Retrospective study of frequency of ABO and Rhesus blood group among population of Safdarabad and Faisalabad cities of Pakistan

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Abstract
Objective: The current study aimed to investigate the ABO and rhesus (Rh) blood group frequency in the people of District Faisalabad and Sheikhupura, Punjab Province, Pakistan. The retrospective study was conducted on more than thirty thousand people including both male and female patients admitted to the Tehsil Headquarter Hospital, Safdarabad and The Best Hospital, Faisalabad. Blood samples were taken from each subject and subsequently ABO and Rh blood groups were evaluated separately. The antigen antibody agglutination slide test for blood grouping (ABO) and Rh were used to assess the blood group frequencies.

Results: The frequencies of ABO blood group distribution indicated that blood group B was predominant in the people of Safdarabad followed by O, A and AB respectively. While, among people of Faisalabad, blood group O was predominant followed B, A and AB respectively. Rh negative phenotype was found lesser distributed as compared to the positive Rh phenotype.

Keywords: ABO blood group, Rh (d) phenotypes, Blood group frequency

Introduction
Throughout the world, the blood is considered a permanent and established identity of an individual. Though the blood group of an offspring is decided by the genetic material inherited from mother and father, even the siblings may have different blood groups, with exception of identical twins and triplets only indicate that blood groups are predisposed to individual genetic makeup [1]. Around 400 blood group systems have been reported till now and among them, the most important are ABO and Rh. ABO and Rh blood group systems are considered as the most crucial since they are crucial in blood transfusion too and are also of great clinical importance by virtue of their relationship with the various hemolytic diseases of newborn [2, 3]. The chromosome 9 and 1 have the genes for ABO and Rh (D) respectively in the human genome.

The ABO blood types were first discovered by the Austrian Physician Karl Landsteiner in 1901. Different sugars and proteins which constitute the blood group antigens are present on the surface of our red blood cells. There are about thirty different types of antigens present on the surface of these red blood cells. The ABO antigens are synthesized well before the birth and persist throughout the whole life. The fetus acquires ABO antibodies passively from their mother before birth, but by three months of age, infants start preparing their own specific antibodies [4]. On the other hand, the Rh blood group system was discovered by Landsteiner and Weiner in 1940. Immunogenicity of the Rh factor together with A, B antigens made it compulsory for pre-transfusion testing

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In the Rh blood group system, unlike ABO blood group, D antigen is formed by a group of conformation-dependent epitopes along with the Rh (D) protein [7]. The variation in ABO and Rh blood group distribution exists from one race to another race; all around the world. People of Pakistan also exhibits this variation [8]. It is believed that blood group prevalence has an important role in evolution, genetics research, organ transplantation, and blood transfusion [9, 10]. The current study was aimed to find out the prevalence percentage of ABO blood group type and Rh (D) frequency in the people of Faisalabad and Safdarabad cities of Punjab Province of Pakistan (Additional file 1: Figure S1).

**Main text**

**Materials and methods**

**Subjects**

A total of 30,682 subjects, including males and females, were screened at Tehsil Headquarter (THQ) Hospital of Safdarabad and The Best Hospital of Faisalabad, Punjab, Pakistan, for blood grouping. Samples were obtained after official permission of competent authorities of hospitals and subsequent verbal or written consent of participants. The samples were collected from the patients presented to above-mentioned hospitals during the period of November 2018 to October 2019. Among these subjects, 15,703 were men and 14,979 were women. Their age was ranged between 16 and 40 years (mean: 27.4 ± 6.2). The majority of study population were presented to hospital for their health screening and blood grouping, which is mandatory for various purposes, such as army recruitment, pre-employment health screening, and screening for driving license etc. Out of 30,682 subjects, 13,477 were from Tehsil Safdarabad, District Sheikhupura and 17,205 were belong to Ghulam Muhammad Abad, Faisalabad. The data were generated and compiled using National Identity Card number as individual identification mark. All data was compiled and recorded in specified perform. The blood samples of the study population were typed by slide method, using ABO and Rh (D) Typing Antisera, Biotec Laboratories®, United Kingdom. Manufacturer’s procedural instructions were followed while experimentation. Results were compared with similar group prevalence studies from neighboring countries. Data were summarized using frequency and percentages.

**Interpretation of results**

Positive: Agglutination; specifies positive reactions to respective subject.

Negative: No agglutination; specifies negative reactions to respective subject (Additional file 2: Table S1).

**Results**

The prevalence of ABO and Rh phenotypes in 30,682 subjects (13,477 were of Tehsil Safdarabad District Sheikhupura and 17,205 were from Ghulam Muhammad Abad, Faisalabad) was tested. Amongst the people of Faisalabad, the most common blood group was O (32.78%), followed by blood group B (29.79%), A (22.58%) and blood group AB found at the lowest prevalence (14.83%) (Table 1). Overall, percentage of positive Rh phenotypes and negative phenotypes was 81.01 and 18.99 respectively (Table 1). Additional details for the prevalence of the Rh (D) phenotypes linked with ABO Blood group is mentioned in Table 2.

However, among the people of Safdarabad, the most common blood group was B with prevalence of 33.81% which was slightly greater than blood group O (33.74%). Blood group A percentage was 25.28% and AB shows the

| Table 1 | Prevalence of the phenotype of ABO and Rh blood groups in Faisalabad and Safdarabad districts |
|---------|-----------------------------------------------|
| Phenotype | Faisalabad |                  | Safdarabad |                  |
|          | Men | %     | Women | %    | Total | %  | Men | %     | Women | %    | Total | %  |
| Distribution of ABO blood groups |  |  |  |  |  |  |  |  |  |  |  |  |
| A       | 1965 | 22.13 | 1920 | 23.07 | 3885 | 22.58 | 1500 | 21.97 | 1908 | 28.68 | 3408 | 25.28 |
| B       | 2634 | 29.66 | 2493 | 29.94 | 5127 | 29.79 | 2325 | 34.06 | 2232 | 33.55 | 4557 | 33.81 |
| AB      | 1632 | 18.38 | 921  | 11.10 | 2553 | 14.83 | 600  | 8.79  | 364  | 5.47  | 964  | 7.15  |
| O       | 2647 | 29.81 | 2993 | 35.94 | 5640 | 32.78 | 2400 | 35.16 | 2148 | 32.29 | 4548 | 33.74 |
| Total   | 8878 | 100   | 8327 | 100   | 17,205 | 100 | 6825 | 100   | 6652 | 100   | 13,477 | 100 |
| Distribution of Rh blood groups |  |  |  |  |  |  |  |  |  |  |  |  |
| Rh (+ ve) | 7185 | 80.93 | 6753 | 81.09 | 13,938 | 81.01 | 6150 | 90.10 | 5980 | 89.90 | 12,130 | 90.00 |
| Rh (– ve) | 1693 | 19.07 | 1574 | 18.91 | 3267 | 18.99 | 675  | 9.90  | 672  | 10.10 | 1347 | 10.00 |
| Total    | 8878 | 51.60 | 8327 | 48.40 | 17,205 | 100 | 6825 | 50.60 | 6652 | 49.35 | 13,477 | 100 |
lowest prevalence with 7.15% percentage (Table 1). Prevalence of Rh phenotypes were almost same as of Faisalabad; 90% Rh positive and 10% Rh negative phenotype (Table 1). Supplementary details for the prevalence of the Rh (D) phenotypes linked with ABO Blood group is mentioned in Table 2.

Discussion

Blood group prevalence has huge importance in medical field since it plays an important role in blood transfusion, organ transplantation [11], evolution, and genetics research. It is also associated with various diseases including cardiovascular diseases [12], erythroblastosis in neonates, duodenal ulcer and diabetes [13–15]. In this study, frequency distribution of ABO and Rh blood group among the people of Safdarabad and Faisalabad cities of Pakistan was estimated. The blood group phenotypes among the people of Safdarabad and Faisalabad cities of Pakistan was estimated. The blood group phenotypes among the people of Safdarabad and Faisalabad appeared to be in the B > O > A > AB and O > B > A > AB orders respectively. Among ABO groups, the AB blood group has been reported the least prevalent group all over the world while O blood group is considered the most common blood group in most of the areas. In the current study, amongst the people of Faisalabad, the blood group O was found the most prevailing blood group while blood group B was found the most frequent in Safdarabad city. The findings of O blood group as the most common in Faisalabad city is in agreement with the studies conducted in Punjab province of India [6]. Findings in both Faisalabad and Safdarabad are different from the reported studies of Turkey [22] and Palestine [23], where blood group A appeared to be the most prevalent blood group. These variations in the blood group frequency are mainly attributed to the genetic makeup of a particular population living in a particular area.

Although, these variations are when compared on national level, it exhibits a heterogeneity among different cities of Pakistan. These differences can be due to geographical environment, ethnic groups and more specifically due to different sample size. Study from Dir upper [25], Peshawar [26], Sakardu [8] and Dir lower [27] shows that blood group A was the commonest group in those areas. Other studies from twin cities Islamabad and Rawalpindi [28], Gujranwala [29], Lahore [30], Mirpur [31] and Multan [32] reflects the same result like presented in this study of Safdarabad. The current findings of Faisalabad city where blood group O is found the most common is in agreement with the studies conducted in Multan [32], Karachi [33], and Gujrat [34] cities (Table 3).

The frequency of Rh (D) positive and negative phenotypes was 90% and 10% respectively for Safdarabad and 81.01% and 18.99% for Faisalabad. Other studies available in literature archive also indicated somewhat similar pattern in various cities of Pakistan (Table 3) and in different other countries (Table 3).

| Blood Groups | Faisalabad | Male participant (n = 8878) | Female participant (n = 8327) | Safdarabad | Male participant (n = 6825) | Female participant (n = 6652) |
|--------------|-----------|----------------------------|----------------------------|------------|----------------------------|----------------------------|
| Total participant | (n = 17,205) | n | % | n | % | n | % | n | % | n | % |
| A Rh- positive | 3450 | 20.05 | 1614 | 18.18 | 1836 | 22.04 | 3237 | 24.02 | 1425 | 21 | 1812 | 27 |
| A Rh- negative | 435 | 2.52 | 351 | 4.00 | 84 | 1.00 | 171 | 1.26 | 75 | 1.01 | 96 | 1.00 |
| B Rh- positive | 4407 | 25.61 | 2391 | 27.00 | 2016 | 24.21 | 4119 | 30.55 | 2175 | 32 | 1944 | 29 |
| B Rh- negative | 720 | 4.18 | 243 | 2.73 | 477 | 5.72 | 438 | 3.25 | 150 | 0.2 | 288 | 0.4 |
| AB Rh-positive | 2232 | 13.00 | 1455 | 16.38 | 777 | 9.33 | 781 | 5.79 | 525 | 0.8 | 256 | 0.4 |
| AB Rh- negative | 321 | 1.86 | 177 | 2.00 | 144 | 1.73 | 183 | 1.35 | 75 | 0.1 | 108 | 0.2 |
| O Rh- positive | 3849 | 22.37 | 1725 | 19.43 | 2124 | 25.50 | 3993 | 29.60 | 2025 | 30 | 1968 | 30 |
| O Rh- negative | 1791 | 10.41 | 922 | 10.38 | 869 | 10.43 | 555 | 4.10 | 375 | 0.5 | 180 | 0.3 |

Table 2 Combined distribution of ABO and Rh blood groups in Faisalabad and Safdarabad districts
Limitations
Our study had few limitations that must be acknowledged. Our results are based on a relatively small sample size that could be improved for developing a more realistic opinion about blood group frequency distribution in the study area.

Supplementary Information
The online version contains supplementary material available at https://doi.org/10.1186/s13104-020-05429-z.

Table 3 Comparison of percentage distribution of ABO and rhesus (Rh) blood groups of Faisalabad and Safdarabad populations with other countries and other cities of Pakistan

| Area             | A   | B   | AB  | O   | Rh+ | Rh- | References |
|------------------|-----|-----|-----|-----|-----|-----|------------|
| Faisalabad       | 22.58 | 29.79 | 14.83 | 32.78 | 81.01 | 18.99 | Current study |
| Safdarabad       | 25.28 | 33.81 | 33.74 | 33.74 | 90   | 10   | Current study |

Comparison to other countries of world

| Area             | A   | B   | AB  | O   | Rh+ | Rh- | References |
|------------------|-----|-----|-----|-----|-----|-----|------------|
| Turkey           | 43.8 | 16.2 | 9.2  | 30.8 | 86.0 | 14  | [22]       |
| Saudi Arabia     | 26  | 18  | 4   | 51  | 92  | 8   | [16]       |
| Bahrain          | 21.5 | 24.4 | 4.5  | 49.6 | 94.5 | 4.5  | [17]       |
| Iran             | 33.1 | 23.3 | 8.9  | 34.7 | 88.7 | 11.3 | [18]       |
| Palestine        | 40  | 22  | 6   | 32  | 97.3 | 2.7  | [23]       |
| India (Punjab)   | 21.9 | 37.6 | 9.3  | 31.2 | 97.3 | 2.7  | [19]       |
| Nigeria          | 24.4 | 23.8 | 2.7  | 48.9 | 95.6 | 4.33 | [20]       |
| Bangladesh       | 26.6 | 23.2 | 9.6  | 40.6 | 96.8 | 3.2  | [24]       |

Comparison to other cities of Pakistan

| Area             | A   | B   | AB  | O   | Rh+ | Rh- | References |
|------------------|-----|-----|-----|-----|-----|-----|------------|
| Sialkot          | 22.2 | 36.5 | 9.7  | 31.34 | 91.2 | 8.7  | [35]       |
| Islamabad        | 25.5 | 33.3 | 10.0 | 31.1  | 91.6 | 8.4  | [28]       |
| Dir upper        | 32.1 | 29.8 | 12.4 | 25.7  | 86.4 | 13.6 | [25]       |
| Dir Lower        | 33.9 | 27.9 | 11.3 | 28.6  | 92.4 | 7.5  | [27]       |
| Gujranwala       | 22.9 | 35.3 | 9.32 | 32.4  | 92.03 | 7.97 | [29]       |
| Peshawar         | 31.2 | 31  | 10.1 | 27   | 92.5 | 7.5  | [26]       |
| Lahore           | 24.2 | 37.8 | 9.1  | 28.8  | 93   | 7    | [30]       |
| Mirpur           | 26.3 | 32.5 | 31.6 | 9.4   | 91.0 | 9    | [31]       |
| Sakardu          | 30.6 | 26.8 | 15.9 | 26.6  | 94.8 | 5.17 | [8]        |
| Multan           | 21.9 | 36.9 | 7.33 | 33.8  | 92.1 | 7.83 | [32]       |
| Gujrat           | 18  | 22  | 4   | 56   | 79.5 | 20.5 | [34]       |
| Karachi          | 14.4 | 38.1 | 8.3  | 39.2  | 94.5 | 5.5  | [33]       |

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Authors’ contributions
AS and FS collected data and contributed to entering data into dataset. AI and HA designed the study. MUI and RKI performed the data analysis. AI, GH, AR and HA prepared the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials
All raw data are available from the corresponding author upon request at drhaseebanwar@gcuf.edu.pk.

Ethics approval and consent to participate
The blood samples were obtained from male and female patients admitted to the Tehsil Headquarter Hospital, Safdarabad and The Best Hospital, Faisalabad after receiving either verbal or written consent. Since some persons were illiterate so a verbal consent was preferred in those cases. The use of these blood samples for analysis and research and exemption of written consent from illiterate persons, were approved from Ethical Review Board, Government College University, Faisalabad with Reference No. GCUF/ERB/132.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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