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A Systematic Review and Meta-Analysis on Prevalence of ABO and Rhesus Blood Groups in Pakistani Population

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Abstract

Objective: The main aim of this review is to document the ABO and Rh blood group distribution pattern among the population of different regions of Pakistan and the overall population of Pakistan.

Methodology: Major databases like Google Scholar, PubMed, Ovid, Web of Science, SciHub, Medscape, PakMediNet, Scopus, and Science Direct were searched. MeSH words like Prevalence, ABO, Rh, Blood Groups were used in the search engine databases. After careful review, 65 studies from January 1977 to December 2020, were included, with no gender, or ethnic restrictions.

Results: Our study recorded 160 studies of which 150 were from the database while 10 were identified through other sources (handcomb search). From these 160 studies, 40 were duplicate and were removed. The remaining 120 studies were screened properly and after the screening, additional 21 studies were excluded. Full-text articles of 99 studies were assessed for eligibility of which 34 were excluded for certain reasons. After applying the inclusion and exclusion criteria, 65 studies were included in the meta-analysis. According to the present study, the frequency distribution of the ABO blood groups in the Pakistani population was in the pattern B>O>A>AB with blood group B (34%) being the commonest, followed by O (32%), A (24%), and AB (10%). In the Rh blood group system, Rh (D) was the most prevalent antigen present in 91% of the population.

Conclusion: Blood group B is the most prevalent while blood group AB is the least prevalent in the Pakistani population. To establish a more reliable and national database of ABO and Rh blood groups in Pakistan, National Database and Registration Authority can play a pivotal role.

Keywords: Blood groups, ABO, Rhesus, Blood donors.

Introduction

The blood groups of the population are determined serologically by the presence of specific antigens on the erythrocytes. From one population to another and one region to another, the incidence of ABO and Rhesus (Rh) groups vary. ABO and Rh blood group systems are the most commonly used genetic markers and have a wide application in transfusion medicine, disease susceptibility studies, population genetics, and forensic pathology. Hence, the data of ABO and Rh blood grouping of any population set is of great importance.

The ground-breaking discovery of blood groups is attributed to the Austrian/German scientist, Dr. Karl Landsteiner, who described the first human blood group system (ABO) in 1901.[1] This landmark discovery resulted in a paradigm shift in the field of transfusion medicine.[2] Later in 1940, Dr. Landsteiner along with Dr. A.S. Weiner discovered and defined the Rhesus (Rh) blood group system.[3] The red blood cells (RBCs) or erythrocytes with A and/ or B antigens occur as the action of the glycosyltransferases enzymes that add specific sugars to the precursor substance.[4] However, a group of conformation-dependent epitopes along the Rh protein forms the D antigen.[5] On red blood cells, more than 600 surface antigens have been found[6] and numerous of these antigens that stem from one allele or are very closely related genes jointly form a blood group system.[7]At present, the International Society of Blood Transfusion (ISBT) listed 41 blood group systems representing over 300 antigens.[8] On the red cell membranes apart from the ABO and Rhesus system, many other types of antigens have been identified. Some of the important group systems are ABO, MNS, P, Rhesus, Lutheran, Kell, Lewis, Duffy, and Kidd, among

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others.[9] The discovery of blood groups significantly paved the way for safe blood and blood component transfusions around the globe with minimum adverse reactions.[10] Transfusion reactions most notably the haemolytic reaction and haemolytic disease of the new-born expresses the curative impact of the ABO and Rh blood group system depending on the ability of agglutinins of Abo and Rh blood groups systems. [11,12,13] The main goal of the present study was to assess the ABO and Rh blood group frequency pattern among the population of different regions of Pakistan and the overall population of Pakistan.

Methodology

Systematic Review and Search Strategy: The study protocol was in accordance with the PROSPERO database[14] and the main outcomes are reported following the "Preferred Reporting Items for Systematic Reviews and Meta-Analyses" (PRISMA) guidelines.[15] We searched Google Scholar, PubMed, Ovid, Web of Science, SciHub, Medscape, PakMediNet, Scopus, and Science Direct. From January 1977 to December 2020, all the studies conducted in Pakistan were included, with no gender, or ethnic restrictions. The authors restricted the language of articles to only English. The search strategy included MeSH (Medical Subject Headings) words and keywords like 'Prevalence', 'ABO blood groups', 'Rh blood groups', and 'blood groups', and terms describing epidemiology and prevalence of blood groups. A total of 160 studies were recorded of which 150 were from the database while 10 were identified through other sources (handcomb search). The 160 articles recognized through the above-mentioned databases were presented to the Endnote version X9 software (reference manager), where 40 duplicate publications were identified and removed independently by two of the authors (IM, NS).

The remaining 120 studies were screened adequately and after the screening of title and abstract, further 21 studies were excluded. A total of 99 full-text articles were assessed for eligibility of which 34 were excluded for reasons mentioned under the below sub-heading. Review articles were excluded but their references were tracked to find any relevant article.

After applying the inclusion and exclusion criteria, a total of 65 studies on the prevalence of ABO and Rh blood groups were included in the present meta-analysis. After the selection of 65 articles that met inclusion criteria, two authors (IM, UW) reviewed all full-text articles. In 11 cases, the full-text article could not be retrieved, so corresponding authors were contacted to share their published articles. Gray literature was searched through the national and provincial health ministries' websites, annual reports, and the WHO website.

Eligibility, Inclusion, and Exclusion Criteria: Articles mentioning the geographic description of the prevalence of blood groups from the year 1977 to 2020 were included. Duplicate data, secondary data, articles published before 1977, articles with a lack of clear depiction of names of the cities, and non-availability of full-text were excluded. The focus was primarily kept on the frequencies of blood groups in the population without any affiliation to diseases, environmental or other factors, therefore, articles that showed prevalence and frequencies of blood groups concerning specific diseases and health conditions were also excluded.

Screening and Data Extraction: Each study was allotted a number for identification. The following data (based on an ad-hoc Excel spreadsheet) were later extracted from every article in the following domains: reference details (this included surname of author, title, journal, year of publication), city name, province/state name, sample size, number of and the reported prevalence and pattern of blood group in descending order (higher to lower prevalence) in the cities and then the provinces/states of the country. Any discrepancy regarding the extracted data was resolved by discussion and mutual consensus.

Article Quality Appraisal: Two authors (WU, MQ) independently judged the quality of the included articles using the JBI (Joanna Briggs Institute) quality assessment tool for prevalence and epidemiological studies with 10 questions.[16] The answer to every question was yes, no, not clear, or not relevant/applicable. The quality of each included article was scored as poor (below the mean score) and good (mean score and above).

Results

A pool of 160 records/articles was yielded after the initial search of the literature. The process of searching, retrieving, and selecting relevant studies is shown in Figure 1. Out of 160 records, 40 were duplicate articles

and were removed as such. The title and abstract of the articles were then reviewed and at this step, 21 articles were omitted. The remaining 99 articles were reviewed and 34 articles were excluded with reasons (mentioned in the methodology section) while 65 articles were selected to determine the prevalence of ABO and Rh blood groups in the country. The results of the meta-analysis of this review have been tabulated separately in the general population/blood donors, different districts/cities, and different provinces/administrative units of Pakistan.

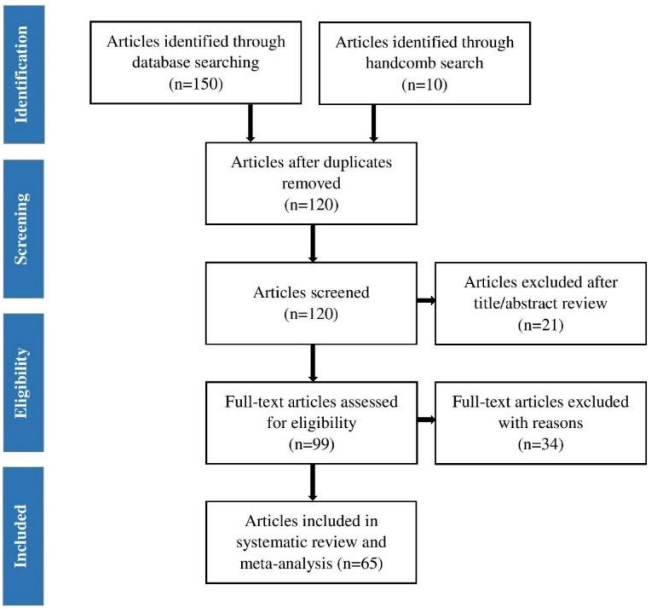

Figure 1: Flowchart of the process by which articles were identified based on PRISMA 2009 guidelines.

These results depict that in most districts/cities, the prevalence of ABO blood groups had a pattern of B>O>A>AB and O>B>A>AB except in a few studies conducted in Dir Upper[63], Gilgit[68], and Skardu[29] where it was A>B>O>AB, in Dir Lower,[53] it was A>O>B>AB, in Mirpur[43], Bannu[27], Peshawar[54], North Waziristan[62], and Karachi,[76] it was B>A>O>AB while in a study from Islamabad,[55]it was B>O, A>AB(A=O). In most districts/cities of Pakistan, the prevalence of Rh-positive blood group ranged from 88.94% to 94.83% while the Rh-negative blood group ranged from 5.17% to 11.05% except in some studies, e.g. in the study from Gilgit[68] (Rh-positive 67.33%; Rh-negative 32.66%), Wah Cant[36] (Rh-positive 73.9 %; Rh$^-$negative 26.1%), and Karachi[56] (Rh$^-$positive 97%; Rh-negative 3%).

After a complete analysis of the current study, the average pattern of ABO blood groups in Pakistan was B>O>A>AB, and Rh-positive was 91% while Rh-negative was 9%. The pooled prevalence of the studies is given in Table 2. The frequency distribution of ABO and Rh blood group systems in different provinces/administrative units of Pakistan is shown in Table 3 and Table 4, respectively.

The ABO and Rh blood groups distribution pattern in the population of different countries other than Pakistan was in the same order as O>A>B>AB except in Australia[78], Nepal[83], and Iran[89] where it was A>O>B>AB. The Rh blood groups in the population of different countries other than Pakistan was showed a similar trend, Rh-positive ranging from 92.40% to 96.81%, and Rh-negative from 3.20% to 7.60% except in Canada[81], Turkey[87], and USA[88] where Rh-positive was 83.1%, 85.9%, and 83.00%, respectively while Rh-negative was 16.9%,14.1%, and 17.00% respectively.

Discussion

The research on the ABO and Rh groups system has been of colossal interest, mainly due to its medical importance in different diseases. During the ongoing COVID-19 pandemic, the blood groups have been extensively studied to ascertain their association with SARS-CoV-2 susceptibility.[91,92] After a meta-analysis, the relative frequency of the ABO and Rh blood groups in various districts of the country was found to be nearly the same.[17,77] Similarly, the frequency distribution of ABO blood groups in different administrative units of Pakistan was almost the same and was in the order of B>O>A>AB except in Gilgit Baltistan, where it was A>B>O>AB and in Sindh, it was O>B>A>AB. The frequency distribution of Rh-positive and Rh-negative blood groups in different administrative units of Pakistan was almost the same ranging from 88.55% to 94.75% and 6.31 to 11.45%, respectively except in Gilgit Baltistan where Rh-positive was 83.98% and Rh-negative was 16.02%. This meta-analysis concluded that the average pattern of ABO blood groups in the Pakistani population was B>O>A>AB, Rh Positive was 91% and Rh-Negative was 9%. However, comparison with the data from the frequency distribution of ABO blood groups in the population of different countries other than Pakistan, i.e., UK[79], Bangladesh[80], India[82], Canada[81], Niger[84], Saudia Arabia[85], Nigeria[86], and USA[88], was in the order as O>A>B>AB, in Australia[78],

Table I: Frequency distribution of ABO and Rh blood groups in differt districts/cities of Pakistan

Population	A (%)	B (%)	AB (%)	O (%)	Rh⁻positive (%)	Rh⁻negative (%)	Pattern	Sample Size
Punjab (1977)[17]	21.20	36.16	9.05	34.14	-	-	B>O>A>AB	1,415
Karachi (1982)[18]	23.00	36.5	10.00	30.00	93.00	7.0	B>O>A>AB	3,012
Peshawar (1982)[19]	28.00	34.00	7.00	31.00	-	-	B>O>A>AB	10,049
Karachi (1988)[20]	23.5	36.5	10	30	93	7	B>O>A>AB	1,500
Swabi (1992)[21]	27.60	34.40	8.80	32.20	-	-	B>O>A>AB	3,000
Larkana (1998)[22]	25.40	32.09	9.18	33.33	-	-	O>B>A>AB	49,061
Jamshoro (1998)[22]	23.67	24.65	2.69	48.99	-	-	O>B>A>AB	49,061
Hyderabad(1998)[22]	15.69	21.79	2.99	60.15	-	-	O>B>A>AB	49,061
Karachi(1998)[22]	19.38	19.62	20.21	40.78	-	-	O>B>A>AB	49,061
Nowshera (1999)[23]	27.10	32.00	11.00	29.80	92.90	7.10	B>O>A>AB	4,510
Quetta(2001)[24]	23.2	31.7	10.1	35	94.75	5.25	O>B>A>AB	2,000
Faisalabad(2002)[25]	23.26	38.00	9.98	28.75	89.19	10.80	B>O>A>AB	1,092
Lahore (2004)[26]	22.6	32.4	8.6	30.5	93.9	6.1	B>O>A>AB	3,000
Bannu (2004)[27]	31.03	36.23	7.67	25.07	89.23	10.77	B>A>O>AB	2,581
Gujrat (2005)[28]	24.89	36.90	6.87	31.31	-	-	B>O>A>AB	2,647
Skardu (2005)[29]	30.62	26.80	15.98	26.60	94.83	5.17	A>B>O>AB	1,045
Multan (2005)[30]	21.92	36.95	7.33	33.8	92.17	7.83	B>O>A>AB	6,000
Liaquatpur (2005)[31]	20.88	35.54	2.02	44.56	90.35	9.65	O>B>A>AB	1,389
Mirpur,(2006)[32]	26.40	32.50	9.50	31.70	91.04	8.96	B>O>A>AB	3,927
Rawalpindi/ Islamabad (2006)[33]	25.53	33.32	10.04	31.09	92.45	7.54	B>O>A>AB	2,518
Mandi Bahauddin (2007)[34]	15.83	28.32	4.48	55.22	91.4	8.6	O>B>A>AB	2,542
Swat (2008)[35]	27.92	32.38	10.57	29.10	90.12	9.87	B>O>A>AB	22,897
Rawalpindi/ Islamabad (2009)[36]	22.86	33.25	10.22	31.44	90.14	9.85	B>O>A>AB	3,519
Poonch (2009)[37]	21.42	36.62	7.0	34.94	89.51	10.48	B>O>A>AB	3,328
Multan (2009)[38]	21.3	42.1	6.7	29.9	-	-	B>O>A>AB	221
Wah Cantt (2009)[36]	18	24	5	53	73.9	26.1	O>B>A>AB	4,462
Gilgit (2010)[39]	24.2	40	10	25.8	89.8	10.2	B>O>A>AB	500
Sahiwal (2011)[40]	22.00	36.85	9.84	29.30	88.94	11.05	B>O>A>AB	20,010
Lahore (2011)[41]	19.03	38.36	10.62	31.99	93.99	6.01	B>O>A>AB	1,035
Rawalpindi/ Islamabad (2012)[42]	24.2	34.3	10.1	31.3	91	9	B>O>A>AB	4,642
Mirpur (2012)[43]	25.93	32.59	17.26	24.20	83.60	14.4	B>A>O>AB	8,227
Islamabad (2013)[44]	22.54	33.58	12.47	31.39	93.44	6.55	B>O>A>AB	1,739
D.G. Khan, Muzaffargarh, Multan, Bahawalpur, Liaquatpur (2013)[45]	22.50	35.90	6.30	35.70	94.80	5.20	B>O>A>AB	60,000
Mardan (2013)[46]	22.4	34.9	10.3	32.4	94.7	5.3	B>O>A>AB	2,893
Gujranwala (2013)[47]	22.90	35.35	9.31	32.41	92.02	7.97	B>O>A>AB	4,754
Lahore (2014)[48]	24.2	37.8	9.1	28.8	93	7	B>O>A>AB	3,000
Bajaur Agency (2014)[49]	29.42	30.00	10.50	30.08	91.43	8.57	O>B>A>AB	1,200
Haripur (2014)[50]	20.75	34.20	6.51	38.52	90.16	9.83	O>B>A>AB	2,140
Lahore (2014)[51]	23.9	35.2	8.8	32.1	91.7	8.3	B>O>A>AB	1,000
Rahim Yar Khan (2015)[52]	20.97	37.41	7.65	33.95	93.64	6.35	B>O>A>AB	9,891
Dir Lower (2015)[53]	31.94	27.99	11.39	28.65	92.45	7.54	A>O>B>AB	13,758
Peshawar (2015)[54]	31.23	31.70	10.02	27.03	92.54	7.32	B>A>O>AB	429
Islamabad (2015)[55]	22	34	11	22	-	-	B>O, A> AB (A=O)	123
Karachi (2015)[56]	21	31	11	37	97	3	O>B>A>AB	100
Sialkot (2015)[57]	22.30	36.50	9.70	31.30	91.30	8.70	B>O>A>AB	1,656
Multan (2015)[58]	26.57	34.15	9.61	29.67	90.72	9.28	B>O>A>AB	937
Bahawalpur (2015)[59]	21	36	6	37	95	5	O>B>A>AB	500
Sindh (2015)[60]	25.83	28.17	8.3	37.78	95.76	4.24	O>B>A>AB	3,000
Lahore (2016)[61]	20.12	37.45	10.57	32.11	92.97	7.03	B>O>A>AB	481
North Waziristan (2016)[62]	27.4	36.7	10.9	25.0	90.6	9.4	B>A>O>AB	1,026
Dir Upper (2016)[63]	32.1	29.8	12.4	25.7	86.4	13.6	A>B>O>AB	1,000
Lahore (2016)[64]	20.38	40.45	8.09	31.06	89.48	10.51	B>O>A>AB	618
Nowshera (2016)[65]	27.38	32.02	10.80	29.77	93	7	B>O>A>AB	1,190
Faisalabad (2017)[66]	18.6	44.8	6.9	29.7	89.6	10.4	B>O>A>AB	145

Islamabad (2018)[67]	24.64	34.72	9.28	31.36	92	8	B>O>A>AB	625
Gilgit (2018)68	38.66	23.33	19.33	18.66	67.33	32.66	A>B>O>AB	1,500
Karachi (2018)69	24.00	32.02	11.24	32.72	97.22	2.78	O>B>A>AB	1,583
D.I. Khan (2018)70	24.46	36.49	8.50	30.54	90.31	9.68	B>O>A>AB	4,941
Karachi (2018)71	25.58	28.96	10.38	35.06	91.94	8.05	O>B>A>AB	385
Quetta (2018)72	19.00	37.00	12.5	31.5	-	-	B>O>A>AB	200
Karachi (2019)73	24.1	33.1	7.2	35.6	91.1	8.9	O>B>A>AB	3521
Rawalpindi (2019)74	24.76	33.91	9.51	31.82	89.03	10.97	B>O>A>AB	105,520
Karak (2020)75	22.67	31.95	15.36	30	96.26	3.73	B>O>A>AB	402
Karachi (2020)76	29.9	33.5	12.7	23.9	92.4	7.6	B>A>O>AB	394
Lahore (2020)77	22	34	10.33	33.66	94	6	B>O>A>AB	3000

Table II: Frequency distribution of blood groups (ABO and Rh) in Pakistan

Country	A (%)	B (%)	AB (%)	O (%)	Rh-positive (%)	Rh-negative (%)	ABO Pattern
Pak.	24	34	10	32	91	9	B>O>A>AB

Table III: Frequency distribution of ABO blood group system in different administrative units of Pakistan

Province/ State	A (%)	B (%)	AB (%)	O (%)	Pattern
ICT (Islamabad)	25.00	34.00	11.00	30.00	B>O>A>AB
Punjab	21.99	35.79	8.27	33.95	B>O>A>AB
KP	27.29	32.90	10.10	29.81	B>O>A>AB
Sindh	23.54	29.83	9.61	37.02	O>B>A>AB
Balochistan	21.1	34.35	11.3	33.25	B>O>A>AB
AJK	24.58	33.90	11.25	30.27	B>O>A>AB
Gilgit Baltistan	31.18	30.04	15.10	23.68	A>B>O>AB

Table IV: Frequency distribution of Rh blood group system in different administrative units of Pakistan

Province/State	Rh-positive (%)	Rh-negative (%)
ICT (Islamabad)	91.81	8.19
Punjab	91.03	8.97
KP	91.56	8.44
Sindh	93.69	6.31
Balochistan	94.75	5.25
AJK	88.55	11.45
Gilgit Baltistan	83.98	16.02

Nepal[83], and Iran[89] it was A>O>B>AB, while in Turkey[87] it was B>O>A>AB. The Rh blood groups in the population of different countries other than Pakistan, i.e. UK[79], Bangladesh[70], India[82], Nepal[83], Niger[84], Saudia Arabia[85], Nigeria[86], and Iran[89] was almost similar to our findings, Rh-positive ranging from 92.40% to 96.81% and Rh-negative from 3.2% to 7.60% except in Canada[81], Turkey[87], and USA[88] where Rh-positive was 83.1%, 85.9%, and 83.00% respectively while Rh-negative was 16.9%, 14.1%, and 17.00% respectively. It is clear from the present meta-analysis that the prevalence of ABO blood groups in Pakistan and Turkey[87] was in the same order as B>O>A>AB.

One of the reasons could be ancestral genetic makeup, however, more research is needed in this regard. Regarding the blood groups frequency distribution, the sharp difference may be attributed to terrestrial variations, environmental factors, and genetic factors.[93] In several studies carried out in different societies and cultures, for example, Bangladesh and

Table V: Comparison of ABO and Rh blood groups among different countries

Country	A (%)	B (%)	O (%)	AB (%)	Rh-positive(%)	Rh-negative (%)	Pattern
Australia[78]	38.0	10.0	49.0	3.0	-	-	A>O>B>AB
UK[79]	41.70	8.60	46.70	3.0	-	-	O>A>B>AB
Bangladesh[80]	26.6	23.2	40.6	9.6	96.81	3.20	O>A>B>AB
Canada[81]	42.00	9.0	46.0	3.0	83.1	16.9	O>A>B>AB
India[82]	23.85	29.95	39.81	6.37	94.20	5.80	O>B>A>AB
Nepal[83]	34.00	29.00	32.50	4.00	96.66	3.34	A>O>B>AB
Niger[84]	24.43	20.09	53.22	3.00	93.88	6.12	O>A>B>AB
Saudi Arabia[85]	24.00	17.00	52.00	4.0	93.00	7.00	O>A>B>AB
Nigeria[86]	21.60	21.40	54.20	2.80	95.20	4.80	O>A>B>AB
Turkey[87]	27.0	30.6	30.4	12.0	85.9	14.1	B>O>A>AB
USA[88]	40.0	11.0	45.0	4.0	83.00	17.0	O>A>B>AB
Iran[89]	45.0	11.0	40.0	4.0	92.40	7.60	A>O>B>AB
China[90]							
Pakistan (current analysis	24.00	34.00	10.00	32.00	91.00	9.00	B>O>A>AB

Latin America, racial (genetic) and environmental factors have been reported to affect the incidence of various blood groups.[94]

The evident difference between Gilgit Baltistan and the rest of the country regarding the pattern of blood groups distribution might be due to the geographical difference (high altitude) and the environment but again needs to be further studied. For varying frequency of the blood groups among the Pakistani population, different genetic and environmental factors are responsible and need to be probed further. In addition to the linkage between blood groups and blood transfusions, the ABO system is reportedly associated with cardiovascular diseases, HBV infection, preeclampsia, organ transplantation, and genetic marker of obesity, among others. Hence, the data reported in our analysis will be useful for healthcare providers, researchers, policymakers, and transfusionists. To establish a more reliable and national database of ABO and Rh blood groups in Pakistan, NADRA (National Database and Registration Authority) can play a pivotal role.

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