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Distribution of ABO, Rhesus phenotypes, and Kell blood group antigens among pregnant women of Lelna ethnic group in Kebbi State, Northwest Nigeria

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ABSTRACT

Objectives: The distribution of ABO, Rhesus (Rh) (D, C, E, c, and e), and K antigens varies from one region or ethnic group to another. The objective of the study was to determine the prevalence of ABO, Rh phenotypes, and Kell antigens among pregnant women of Lelna ethnic group in Kebbi state, Northwest Nigeria.

Material and Methods: One-hundred and ninety-six pregnant women, aged 18–42 years, were recruited for the study from the antenatal Clinic of General Hospital, Zuru, Kebbi State, between October 2021 and November 2022. ABO, Rh (D, C, E, c, and e), and K antigens were determined using standard techniques.

Results: The study showed the prevalence of blood groups A, B, O, and AB as 20.9%, 13.3%, 64.3%, and 1.5%, respectively, while Rh (D)-positive and Rh (D)-negative individuals were 95.4% and 4.6%, respectively. The frequencies of C, E, c, e, and K were 15.3%, 14.3%, 14.3%, 20.9%, and 6.6%, respectively. However, cDe/cDe (RoRo) had the highest frequency of Rh phenotype of 70.4% while CDe/cDe (R_1Ro) had the least frequency of Rh phenotype among Rh (D) positive pregnant women, but cde/cde (rr) phenotype had the highest prevalence among the Rh (D) negative pregnant women of 3.1%.

Conclusion: The study has shown that blood group O and cDe/cDe (RoRo) were the most common ABO and Rh blood group phenotypes, respectively, among the pregnant women of the Lelna ethnic group in Kebbi state. This knowledge can serve as a guide to the blood bank in adjusting the bloodstock by blood type and assuring adequate blood supply to meet up with the demands of the patients and, most especially pregnant women to minimize or prevent blood transfusion reactions in the locality.

Keywords: ABO, Antigens, Distribution, K, Kebbi, Rhesus

INTRODUCTION

ABO blood group system is the most significant blood group system among other blood group systems in transfusion medicine and transplantation.[1] The composition of the ABO blood type of an individual has been linked to the inheritance of a gene on chromosome 9 (9q 34), which encodes glycosyl transferases that transfer some oligosaccharides residues to H antigen and results in the formation of blood group A and B antigens while blood group O individuals lack such activity.[2]

Apart from the ABO blood group that is determined by inheritance, natural selection associated with susceptibility to particular diseases or disorders could influence the frequencies of ABO types.[3-5]

The human ABO types have been associated with three alleles (A, B, and O), and the phenotypes are O, A, B, and AB.[2]

Rhesus (Rh) blood group system is the next important blood group system after the ABO system.[6] The two genes of the Rh system (RhD and Rh CE) are found on the short arm of chromosome 1, locus 34-36[7], but the Rh antigens are carried on three non-glycosylated transmembrane proteins, which are encoded in the two genes, RHD and RHCE.[8]

The two Rh proteins, RhD and RhCE, are identical, but they are different in only 36 of the 417 amino acids in which each of them comprises. However, the clinically essential difference between Rh (D) positive and Rh (D) negative is the presence or absence of the Rh (D) protein in the red cell membrane.[9]

The differences between RhD and RhCE occur in the extracellular region, in which the loops (extracellular portions) 2, 3, 4, and 6 are restricted.[7]

The RhD protein expresses the D antigen while the RhCcEe protein carries either C or c antigen together with E or e antigen on the protein.[10] The D, C, E, c, and e antigens have been considered to be of medical importance for all the Rh antigens identified.[1,11]

The most frequently occurring forms of RHCE and RHD encode 8 haplotypes, which are Dce, dce, DCe, dCe, DcE, dcE, DCE, and dCE. These haplotypes are also known as Ro, r, R_1, r', R_2, r", Rz, and ry, respectively. This notation is of practical value in transfusion medicine as it helps in the communication of the Rh phenotype of the individual.[10]

The C antigen is antithetical to the c antigen, while the E antigen is antithetical to the e antigen; however, each chromosome contains the C or c and E or e genes.[12]

The expression of Rh on the RBC surface depends on the functional glycoprotein associated with Rh (RhAG) protein. If RhAG is absent, there will be no expression of D, E, C, e, and c antigens, and the phenotype will be referred to as Rh null.[13]

The distribution of ABO and Rh (D) blood groups varies in different populations of the world due to variation in geographic locations, genetic and ethnic factors.[14]

Kell blood group system is the next most significantly important blood group system after ABO and Rh blood group systems.[1]

The KEL gene can be found on chromosome 7, 7q33, which contains different alleles at this locus that encode more than 25 antigens, defining the Kell blood group system.[15,16]

There are two major codominant allelic genes that produce K and k antigens (known as Kell and Cellano, respectively) that are different by a single amino acid. The k antigen is more common than the K antigen in most populations, as the K-k+ phenotype is 98% for blacks but 91% for Caucasians. However, the original K antigen is the most significant in transfusion medicine and hemolytic disease of the newborn.[15,17]

The rare null phenotype of the Kell system is referred to as Ko, which lacks Kell antigens. However, individuals with Ko produce anti-Ku when they encounter red blood cells that express Kell antigens. Anti-Ku has been responsible for mild to severe transfusion reactions.[18]

Different frequencies and distributions of ABO, Rh, and K antigens have been observed by the earlier authors. The predominant ABO blood group reported in Nigeria and America was blood group O[14,19], while blood group B was the most common among North Indian blood donors[20]; however, other studies revealed that blood group A was predominant in Turkey.[21,22]

The prevalence of Rh (D) positive individuals ranged from 91.5% to 98% from the previous reports; however, Rh phenotype cDe/cDe (RoRo) was predominant in Calabar, Nigeria[23], while CDe/cde (R_1r) and CDe/CDe (R_1R_1) were the most common in Iranian and Indian populations, respectively[20,24] but the prevalence of Kell (K) antigen in Nigerian studied population ranged from 0% to 2%.[25-27]

Apart from the scanty information available on the prevalence of Rh phenotypes and K antigens in Nigeria, Kebbi State has no published data on the distribution of ABO, Rh phenotypes, and K antigens. Therefore, this study was undertaken to determine the frequencies of these antigens among the pregnant women of the Lelna ethnic group in Kebbi State of Nigeria.

MATERIAL AND METHODS

One hundred and ninety-six pregnant women, aged 18–42 years, attending antenatal clinic in General Hospital, Zuru, Kebbi State, were consecutively recruited for this study between October 2021 and November 2022. Informed consent was obtained from each participant, while ethical approval was granted by the Ethical Committee of the Kebbi State Ministry of Health through a letter numbered MOH/KSREC/VOL.I/57.

Three milliliters of aseptically collected venous blood from each subject was put into ethylene diamine tetra-acetic acid bottle for the determination of ABO, Rh (D, C, c, E, and e), and Kell (K) blood group phenotypes. ABO phenotypes were determined according to the manufacturer's instructions using anti-A, anti-B, and anti-A B monoclonal reagents with catalog numbers 600010E, 610010E, and 620010E, respectively. Rh (D) typing was done according to the manufacturer's instructions using monoclonal anti-D with catalog number 740010, while C, E, c, and e antigen testing was carried out according to the manufacturer's instructions using monoclonal anti-C, anti-E, anti-c, and anti-e blood

grouping reagents with catalog numbers 690005, 691005, 692005, and 693005, respectively. However, the K antigen was determined according to the manufacturer's instructions using monoclonal anti-K with catalog number 760010. All the blood grouping reagents for ABO, Rh (D, C, E, c, and e), and K were manufactured by Lorne Laboratories Limited, United Kingdom.

Inclusion criteria

- The consenting pregnant women from the Lelna ethnic group of Kebbi state, aged 18–42 years, were included in the study.

Exclusion criteria

- Pregnant women who did not satisfy the inclusion criteria.
- Pregnant women from Lelna ethnic group but had recent red cell transfusion in the last 3 months were excluded.

Data analysis

Data collected were analyzed using the software Statistical Package for the Social Sciences version 20.0 (Chicago, Illinois), and the results were expressed as percentages.

RESULTS

Table 1 shows the ABO and Rh (D) distribution in pregnant women of Lelna ethnic group. The prevalence of blood groups A, B, O, and AB was 20.9%, 13.3%, 64.3%, and 1.5%, respectively. However, 95.4% of the studied population were Rh (D) positive, while 4.6% were Rh (D) negative.

The frequencies of clinically significant minor blood group antigens are shown in Table 2. The frequencies of C, E, c, e, and K were 15.3%, 14.3%, 14.3%, 20.9%, and 6.6%, respectively.

The prevalence of Rh phenotypes of the studied population is revealed in Table 3. Among the studied population, cDe/cDe (RoRo) had the highest prevalence (70.4%), followed by CDe/CDe (R_1R_1) of 9.7%, cDE/cDE (R_2R_2) of 7.1%, cDE/cDe (R_2Ro) of 3.6%, CDE/CDE (RzRz) and CDe/cDe (R_1Ro) of 1.5% each, CDE/cDE (RzR_2) of 1.0%, and CDE/CDe (RzR_1) of 0.5% while among the Rh (D) negative subjects, cde/cde (rr) had the highest prevalence of 3.1%, followed by similar prevalence of 0.5% for each of Cde/cde (r'r), Cde/Cde (r'r'), and cdE/cdE (r"r").

Table 1: ABO and Rh (D) distribution among pregnant women of Lelna ethnic group (*n*=196).

Blood group	Number of pregnant women (%)
A	41 (20.9)
B	26 (13.3)
O	126 (64.3)
AB	3 (1.5)
Rh (D) positive	187 (95.4)
Rh (D) negative	9 (4.6)

Rh: Rhesus

Table 2: Distribution of clinically significant minor blood group antigens among pregnant women (*n*=196).

Blood group	Number of pregnant women; n (%)
C	30 (15.3)
E	28 (14.3)
c	28 (14.3)
e	41 (20.9)
K	13 (6.6)

Table 3: Frequencies of Rh phenotypes among pregnant women (*n*=196).

Rh phenotype	Number of pregnant women; n (%)
cDe/cDe (RoRo)	138 (70.4)
cDE/cDE (R_2R_2)	14 (7.1)
cDE/cDe (R_2Ro)	7 (3.6)
CDe/CDe (R_1R_1)	19 (9.7)
CDE/CDE (R_ZR_Z)	3 (1.5)
CDE/cDE (R_ZR_2)	2 (1.0)
CDE/CDe (R_ZR_1)	1 (0.5)
CDe/cDe (R_1Ro)	3 (1.5)
cde/cde (rr)	6 (3.1)
Cde/cde (r'r)	1 (0.5)
Cde/Cde (r'r')	1 (0.5)
cdE/cdE (r"r")	1 (0.5)

Rh: Rhesus, *n*: number

DISCUSSION

ABO, Rh, and Kell blood group systems have been associated with hemolytic disease of the fetus and newborn and hemolytic transfusion reactions apart from being linked to diseases that are still at the experimental stages.[1] The knowledge of the clinically significant blood group system in every locality is important since the prevalence of ABO, Rh, and Kell antigens are being influenced by geographical locations, regions, ethnicity, and susceptibility to particular diseases.[3-5,14,19]

Our study has shown that the most common blood group among pregnant women was O (64.3%), followed by blood group A (20.9%), blood group B (13.3%), and AB (1.5%). This is in support of the overall prevalence in Nigeria, which showed 52.93% for blood group O, 22.77% for blood group A, 20.64% from blood group B, and 3.66% for

blood group AB[19], and the findings from Tanzania which revealed the frequencies of 52% for blood group O, 26% for blood group A, 19% for blood group B, and 3% for blood group AB.[28] However, the studies in Turkey showed that blood group A was the most prevalent[21,22], as Salduz *et al*.[21] showed frequencies of 43.44%, 33.02%, 15.0%, and 8.54% for blood groups A, O, B, and AB, respectively, and Kayiran *et al*.[22] showed overall frequencies of 43.5%, 33.2%, 16.0%, and 7.3% for blood groups A, O, B, and AB, respectively. The study of Agarwal *et al*.[20] revealed that blood group B was the most common among blood donors in North India, with blood group frequencies of 36.51% for blood group B, followed by blood group O at 32.37%, blood group A at 21.91%, and blood group AB at 9.19%. These differences in the frequencies of ABO blood groups could be associated with variations in geographical locations, races, genetic factors, and sample sizes.

The study has further revealed that 95.4% of the studied population were Rh (D) positive while 4.6% were Rh (D) negative. The prevalence of Rh (D) positive among the studied population is in agreement with the previous findings of 94%-96.9% documented in the Northern and Southern regions of Nigeria[19] but at variance with the lower prevalence of 91.5% reported in Ethiopia[29] and higher frequency of 97.7% in Tanzania.[28] Different frequencies of Rh (D) positivity among the authors could be attributed to changes in sample sizes and genetic and geographical factors.

The frequency of C antigen in this study was 15.3%, and this is consistent with the earlier report of 20.5% in Nigeria[27] but deviates from the reports from Port-Harcourt that showed 38.09%[30] and Calabar with the frequency of 30.7%.[23] However, Erhabor *et al*.[31] showed variation in the prevalence of Rh C phenotype on the basis of ethnicity as 47.4% among the Fulani ethnic group, 27.8% among Igbos, 23.4% among the Hausas, 22.2% among Yorubas, and 13.3% among the minority ethnic group resident in Sokoto; however, Thakral *et al*.[32] observed Rh C prevalence of 84.76% among blood donors in North India. These different frequencies of Rh C antigen observed by various authors could be linked to ethnic, racial, and genetic factors.

This study has summarized the prevalence of c antigen to be 14.3%. This is contrary to previous reports of 98.5% frequency for c antigen in Calabar,[23] 97.7% in a multi-ethnic cohort study in Nigeria,[27] and 54.9% in Southern India.[11] However, variation in the prevalence of Rh c antigen could be due to ethnicity, geographical factors, and different sample sizes from the studies.

The study has further shown that the frequency of Rh E antigen was 14.3%, which is in line with the earlier reports of 17.9% observed by Thakral *et al*.,[32] 19.5% from a multi-ethnic cohort study in Nigeria,[27] 20.1% among Nigerian antenatal women,[33] and 18.8% among blood donors in Southern India.[11] This shows that there might not be influence of ethnicity and geographical locations in the prevalence of Rh E antigen.

The prevalence of Rh e antigen in our studied population was 20.9%. This is lower than that of the earlier findings of 98.3% among North Indian blood donors,[32] 97.4% in a multi-ethnic cohort study in Nigeria,[27] 54.0% among Nigerian antenatal women,[33] and 95.4% among blood donors in Calabar.[23] These differences in the prevalence rates of Rh e antigen could be due to ethnicity and environmental or geographical factor.

The study has demonstrated that the most prevalent Rh phenotype was cDe/cDe (RoRo) of 70.4%. This agrees with the previous findings in Nigeria.[23,27] However, R1r (Dce/dce) of 27.7% was the highest prevalence among the Iranian population[24], while CDe/CDe (R_1R_1) of 42.93% was the most common among the North Indian blood donors[20] and Gwalior blood donors of 43% prevalence.[34] The differences in the frequencies of Rh phenotypes could be associated with ethnicity, racial, and environmental factors.

However, the least Rh phenotype among the Rh (D)-positive pregnant women in this study was CDE/CDe (R_zR_1) of 0.5%, which agrees with the report from the blood donors in Gwalior[34] but disagrees with the least Rh phenotype of CDE/CDE (R_zR_z) documented by other researchers.[20,24]

The cde/cde (rr) had the highest prevalence of 3.1% among Rh (D)-negative pregnant women in this study. This supports the findings of previous studies.[11,20,35]

The prevalence for K antigen varies from one ethnic group or region to the other as Akasha[36] observed a frequency of 5.6% among major Sudanese tribes, Mehmoud *et al*.[37] reported a 4.05% prevalence of K antigen among blood donors in Northern Pakistan. However, a frequency of 0% for K antigen was observed in a multi-ethnic study in Nigeria[27], while Ugboma and Nwauche[25] documented a 2% prevalence of K antigen among Nigerians resident in Port-Harcourt. Our study revealed the prevalence of K antigen as 6.6%.

CONCLUSION

This study has shown that the pregnant women from Lelna ethnic group in Kebbi State had blood group O and cDe/cDe (RoRo) as the most common phenotypes for ABO and Rh blood group systems, respectively, while blood group AB and CDE/CDe (R_zR_1) were the least ABO and Rh blood group phenotypes, respectively. However, the frequency of the K antigen was relatively high.

The distribution of ABO and Rh blood group phenotypes in this study can serve as a guide to the blood bank staff in adjusting the bloodstock by blood type and maintaining the adequacy of safe blood supply to meet up with the demand of the patients and, most especially, the pregnant women to

possibly prevent or minimize hemolytic transfusion reactions and hemolytic disease of the newborn.

It is therefore recommended that women requiring blood transfusions should be screened for C, c, E, e, and K antigens together with ABO and Rh (D) typing to guide the blood bank staff in the selection of phenotypically matched blood and blood products to prevent blood transfusion reactions in the locality.

Ethical approval: The research/study was approved by the Institutional Review Board at the Ethical Committee of Kebbi State Ministry of Health, number MOH/KSREC/VOL.I/57, dated 2021.
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