Serological markers of transfusion transmissible infections and ABO blood groups in Najran, Saudi Arabia

Ahmad A. Alshehri, MSc, PhD, Ahmad Adebayo Irekeola, MSc, PhD, Mohammed Merae Alshahrani, MSc, PhD, Khaja Shameem Mohammed Abdul, MSc, PhD, Saeed Ahmed Asiri, MSc, PhD, Banan F. Aboluluy, BSMLS, et al.

ABSTRACT

الأهداف: التعرف على معدل انتشار العدوى المنقولة عن طريق نقل الدم « تي تي آي » (TTIs) بين المتبرعين في منطقة نجران. بالإضافة إلى التعرف على الارتباط المحتمل بين تطور « TTI » ونوع فصيلة الدم حسب نظام التصنيف (Rh) / (ABO).

المنهجية: تمت المراجعة بأثر رجعي لبيانات 4120 من المتبرعين خلال فترة امتدت من شهر يناير إلى ديسمبر 2020. تم مسح دم المتبرعين بحثاً عن العلامات المصلية بما في ذلك المستضد السطحي لفيروس الكبد الوبائي ب (HBs Ag)، الجسم المضاد لفيروس الكبد الوبائي ب (anti–HBc)، الجسم المضاد لفيروس الكبد الوبائي سي (anti–HCV)، الجسم المضاد لفيروس نقص المناعة البشري نوع 1 و 2 (anti–HIV 1 & 2) ، الجسم المضاد لفيروس تي اللمفاوي البشري نوع 1 و2 ومستضد الزهري syphilis antigen).

النتائج: تم تحديد علامات (TTI) بشكل إيجابي بين المتبرعين بنسبة 10.9% (العدد=449). يعتبر الجسم المضاد لفيروس الكبد الوبائي ب الإيجابي الأكثر تحديداً (8.9%، العدد= 366) يليه المستضد السطحي لفيروس الكبد الوبائي ب (0.7%، العدد=29). العلامات المصلية الأخرى تم تحديدها في أقل من 1% من المتبرعين. الجسم المضاد لفيروس الكبد الوبائي ب الإيجابي كان مرتفع بشكل ملحوظ بين غير السعوديين. يوجد ارتباط بين الفئات العمرية وإيجابية الجسم المضاد لفيروس الكبد الوبائي سي (p=0.002)، الجسم المضاد لفيروس تي اللمفاوي البشري (دلالة إحصائية = 0.004) و مستضد الزهري (دلالة إحصائية = 0.02). أظهرت فصيلة الدم AB+ أكثر إيجابية لعلامات TTI، يليها فصيلة الدم O+. بشكل مشابه، يوجد ارتباط بين فصائل الدم ABO وإيجابية المستضد السطحي لفيروس الكبد الوبائي ب (دلالة إحصائية = 0.01) ، الجسم المضاد لفيروس الكبد الوبائي ب (دلالة إحصائية = 0.001) ، الجسم المضاد لفيروس الكبد الوبائي سي (دلالة إحصائية أقل من 0.001).

الخلاصة: التركيز على تنفيذ تدابير مسح فاعلة للدم المتبرع به تم التأكيد عليه في هذه الدراسة. هناك حاجة إلى دراسة مستقبلية لتقييم العدوى المنقولة عبر الدم (TTI) على نطاق واسع لتعزيز فهمنا لاتجاهات TTI.

Objectives: To ascertain the prevalence of transfusion transmissible infections (TTIs) across diverse donor groups in the Najran province. Additionally, to establish a potential association between the development of TTI and the donors' blood group, as determined by the ABO/Rh blood grouping system.

Methods: Blood donation data of 4120 donors, spanning from January to December 2020, were retrospectively reviewed. The blood were screened for TTI markers, including hepatitis B surface antigen (HBsAg), anti-hepatitis B core (anti-HBc), anti-hepatitis C virus (anti-HCV), anti-human immunodeficiency viruses 1 and 2 (anti-HIV1&2), anti-human T-lymphotropic virus types 1 and 2 (anti-HTLV-1&2), and syphilis antigen.

Results: Positive TTI markers were detected in 10.9% of the donors. The most detected TTI marker was anti-HBc (8.9%), followed by HBsAg (0.7%). Other markers were individually detected in <1% of the donors. Anti-HBc-positive was significantly elevated among non-Saudi blood donors. There was an association between age groups and anti-HCV (p=0.002), anti-HTLV (p=0.004) and syphilis antigen (p=0.02) markers positivity. The AB positive blood group exhibited the most positivity for TTI markers, followed by O positive blood group. Similarly, association was found between ABO group and HBsAg (p=0.01), anti-HBc (p=0.001), and anti-HCV (p<0.001) markers positivity.

Conclusion: Emphasis on implementing robust screening measures for donated blood is underscored by this study. There is the need for future study to extensively evaluate TTI status to enhance our understanding of the trend in TTI.

Keywords: transfusion transmissible infection, TTI, blood donor, blood group, marker, seroprevalence

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From the Department of Clinical Laboratory Sciences (Alshehri, Alshahrani MM, Asiri, Al Awad, Alhasaniah, Almazni, Alshamrani, Elnoubi), College of Applied Medical Sciences, Najran University; from the Health Research Center (Alshehri), Najran University; from the Department of Clinical Laboratory Sciences (Aboluluy), Najran University Hospital, Najran University, Najran; from the Department of Public Health (Alshahrani AJ), General Directorate of Health Affairs in Asir Region, Asir; from the Department of Clinical Laboratory Sciences (Saif, Hakami), College of Applied Medical Sciences, King Khalid University, Abha; from the Department of Pathology and Medical Laboratory - Molecular Genetics (Almohi), University Hospital, King Khalid University, Abha; from the Department of Clinical Laboratory Sciences (Othman), College of Applied Medical Sciences, Shaqra University, Shaqra, Kingdom of Saudi Arabia; from the Department of Medical Microbiology & Parasitology (Irekeola), School of Medical Sciences, Universiti Sains Malaysia, Kelantan, Malaysia; from the Microbiology Unit, Department of Biological Sciences (Irekeola), College of Natural and Applied Sciences, Summit University Offa, Kwara, Nigeria; and from the Cardiovascular Signaling Division (Mohammed Abdul), Huntington Medical Research Institutes, California, United States of America.

Other authors: ***Ahmed Abdullah Al Awadh,*** *MSc, PhD,* ***Abdulaziz Hassan Alhasaniah,*** *MSc, PhD,* ***Ibrahim Abdullah Almazni,*** *MSc, PhD,* ***Saleh A. Alshamrani,*** *MSc, PhD,* ***Abdullah J. Alshahrani,*** *MSc, MPH,* ***Ahmad M. Saif,*** *MSc, PhD,* ***Osman AE. Elnoubi,*** *MSc, PhD,* ***Abdulrahim R. Hakami,*** *MSc, PhD,* ***Abdulrazzag Abdulaziz Othman,*** *BSMLS, MSc,* ***Mansor H. Almohi,*** *BSMLS, MSc.*

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Address correspondence and reprint request to: Dr. Ahmad A. Alshehri, Department of Clinical Laboratory Sciences, College of Applied Medical Sciences, Najran University, Najran, Kingdom of Saudi Arabia. Email: aalshehri@nu.edu.sa | ORCID ID: https://orcid.org/0000-0002-3143-3023

Blood transfusion, being a crucial component of healthcare services saves millions of lives across the globe. It is often used to support complex medical and surgical procedures, such as transplants and cardiovascular surgery in developed nations, whereas in developing nations, it is used in cases of trauma, obstetric emergencies in women, and malnourished and anemic children.[1,2] Hence, scarcity of qualitative safe blood or its components may impede necessary health care services.

Transfusion transmissible infections (TTI) are major public health concerns, particularly in developing countries.[3] Importantly, the frequency of TTI among blood donors varies across different nations of the world, as well as within Saudi Arabia.[4-11] There is a threat of developing life-threatening illnesses, including TTI, due to unsafe blood transfusion. Human immunodeficiency virus (HIV) types 1 and 2, and hepatitis B and C viruses have all been implicated in TTI.[12-16] In clinical practice, the ABO blood grouping is widely used. These blood groups are associated with susceptibility towards a number of chronic diseases and viral infections.[17]

In the Kingdom of Saudi Arabia (KSA), Ministry of Health (MOH) actively oversees donor blood collection and its related services. All donated blood is screened for various immunological markers including anti-HBc, anti-HBsAg, anti-HCV, anti-HIV1&2, anti-HTLV-1&2, HBsAg, the TPHA and malaria antigen test. However, it is not clear whether any of the TTI has specific prevalence among a peculiar group of donors, such as specific age, gender, or nationality within KSA. In fact, only few studies have attempted to address these issues.[2] In addition, it is not clear weather incidences of infection due to transfusion is linked to the recipient's ABO/Rh blood group. However, previous studies suggest that ABO/Rh blood groups may influence the susceptibility of a subject to a specific TTI development.[18] In this study, our aim was to evaluate the occurrence of TTI in various donor groups in Najran province and establish a potential correlation between TTI development and the donors' blood group, basing on the ABO/Rh blood grouping.

Methods. Prior to commencing data collection, ethical approval for this study was obtained from the relevant local authority. The study received approval from the Health Affairs' General Directorate in Najran city (IRB No. 2022-39 E). Past studies related to this work were reviewed after searching well-known publicly available databases such as PubMed and Google Scholar, among others. Further, this study was conducted in agreement with Helsinki declaration.

Archived data of directed blood donations received at King Khalid Hospital (KKH), the main hospital in Najran province of the Kingdom of Saudi Arabia, were retrospectively reviewed and analyzed. The data consists of 4187 blood donations from January 2020 to December 2020. Subjects with missing demographic data (n=67) were excluded from the study. Inclusion criteria for the actual study subjects (n=4120) were age between 17-65 years, weight not less than 50 kg, being in a good health, no infectious diseases record and hemoglobin level above 13 grams/dl for men and 12 grams/dl for women. The criteria were in line with the national guidelines for blood donation. All participants were screened using appropriate screening tests. Demographic characteristics (age, gender, and nationality), ABO/Rh blood group, and serological markers for TTI were extracted from donor databases.

Blood grouping. Blood group tests including ABO and Rh typing were performed in the hospital laboratory utilizing the IH-500 fully automated blood typing system (Bio-Rad Laboratories Inc., headquartered in California, USA). This cutting-edge system conducts in vitro serological analysis to determine blood grouping and detect antibodies in blood samples, leveraging data from gel card images to deliver accurate results.

Blood screening for TTI. Every blood donation underwent screening via enzyme-linked immunosorbent assay test kits obtained from Abbot Laboratories, Chicago, US, for HBsAg, anti-HBc, anti-HCV, anti-HIV1&2 and anti-HTLV-1&2, rapid plasma reagin card (RPR) test kit (Thermo Fisher Scientific, Waltham, US) for syphilis antigen and the Care Start Malaria PF (HRP-2) Ag RDT (Access Bio, Somerset, New Jersey, USA) for malaria. Each test was performed as per the instructions of the manufacturer. All positive samples underwent additional confirmation by the regional laboratory to validate the results further.

Statistical analysis. Demographic and ABO/Rh blood group data were statistically evaluated utilizing the sixth version of Graph Pad Prism (San Diego, California, USA) to determine the relationship of age, nationality, and blood group with TTI. Pearson correlation coefficient test was performed for the association of different age groups with TTI serological markers, while Spearman's rank correlation coefficient

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test was performed for the association of ABO groups with TTI serological markers. Furthermore, tests including Chi-square and ANOVA were done on each of the outcome evaluated by grouping the demographic factors of the donor. A *p*-value of <0.05 was used to indicate significance.

Results. The current research involved 4120 volunteer blood donors from Najran to determine the prevalence of TTI among the subjects, and their correlation with ABO/Rh blood grouping. A total of 4020 subjects were selected for the study while 67 subjects were excluded as there were missing data. All samples were collected between January 2020 to December 2020 (Figure 1).

The majority of subjects were males, representing 98.7% (n=4067), compared to female subjects (1.3%). The subjects were within 70 years old, and virtually all age groups were represented as depicted in Table 1. Saudi citizens constituted 70.9% (n=2922) of subjects while non-Saudi citizens constituted 29.1% (n=1198). A total of 449 (10.9%) samples had a positive TTI markers. The anti-HBc is recorded as the highest serological marker (8.9%). This was followed by HBsAg (0.7%) and other serological markers which were all individually found to be less than 1% of the entire subjects. A co-infection pattern was observed among 12 subjects as shown in Table 1. The anti-HBc was found to be the dominant marker among the subjects with co-infection. Further, the distribution of ABO/Rh blood types among the subjects revealed that O positive (+ve) was the most dominant blood group (50%) followed by A+ve (26.8%), B+ve (9.9%), and O negative (-ve) 6.5%.

The association between different age groups and TTI markers positivity was analyzed using Pearson correlation coefficient test. Unlike anti-HBc, anti-HIV I/II p24 and HBsAg, the statistical analysis showed a significant association between anti-HCV, anti-HTLV and RPR with age group. The association between ABO group and TTI markers positivity is also represented in Table 2.

The correlation between age and serological markers of TTI was analyzed and showed a significant increase in anti-HBc with age (Figure 2A). The anti-HCV serological marker showed a significant result in 51-60 years age group as compared to 21-30 years (Figure 2B). Although a higher positivity rate was recorded in the age group 51-60 years, there was no significant difference in anti-HIV-I/II p24, anti-HTLV-I/II and RPR serological markers.

Transfusion transmissible infections test positivity was significantly associated with nationality for anti-HBc, with non-Saudi subjects significantly higher than Saudi subjects. The data of HBsAg, anti-HIV-I/II, anti-HTLV-I/II and RPR revealed that Saudi and non-Saudi subjects have fairly similar positivity rate (Figure 3).

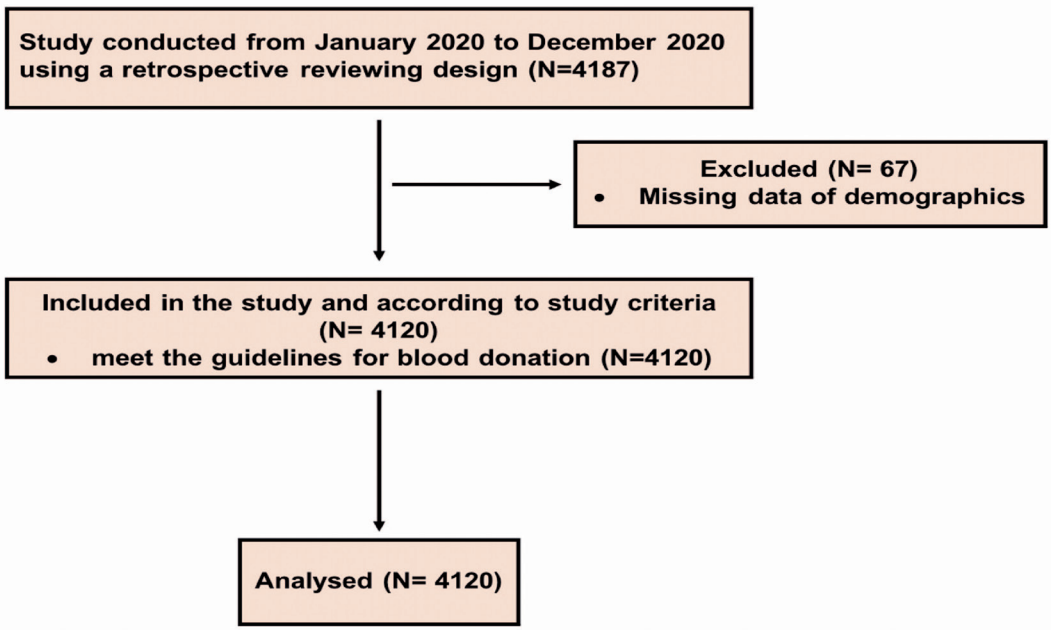

Figure 1 - A flowchart showing the study design with participant selection criteria.

Table 1 - Characteristics of subjects within this study.

Demographic characteristics of subjects		
Demographic characteristics	**n**	**(%)**
Age		
≤ 20 years old	249	6.0
21-30 years old	1663	40.3
31-40 years old	1418	34.4
41-50years old	613	14.8
51-60 years old	166	4.0
61-70 years old	11	0.3
Gender		
Male	4067	98.7
Female	53	1.3
Nationality		
Saudi	2922	70.9
Non-Saudi	1198	29.1
Total	n= 4120	100 %
Prevalence of serological markers of TTI among study subjects		
Serological Marker		
HBsAg	29	0.70
Anti-HBc	366	8.88
Anti-HCV	23	0.56
Anti-HIV-I/II p24	4	0.10
Anti-HTLV-I/II	16	0.39
RPR	11	0.27
Prevalence of multiple markers of TTI among seropositive samples		
Co-infection pattern		
Anti-HBc + Anti-HCV	3	0.07
Anti-HBc + Anti-HTLV-I/II	3	0.07
Anti-HBc + RPR	5	0.12
Anti-HCV + Anti-HIV-I/II p24	1	0.02

Positivity rate of all conventional TTI markers with respectiveABO/Rh blood groups*		
ABO/Rh		Seropositive samples, n (%)
AB+	107 (2.6)	18 (16.8)
A+	1105 (26.8)	122 (11.0)
B+	409 (9.9)	39 (9.5)
O+	2063 (50.1)	239 (11.6)
AB-	10 (0.2)	1 (10.0)
A-	120 (2.9)	12 (10.0)
B-	37 (0.9)	1 (2.7)
O-	269 (6.5)	16 (5.9)
Total	4120 (100)	448 (10.9)

*One sample positive for a TTI marker (anti-HTLV-I/II) did not have the blood group record and was thus excluded from the analysis of TTI markers based on blood groups. TTI: transfusion transmissible infection, HBsAg: hepatitis B surface antigen, Anti-HBc: anti-hepatitis B core, Anti-HCV: anti-hepatitis C virus, Anti-HIV-I/II: anti-human immunodeficiency viruses 1 and 2, Anti-HTLV-I/II: anti-human T-lymphotropic viruses types 1 and 2, RPR rapid plasma reagin test for syphilis antigen.

Table 2 - Association between transfusion transmissible infections (TTIs) markers positivity and different age and ABO groups.

TTI markers	P-value
Association with age groups	
HBsAg	0.19
Anti-HBc	0.34
Anti-HCV	0.002
Anti-HIV	0.40
Anti-HTLV	0.004
RPR	0.02
Association with ABO group	
HBsAg	0.01
Anti-HBc	0.001
Anti-HCV	<0.001
Anti-HIV	0.15
Anti-HTLV	0.09
RPR	0.06

HBsAg: hepatitis B surface antigen, Anti-HBc: Anti-hepatitis B core, Anti-HCV: Anti-hepatitis C virus, Anti-HIV: anti-human immunodeficiency virus, Anti-HTLV: anti-human T-lymphotropic virus, RPR: rapid plasma reagin test for syphilis antigen

The TTI serological tests for anti-HBc among blood grouping showed a significant association between AB+ve and O-ve, as well as between O+ve and O-ve. A-ve blood group demonstrated high positivity towards the anti-HCV test. The O-ve blood group showed a significant rise in anti-HIV-I/II p24 serological marker compared to O+ve blood group. In the anti-HTLV-I/II serological test data, the A-ve and AB+ve blood groups showed the highest positivity among other blood groups. The O+ blood group had the highest positivity in PRP serological marker test (Figure 4).

Discussion. The identification of TTI antibodies in donor blood is crucial for ensuring the integrity and safety of the blood supply. It protects both donors and recipients by preventing the transmission of infectious agents during blood transfusions and other medical procedures. These have made rigorous screening protocols and compliance with regulatory standards essential components of blood safety programs worldwide. Thus, our study aims to estimate the occurrence of TTI markers among donors and their correlation with ABO/Rh blood grouping.

The donors in this study were found to be predominantly male (98.7%). This disparity in gender composition was not surprising as women tend to have higher deferral rates. Moreover, the finding is comparable to other previous reports where majority of donors were males.[15,19] Few studies on TTI seroprevalence among blood donors in Saudi Arabia was conducted previously.[15] The study conducted by Alshahrani et al[19] in Abha, revealed that the overall prevalence of TTI serological markers was 11%, which is similar to the finding in our study (10.9%). However, our finding is higher than the overall prevalence rate reported in Qatar (2.7%), as well as in Riyadh, Saudi Arabia (0.7%).[4,20] These results highlight the need for

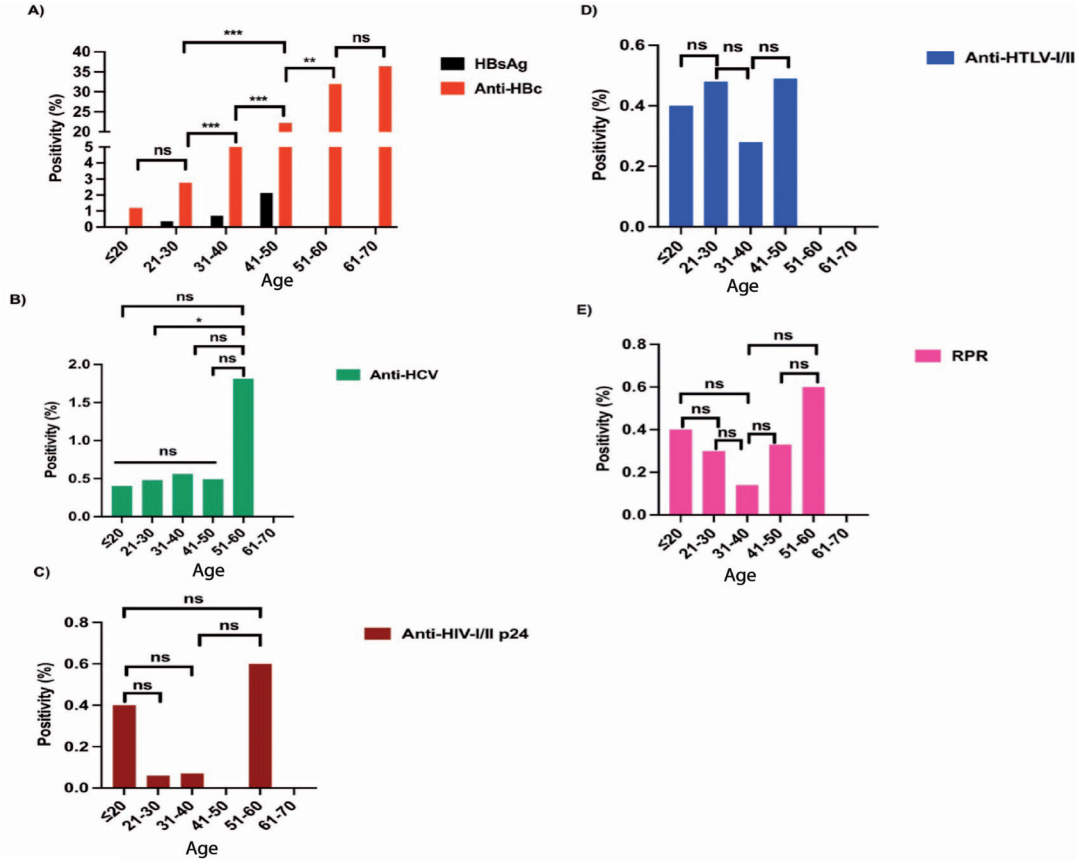

Figure 2 - Age groups versus markers of transfusion transmissible infections (TTI) from positive subjects. Comparison of different age groups yielded different statistical results for (**A**) Anti-hepatitis B core (anti-HBc): ≤20 versus 21-30 (p=0.14), 21-30 versus 31-40 (p<0.001), 31-40 versus 41-50 (p<0.001), 41-50 versus 51-60 (p<0.009), 51-60 versus 61-70 (p=0.76), 21-30 versus 41-50 (p<0.001) (**B**) Anti-hepatitis C virus (anti-HCV): ≤20 versus 21-30 (p=0.86), 21-30 versus 31-40 (p=0.92), 31-40 versus 41-50 (p=0.83), 41-50 versus 51-60 (p=0.08), 31-40 versus 51-60 (p=0.06), 21-30 versus 51-60 (p=0.03), ≤20 versus 51-60 (p=0.15) (**C**) Anti-human immunodeficiency viruses 1 and 2 (Anti-HIV-I/II p24): ≤20 versus 21-30 (p=0.12), ≤20versus 31-40 (p=0.16), 31-40 versus 51-60 (p=0.16), ≤20 versus 51-60 (p=0.77) (**D**) Anti-human T-lymphotropic virus types 1 and 2 (Anti-HTLV-I/II): ≤20 versus 21-30 (p=0.86), 21-30 versus 31-40 (p=0.45), 31-40 versus 41-50 (p=0.46) and (**E**) Rapid plasma reagin (RPR): ≤20 versus 21-30 (p=0.79), ≤20 versus 31-40 (p=0.37), 41-50 versus 51-60 (p=0.61), 31-40 versus 51-60 (p=0.19).

further awareness campaigns, especially in regions with higher prevalence rate of TTI.

In line with the study of Alshahrani et al[19] who identified anti-HBc as dominant among other serological markers, the serological marker was the most dominant in our study with the highest rate of 8.9%. However, this rate is higher than that previously reported in Abha (5.9%) and the Eastern region of Saudi Arabia (2.9%).[19] Additionally, lower rates have been reported in Croatia (1.3%) and Lebanon (7.7%). were reported.[21,22] Variable rates of anti-HBc among blood donors have been reported in other parts of the world including much higher rates of 41% in Lao and 48.5% in Nigeria.[23,24] Additionally, we found a significantly higher rates of anti-HBc positivity among the non-Saudi donors compared to the Saudis in this present study. The observation was, however, not startling, as anti-HBc positivity rates that hovers around 10% have been documented among some blood donor groups in neighboring Yemen which shares border with Saudi Arabia.[25,26] Indeed, approximately 64% of donors with anti-HBc positivity in this study were Yemenis (data not shown). Anti-HBc serves as a valuable indicator of exposure to HBV, regardless of the individual's current infectious status. This is particularly significant at the end of a resolving infection when HBsAg and HBV nucleic acid testing might not yield positive results.[27] Notably, our study also demonstrates that anti-HBc positivity increased with age.

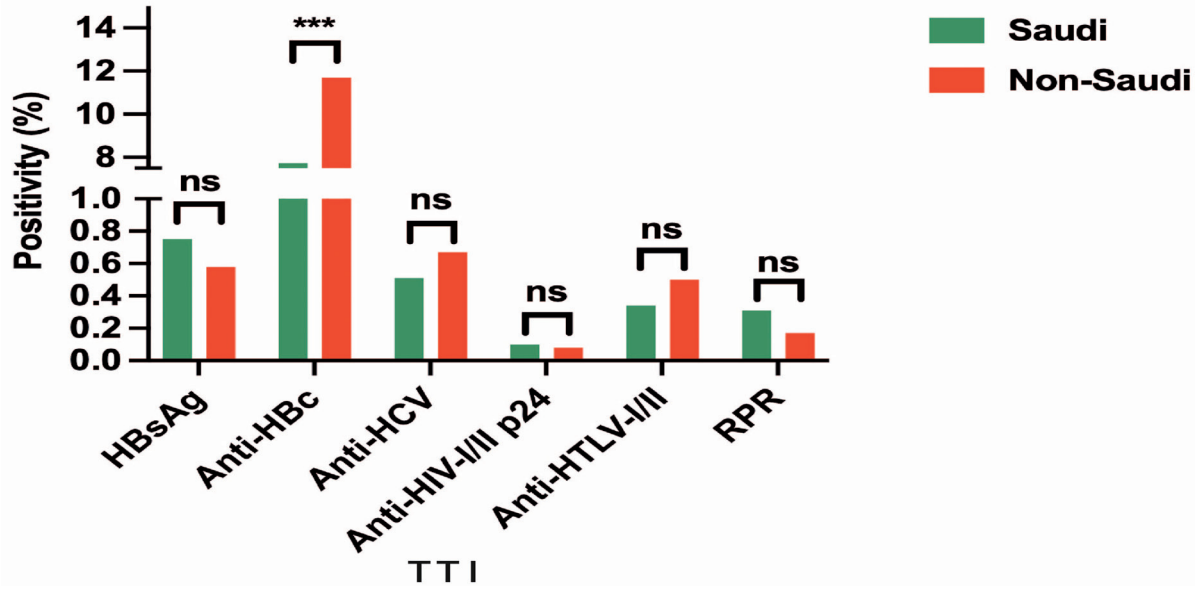

Figure 3 - Nationality versus serological markers of transfusion transmissible infections (TTI) from positive subjects. Comparison of Saudi and non-Saudi participants yielded different statistical results for hepatitis B surface antigen (HBsAg) (p>0.05), anti-hepatitis B core (anti-HBc) (p<0.001), anti-hepatitis C virus (anti-HCV) (p>0.05), Anti-human immunodeficiency viruses 1 and 2 (Anti-HIV-I/II p24) (p>0.05), Anti-human T-lymphotropic virus types 1 and 2 (anti-HTLV-I/II) (p>0.05), and rapid plasma reagin (PRP) (p>0.05).

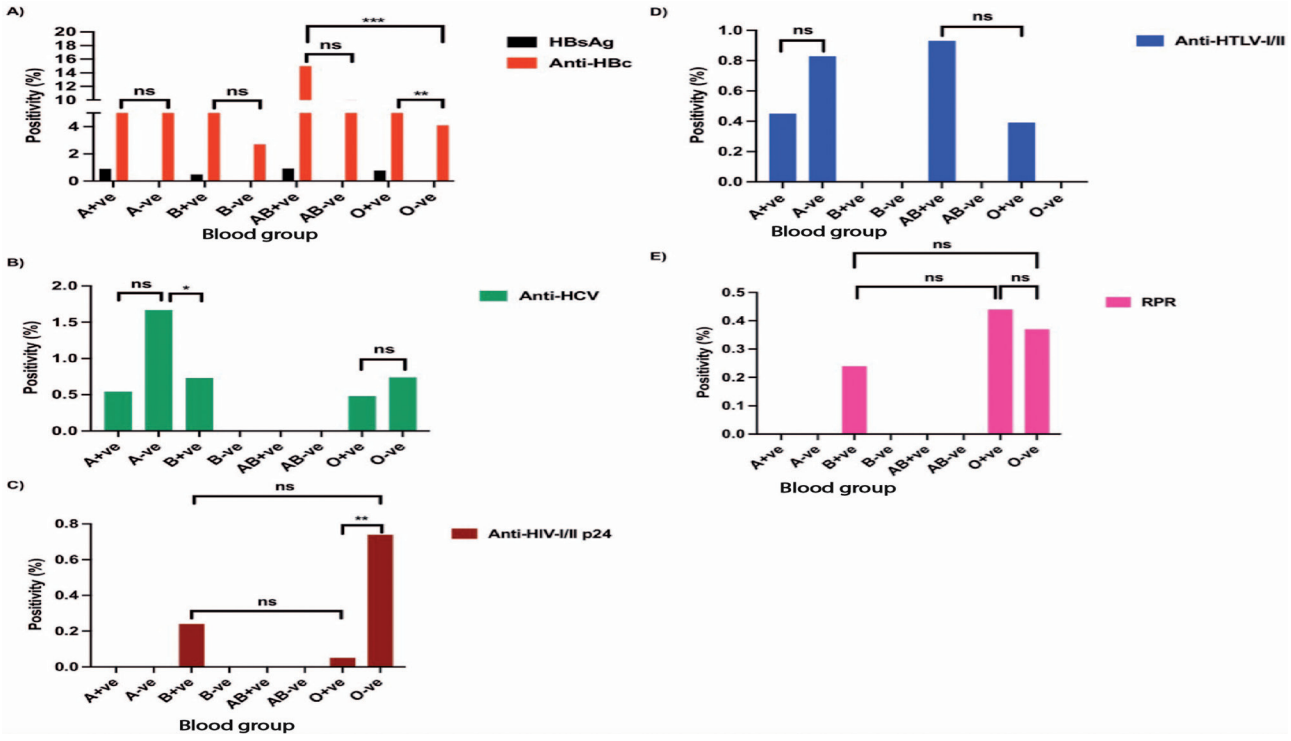

Figure 4 - All blood groups versus serological markers of transfusion transmissible infections (TTI) from positive subjects. Comparison of different blood groups yielded different statistical results for (**A**) anti-hepatitis B core (anti-HBc): A+ve versus A-ve (p=0.55), B+ve versus B-ve (p=0.25), AB+ve versus AB-ve (p=0.67), O+ve versus O-ve (p<0.004) (**B**) Anti-hepatitis C virus (Anti-HCV): A+ve versus A-ve (p=0.14), A-ve versus B+ve (p=0.01), O+ve versus O-ve (p=0.57) (C) Anti-human immunodeficiency viruses 1 and 2 (Anti-HIV-I/II p24): B+ve versus O+ve (p=0.20), O+ve versus O-ve (p=0.003), B+ve versus O-ve (p>0.05) (**D**) Anti-human T-lymphotropic virus types 1 and 2 (Anti-HTLV-I/II): A+ve versus A-ve (p=0.57), AB+ versus O+ve (p=0.39) and (**E**) Rapid plasma reagin (PRP): B+ve versus O+ve (p=0.57), and O+ve versus O-ve (p=0.87).

Unlike anti-HBc, we observed a low prevalence of anti-HBsAg (0.7%) among the donors. This rate is lower than the 5.8% reported in Asir, but comparable to the 1.1% in Makkah 29 and 0.3% in Eastern Saudi Arabia.[28,30] Our finding is, however, not surprising as the prevalence of HBV chronic disease in Saudi Arabia is estimated at <2%, making the country a low-risk area for international travellers.[31] The other serological markers assessed in this study were found in less than 1% of the study population, suggesting the relative safety of the donated blood. Although possible cases of co-infection were identified, the cases represented an infinitesimal fraction of the donors assessed in this study. Overall, although not accounted for in this study, the differences in the reported TTI markers occurrence could be attributed to the study participant's economic status and lifestyle.

In our study, donors with blood group O were the most dominant, accounting for more than 50% of the donors. This is not surprising as blood group O is considered the most common blood type among people.[18,32] Moreover, in a previous report in Saudi Arabia, about 47% of blood donors were identified as O+ve.[15] In a study conducted in India, the highest TTI sero-reactivity was found in blood group B+ve blood donors (1.8%) followed by O+ve (1.54%).[33] Another study similarly reported the highest sero-reactivity for TTIs among donors with blood group B (2.2%) and blood group A (2.2%).[34] In contrast, our study detected the highest TTI sero-reactivity among AB+ve blood group donors, followed by those with O+ve blood group.

We further assessed the potential association of the donors' blood groups and TTI positivity given that the ABO blood group has been associated with certain infectious diseases in the past. For example, a meta-analysis study found an association between blood groups and infection with SARS-CoV-2. It was hypothesized that blood group A has the highest risk, whereas the lowest risk is associated with the O blood group.[35] However, a recent retrospective study in Ethiopia investigating TTI prevalence among 27027 blood donors did not find any significant association between the donors' ABO/Rh blood group and the TTI markers tested (HIV, HBV, HCV, and syphilis).[32] Interestingly, our study found an association between ABO blood group and HBsAg, anti-HBc, and anti-HCV positivity. While these associations were observed in Najran, it is crucial to evaluate the phenomena in donors from other regions of Saudi Arabia.

Study limitations. Although expected, the number of female donors were low. This hindered us from performing an extensive gender-based analysis. Further, the study is a single-center study even though it was conducted at the main hospital in Najran province. Inclusion of donors from multiple locations within Najran may provide a broader overview of the status of TTI among blood donors in Najran province.

In conclusion, TTI antibody screening plays a central role in maintaining the safety and integrity of the blood supply. It is a critical practice that helps check infectious diseases transmission, protect recipients' health, and ensure the overall safety of blood transfusions and related medical interventions. This study investigated several TTI markers among blood donors in Najran, Saudi Arabia, and found an overall TTI rate of 10.9%, with anti-HBc being the most dominant. The findings from this study underscore the need for effective and robust screening of donor blood.

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References

1. Muleta MB, Yisak EH, Gebreselassie HA, Tefera T, Berhanu E, Mekonnen AL, et al. A cross-sectional study to analyze blood and blood component transfusion practice at tertiary care hospital of Ethiopia. *Clinical Audit* 2021; 13: 29-35.
2. Kolin DA, Shakur-Still H, Bello A, Chaudhri R, Bates I, Roberts I. Risk factors for blood transfusion in traumatic and postpartum hemorrhage patients: Analysis of the CRASH-2 and WOMAN trials. *PLoS One* 2020; 15: e0233274.
3. World Health Organization. Global progress report on HIV, viral hepatitis and sexually transmitted infections, 2021 [Internet]. 2021 [cited 2024 Jan 10]. Available from: https://www.who.int/publications/i/item/9789240027077
4. Aabdien M, Selim N, Himatt S, Hmissi S, Merenkov Z, AlKubaisi N, et al. Prevalence and trends of transfusion transmissible infections among blood donors in the State of Qatar, 2013-2017. *BMC Infect Dis* 2020; 20: 617.
5. Mohammed BAB, Badneen MA, Gibreel MO, Othman SA. Prevalence of transfusion-transmissible infections among blood donors in Port Sudan. *Egypt J Haematol* 2019; 44: 72-76.
6. Ghazanfar S, Hassan S, Shahid Z, Khan MS, Malik AR, Bhutta HS, et al. Frequency of transfusion transmissible infections among blood donors of Rawalpindi District, Pakistan. *Afr Health Sci* 2022; 22: 590-598.
7. Singogo E, Chagomerana M, Van Ryn C, M'bwana R, Likaka A, M'baya B, et al. Prevalence and incidence of transfusion-transmissible infections among blood donors in Malawi: A population-level study. *Transfus Med* 2023; 33: 483–496.
8. Pessoni LL, Aquino ÉC de, Alcântara KC de. Prevalence and trends in transfusion-transmissible infections among blood donors in Brazil from 2010 to 2016. *Hematol Transfus Cell Ther* 2019; 41: 310–315.

9. Cheema S, Rana V, Kulhari K, Yadav A, Sachdeva A. Prevalence of transfusion transmissible infections and associated factors among healthy blood donors in North Indian population–4-Year experience of licensed blood bank at tertiary care hospital. *J Mar Med Soc* 2022; 24: S47-S52.
10. Aliyo A, Ashenafi G, Adem S. Evaluation of transfusion transmissible infections prevalence and trend among blood donors attended at Bule Hora Blood Bank, West Guji, South Ethiopia. *Health Serv Res Manag Epidemiol* 2022; 9: 23333928221136716.
11. Alharazi T, Alzubiery TK, Alcantara JC, Qanash H, Bazaid AS, Altayar MA, et al. Prevalence of transfusion-transmitted infections (HCV, HIV, Syphilis and Malaria) in blood donors: a large-scale cross-sectional study. *Pathogens* 2022; 11: 726.
12. Alabdulmonem W, Shariq A, Alqossayir F, AbaAlkhail FM, Al-Musallam AY, Alzaaqi FO, et al. Sero-prevalence ABO and Rh blood groups and their associated transfusion-transmissible infections among blood donors in the central region of Saudi Arabia. *J Infect Public Health* 2020;13: 299–305.
13. Alqahtani SM, A Alsagaby S, Mir SA, Alaidarous M, Bin Dukhyil A, Alshehri B, et al. Seroprevalence of Viral Hepatitis B and C among Blood Donors in the Northern Region of Riyadh Province, Saudi Arabia. *Healthcare (Basel)* 2021; 9: 934.
14. Altayar MA, Jalal MM, Kabrah A, Qashqari FSI, Jalal NA, Faidah H, et al. Prevalence and association of transfusion transmitted infections with ABO and Rh blood groups among blood donors in the western region of Saudi Arabia: A 7-year retrospective analysis. *Medicina (Kaunas)* 2022; 58: 857.
15. Alshehri OM, Nahari MH, Hassan EE, Alqahtani MF, Awaji TH. Prevalence of ABO, Rh and KELL Blood Group Types and Transfusion- Transmissible Infections (TTI) among Blood Donors in Najran City, Saudi Arabia. *Biomed Pharmacol J* 2021; 14.
16. Zhao J, Zhao F, Han W, Xu X, Wang L, Li R, et al. HTLV screening of blood donors using chemiluminescence immunoassay in three major provincial blood centers of China. *BMC Infect Dis* 2020; 20: 581.
17. Abegaz SB. Human ABO blood groups and their associations with different diseases. *Biomed Res Int* 2021; 2021: 1–9.
18. Legese B, Shiferaw M, Tamir W, Eyayu T, Damtie S, Berhan A, et al. Association of ABO and rhesus blood types with transfusion-transmitted infections (TTIS) among apparently healthy blood donors at bahir Dar blood bank, bahir Dar, North West, Ethiopia: a retrospective cross-sectional study. *J Blood Med* 2022; 581-587.
19. Alshahrani MY, Alamri AM, Alshahrani AS, Alshehri AA, Alsulaiman AS, Alshahrani AJ, et al. Prevalence of selected blood-borne infectious diseases among voluntary blood donors in abha, Saudi Arabia. *Southeast Asian J Trop Med* 2021; 52: 274-285.
20. AL Majid F. Prevalence of transfusion-transmissible infections among blood donors in Riyadh: A tertiary care hospital-based experience. *J Nat Sci Med* 2020; 3: 247-251.
21. Miletić M, Bingulac-Popović J, Stojić Vidović M, Hećimović A, Berendika M, Babić I, et al. Anti-HBc prevalence among Croatian blood donors in a 14-year period (2004–2017): Assessment of trends, risks and need for implementing routine testing. *Transfus Clin Biol* 2019; 26: 257-262.
22. Amani A, Marwa H, Batoul A, Batoul D, Mahmoud H. Prevalence of Anti HBC antibodies in blood donors from different centers in Lebanon. *J Gastroenterol Hepatol* 2021; 2: 1-8.
23. Nouanthong P, Hefele L, Keokhamphue J, Sorrasin V, Khounvisith V, Souksakhone C, et al. Analyses of blood donor samples from eight provinces in Lao PDR suggest considerable variation concerning HBV exposure and carriage. *PLoS One* 2021; 16: e0259814.
24. Fasola FA, Fowotade AA, Faneye AO, Adeleke A. Prevalence of hepatitis B virus core antibodies among blood donors in Nigeria: Implications for blood safety. *Afr J Lab Med* 2022; 11: 1434.
25. Al-khulidi JMS, Al-Taj MA, Abdullah AA. Detection of hepatitis B virus by HBsAg and total HBc antibody among blood donors at National Blood Transfusion and Research Center in Taiz City, Yemen. *Al-Saeed University Journal of Applied Sciences* 2023; 6: 66-81.
26. Alzubiery TKA, Alhazari T, Alcantara JC, Majed SA, Bazaid AS, Aldarhami A. Updated seroprevalence of hepatitis B surface antigen and anti-hepatitis core antibody among blood donors in Yemen. *Infect Drug Resist* 2022; 15: 2787-2796.
27. Conners EE, Panagiotakopoulos L, Hofmeister MG, Spradling PR, Hagan LM, Harris AM, et al. Screening and testing for hepatitis B virus infection: CDC recommendations - United States, 2023. *MMWR Recomm Rep* 2023; 72: 1-25.
28. Shaikh AA, Alqasem HM, Alshubruqi YA, Alasmari SZ, Makkawi MH. Association of ABO, Rh-D and Kell blood groups with transfusion transmitted infections among blood donors from the Asir Region, Saudi Arabia: A retrospective observational study. *Saudi Med J* 2024; 45: 414-423.
29. Kabrah SM, Alandijany TA, Felimban RI, Alserihi RF, Theyab A, Ebid GT. The prevalence of transfusion-transmitted infection markers among blood donors at Saudi Hospital, Makkah. *Clin Lab* 2023; 69 (2).
30. Alzahrani FM, Shaikh SS, Alomar AI, Acharya S, Elhadi N. Prevalence of Hepatitis B Virus (HBV) among blood donors in Eastern Saudi Arabia: results from a five-year retrospective study of HBV seromarkers. *Ann Lab Med* 2019; 39: 81-85.
31. CDC. Hepatitis B: CDC Yellow Book 2024. [updated 2023 May 01; cited 2023 Jan 13]. Available from: https://wwwnc.cdc.gov/travel/yellowbook/2024/infections-diseases/hepatitis-b#5514
32. National Health Service. Blood groups [Internet]. [updated 2023 May 10; cited 2024 Jan 12]. Available from: https://www.nhs.uk/conditions/blood-groups/
33. Arif SH, Alam K, Saeed N, Shams A, Hassan MJ. Association of ABO and Rh blood group with transfusion transmitted infections (TTI) among blood donors in north India. *Indian J Pathol Oncol* 2021; 8: 271-275.
34. Prakash S, Sahoo D, Mishra D, Routray S, Ray GK, Das PK, et al. Association of transfusion transmitted infections with ABO and Rh D blood group system in healthy blood donors: a retrospective analysis. *Int J Community Med Public Heal* 2020; 7: 4444-4448.
35. Banchelli F, Negro P, Guido M, D'Amico R, Fittipaldo VA, Grima P, et al. The role of ABO blood type in patients with SARS-CoV-2 infection: A systematic review. *J Clin Med* 2022; 11: 3029.