibility of association between blood groups and lipid profile revealed that B and O phenotypes have relatively greater disturbances in lipid profile than other blood groups [68].

4. Association with Diabetes Mellitus (DM)

Waseem *et al* conducted a study in Rawalpindi which concluded that there is association between AB blood group with higher chances of DM as compared to group A and B [69].
A study was conducted at Services Hospital Lahore by Zaidi *et al* to find association between Type II Diabetes and blood group. It's established that the frequency of group B is significantly higher in DM patients [70].

A much recent study from the year 2022 by Ghafar *et al* showed the association of ABO and Rh blood groups and diabetes in Karachi. It concluded that diabetes has some association with ABO and people with blood type B are more prone to diabetes [71].

5. Association with ophthalmic diseases

One study done with the aim to assess association between blood groups and refractive errors revealed that individuals with group O have slight predominance to myopia whereas other blood groups did not show any relevance to refractive errors [72].

A study undertaken by Imran *et al* to evaluate the relationship between blood groups and glaucoma in Pakistani population concluded that group B is related with glaucoma of all types and the Rh-ve is associated only with primary open-angle glaucoma [73].

6. Association with psychiatric disorders

A study done with the objective to relate blood grouping with depression, concluded that group B+ individuals have higher depression while with AB-ve have less depression [74].

A study done to assess the association between blood groups and various stressors like physical, environmental, interpersonal and academics in medical students revealed that all variables stressors had insignificant relationships with blood group [75].

7. Association with allergy

Allergic diseases are the most common chronic health problems all over the globe. A study done in Islamabad to explore the association of blood groups with dust, pollen and skin allergy revealed that in the study population, group B was common and at higher risk for developing allergies. Blood groups A and O were nearly at same level while group AB was least affected [76].

Association with fingerprints pattern

A study was conducted on preclinical students studying at AJK Medical College to find the relationship between blood groups and patterns of fingerprints. It disclosed that loops (most common type of fingerprint) are dominant in persons having group B while less found in persons with group AB. Loops were more prevalent in individuals with Rh+ve [77].

Association with body mass index (BMI)

To study the association between BMI and blood groups, a study was conducted in a medical college in Karachi with its students as subjects. 181 students were selected. The researchers found out that highest BMI was found in group A, which was 24.3 ± 5.04 kg/m^2 and the lowest BMI was found in group AB, which was 23.0 ± 2.91kg/m^2. Rh+ve was found to have higher BMI compared to Rh-ve [78].

Another study was conducted to assess the frequency of blood groups among female students of medicine and to find the association of blood groups and BMI with blood pressure. There were 145 students who were selected. It discovered that students having blood group O and BMI >25kg/m^2 (obese) are at a greater risk for pre-hypertension than others. The result was then validated by logistic regression analysis which showed significant p-value [79].

Conclusion

This review concludes that B blood group is the most prevalent among Pakistani population followed by O, A and AB. Moreover, this paper shows that blood groups act as a risk factor for many diseases. For ischemic heart diseases, ‘A’ blood group seems to be the potential risk factor, which is the same as shown by the Western researchers. For other diseases, conclusion is nonspecific because each study has different results.

Future Recommendation:
The Pakistani researchers are suggested to come up with more work regarding the association of blood groups with different diseases and also on genetic polymorphisms in ABO blood groups. The researchers worldwide have already started working on the genetic make-up of these blood groups to find out the cause of association with different ailments and they are declaring ABO blood groups and their genotypes as potential risk factors for different diseases.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE
Not applicable.

HUMAN AND ANIMAL RIGHTS
No animals were used in this study. The study on humans was conducted in accordance with the ethical rules of the Helsinki Declaration and Good Clinical Practice.

CONSENT FOR PUBLICATION
Not applicable.

AVAILABILITY OF DATA AND MATERIALS
None.

FUNDING
None.

CONFLICT OF INTEREST
The authors declare no conflict of interest, financial or otherwise.

ACKNOWLEDGEMENTS
None.

REFERENCES
1. Pramanik T, Pramanik S. Distribution of ABO and Rh blood groups in Nepalese medical students: A report. East Mediterr Health J 2000; 6: 156-8
2. Sidhu S. Distribution of the ABO blood groups and Rh (D) factor among the scheduled caste population of Punjab group markers among the four scheduled caste. Anthropologist 2003; 5: 203-4. https: //doi.org/10.1080/09720073.2003.11890806
3. Khichi QK, Ali SA, Malik MS. Prevalence of ABO and Rh (D) blood groups in Bahawalpur division. Pak Ped J 2000; 24(1): 1-2. https: //doi.org/10.1016/j.ejmhg.2011.08.006
4. Hussain A, Sheikh SA, Haider M, Rashied T, Malik MR. Frequency distribution of ABO and rhesus blood groups in population of Baluchistan, Pak Armed Forces Med J *20*01; 51 (1): 22-6
5. Hameed A, Hussain W, Ahmed J, Rabbi F, Qureshi JA. Prevalence of Phenotypes and Genes of ABO and Rhesus (Rh) Blood Groups in Faisalabad, Pakistan. Pak J Biol Sci 2002; 5: 722-4
6. Ghori MU, Tayyab M, Raziq F. Frequency of ABO and RhD Blood Groups in Transfusion Dependent Patients. *J Postgrad Med Inst 2003*; *17*(2): 177-83. https: //jpmi.org.pk/index.php/jpmi/article/view/822
7. Khan MS, Tahir F, Sheikh MA, Mubashir Ahmed Sheikh, Subhan F, Kazi BM, Dil AS, Deepa F, Irshad Ali I, Baloch MK. An analysis of genotype frequencies of blood group antigens from Bannu region (NWFP) in Pakistan. Gomal J Med Sci 2004; 2(1): 1-5
8. Rahman M, Lodhi Y. Frequency of abo and rhesus blood groups in blood donors in Punjab, Pak J Med Sci *20*04; 20(4): 315-8

9. Bhatti R. Distribution of ABO and Rhesus blood alleles in a strict endogamous subtribe of lower Sindh (Pakistan): Setharani (Tribe: Noohani). Pak J Zool 2004; 36(2): 125-8
10. Khan MS, Sibtain F, Tahir F, Kazi BM, Dil AS, Sultan S, Deepa F, Khan F. Prevalence of Blood Groups & Rh factor in Bannu region NWFP (Pakistan) Pak J Med Res 2004; 43(1): 8-10
11. Anees M, Mirza MS. Distribution of ABO and Rh blood group alleles in Gujrat region of Punjab, Pakistan. Proc Pakistan Acad Sci 2005; 42(4): 233-8.
12. Alam M. ABO and Rhesus blood groups in potential blood donors at Skardu (Northern Areas). Pak J Pathol 2005; 16: 94-97
13. Ali N, Anwar M, Bhatti FA, Nadeem M, Nadeem A, Ali AM. Frequency of ABO and RH blood groups in major ethnic groups and casts of Pakistan, Pak. J. Med. Sci 2005; 21 (1): 26-29
14. Rehman A, Khan MA, Ashraf M, Malik SA, Saeed MA, Rafique A, Ali A. ABO & Rhesus Blood Groups Professional Med J 2005; 12(4): 368-371
15. Khan MS, Farooq N, Qamar N, Tahir F, Subhan F, Kazi BM, *et al*. Trend of blood groups and Rh factor in the twin cities of Rawalpindi and Islamabad. J Pak Med Assoc 2006; 56(7): 299-302
16. Khalid M, Qureshi MA. Frequencies of blood group antigens and corresponding alleles in the population of Mirpur, Azad Jammu Kashmir, Pakistan. J Anim Pl Sci 2006; 16(3-4): 96-8
17. Anees M, Jawad A, Hashmi I**.** Distribution of ABO and Rh blood group alleles in Mandi Bahauddin district of Punjab, Pakistan. Proc. Pakistan Acad. Sci 2007; 44(4): 289-94
18. Khattak ID, Khan TM, Khan P, Shah SMA, Khattak ST, Ali A. Frequency of ABO and Rhesus blood groups in district Swat, Pakistan. J Ayub Med Coll Abbottabad 2008; 20(4): 127-9
19. Khan MN, Khaliq I, Bakhsh A, Akhtar MS, Din AM. Distribution of ABO and Rh D blood groups in the population of Poonch district, Azad Jammu and Kashmir. Eastern Mediterranean Health J 2009; 15: 3721-17 ,
20. Iqbal M, Niazi A, Tahir M. Frequency of ABO and Rh blood groups in healthy donors. J Rawalpindi Med College 2009; 13(2): 92-4
21. Pasha AK, Hashir MM, Khawar S. Frequency of ABO blood groups among medical students. J Sur Pak 2009; 14(2): 93-5
22. Anees M, Jawad A. Distribution of ABO and Rh Blood Group Alleles in Sahiwal district of the Punjab, Pakistan. Proceedings of Pak Acad Sci 2011; 48 (1): 39-43
23. Chisti HM, Waheed U, Ansari MA, Wazir I, Hussain Z. ABO and Rh blood group phenotypes in Mirpur, Azad Kashmir, Pakistan. J Pub Health Biological Sci 2012; 1(2): 41-3
24. Shakir M, Khan SA, Ghani E. Frequency of ABO and Rh (D) blood groups among blood donors in Rawalpindi/Islamabad area. Pak. Armed Forces Med. J 2012; 62(2): 304-6
25. Anwar B, Kaleem F, Moazzam A, Rizvi SR, Karamat KA. Distribution of Blood Groups in Population of Lehtrar Road Islamabad. J Islamabad Med & Dent College 2013; 2(1): 13-6
26. Shams S, Afridi SG, Waddod A, Iqbal M, Munir M, Shams U, Khan M, Yousaf S. Frequency Distribution of Blood Groups ABO and RhD among the Students of Abdul Wali Khan University Mardan, Pakistan. Int J Agro Veterinary and Med Sci 2013;
27. Ilyas M, Iftikhar M, RasheedU. Frequency of ABO and Rh Blood groups in Gujranwala (Punjab), Pakistan. Biologia (Pakistan) 2013; 59(1): 107-14
28. Malik S, Din AM. Genetic Heterogeneity and Gene Diversity at ABO and Rh Loci in the Human Population of Southern Punjab, Pakistan. Pak J Zool 2013; 45(5): 1185-90
29. Khan MU, Bashir MW, Rehman R, Kian RA. Frequency of ABO and Rh (D) Blood Groups Among Blood Donors In Lahore, Pakistan. Int J Advanced Biological and Biomed Res 2014; 2(3): 2014: 597-600

30. 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; J33 (1): 123-135
31. Nazli R, Haider J, Khan MA, Akhtar T, Aslam H. Frequency of ABO blood groups and RhD factor in the female population of District Peshawar. Pak J Med Sci *20*15; 31(4): 984-6
32. Ilyas M. Distribution of blood groups ABO and Rh reported from district Sialkot (Punjab) Pakistan. Sci Int 2015; 27(3): 2021-3
33. Rehman FU, Siddiqui MM, Nazir I, Khan MM, Zafar S, Ch ZA, Qadir I. Study of ABO and Rh-D Blood Groups among the Common people of Multan City Corporation area of Pakistan. Pak J Med Health Sci *20*15; 9(3): 892-6.
34. Karim F, Moiz B, Muhammad FJ, Ausat F, Khurshid M. Rhesus and Kell Phenotyping of Voluntary Blood Donors: Foundation of a Donor Data Bank. J College of Physicians and Surgeons Pak2015; 25(10): 757-60
35. Ahmad S. Prevalence frequency of ABO and Rhesus blood groups in human in district Rahim Yar Khan, Pakistan. Am J Biosci 2015; 3(4): 141-4
36. Kanwal S, Qureshi HJ, Aslam MS, Masood S. Frequency of ABO and Rh blood groups in students of Akhtar Saeed Medical and Dental college, Lahore. Pak J Physiol 2016; 12(1): 29-30
37. Butt DS, Malik S, Khalid MZ, Aziz M, Humayun A. Gender Distribution of ABO and Rhesus Blood Groups among Medical Students of a Public Medical School in Lahore, Pakistan. Proceeding S.Z.P.G.M.I.2016; 30(2): 77-81
38. Saeed M, Hussain S, Arif M. Distribution of blood type and Rh factor among blood donors of Lahore. Pak Armed Forces Med J 2016; 66 (Suppl-3): S228-S232
39. Shaikh S, Shariq A, Zuberi AM. ABO and Rhesus blood group distribution in residents of Karachi. Pak J Med and Dent 2018; 7 (03): 32-5
40. Hussain I, Naqvi AN, Amir S, Abbas G, Mehdi Q. Blood groups distribution pattern among limited adult human population of district Gilgit, Gilgit-Baltistan, Pakistan. Int J Pure and Applied Zoology 2018; 6(2): 18-24
41. Butt SJ, Malik S, Malik H, Butt AJ**.** ABO and Rhesus Blood Grouping in Voluntary Blood Donors and its gender association. P J M H S 2018; 12(1): 268-71
42. Jabin F, Waheed U, Ahmed S, Arshad M, Arshad A, Zaheer HA. Red blood cell phenotyping of blood donors in Islamabad, Pakistan. *Global J Transfusion Med 2018*; *3*(1): 26-9
43. Abbasi SQ, Sattar R, Mansoor G. Association of gender with ABO and Rh blood groups - a cross-sectional study. Pak J Physiology 2018; 14(3): 25-7
44. Khan MU, Shahzada N, Rehman R, Baig AA, Khan SA, Kiani RA. An overview of ABO and Rh blood group dissemination in general population of Azad Kashmir, Pakistan. Int J BioSci 2019; 15(5): 511-7
45. Ahmed M, Memon A, Iqbal K. Distribution pattern of ABO and Rhesus blood groups among different ethnic population of Karachi. J Pak Med Assoc 2019; 69(10): 1474-8
46. Noshkey A, Yazdani MS, Rathore MA, Hashmi IQJ, Hashmi AR, Hashmi KTK. Frequency Distribution of ABO and RhD Blood Groups amongst Blood Donors: A single centre study. P J M H S 2019; 13(3): 697-9
47. Irshad Z, Parween S, Kumar S, Anwar M, Shabbir A, Sultan BA. The ABO and Rhesus (RH) Blood Groups Distribution among the Female Blood Donors in Tertiary Care Hospital, Karachi. J Liaquat Uni Med Health Sci 2020; 19(01): 28-32
48. Nuzhat A. ABO blood groups are efficient in delineating relationships across Linguistic Subpopulations of Pakistan. Pak J Med Dentistry 2020, VOL. 9 (01)
49. Rehman. ABO and Rh (D) blood groups distribution in Pakistan: a systematic review. Forensic Res Criminol Int J 2020; 8(6): 237-44

50. Sabir, A., Iftikhar, A., Ijaz, M.U. *et al*. Retrospective study of frequency of ABO and Rhesus blood group among population of Safdarabad and Faisalabad cities of Pakistan. BMC Res Notes 2021; 14**,** 12. https: //doi.org/10.1186/s13104-020-05429-z
51. Rehman GU, Shi H. ABO and RH (D) Blood Groups Distribution In Pakistan: A Systematic Review. Int. J. Pure Appl. Zool 2021; 9(1): 1-9
52. Muhammad I, Saba N, Waheed U, Ullah W, Qasim M, Ahmed S, *et al*. A Systematic Review and Meta-Analysis on Prevalence of ABO and Rhesus Blood Groups in Pakistani Population 2022; 1: 110
53. Garratty G. Blood groups and disease: A historical perspective. Transfusion Med Rev 2000; 14(4): 291-301
54. Akhund IA, Alvi IA, Ansari AK, Mughal MA, Akhund AA. A study of relationship of ABO blood groups with myocardial infarction and angina pectoris. J Ayub Med Coll Abbottabad 2001; 13(4): 25-6
55. Wazirali H, Ashfaque RA, Herzig JW. Association of blood group A with increased risk of coronary heart disease in the Pakistani population. Pak J Physiol 2005; 1: 1-2
56. Lutfullah, Bhatti TA, Hanif A, Shaikh SH, Khan BZ, Bukhshi IA. ABO Blood Group Distribution and Ischemic Heart Disease. Annals 2011; 17(1): 36-40
57. Sharif S, Anwar N, Farasat T, Naz S. ABO blood group frequency in Ischemic heart disease patients in Pakistani population. Pak J Med Sci 2014; 30(3): 593-5
58. Siddiqui ZH, Chaudhry MA, Nigar M, Butt H. A study of association between ABO and Rh blood groups, sex, age and angina pectoris", Sci. Int. (Lahore), 2011; 23(2): 113-6
59. Ashraf MZ, Khan IA, Zeeshan N, Chaudhry MA. Association of blood group A with ischemic heart disease. Biomedica 2017; 33(2): 131-5
60. Iftikhar I, Khan HS, Rehman AU. Acute Myocardial Infarction and its association with ABO blood groups in the Pakistani population. J Rawalpindi Medical College (JRMC); 2020; 24(2): 103-7
61. Noor A, Tashfeen S, Akhtar F, Anwar N, Din HU, Akhtar F. Association of COVID-19 with ABO blood groups in tertiary care center of Pakistan. Pak Armed Forces Med J 2020; 70 (COVID-19) (1): S251-55
62. Rahim F, Amin S, Bahadur S, Noor M, Mahmood A, Gul H. ABO / Rh-D Blood types and susceptibility to Corona Virus Disease-19 in Peshawar, Pakistan. Pak J Med Sci 2021; 37(1): 4-8.
63. Bari, A., Ch, A., Hareem, S., Bano, I., Rashid, J., & Sadiq, M. Association of Blood Groups with the Severity and Outcome of COVID-19 Infection in Children. J College Physicians Surgeons-Pakistan: JCPSP, 2021; 30(1): S57-S59
64. Rehman FU, Omair SF, Memon F, Rind BJ, Memon DA, Ali SA, *et al*. The relation of ABO blood group to the severity of coronavirus disease: A cross-sectional study from a tertiary care hospital in Karachi. Cureus, 2021, 13(7).
65. Burhan H, Hasan AS, Haque SM, Zaidi G, Shaikh T, Zia A. Association between blood group and susceptibility to malaria and its effects on platelets, TLC, and Hb. J Infect Dev Ctries 2016; 10(10): 1124-8
66. Shakeel HA, Maqsood H, Ali B, Khan AR. Association of chronic viral hepatitis with ABO blood groups and rhesus (Rh) factor. Int J Res Med Sci 2018; 6(4): 1114-8
67. Anwar M, Siddiqi GM, Haq S, Khokhar N, Jaffery G, Sharif N. Association of blood group types to hepatitis B and hepatitis C virus infection 2011.
68. S ALAM, Association of ABO, Rh blood group systems with lipids and other anthropometric Co variables as Predictors of Cardiovascular Risk in NWFP, Pakistan. ANNALS, 2004; 10(2).
69. Waseem AG, Iqbal M, Khan OA, Tahir M. Association of diabetes mellitus with ABO and Rh blood groups. Ann Pak Inst Med Sci 2012; 8(2): 134-136

70. Zaidi SSH, Ch. Ather AA, Kiran R, Syed U, Ashfaq U, Musharraf MU. Frequency of ABO blood groups among the Type II diabetes mellitus patients. Endocrinol Diabetes Res 2018; 4(2): 212-4
71. M. GhafarS. KhwajaM. ZahidS. I. HussainA. KarimA. Akram. Association of blood groups/Rh and diabetes mellitus in Karachi city, Pakistan. Brazilian J Biol 2024; 84: e252952.
72. Zahra M, Hussain A. Association between blood groups and refractive errors. Ophthalmology; 6(2): 26-28
73. Khan MI, Micheal S, Akhtar F, Naveed A, Ahmed A, Qamar R. Association of ABO blood groups with glaucoma in the Pakistani population. Canadian J Ophthalmol 2009; 44(5): 582-6.
74. Qadir MI and Hanif AZM. Blood Group System Connection with Depression. J Ment Disord Treat 2018; 4: 170. Doi: 10.4172/2471-271X.1000170
75. Iqbal S, Akram R, Akram S, Saif ullah M, Fatima QA, Afzal HMI. Association between ABO blood group phenotype and reaction to academic stress in young medical students. Int J Contempor Med Res 2019; 6(11): K6-K9
76. Abid K. Prevalence of ABO blood groups and their association with dust, pollen and skin allergy in young adults. Ann Pak Inst Med Sci 2015; 11(1): 12-5
77. Hashme RI, Khan NA. A study of fingerprints pattern in relation to ABO & Rh blood groups among medical students of AJK Medical College, Muzaffarabad. Med Forum 2014; 25(12): 7-10
78. Parveen N, Rehman J, Hassan SH, Hassan Z, Rehman M. Different blood groups; Association with body mass index in medical students of Karachi. Professional Med J 2016; 23(8): 1001-4.
79. Jawed S, Zia S, Tariq S. Frequency of different blood groups and its association with BMI and blood pressure among the female students of Faisalabad. Pak J Med Assoc 2017; 67(8): 1132-7.