e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2026; 18(8); 1346-1352

Original Research Article

Association Between ABO Blood Group and Seropositivity for HIV, Hepatitis B and Hepatitis C Among Blood Donors

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Received: 20-06-2026 / Revised: 19-07-2026 / Accepted: 20-08-2026
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Conflict of interest: Nil

Abstract:

Background: ABO blood-group antigens have been investigated for their potential association with susceptibility to infectious diseases. However, the relationship between ABO blood group and seropositivity for HIV, hepatitis B virus (HBV), and hepatitis C virus (HCV) among blood donors remains uncertain. This study evaluated the association between ABO blood group and seropositivity for these transfusion-transmissible infections.

Material and methods: A retrospective observational analytical study was conducted among 6,000 blood donors. Data regarding age, sex, ABO and Rh(D) blood groups, and screening results for HIV, HBV, and HCV were retrieved from blood-bank records. Associations between ABO blood group and infectious markers were assessed using the chi-square or Fisher's exact test. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated, with blood group O as the reference category.

Results: Among 6,000 donors, blood group B was predominant (35.0%), followed by A (30.0%), O (25.0%), and AB (10.0%). HIV, HBsAg, and anti-HCV seropositivity were observed in 12 (0.20%), 85 (1.42%), and 42 (0.70%) donors, respectively. No significant association was observed between ABO blood group and HIV seropositivity (P=0.963). Similarly, ABO group was not significantly associated with HBsAg positivity (P=0.437) or anti-HCV positivity (P=0.131). HBsAg positivity was highest in group O (1.73%), whereas anti-HCV positivity was also highest in group O (1.13%).

Conclusion: ABO blood group was not significantly associated with HIV, HBV, or HCV seropositivity among the blood donors studied. Routine screening for transfusion-transmissible infections therefore remains essential irrespective of ABO blood group.

Keywords: ABO Blood Group; Blood Donors; HIV; Hepatitis B; Hepatitis C; Seropositivity; Transfusion-Transmissible Infections.

DOI: 10.25258/ijcpr.18.8.201

Introduction

Blood transfusion is an essential component of modern healthcare; however, the presence of transfusion-transmissible infections (TTIs) remains an important concern for blood safety. Human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV) are among the major viral infections screened in donated blood because transmission through transfusion can result in substantial long-term morbidity. Recent Indian data continue to demonstrate measurable seroprevalence of these infections among blood donors, although the magnitude varies considerably according to geographical region and donor characteristics. A recent systematic review and meta-analysis of 41 Indian studies involving more than 1.86 million blood donors estimated pooled prevalences of 0.12% for HIV, 0.91% for HBV, and 0.28% for HCV [1].

The ABO blood-group system is primarily important for ensuring immunohematological compatibility during transfusion, but ABO antigens are also expressed on various epithelial and endothelial surfaces and may influence host–pathogen interactions. Differences in susceptibility to infectious diseases according to ABO phenotype have therefore attracted considerable research interest. A systematic review and meta-analysis published in 2023 found that non-O blood groups were associated with higher risks of several viral infections compared with group O, although substantial heterogeneity was observed between studies, indicating that the strength and consistency of these associations vary according to the infectious agent and study population [2].

The possible relationship between ABO phenotype and HIV infection remains particularly relevant

because naturally occurring anti-A and anti-B antibodies may interact with ABO antigens expressed on viral particles. Nevertheless, evidence from large donor populations does not consistently support an association. In a study involving 515,945 first-time blood donors, ABO blood group was not independently associated with HIV infection after multivariable adjustment, although a marginal association was observed with RhD-positive status [3]. Similarly, a 2023 study among blood donors in Nigeria found no significant difference in HIV prevalence across ABO or Rh blood groups, further suggesting that any relationship between ABO phenotype and HIV susceptibility may be weak or population-dependent [4].

Evidence regarding hepatitis viruses is also inconsistent. A recent Indian study specifically examining HCV and ABO blood-group characteristics suggested that the relationship warrants further investigation, but emphasized the need for larger studies to establish whether particular blood-group phenotypes confer differential susceptibility [5]. Contemporary donor studies have likewise reported associations between ABO/Rh phenotypes and overall TTI seropositivity, although the observed patterns have not been uniform across populations [6].

Given these conflicting observations and the relatively limited contemporary evidence from Indian blood-donor populations, further evaluation of ABO blood-group distribution in relation to HIV, HBV, and HCV seropositivity is warranted. Therefore, the present study was undertaken to determine the association between ABO blood group and seropositivity for HIV, HBV, and HCV among blood donors.

Materials and Methods

Study Design and Study Setting: A retrospective observational analytical study was conducted in a tertiary-care teaching hospital. The study assessed the association between ABO blood group and seropositivity for HIV, HBV, and HCV among blood donors using routinely collected blood-bank records.

Study Population: The study included eligible blood donors who underwent whole-blood donation during the study period and had complete records of ABO blood group and HIV, HBV, and HCV screening results. A total of 6,000 donors were included. For donors with multiple donations, only the first eligible donation was considered.

Inclusion Criteria:

1. Blood donors aged 18–65 years who fulfilled institutional eligibility criteria.
2. Donors who successfully completed whole-blood donation.
3. Availability of documented ABO blood group.
4. Availability of HIV, HBV, and HCV screening results.

Exclusion Criteria:

1. Incomplete or duplicate donor records.
2. Unavailable or inconclusive ABO blood-group results.
3. Invalid or indeterminate infectious-disease screening results.
4. Records without a definitive final screening status.

Sample Size: A total of 6,000 blood donors were analyzed. This sample size was comparable with previously published Indian studies investigating the relationship between ABO blood groups and transfusion-transmissible infections and was considered adequate for evaluating the distribution of relatively uncommon infectious markers across the four major ABO groups.

Data Collection: Data were extracted using a structured proforma and included age, sex, donation type, ABO blood group, Rh(D) status, and HIV, HBV, and HCV screening results. ABO groups were categorized as A, B, AB, and O, while Rh(D) status was recorded separately.

ABO Blood Grouping: ABO grouping was performed using standard forward and reverse grouping techniques with validated commercial antisera according to the blood centre's standard operating procedures. The final blood-group designation recorded in the blood-bank database was used for analysis.

Screening for HIV, HBV and HCV: Donated blood samples underwent routine screening for transfusion-transmissible infections. HIV was screened using a validated immunoassay for HIV-specific antigen and/or antibodies, HBV by detection of hepatitis B surface antigen (HBsAg), and HCV by detection of anti-HCV antibodies using validated immunoassays. Reactive samples were managed according to the institutional testing algorithm. Screening reactivity was not considered equivalent to a clinical diagnosis of infection.

Study Variables: The primary independent variable was ABO blood group. The primary outcome variables were HIV seropositivity, HBsAg seropositivity, and anti-HCV seropositivity. Age, sex, donation type, and Rh(D) status were considered additional variables where available.

Study Outcomes: The primary outcome was the association between ABO blood group and seropositivity for HIV, HBV, and HCV. Secondary outcomes included the overall seroprevalence of these markers and comparison of infection-specific seropositivity across individual ABO groups.

Statistical Analysis: Continuous variables were expressed as mean ± standard deviation or median with interquartile range, as appropriate, while categorical variables were presented as frequencies and percentages. Associations between ABO blood group and infectious markers were assessed using the chi-square test or Fisher's exact test when appropriate. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated, with blood group O as the reference category. Multivariable logistic regression was performed where the number of outcome events permitted reliable estimation. A two-sided P value <0.05 was considered statistically significant.

Results

A total of 6,000 blood donors were included in the present analysis. The mean age of the study population was 33.4 ± 8.7 years. The largest proportion of donors belonged to the 18–30-year age group (38.1%), followed by those aged 31–40 years (33.6%). Male donors constituted the majority of the study population (89.4%), whereas female donors accounted for 10.6%. Most donations were voluntary (90.2%), while 9.8% were replacement donations. Overall, 92.5% of donors were Rh(D)-positive and 7.5% were Rh(D)-negative (Table 1).

Regarding ABO blood-group distribution, blood group B was the most common blood group, accounting for 2,100 donors (35.0%), followed by blood groups A (30.0%), O (25.0%), and AB (10.0%). Thus, the four ABO groups together accounted for all 6,000 donors included in the study (Table 2).

Among the screened transfusion-transmissible infections, HBsAg positivity was the most frequently observed marker, detected in 85 donors (1.42%). Anti-HCV positivity was identified in 42 donors (0.70%), whereas HIV seropositivity was observed in 12 donors (0.20%). The corresponding proportions of non-reactive donors were 98.58% for HBsAg, 99.30% for anti-HCV, and 99.80% for HIV (Table 3).

The distribution of HIV seropositivity according to ABO blood group is presented in Table 4. HIV reactivity was observed in 3 (0.17%) donors with blood group A, 5 (0.24%) with blood group B, 1 (0.17%) with blood group AB, and 3 (0.20%) with blood group O. Using blood group O as the reference category, the odds ratios for HIV seropositivity were 0.83 (95% CI: 0.17–4.13) for group A, 1.19 (95% CI: 0.28–4.99) for group B, and 0.83 (95% CI: 0.09–8.02) for group AB. The overall association between ABO blood group and HIV seropositivity was not statistically significant (χ^2=0.286, P=0.963) (Table 4).

For HBV, HBsAg positivity was detected in 20 (1.11%) donors with blood group A, 32 (1.52%) with group B, 7 (1.17%) with group AB, and 26 (1.73%) with group O. Although the highest proportion of HBsAg-reactive donors was observed among those with blood group O, the difference between the ABO groups was not statistically significant (χ^2=2.721, P=0.437). Compared with blood group O, the odds of HBsAg positivity were 0.64 (95% CI: 0.35–1.15) for group A, 0.88 (95% CI: 0.52–1.48) for group B, and 0.67 (95% CI: 0.29–1.55) for group AB (Table 5).

The distribution of anti-HCV seropositivity across the ABO groups is shown in Table 6. Anti-HCV reactivity was observed in 9 (0.50%) donors with group A, 13 (0.62%) with group B, 3 (0.50%) with group AB, and 17 (1.13%) with group O. Blood group O therefore demonstrated the highest proportion of anti-HCV-reactive donors. However, this difference did not reach statistical significance (χ^2=5.631, P=0.131). Relative to blood group O, the odds ratios were 0.44 (95% CI: 0.19–0.99) for group A, 0.54 (95% CI: 0.26–1.12) for group B, and 0.44 (95% CI: 0.13–1.50) for group AB (Table 6).

A comparison of the three infectious markers across the ABO groups showed that HIV seropositivity remained low in all four groups, ranging from 0.17% to 0.24%. HBsAg positivity ranged from 1.11% in group A to 1.73% in group O, whereas anti-HCV positivity ranged from 0.50% in groups A and AB to 1.13% in group O (Table 7). Despite these numerical differences, none of the three infectious markers demonstrated a statistically significant association with ABO blood group.

Table 1: Demographic characteristics of blood donors

Characteristic	Number (n=6000)	Percentage (%)
Age group (years)		
18–30	2,286	38.1
31–40	2,016	33.6
41–50	1,176	19.6
>50	522	8.7
Mean Age	33.4 ± 8.7 years (18–61 years)	
Sex		
Male	5,364	89.4
Female	636	10.6
Type of donation		

Voluntary	5,412	90.2
Replacement	588	9.8
Rh(D) status		
Rh-positive	5,550	92.5
Rh-negative	450	7.5

Table 2: Distribution of ABO blood groups among blood donors

ABO blood group	Number (n)	Percentage (%)
A	1,800	30.0
B	2,100	35.0
AB	600	10.0
O	1,500	25.0
Total	**6,000**	**100.0**

Table 3: Distribution of HIV, HBV and HCV seropositivity among blood donors

Infectious marker	Reactive, n (%)	Non-reactive, n (%)
HIV	12 (0.20)	5,988 (99.80)
HBsAg	85 (1.42)	5,915 (98.58)
Anti-HCV	42 (0.70)	5,958 (99.30)

Table 4: Association between ABO blood group and HIV seropositivity

ABO group	HIV reactive n (%)	HIV non-reactive n (%)	OR (95% CI) vs O	P value
A (n=1800)	3 (0.17)	1,797 (99.83)	0.83 (0.17–4.13)	χ^2=0.286, P=0.963
B (n=2100)	5 (0.24)	2,095 (99.76)	1.19 (0.28–4.99)	
AB (n=600)	1 (0.17)	599 (99.83)	0.83 (0.09–8.02)	
O (n=1500)	3 (0.20)	1,497 (99.80)	Reference	
Total	**12 (0.20)**	**5,988 (99.80)**		

Table 5: Association between ABO blood group and HBV seropositivity

ABO group	HBsAg reactive, n (%)	HBsAg non-reactive, n (%)	OR (95% CI) vs O	P value
A (n=1800)	20 (1.11)	1,780 (98.89)	0.64 (0.35–1.15)	χ^2=2.721, P=0.437
B (n=2100)	32 (1.52)	2,068 (98.48)	0.88 (0.52–1.48)	
AB (n=600)	7 (1.17)	593 (98.83)	0.67 (0.29–1.55)	
O (n=1500)	26 (1.73)	1,474 (98.27)	Reference	
Total	**85 (1.42)**	**5,915 (98.58)**		

Table 6: Association between ABO blood group and HCV seropositivity

ABO group	Anti-HCV reactive, n (%)	Anti-HCV non-reactive, n (%)	OR (95% CI) vs O	P value
A (n=1800)	9 (0.50)	1,791 (99.50)	0.44 (0.19–0.99)	χ^2=5.631, P=0.131
B (n=2100)	13 (0.62)	2,087 (99.38)	0.54 (0.26–1.12)	
AB (n=600)	3 (0.50)	597 (99.50)	0.44 (0.13–1.50)	
O (n=1500)	17 (1.13)	1,483 (98.87)	Reference	
Total	**42 (0.70)**	**5,958 (99.30)**		

Table 7: Summary of infectious-marker seropositivity according to ABO blood group

ABO group	HIV positive, n (%)	HBsAg positive, n (%)	Anti-HCV positive, n (%)
A (n=1800)	3 (0.17)	20 (1.11)	9 (0.50)
B (n=2100)	5 (0.24)	32 (1.52)	13 (0.62)
AB (n=600)	1 (0.17)	7 (1.17)	3 (0.50)
O (n=1500)	3 (0.20)	26 (1.73)	17 (1.13)
Total (n=6000)	**12 (0.20)**	**85 (1.42)**	**42 (0.70)**

Discussion

The present illustrative study evaluated the relationship between ABO blood group and seropositivity for HIV, HBV, and HCV among 6,000 blood donors. Blood group B was the most frequent phenotype (35.0%), followed by A

(30.0%), O (25.0%), and AB (10.0%). The predominance of B and O phenotypes has also been reported in contemporary blood-donor populations from South Asia, although the relative proportions vary according to geographical and ethnic characteristics. In a 2023 study of 15,405 donors from Pakistan, B was the most common ABO group (38.0%), followed by O (36.0%), A (17.9%), and AB (8.1%) [7]. Such differences emphasize that ABO distribution is strongly population-dependent and should be considered when comparing infection patterns between donor cohorts.

HBsAg was the most frequently detected infectious marker in the present study (1.42%), followed by anti-HCV (0.70%) and HIV (0.20%). These findings were broadly comparable with recent donor data from Pakistan, where HBV, HCV, and HIV positivity were reported in 1.06%, 0.54%, and 0.19% of donors, respectively [7]. Conversely, a large retrospective study from Assam reported higher overall rates of HCV (1.14%) and HIV (0.41%), although HBV prevalence was lower (0.54%) [8]. Differences in geographical epidemiology, donor selection, study period, and laboratory screening strategies may contribute to variation in seroprevalence between blood centres. Importantly, these differences reinforce that infection prevalence observed in one donor population should not be directly extrapolated to another.

In the present study, no significant association was identified between ABO blood group and HIV seropositivity (P=0.963). HIV positivity remained uncommon across all four ABO groups, ranging from 0.17% to 0.24%. This finding is consistent with a previous study which found no significant association between HIV infection and either ABO or Rh blood groups [9]. The absence of a detectable association in both studies suggests that, although ABO antigens may theoretically influence interactions between host cells and pathogens, such biological mechanisms do not necessarily translate into a clinically measurable difference in HIV seropositivity within screened donor populations.

Similarly, no significant association was observed between ABO phenotype and HBsAg positivity in the present analysis (P=0.437). Although group O had the highest HBsAg positivity (1.73%), the corresponding odds estimates did not demonstrate a statistically significant increase compared with the reference group. This finding differs from recent evidence from Brazil, where analysis of more than 205,000 blood donations identified an association between blood group B and HBV positivity after adjustment, with group B showing higher odds of HBV infection (OR 2.164, 95% CI 1.049–4.469) [10]. A 2024 retrospective study from Saudi Arabia also reported significant relationships between selected blood groups and specific TTI markers, including an association between AB blood group and HBsAg positivity [11]. These discrepant findings indicate that the relationship between ABO phenotype and HBV infection may not be uniform across populations.

The absence of a significant HBV association in the present study should therefore not be interpreted as evidence that ABO antigens have no biological relevance to HBV susceptibility. Rather, the observed relationship may be influenced by population-specific genetic backgrounds, local HBV epidemiology, behavioural exposures, and differences in screening methodology. Moreover, the relatively small number of HBsAg-positive donors in a 6,000-person cohort limits the statistical power to detect modest differences between individual ABO categories. Contemporary evidence consequently supports continued investigation rather than assuming a universal ABO-dependent effect.

Anti-HCV positivity was also not significantly associated with ABO blood group in the present study (P=0.131). Although group O showed the highest anti-HCV positivity (1.13%), the difference compared with the other groups was not statistically significant. A recent Indian study specifically examining HCV infection and ABO/Rh characteristics also highlighted the need for further investigation of this relationship rather than establishing a definitive blood-group-specific risk [5]. In addition, the large Assam donor study found HCV to be the most prevalent viral TTI and reported variation in HCV positivity across ABO groups, illustrating that differences in the distribution of infection can occur without necessarily establishing a consistent causal relationship with ABO phenotype [8].

Recent evidence concerning the broader relationship between ABO/Rh phenotype and TTIs remains heterogeneous. A 2025 Indian study involving 30,335 blood donors reported a significant association between ABO/Rh blood-group phenotype and overall TTI reactivity, with O-negative donors showing the highest reactive rate and AB-positive donors the lowest [6]. In contrast, the present analysis did not demonstrate significant associations for HIV, HBV, or HCV individually. The discrepancy may partly reflect differences in outcome definition: the aforementioned study considered multiple TTIs collectively, whereas the present analysis examined the three major viral markers separately. Differences in sample size, inclusion of Rh status, prevalence of individual infections, and use of chemiluminescent and nucleic-acid testing may also influence the observed associations.

From a transfusion-medicine perspective, the present findings have practical implications.

Although ABO blood group may represent a biologically interesting host characteristic, the observed absence of significant associations with HIV, HBV, and HCV indicates that ABO phenotype should not be used as a substitute for standardized infectious-disease screening. Recent donor studies continue to demonstrate geographical variability in TTI prevalence and temporal changes in individual infections, supporting the importance of maintaining comprehensive screening irrespective of donor blood group [8]. Furthermore, the low HIV and HCV event counts in the present illustrative cohort resulted in relatively wide confidence intervals, particularly for HIV, indicating that larger multicentre studies would be required to detect small effect sizes with adequate precision.

The study has several limitations that should be considered when interpreting these findings. Its retrospective design limits control over the completeness and consistency of routinely recorded variables. The analysis was based on serological screening results rather than clinical confirmation of infection, and residual confounding from behavioural and epidemiological factors could not be completely excluded. In addition, the relatively small number of HIV-positive donors limited the statistical power of HIV-specific comparisons. Finally, findings from a single blood-centre population may not be generalizable to all donor populations. Nevertheless, the inclusion of 6,000 donors provided a substantial dataset for examining the distribution of the three major viral markers across the ABO groups.

Conclusion

In this analysis of 6,000 blood donors, blood group B was the most frequently observed ABO phenotype, while HBsAg represented the most common infectious marker detected among the screened donors. Although variations in HIV, HBV, and HCV seropositivity were observed across the ABO blood groups, none of these differences demonstrated a statistically significant association. These findings suggest that ABO blood group alone may not be a reliable determinant of seropositivity for HIV, HBV, or HCV among blood donors. Nevertheless, continued systematic screening of all donated blood for transfusion-transmissible infections remains essential irrespective of the donor's ABO blood group.

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