Open Access

ORIGINAL ARTICLE

Phenotypic Profile of Kidd Blood Group System in Northern Pakistani Population

Kehkashan Hassan, Asad Mahmood, Ayesha Khursheed, Zara Tasneem, Saima Shafaat, Fouzia Khan, Kashaf-ad-Duja Awais

Department of Hematology, Armed Forces Institute of Pathology (AFIP), Rawalpindi, Pakistan

ABSTRACT

Objective: To investigate the phenotypic profile of Kidd blood group system in Northern Pakistani population.

Methodology: This was a descriptive cross-sectional study. The research was conducted at department of immunohematology, Armed Forces Institute of Transfusion (AFIT) Rawalpindi, Pakistan, from Dec 2022 to Jun 2023. The study included 280 donors of all ages and both genders fulfilling the WHO Healthy Volunteer Donor criteria for blood donation. Individuals were included in this study while individuals not fulfilling the criteria were excluded from this study. Blood grouping was performed by tube agglutination method and for data analysis version 23.0 of Statistical Package for Social Sciences (SPSS) was used.

Results: The frequencies of A, B, AB, and O antigens were (23.9%), (33.6%), (10.0%), and (32.5%), respectively among all the 280 participants while the frequencies of Kidd Jk^a and Jk^b were 73.2% and 75.4% respectively. The expression of phenotypic profile was Jk (a+b+) in 49.6%, Jk (a-b+) in 25.7%, Jk (a+b-) in 23.6%, and Jk (a-b-) in 1.1%.

Conclusion: Kidd antigen was found in a significant proportion of our donor population which arises the need for undertaking extended antigen typing for this minor blood group as a routine in our blood banks to be able to provide antigen free blood units to chronically transfused, pregnant and anaemic individuals for prevention of delayed haemolytic transfusion reactions.

Keywords: Jk^a and $Jk^{b;}$ Kidd blood group; phenotypic profile.

Authors' Contribution:
[1]Conception; Literature research; manuscript design and drafting; [1]Critical analysis and manuscript review; [1]Data analysis; Manuscript Editing.

Correspondence:
Kehkashan Hassan
Email. kehkashan_hassan@yahoo.com

Article info:
Received: November 28, 2022
Accepted: December 28, 2023

Cite this article. Hassan K, Mahmood A, Khursheed A, Tasneem Z, Shafaat S, Khan F, Awais DK. Phenotypic Profile of Kidd Blood Group System in Northern Pakistani Population. J Islamabad Med Dental Coll. 2023; 12 (4): 276-281
DOI: https://doi.org/10.35787/jimdc.v12i4.1056

Funding Source: Nil
Conflict of interest: Nil

Introduction

There are currently 36 blood group systems recognized by the International Society of Blood Transfusion (ISBT) and over 346 RBC antigens.[1] Blood group system is based on antigenic substances (proteins) on the surface of the Red Blood Cell. Blood group antigens are polymorphic antigens located on the surface of red cells, which have the potential to trigger an immune response in individuals susceptible to haemolytic transfusion reaction after receiving the blood transfusion.[2] In addition to major blood group systems (ABO and Rhesus), minor blood group systems such as Kidd, Duffy, and Kell play an important role in clinical transfusions due to their immunogenicity and activity at body temperature (37°C).[3]

The Kidd blood group antigens are found on the glycoprotein called urea transporter UT-B.[4]A haemolytic disease of the new born, HDN, caused by erythrocyte antibodies (anti-JKA) in the serum of Mrs. Kidd's infant led to the discovery of the Kidd (JK) blood group system in 1951. After Jhon Kidd's name, the antigen was named Jka. Two years later, the Jkb antigen was identified as an antithetical antigen to Jka. This blood group system primarily comprises of three antigens, Jka, Jkb, and Jk3, which are all encoded by the SLC14A1 gene (solute carrier family 14, member 1).[5] These antigens give rise to four distinct phenotypes: Jk(a+b+), Jk(a-b+), Jk(a+b-), and the uncommon Jk(a-b-) or null phenotype which occurs with greater incidence in Asian and Polynesian people.[6] Null phenotypes are caused by mutations such as SNPs or deletions that result in an absence of the JK antigen on RBC surfaces. Most populations have polymorphisms Jka and Jkb, which are identified by two autosomal codominant alleles. Jk3 is present on the surface of all red blood cells that carry either the Jka or Jkb antigens, except for the highly peculiar and rare cases of null kidd phenotype.[7] Antibodies targeting these three antigens hold significant clinical significance, as they can lead to rapid haemolytic transfusion reactions and are a common underlying factor in delayed transfusion reactions. The occurrence of the phenotypes varies significantly depending on the ethnic background of the individuals.[8] The Kidd-null phenotype is highly uncommon among the majority of ethnic communities, but it has clinical relevance because people with this condition may develop antibodies that are specific for the common Jk3 antigen. Anti-Jk3 antibodies function identically to anti-Jka or anti-Jkb antibodies, being able to induce both immediate and prolonged haemolytic responses. Though this is often insignificant, haemolytic disease in foetus and infants may also be caused by antibodies targeting any of the three Kidd antigens.[9] Despite the Kidd system expressing only two alleles in normal circumstances, mutations within the Kidd system can result in weak or modified antigen expression profiles.[10]

There are not as many published studies on this topic in South Asia, especially in Pakistan. This study's primary objective was to establish a phenotypic profile of the Kidd blood group system in the population of Northern Pakistan.

Methodology

This is a descriptive cross-sectional study carried out at the Armed Forces Institute of Transfusion (AFIT), Rawalpindi for the duration of six months. Institutional Review Board (IRB) vide reference number (FC-HEM22-6/READ-IRB/22/1542) provided us the ethical clearance. After taking informed consent and a thorough literature search, a sample size of 260 was calculated using the WHO calculator, keeping a 6% margin of error and 95% confidence level. Sampling was done using a non-probability consecutive sampling method.

Inclusion Criteria: This study included a diverse group of participants of different age groups. Both males and females were included in the study. All the individuals met the eligibility criteria established by the World Health Organization (WHO) for Healthy Volunteer Donation, ensuring that only qualified and safe donors were included in this research.

Exclusion Criteria: Individuals who did not fulfil the World Health Organization (WHO) donor criteria were excluded from this study.

The research project was started after obtaining verbal and written consent from all individuals. Blood samples from all participants were collected into the EDTA (Ethylenediaminetetraacetic acid) vials. After preliminary blood grouping for ABO and Rh D, the EDTA blood samples were phenotype for Jka and Jkb antigens. For the Kidd blood grouping tube agglutination method was used. Red blood cell suspension of 5% was prepared in isotonic saline. An equal amount of Lorne reagent (Anti-Jk^a and

Anti-Jk^{b} monoclonal manufactured by Lorne Laboratories LTD) and red blood cell suspension were placed in a labelled test tube and incubated at room temperature for the duration of 5 minutes after mixing. All the test tubes were centrifuged for a duration of 15 seconds at 3000 revolutions per minute (rpm). The red cell button was gently re-suspended and macroscopic examination was conducted to check for agglutination. The presence of Kidd antigen was confirmed by agglutination of the test red cells, and the results were considered positive. No agglutination of the test red cells indicated the absence of appropriate Kidd antigen, and the results were considered negative.

Data analysis was conducted by using Statistical Package for Social Sciences (SPSS) version 23.0. Descriptive statistics including the mean and standard deviation were determined for continuous variables. Frequency and percentage were calculated for categorical variables.

Results

This study comprised a total of 280 participants of all the age groups. Out of the total, 271 (96.8%) participants were male and 9 (3.2%) were females. The average age of male participants was 27.65 ± 6.53 years while average age of female participants was 24.11 ± 4.81 years. Frequency of blood group O was 32.5 % comprising of 87 males and 4 females, while group AB was the least encountered group with a frequency of 10% among the samples analysed. The frequency of group A antigen accounted for 23.9% comprising of 66 males and 1 female whereas group B antigen accounted for 33.6% consisting of 91 males and 3 females. In our study, the JK^{a} and JK^{b} antigens were observed with a frequency of 73.2% (201 males and 4 females) and 75.4% (205 males and 6 females), respectively as seen in Table-I.

Table-I: Antigen frequencies of blood group antigens

Blood Group	Males	Females	Frequencies n (%)
A	66 (98.5%)	1 (1.5%)	67 (23.9%)
B	91 (96.8%)	3 (3.2%)	94 (33.6%)
AB	27 (96.4%)	1 (3.6%)	28 (10.0%)
O	87 (95.6%)	4 (4.4%)	91 (32.5%)
Kidd (JK^{a})	201 (98.0%)	4 (2.0%)	205 (73.2%)
Kidd (JK^{b})	205 (97.1%)	6 (2.9%)	211 (75.45)

Four different phenotypes were observed in our population and their frequencies are represented in Table ll and Fig 1 represents them graphically. Jk(a+b+) phenotype was found in 139 individuals, accounting for 49.6% and Jk(a-b+) phenotype was observed in 72 individuals, constituting 25.7% of the total samples. The Jk(a+b-) phenotype was identified in 23.6% or among 66 individuals of the total population. The null phenotype Jk(a−b−) was represented by 1.1% or 3 individuals.

Table-ll: Distribution of phenotype frequencies of Kidd blood group system

Phenotype	Frequency n (%)
Jk(a+b+)	139 (49.6%)
Jk(a-b+)	72 (25.7%)
Jk(a+b-)	66 (23.6%)
Jk(a-b-)	3 (1.1%)

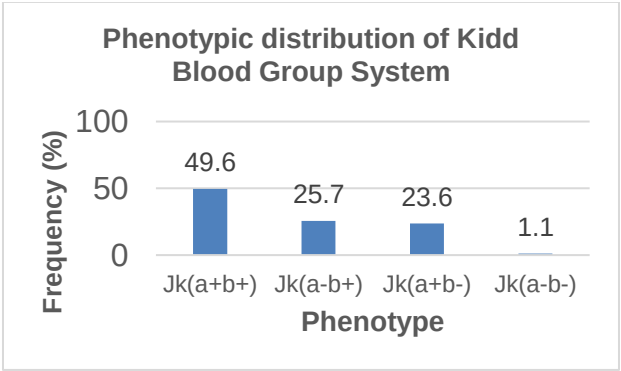

Figure-1: Phenotypic distribution of Kidd blood group system

Discussion

Jk glycoprotein of Kidd blood group system serves as a urea transporter for RBCs. It is encased in the membrane and quickly transfers urea to and from the RBCs while preserving the RBC's osmotic stability and structure. This glycoprotein is additionally produced in the kidney, allowing the organ to accumulate the high urea concentrations required for the production of concentrated urine.

Individuals having sickle cell disease and thalassemia are transfusion dependent and frequently require blood transfusions.[11] To prevent transfusion transmitted infections and reduce the occurrence of transfusion reactions, blood transfusion services aims at providing safe and healthy blood product.[12] Promoting smooth transfusions and optimizing patient-donor matching requires a comprehensive knowledge of genotypic and phenotypic characteristics of various blood group types.[13] As a result, it could mitigate any HTR caused by the transfusion of numerous units of blood as well as RBC alloimmunization.[14] Erythroblastosis fetalis is one of the most prevalent risks among transfusion-related reactions.

Blood transfusions to patients with sickle cell anaemia, thalassemia, and cancer is likely to generate antibodies mostly against the minor blood group systems as its practically not feasible to precisely match all the antigens of minor blood types before transfusion.[15] Therefore, It can be challenging to find compatible blood units for these individuals without being aware of the prevalence of the relevant antigens in the local community.

A study conducted by Makroo RN *et al*,[16] determined the prevalence of the Kidd blood group antigens in the Indian blood donors which came out to be 81.4% for Jka and 67.6% for Jkb. This frequency was in coherence with Chinese having Jka 73% and Jkb 76%, Caucasians having Jka 77% and Jkb 74%. While in Blacks significantly different was observed in the frequencies of Jka, with the prevalence of 92%, and Jkb, with the prevalence of 49%. Jk(a+b-) was the most prevalent Kidd phenotype in Blacks (57%), while the most prevalent Kidd phenotype in Caucasian and Chinese groups was Jk(a+b+). Another rare Kidd phenotype Jk (a-b-) was observed in two individuals. This study was comparable to the current study.[16]

Research done by Musa RH *et al*,[17] suggested that the Jk (a+b+) Kidd phenotype was the most prevalent across every ethnic category, occurring in Chinese (50.7%), Malays (43.0%), and Indians (43.3%). Of the total participants, 7 Malays and 2 Indians showed Jk (a-b-) phenotype. There was no statistically significant difference (P value >0.001) observed for the distribution.[17]

Jabin F *et al*,[18] conducted research that showed somewhat different results to the present study. This research considered different blood group systems including the Kidd blood group system. Based on this research, the antigen frequency of Jka is 65.28 % and Jkb was 42.4%. Jka + JKb - phenotypic frequency was determined to be 40%, making it the most prevalent phenotype. The calculated gene frequency of Kidd system antigens Jka and Jkb were 0.538, and 0.462, respectively.[18]

Another investigation by Halawani AJ *et al*,[19] demonstrated that Jka was present in 90.64% (n=126) and Jkb was present in 69.40% (n=93) of the total sample population. The percentages of different phenotypes were as follows: 52.45% Jk (a + b +) (n = 75), 34.96% Jk (a + b −) (n = 51), 0% Jk (a − b −), 12.59% Jk (a − b +) (n = 18). When compared to the Asian demographics, the frequencies of the Kidd system phenotypes in the Jazan community were substantially different (P < 0.05).[19]

The present research showed consistent results with another study by Al-Riyami AZ *et al.*[20] According to this investigation, the frequency of Jka was 82.4% and that of Jkb was 64.3%. And just like the current study, the most prevalent phenotype of the Kidd system based on this study was Jk(a+b+) [20]

Table III shows a comparison of antigenic frequency of various study groups.

Table-III Comparison of Prevalence of Kidd antigens across various research papers with the findings of current study

Kidd Antigens	Present study	Makroo RN *et al*[16]	Jabin F *et al*[18]	Halawani AJ *et al*[19]	Al-Riyami AZ *et al*[20]
JK[a]	73.2 %	81.4 %	65.28 %	90.64 %	82.4 %
JK[b]	75.4 %	67.6 %	42.4 %	69.40 %	64.3 %

Understanding the most commonly occurring minor blood group antigens can help with both the prevention and treatment of this condition as well as the provision of antigen-free compatible blood to individuals who present with multiple alloantibodies. This effort determines that an extensive population comprises particular minor blood group antigens, which may culminate in fatal haemolytic transfusion responses.

Conclusion

This research demonstrated that it is necessary for all of Pakistan's blood banks to routinely undertake extended antigen typing for minor blood groups. This study presents a demographic snapshot of known antigens that are useful for providing antigen-matched blood units to pregnant, anaemic, and chronically transfused individuals.

References

1. Storry JR, Clausen FB, Castilho L, Chen Q, Daniels G, Denomme G, Flegel WA, Gassner C, de Haas M, Hyland C, Yanli J. International society of blood transfusion working party on red cell immunogenetics and blood group terminology: report of the Dubai, Copenhagen and Toronto meetings. Vox sanguinis. 2019 Jan;114(1):95-102. https://doi.org/10.1111/vox.12717
2. Romphruk AV, Butryojantho C, Jirasakonpat B, Junta N, Srichai S, Puapairoj C, Simtong P. Phenotype frequencies of Rh (C, c, E, e), M, Mia and Kidd blood group systems among ethnic Thai blood donors from the north-east of Thailand.Int J Immunogenet. 2019 Jun;46(3):160-5. https://doi.org/10.1111/iji.12420
3. Jabin F, Waheed U, Ahmed S, Arshad M, Arshad A, Zaheer HA. Red blood cell phenotyping of blood donors in Islamabad, Pakistan. J Transfus Med. 2018 Jan 1;3(1):26-9. https://doi.org/10.4103/GJTM.GJTM_54_17
4. Liang S, Su YQ, Liang YL, Wu F, Zhang H, Shi JH, Hong WX, Xu YP. DNA sequence analysis and Jk blood group genotype-phenotype assessment. Ann Transl Med .2020Oct; 8(19). https://doi.org/10.5001/omj.2019.92doi: 10.21037/atm-20-6504
5. Vardan G, Ayushi G, Sonika S, Singh RK. Int J Innov Pharm Sci res. DOI: 10.21276/IJIPSR.2020.08.10.786
6. Olanrewaju PO, Joy PG, Matthew O. Blood Group System: Clinical Insight and Relevance in Medical Practice. Eur J Med Sci. 2023 Apr 20;9(1):1-1. https://doi.org/10.47672/ejhs.1425
7. Thornton NM, Grimsley SP. Clinical significance of antibodies to antigens in the ABO, MNS, P1PK, Rh, Lutheran, Kell, Lewis, Duffy, Kidd, Diego, Yt, and Xg blood group systems. Immunohematology. 2019 Sep 1;35(3):95-101. https://doi.org/10.21307/immunohematology-2020-021
8. Halawani AJ, Saboor M, Abu-Tawil HI, Alhazmy AY, Mashlawi WQ, Bantun F, Mansor AS. The frequencies of Kidd blood group antigens and phenotypes among Saudi blood donors in Southwestern Saudi Arabia. Saudi J Biol Sci. 2022 Jan 1;29(1):251-4. https://doi.org/10.1016/j.sjbs.2021.08.081
9. Lawicki S, Coberly EA, Lee LA, Johnson M, Eichbaum Q. Jk3 alloantibodies during pregnancy—blood bank management and hemolytic disease of the fetus and newborn risk. Transfusion. 2018 May;58(5):1157-62. https://doi.org/10.1111/trf.14548
10. Hamilton JR. Kidd blood group system: outwardly simple with hidden complexity. ISBT Science Series. 2019,Feb;14(1):3-88. https://doi.org/10.1111/voxs.12458
11. Kuriri FA, Ahmed A, Alanazi F, Alhumud F, Ageeli Hakami M, Atiatalla Babiker Ahmed O. Red Blood Cell Alloimmunization and Autoimmunization in Blood Transfusion-Dependent Sickle Cell Disease and β-Thalassemia Patients in Al-Ahsa Region, Saudi Arabia. Anemia. 2023 Apr 28;2023. https://doi.org/10.1155/2023/3239960
12. Stainsby D, Jones H, Asher D, Atterbury C, Boncinelli A, Brant L, Chapman CE, Davison K, Gerrard R, Gray A, Knowles S. Serious hazards of transfusion: a decade of hemovigilance in the UK. Transfusion

medicine reviews. 2006 Oct 1;20(4):273-82. https://doi.org/10.1016/j.tmrv.2006.05.002
13. Kutner JM, Mota M, Conti F, Castilho L. Blood genotyping for improved outcomes in chronic transfusion patients: current and future perspectives. Int J Clin Transfus Med. 2014 Sep 4:65-72. https://doi.org/10.2147/IJCTM.S48394
14. Thedsawad A, Taka O, Wanachiwanawin W. Prevalence and clinical significances of red cell alloimmunization and red cell bound immunoglobulin G in polytransfused patients with thalassemias. Haematology. 2019 Jan 1;24(1):208 https://doi.org/10.1080/16078454.2018.1549818
15. Dean L, Dean L. Blood groups and red cell antigens. Bethesda: NCBI; 2005.
16. Makroo RN, Bhatia A, Gupta R, Phillip J. Prevalence of Rh, Duffy, Kell, Kidd & MNSs blood group antigens in the Indian blood donor population. Ind J Med Res. 2013 Mar1 37(3):521.
17. Musa RH, Ahmed SA, Hashim H, Ayob Y, Asidin NH, Choo PY, Al-Joudi FS. Red cell phenotyping of blood from donors at the National blood center of Malaysia. Asian journal of transfusion science. 2012 Jan;6(1):3. 10.4 https://doi.org/103/0973-6247.95042
18. Jabin F, Waheed U, Ahmed S, Arshad M, Arshad A, Zaheer HA. Red blood cell phenotyping of blood donors in Islamabad, Pakistan. Glob J Transfus Med. 2018 Jan 1;3(1):26-9. DOI: 10.4103/GJTM.GJTM_54_17 https://doi.org/10.4103/GJTM.GJTM_54_17
19. Halawani AJ, Saboor M, Abu-Tawil HI, Alhazmy AY, Mashlawi WQ, Bantun F, Mansor AS. The frequencies of Kidd blood group antigens and phenotypes among Saudi blood donors in Southwestern Saudi Arabia. Saudi J Biol Sci. 2022 Jan 1;29(1):251-4. https://doi.org/10.1016/j.sjbs.2021.08.081
20. Al-Riyami AZ, Al-Marhoobi A, Al-Hosni S, Al Mahrooqi S, Schmidt M, O'brien S, Al-Khabori M. Prevalence of red blood cell major blood group antigens and phenotypes among Omani blood donors. Oman Med. J. 2019 Nov 34(6):496. https://doi.org/10.5001/omj.2019.92