



Phenotypic Distribution and Clinical Relevance of Rh and Kell Antigens in Blood Donors: A Cross-Sectional Study

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INTRODUCTION

The Rh and Kell blood group systems are vital in transfusion medicine due to their associations with hemolytic transfusion reactions and hemolytic disease of the fetus and newborn (HDFN). Comprehensive antigen distribution data are critical for minimizing alloimmunization risks, especially in multi-transfused patients.

OBJECTIVE

To determine the phenotypic distribution of Rh (D, C, c, E, e) and Kell antigens in voluntary blood donors and explore the implications for improving transfusion safety and donor-recipient matching.

MATERIAL AND METHODS

A cross-sectional study of 5,754 voluntary blood donors was conducted. Blood samples were phenotyped for Rh (D, C, c, E, e) and Kell antigens using the Neo Iris Immucor platform. Statistical significance was assessed using chi-square tests, and findings were compared with global data for broader clinical relevance.

RESULTS

Among the donors, 91.9% were RhD-positive, and 8.1% were RhD-negative. The e antigen was the most prevalent (98.5%), followed by C (83.8%), c (60.7%), and E (19.2%). The Kell antigen was detected in 3.5% of donors, with significant correlations found between RhD-negative status and blood group O (9.6%, $p = 0.009$), and E antigen and blood group A ($p = 0.004$). Notably, the R1r (DcE/dce) genotype was observed in 38.8% of donors, with rare combinations like r'r (dCe/dce) present in only 0.14%, indicating challenges in rare donor matching.

Compared to studies in Europe and Asia, this donor population shows a higher prevalence of RhD-positive individuals, while rare genotypes like r'r align with global rarity trends. These findings suggest a need for expanded regional donor registries and antigen-matching protocols, especially for at-risk patients.

Wiener	Fisher Race	Rosenfield	No. of Cases	Frequency (%)
R1r	DcE/ce	Rh: 1, 2, -3, 4, 5	2234	38.8%
R1R1	DCe/DCe	Rh: 1, 2, -3, -4, 5	2515	43.7%
R1R2	DCe/DcE	Rh: 1, 2, 3, 4, 5	12	0.21%
R2r	DcE/ce	Rh: 1, -2, 3, 4, 5	76	1.3%
R2R2	DcE/DcE	Rh: 1, -2, 3, 4, 5	307	5.3%
R0r	Dce/ce	Rh: 1, -2, -3, 4, 5	0	0
ROR0	Dce/Dce	Rh: 1, -2, -3, 4, 5	146	2.5%
Rz	DCE/ce	Rh: 1, 2, 3, 4, -5	0	0
Rr	ce/ce	Rh: -1, -2, -3, 4, 5	453	7.9%
r'r	Ce/ce	Rh: -1, 2, -3, 4, 5	8	0.1%
r'r'	Ce/Ce	Rh: -1, 2, -3, -4, 5	0	0
r''r	cE/ce	Rh: -1, -2, 3, 4, -5	0	0
r''r'	cE/Ce	Rh: -1, -2, 3, 4, 5	0	0
(ryr)	CE/ce	Rh: -1, 2, 3, 4, 5	3	0.1%

Table 1: Distribution of Donors by Modified Weiner, Fisher-Race, and Rosenfield Classifications

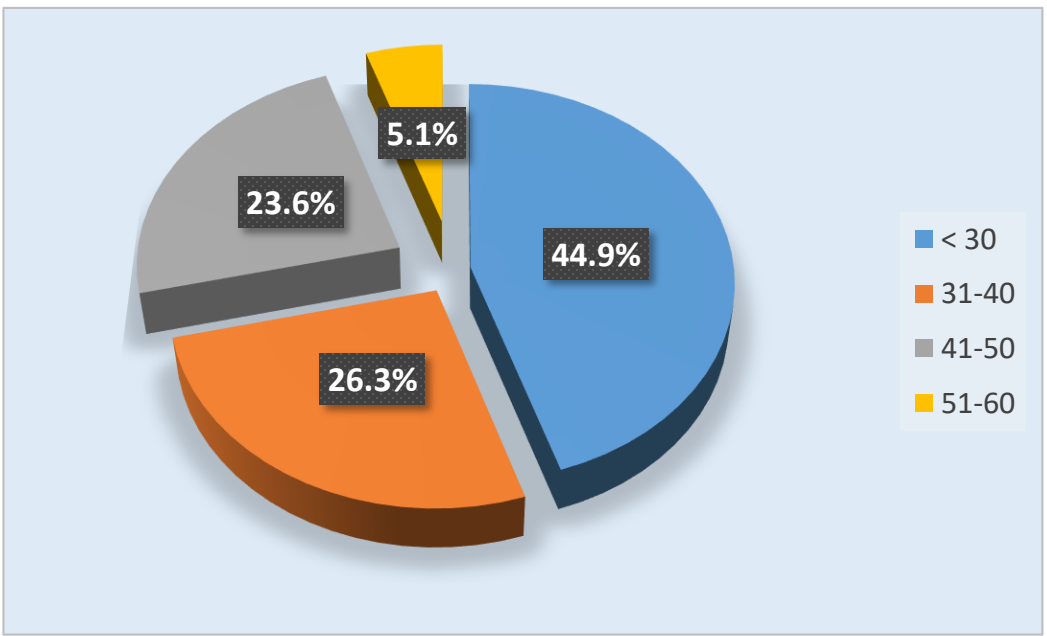


Figure 1: Distribution of Blood Donors by Age Group

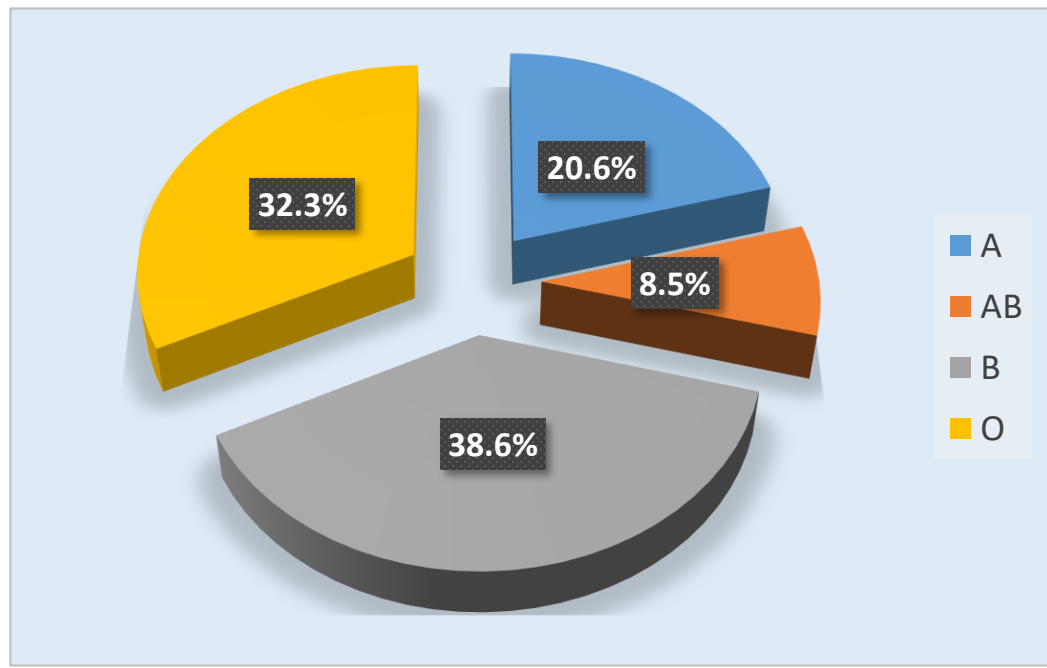
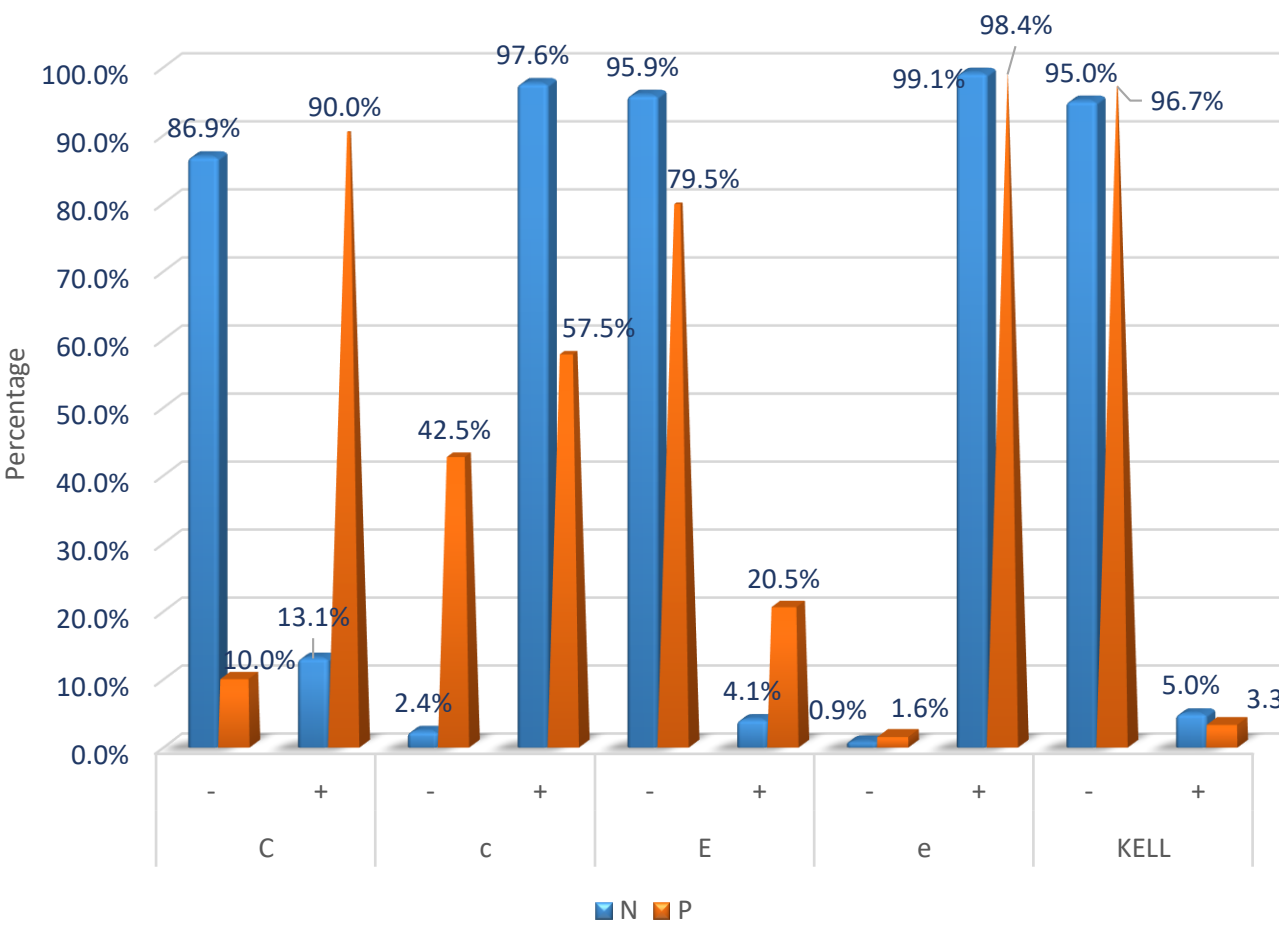


Figure 2. Distribution of ABO group

Figure 3. Distribution of Antigens in Rh-positive and negative donors



CONCLUSION

Knowledge of Rh and Kell antigen frequencies enhances transfusion support by guiding antigen-matched blood provision, reducing alloimmunization, and improving transfusion safety. Establishing an antigen-specific donor registry based on these findings supports targeted and efficient transfusion practices for multi-transfused patients.

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