Clin. Lab. 2026;72:XXX-XXX

REVIEW ARTICLE

An Overview of Transfusion-Transmitted Infectious Agents among Blood Donors in Saudi Arabia

Hassan A. Hamali

Department of Medical Laboratory Technology, College of Nursing and Health Sciences, Jazan University, Jazan, Saudi Arabia

SUMMARY

***Background*: The safety of donated blood during transfusion is important; however, blood donation can entail risks owing to contamination of the blood with transfusion-transmitted infections (TTIs). Ensuring the safety of blood and blood components is a major global goal to guarantee their availability to patients. Unsafe blood not only affects the patients but also extends the risk to their partners, contributing to the spread of TTIs and posing a burden on society. This review emphasizes the trends and prevalence of TTIs among blood donors in Saudi Arabia over the years.**

***Methods*: A systemic search of the main electronic databases were conducted for publications on TTIs among blood donors in Saudi Arabia.**

***Results*: The overall prevalence of TTIs among blood donors varies from province to province with a higher incidence observed among older individuals. Despite an overall decline in TTIs among blood donors in the country, the frequency of these infections persists among donors. In addition, screening tests for occult HBV should be considered.**

***Conclusions*: The overall findings regarding TTIs in Saudi Arabia vary by province, with a higher incidence observed among older individuals. Comprehensive investigations into the overall incidence of TTIs in Saudi Arabia are warranted, with extensive studies from different regions and blood donation centers.**

(Clin. Lab. 2026;72:xx-xx. DOI: 10.7754/Clin.Lab.2025.250722)

Correspondence:
Hassan A. Hamali, PhD
Department of Medical Laboratory Technology
Faculty of Nursing and Health Sciences
Jazan University
P.O. Box 1906
Gizan 45142
Saudi Arabia
Phone: +966 173295000
Email: hhamali@jazanu.edu.sa

KEYWORDS

transfusion-transmitted infections, blood donors, HIV, HBV, HCV, Saudi Arabia

INTRODUCTION

Infectious agents represent a significant global health burden, resulting in 2.3 million deaths each year [1]. The prevalence of transfusion-transmitted infections (TTIs) among blood donors is a major health and economic concern in transfusion medicine, as these infectious agents can be transmitted through blood transfusions. TTIs, including hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV), are ranked among the leading causes of death worldwide [2,3]. Viral hepatitis alone is a major cause of morbidity and mortality globally [2]. An estimated 2 billion people are infected with HBV, 25.7 million with

Review Article accepted July 14, 2025

HCV, and 35.3 million with HIV worldwide [4].

The most common TTI agents screened in donated blood include HBV, HCV, HIV, anti-human T Lymphotropic Virus I/II antibodies (HTLV I/II), Treponema pallidum (syphilis) [5,6], and Plasmodium species (malaria) [7]. In some areas, screening protocols extend to other blood-borne viruses, including cytomegalovirus and emerging viruses such as West Nile. Despite measures taken to screen donated blood for TTIs, transmission to patients still occurs [5]. Therefore, various safety measures have been implemented to ensure that transfused blood is safe and poses a low risk of causing TTIs. These measures include checking clinical history and gathering personal information regarding sexual activity and travel to endemic areas [1]. Strict donor screening protocols are essential for the safety of transfused blood and blood components for patients [6]. Current screening protocols utilize a combination of sensitive, conventional serological methods and molecular techniques to detect TTIs, even in the early stages (during the early antigen period) and among asymptomatic individuals [6,8]. The most commonly used serological markers for TTIs are related to viral infections. A combination of serological markers and molecular techniques (nucleic acid testing [NAT]) is widely employed for detection of HBV, HCV, and HIV. The serological markers for HBV include hepatitis B surface antigen (HBsAg), anti-hepatitis B surface antibodies (anti-HBs), and anti-hepatitis B core antibodies (anti-HBc), while the NAT marker is HBV DNA. The serological marker for HCV is anti-hepatitis C virus (anti-HCV), and for NAT, the marker is HCV-RNA. The serological marker for HIV is anti-HIV antibodies (anti-HIV), with HIV-RNA as the NAT marker. Serological markers are also used for HTLV I/II, syphilis, and malaria [6].

Saudi Arabia is considered an endemic area for HBV infection [9,10], with recent prevalence estimated at around 1.3% [11], while HCV prevalence is estimated at 1.1% [12]. A previous report estimated the prevalence of HBV infection to be 16.7% in Saudi Arabia in 1989 [13]. HBV and HCV are significant health burdens that require immediate intervention and public health strategies to control the spread of these infections [10-12]. In contrast to them, the incidence of HIV is estimated to be 3 per 100,000 in Saudi Arabia [14]. Alswaidi and O'Brien (2010) reported the prevalence of HBV to be 1.31%, HCV 0.33%, and HIV 0.03% in a study involving 74,662 individuals who underwent premarital screening in Saudi Arabia [15]. The incidence of TTIs among blood donors is also a major health concern owing to the deleterious effects of these viral infections, such as liver cirrhosis and hepatic carcinoma. Given that Saudi Arabia is a large country with a high population of both citizens and expatriates, epidemiological studies on the exact prevalence and percentage of TTIs among blood donors will provide a better understanding of the situation. This information can help establish national strategies and initiatives to eliminate blood-borne viruses, thereby reducing the risk of TTIs and ensuring the transfusion of safe, risk-free blood. Blood safety and availability are crucial for effective healthcare systems. According to WHO estimates, around 118.5 million blood units are donated annually worldwide [16], with approximately 325,847 whole blood units collected in Saudi Arabia per calendar year [17]. Furthermore, the Saudi Arabian vision 2024 is to improve the healthcare system [18]. Therefore, this review aims to provide a comprehensive overview of the frequency and patterns of TTI agents, including HBV, HCV, and HIV, among blood donors across all 13 provinces of Saudi Arabia.

MATERIALS AND METHODS

A systematic electronic search was conducted for published reports on TTIs among blood donors in Saudi Arabia using major databases, including PubMed/PubMed Central, Web of Science, Science Direct, DOAJ, EBSCO, Scopus, and Google Scholar. The search keywords included HBV, HCV, HIV, TTIs, prevalence, incidence, seroprevalence, blood donors, and Saudi Arabia, either alone or in combination. Reports on the incidence of TTIs among the general population or patients from hospitals were excluded from this review.

Incidence of TTIs among blood donors worldwide

The seroprevalence of TTIs in China among 66,311 blood donors from 2005 to 2010 was 0.87% for HBV, 0.86% for HCV, and 0.31% for HIV [19]. In Iraq, the seroprevalence among 69,915 blood donors was 2.3% for HBV and 0.1% for HCV [20]. In the Gulf countries (Saudi Arabia, United Arab Emirates, Bahrain, Qatar, Kuwait, and Oman), the incidence of TTIs, including HBV, has been declining over the years [21].

Incidence of TTIs among blood donors in Saudi Arabia

The frequency and pattern of TTIs among blood donors vary by province in Saudi Arabia [22-29], although a decline in rates has been reported over the years [26, 30]. In 2003, a nationwide study reported the incidence of HCV among 557,813 blood donors from 1998 to 2002 at 1.1% [22], with the Eastern region showing the highest incidence of HCV [22]. In 2022, another nationwide study involving 375,218 blood donors indicated an overall positivity rate of 8.7% for TTIs [31]. Furthermore, this study reported a prevalence of TTIs among blood donors at 2,256 per 100,000 [31]. The serological markers indicated that out of the 8.7% (32,785), the majority were for HBV, including 10.4% for HBsAg, 52.5% for HBcAb, and 22.8% for HBV NAT. Additionally, the seroprevalence of HCV-Ab was 4.6%. The study further revealed that the highest incidence of TTIs was around 4.3% in the central regions, followed by approximately 3% in the southern regions, with other regions showing rates of 1.1% to 1.3% [31].

Incidence of TTIs among blood donors in Riyadh province

In 1998, the prevalence of HBV and HCV among 15,006 blood donors in Riyadh city from 1992 to 1995 was reported as 4% for HBsAg and 1% for anti-HCV [32]. In 2004, the seroprevalence of 24,173 blood donors in Riyadh city from January 2000 to December 2002 showed a prevalence of 1.5% for HBsAg, 0.4% for anti-HCV, and no detection of HTLV I/II or HIV [24]. In 2016, the prevalence of TTIs among 8,501 blood donors at King Khalid University Hospital in Riyadh from January 2011 to January 2012 was 0.7% for HBV, with occult HBV at 0.2% [33].

In 2018, the prevalence of TTIs among 3,014 donors who donated to the blood bank of King Khalid University Hospital was 0.03% for HBsAg, 8.8% for anti-HBc, and 0.23% for both HBsAg and anti-HBc [34]. In 2020, the positive reactivity of TTIs among 4,590 blood donors was 1.0% for HBV, HCV, and other TTIs, but negative for HIV [25]. Another study in 2020 reported a 0.7% prevalence of TTIs among 38,621 blood donors who donated blood from January 2016 to December 2018 at King Khalid University Hospital [35]. The prevalence of HBsAg was 0.29%, anti-HBc was 4%, HCV was 0.3%, and HIV was 0.005% [35]. In 2021, a study of 3,733 young adult blood donors from January 2019 to December 2020 showed that 0.19% tested positive for HBsAg, 5.44% for anti-HBs, 6.96% for anti-Bc, and 0.27% for HBV NAT. Additionally, 0.32% and 0.027% were positive for anti-HCV and HCV NAT, respectively [36]. A recent study (2023) in Riyadh reported that out of 58,898 blood donors, 0.6% were positive for HBsAg, 9.0% for anti-HBc, 0.9% for HCV, 0.4% for HIV, 0.4% for HTLV, 0.6% for syphilis, and 0.1% for malaria [37]. NAT showed that 0.6% tested positive for HBV-DNA, HCV-RNA, and HIV-RNA [37].

In 2018, the seroprevalence of TTIs among 3,028 blood donors over two years in Majmaah (city and governorate) in Riyadh province reported an incidence of HBsAg at 0.33%, anti-HBc at 9.81%, anti-HBs at 7.81%, HCV at 0.4%, HIV at 0.2%, HTLV at 0.20%, syphilis at 0.53%, and no detection of malaria [23]. The NAT results were 0.46% for HBV, 0.66% for HCV, and 0.07% for HIV [23]. In Al-Quwayiyah, another city in Riyadh province, the incidence of HBV and HCV among 2,400 blood donors from Al-Quwayiyah General Hospital was reported at 2.12% and 2.37%, respectively [38].

Incidence of TTIs among blood donors in the Eastern Province

The prevalence of HBV and HCV among 95,539 blood donors at King Fahad Hospital, Al-Hofuf, Al-Hasa, from 1987 to 1999 was 3.27% and 0.98%, respectively [39]. In 2004, the seroprevalence of TTIs among 13,443 blood donors from 1998 to 2001 was 2.3% for HBsAg, 15.8% for anti-HBc, 1.4% for anti-HCV, 0.06% for HTLV I/II, and no samples were reactive for malaria or HIV 1/2 [26]. The prevalence of HBsAg, anti-HBc, or anti-HBs and anti-HBc among 26,606 blood donors at King Fahad Hospital from 2000 to 2003 was 1.9% (514), 3.2% (853), and 10.1%, respectively [40]. In 2011, the incidence of anti-HBc and HCV was 9.15% and 0.83%, respectively, in Dammam [41]. In 2015, the prevalence of TTIs among 7,620 blood donors at King Fahad Hospital, Al-Hofuf, from August 2009 to July 2010 showed 0.67% for HBsAg, 0.9% for anti-HBc, 7.04% for both HBsAg and anti-HBc, 0.013% for HCV, and 0.013% for HIV [42]. NAT results missed early periods of HBV and occult HBV, as reported by Al-Turaifi in 2015 [42]. In 2019, the incidence of TTIs among 22,842 Saudi blood donors from 2011 to 2015 in Dammam showed an overall prevalence of 3.24% for HBV and 0.05% for occult infection of HBV [43]. The overall incidence of TTIs over the years showed a significant reduction from 2011 to 2019 [26,42,43].

Incidence of TTIs among blood donors in Makkah province

In Makkah province, the prevalence of TTIs among 959,431 blood donors at King Faisal Specialist Hospital and Research Center from January 2013 to December 2019 was 7.93% [44]. The prevalence of HBcAb was 4.3074%, HIV 0.055%, HBV 0.34%, anti-HCV 0.3991%, HBsAg 0.1484%, and HBsAb 0.1208% [44]. NAT analysis showed positive results for 0.12% HBV, 0.1234% HCV, and 0.02% HIV [44].

In Makkah city (the second largest city in Makkah province), the prevalence of TTIs among 22,963 blood donors reported from 2011 to 2014 was 0.7% for HBsAg, 6.7% for anti-HBc, 0.44% for anti-HCV, and 0.07% for anti-HIV in 2015 [45]. The NAT analysis showed 0.72%, 0.05%, and 0.03% for HBV-DNA, HCV-RNA, and HIV-RNA, respectively [45]. The overall rate of TTIs among 22,963 blood donors was 7.4% (1,689 blood donors) [45]. A recent report indicated the incidence of HBsAg at 0.4%, anti-HBc at 6%, anti-HBs at 5.5%, HCV at 0.3%, and HIV at 0.3% among 13,706 blood donors [46]. Another recent study in 2024 reported the overall prevalence of TTIs among 40,287 blood donors at Al-Noor Specialist Hospital from January 2017 to December 2022 in Makkah at 7.4% with 6.1% for anti-HBc, 0.4% for HCV, and 0.06% for HIV [47].

In Jeddah, the largest city in Makkah province, the prevalence of HIV among 1,061 patients and blood donors screened for HIV from 2007 to 2008 at King Abdulaziz Hospital and King Fahad Hospital in Jeddah was 1.4% (15 out of 1,061) [48]. In 2012, Redwan et al. reported a positivity rate of HBsAg among 638 (139 males and 499 females) Saudi and non-Saudi individuals at 6.11% (39 out of 638) in Jeddah [49]. HBsAg was higher in males (8%; 11 out of 139) than in females (5.61%; 28 out of 499) [49].

In Taif city (another city in Makkah province), only one report indicated HBsAg incidence at 0.33% among 600 blood donors from February 2005 to April 2007 at Al-Hada Armed Forces Hospital, Taif [50].

Incidence of TTIs among blood donors in Qassim province

The prevalence of HBV (HBsAg) and HCV among 11,007 Saudi and non-Saudi healthy blood donors at King Fahad Specialist Hospital, Buraidah, Qassim province, was 3.4% (378 out of 11,007) and 3.7% (403 out of 11,007), respectively [27]. The positive sample of HBsAg was more prevalent in the total population, regardless of nationality, while HCV was more prevalent among non-Saudis [27]. In 2012, the prevalence of HBV and HCV among 8,082 blood donors visiting King Fahad Hospital, Buraidah, from 2008 to 2011 was 1.4% and 0.4%, respectively [51].

Incidence of TTIs among blood donors in Asir province

The prevalence of TTIs among 6,698 Saudi and non-Saudi blood donors in the Asir province, who donated blood from March 2012 to January 2013, was 1.03% (69 out of 6,698) for HBsAg and 6.14% (411 out of 6,698) for anti-HBc [52]. HBsAg was positive only in the male population [52]. In 2013, the prevalence of HBV and HCV among 7,267 healthy blood donors (26 females and 7,241 males) at the Blood Transfusion Center was 0.98% (71 out of 7,267) for HBsAg and 0.069% (5 out of 7,267) for HCV [53]. In 2024, the prevalence of TTIs among 10,095 blood donors who donated blood from November 2020 to December 2022 at Asir Central Hospital, Abha, was 6.3% (633 out of 10,095) [54]. HBsAg was positive in 37 (0.37%) blood donors, anti-HBc in 443 (4.4%) blood donors, and HCV in 45 (0.45%) blood donors [54]. The molecular test showed positivity in 32 donors (0.32%) for HBV-DNA, in 3 (0.03%) for HCV-RNA, and in 9 (0.09%) for HIV-RNA [54].

Incidence of TTIs among blood donors in Jazan province

The prevalence of HBsAg among 14,883 blood donors from June 1995 to June 1997 was 5.4% in Jazan province [29]. Additionally, Ayoola et al. (2003) reported a prevalence rate of HBsAg of 0.9% among 229 children, 5.1% among 1,172 healthy adults, and 9.7% among 4,692 patients [29]. The prevalence of TTIs among 29,949 Saudi blood donors from January 2004 to December 2009 was 3.8% positive for HBsAg, 5.7% positive for anti-HBc, and 0.41% positive for anti-HCV [30]. The incidence of HBV has significantly declined among Saudi blood donors over the years [30]. The prevalence of TTIs among 4,977 blood donors at Samtah General Hospital, Samtah city, from January 2019 to August 2020 was 0.60% for HBsAg, 3.34% for anti-HBs, 7.31% for anti-HBc antibodies, 1.09% for HCV, and 0.16% for anti-HIV [7]. NAT showed 0.4% for HBV-DNA and 0.16% for HCV-RNA [7].

Incidence of TTIs among blood donors in Al-Baha province

In 2016, the overall prevalence of TTIs was 1.3% among 2,807 blood donors from January 2009 to November 2011 in Al-Baha city [55]. The prevalence of HBsAg was 0.8%, anti-HBc was 8.0%, anti-HBs was 5.0%, HCV was 0.04%, and HIV was 0.07% [55]. In 2020, the prevalence of TTIs among 3,461 blood donors from October 2014 to May 2017 in Al-Baha city was 0.3% (10) for HBsAg, 7.3% (253) for anti-HBc, and 0.2% (8) for HCV [56]. Out of the eight who tested positive for HCV, six were confirmed with HCV-RNA, and HBV-DNA was positive in 0.4% (12) [56]. Additionally, 0.2% tested positive for occult hepatitis in 2016 [55] and 0.01% in 2020 [56].

Incidence of TTIs among blood donors in Hail province

In 1999, the prevalence of anti-HCV was reported at 5.09% among 8,862 diverse subjects, including blood donors at King Khalid General Hospital, Hail city (Hail city is the main city in Hail province of Saudi Arabia) [57]. In 2016, the serological markers from a low sample size population of 361 blood donors recruited over two years (2014 - 2015) in Hail city showed 10% for HBsAg, 8.6% for anti-HBc, 7.2% for HCV, 4.7% for HIV, and 2.2% for HTLV I/II [58]. In 2018, the overall prevalence of TTIs among 11,162 blood donors who donated blood from January 2013 to December 2015 in Hail city was 1.5%. The prevalence of HBV and HCV were 1.2% and 0.04%, respectively, and HIV was non-reactive [59].

Incidence of TTIs among blood donors in Madinah province, Tabuk province, and Najran province

Single reports have been found for each of these three provinces (Madinah, Tabuk, and Najran). In Madinah province, the seroprevalence of HBV among 17,131 blood donors from King Fahad Hospital, Madinah city, was 9.02% for HBsAg, 9.02% for Anti-HBc, and 7.93% for anti-HBs [60].

In Tabuk province, northwest of Saudi Arabia, the incidence of HBV among 3,192 blood donors from June 2005 to May 2006 was reported at 3.0% for HBsAg, and 18.7% for anti-HBc [28].

In Najran province, South of Saudi Arabia, the overall prevalence of TTIs among 955 blood donors in Najran hospital was 5.66% [61]. The prevalence of HBsAg was 0.315%, anti-HBc 5.037%, HCV 0.105%, and HIV 0.21% [61].

Occult hepatitis B infection

Occult hepatitis B infection has been noted among blood donors [43,50]. Occult HBV infection poses a major challenge in blood donation, as it can be missed by routine serological tests [34,50]. Therefore, the use of NAT in Saudi Arabia is recommended, despite the low rates of HBV infection in the Saudi population [50, 56].

Factors associated with TTIs

There is no evidence of factors associated with increased TTIs. However, a higher incidence of HBV has been observed among older populations compared with younger individuals in Saudi Arabia [56,62]. An overall reduction in HBsAg has been noted among blood donors, particularly among younger individuals [56]. The incidence of HBV and HCV has decreased in younger age groups, attributed to the introduction of the HBV vaccine and HCV screening program among blood donors, as well as the premarital screening program [56]. Additionally, this reduction is largely due to control and preventative strategies aimed at eliminating HBV [11]. The data indicate a link between the incidence of TTIs, primarily HBV and HCV, and age [24,27,28,45,60]. Understanding the relationship between the types of TTIs and demographic characteristics, including age, is crucial for identifying potential risk factors and limiting the rate of TTIs. It has been reported that the lack of immunization contributes to the high incidence of hepatitis B infection among older people [28]. Therefore, raising awareness about the benefits of immunization could be a strategic approach to eliminate hepatitis B infection. Furthermore, a higher rate of TTIs has been observed in non-Saudi blood donors. The data also indicate increases in certain regions of Saudi Arabia, attributed to the presence of expatriates [56].

CONCLUSION

The overall findings regarding TTIs in Saudi Arabia vary by province, with a higher incidence observed among older individuals. Although the prevalence of TTIs differs across province and within province in Saudi Arabia, the review indicates a high prevalence in the northern parts of the country, when compared with other provinces. This review demonstrates an overall reduction in TTIs over the years but points out that they have not been eliminated. Thus, comparing these trends in TTIs among all provinces in Saudi Arabia should be warranted to provide additional insights. Therefore, understanding the prevalence and pattern of TTIs will help tackle this issue and ensure safe transfusion of blood and blood components for patients. Therefore, further reports should be conducted in all provinces of Saudi Arabia. This will enable healthcare policymakers to provide future directions on tackling TTIs among blood donors (both Saudi and expatriate) and develop strategies to improve prevention and control measures, such as booster vaccinations for HBV or revisions of the current vaccination strategy in Saudi Arabia.

Source of Funds:

The authors extend their appreciation to the Deputyship for Research & Innovation, Ministry of Education in Saudi Arabia, for funding the research work through project number ISP22-1.

Declaration of Interest:

The author has read the journal's policy, and the author declares no conflict of interest.

References:

1. World Health Organization. Progress report on HIV, viral hepatitis and sexually transmitted infections, 2019. https://iris.who.int/bitstream/handle/10665/324797/WHO-CDS-HIV-19.7-eng.pdf

2. Committee on a National Strategy for the Elimination of Hepatitis B and C; Board on Population Health and Public Health Practice; Health and Medicine Division; National Academies of Sciences, Engineering, and Medicine; Buckley GJ, Strom BL E. Eliminating the Public Health Problem of Hepatitis B and C in the United States: Phase One Report. Washingt Natl Acad Press 2016 June. (PMID: 27336113)

3. Frank TD, Carter A, Jahagirdar D, et al. Global, regional, and national incidence, prevalence, and mortality of HIV, 1980 - 2017, and forecasts to 2030, for 195 countries and territories: A systematic analysis for the Global Burden of Diseases, Injuries, and Risk Factors Study 2017. Lancet HIV 2019 Dec;6(12):e831-59. (PMID: 31439534)

4. Weldemhret L. Epidemiology and Challenges of HBV/HIV Co-Infection Amongst HIV-Infected Patients in Endemic Areas: Review. HIV AIDS (Auckl) 2021 May;13:485-90. (PMID: 33981165)

5. Zaaijer HL. Prevention of transfusion-transmitted infections: Dilemmas. Front Med (Lausanne) 2017 Dec 12:4:221. (PMID: 29312940)

6. Raman L, Armstrong B, Smart E. Donation testing and transfusion transmissible infections. ISBT Sci Ser 2020 Dec;15:192-206. https://doi.org/10.1111/voxs.12597

7. Mobarki AA, Madkhali MM, Dobie G, et al. Patterns of Hepatitis B, Hepatitis C and HIV Among Blood Donors in Samtah-Jazan Region. J Epidemiol Glob Health 2022 Jul;12(3):304-10. (PMID: 35907148)

8. Fong IW. Blood Transfusion-Associated Infections in the Twenty-First Century: New Challenges. Curr Trends Concerns Infect Dis 2020 Mar:191-215. https://link.springer.com/chapter/10.1007/978-3-030-36966-8_8

9. Alghamdi M, Alghamdi AS, Aljedai A, et al. Revealing Hepatitis B Virus as a Silent Killer: A Call-to-Action for Saudi Arabia. Cureus 2021 May;13(5):e14811. (PMID: 34094765)

10. Alghamdi IG, Alghamdi RM, Alghamdi MS, et al. Epidemiology of Hepatitis B in Saudi Arabia from 2006 to 2021. Hepat Med 2023 Dec;15:233-47. (PMID: 38146425)

11. Aljumah AA, Babatin M, Hashim A, et al. Hepatitis B care pathway in Saudi Arabia: Current situation, gaps and actions. Saudi J Gastroenterol 2019 Mar-Apr;25(2):73-80. (PMID: 30720000)

12. Bawazir A, AlGusheri F, Jradi H, AlBalwi M, Abdel-Gader AG. Hepatitis C virus genotypes in Saudi Arabia: a future prediction and laboratory profile. Virol J 2017 Nov 2;14(1):208. (PMID: 29096662)

13. El-Hazmi MA. Hepatitis B virus in Saudi Arabia. J Trop Med Hyg 1989 Feb;92(1):56-61. (PMID: 2918579)

14. Al-Mozaini M, Alrahbeni T, Dirar Q, Alotibi J, Alrajhi A. HIV in the Kingdom of Saudi Arabia: Can We Change the Way We Deal with Co-Infections. Infect Drug Resist 2021 Jan;14:111-7. (PMID: 33500633)

15. Alswaidi FM, O'Brien SJ. Is there a need to include HIV, HBV and HCV viruses in the Saudi premarital screening program on the basis of their prevalence and transmission risk factors? J Epidemiol Community Health 2010 Nov;64(11):989-97. (PMID: 19822552)

16. World Health Organization. Global status report on blood safety and availability 2021. Available from: https://www.who.int/publications/i/item/9789240051683

17. Alsughayyir J, Almalki Y, Alalshaik M, et al. Demography and blood donation trends in Saudi Arabia: A nationwide retrospective, cross-sectional study. Saudi J Biol Sci 2022 Dec;29(12): 103450. (PMID: 36177384)

18. Almalki M, Fitzgerald G, Clark M. Health care system in Saudi Arabia: an overview. East Mediterr Heal J 2011 Oct;17(10):784-93. (PMID: 22256414)

19. Song Y, Bian Y, Petzold M, Ung CO. Prevalence and trend of major transfusion-transmissible infections among blood donors in Western China, 2005 through 2010. PLoS One 2014 Apr 8;9 (4):e94528. (PMID: 24714490)

20. Al-Rubaye A, Tariq Z, Alrubaiy L. Prevalence of hepatitis B seromarkers and hepatitis C antibodies in blood donors in Basra, Iraq. BMJ open Gastroenterol 2016 Jan;3(1):e000067. (PMID: 26966550)

21. Alali AA, Abo-Shehada MN. Prevalence of Hepatitis B Virus infection in the Gulf Cooperation Council: a systematic review and meta-analysis. BMC Infect Dis 2022 Nov 7;22(1):819. (PMID: 36344923)

22. Shobokshi OA, Serebour FE, Al-Drees AZ, Mitwalli AH, Qahtani A, Skakni LI. Hepatitis C virus seroprevalence rate among Saudis. Saudi Med J 2003 Jul;24:S81-6. (PMID: 12897907)

23. Alaidarous M, Choudhary RK, Waly MI, et al. The prevalence of transfusion-transmitted infections and nucleic acid testing among blood donors in Majmaah, Saudi Arabia. J Infect Public Health 2018 Sep-Oct;11(5):702-6. (PMID: 29703711)

24. El-Hazmi M. Prevalence of HBV, HCV, HIV-1, 2 and HTLV-I/II infections among blood donors in a teaching hospital in the Central region of Saudi Arabia. Saudi Med J 2004 Jan;25(1):26-33. (PMID: 14758374)

25. Alabdulmonem W, Shariq A, Alqossayir F, 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 Feb;13(2):299-305. (PMID: 31953019)

26. Bashawri L, Fawaz NA, Ahmad MS, Qadi AA, Almawi WY. Prevalence of seromarkers of HBV and HCV among blood donors in eastern Saudi Arabia, 1998 - 2001. Clin Lab Haematol 2004 Jun;26(3):225-8. (PMID: 15163322)

27. Mehdi SR, Pophali A, Al-AbdulRahim KA. Prevalence of hepatitis B and C and blood donors. Saudi Med J 2000 Oct;21(10): 942-4. (PMID: 11369958)

28. El Beltagy KE, Al Balawi IA, Almuneef M, Memish ZA. Prevalence of hepatitis B virus markers among blood donors in a tertiary hospital in Tabuk, northwestern Saudi Arabia. Int J Infect Dis 2008 Sep;12(5):495-9. (PMID: 18400539)

29. Ayoola AE, Tobaigy MS, Gadour MO, Ahmad BS, Hamza MK, Ageel AM. The decline of hepatitis B viral infection in South-Western Saudi Arabia. Saudi Med J 2003 Sep;24(9):991-5. (PMID: 12973485)

30. Abdullah SM. Prevalence of hepatitis B and C in donated blood from the Jazan region of Saudi Arabia. Malaysian J Med Sci 2013 Mar;20(2):41-6. (PMID: 23983576)

31. Alsughayyir J, Almalki Y, Alburayk I, et al. Prevalence of transfusion-transmitted infections in Saudi Arabia blood donors: A nationwide, cross-sectional study. Saudi Med J 2022 Dec;43(12): 1363-72. (PMID: 36517064)

32. Altamimi W, Altraif I, Elsheikh M, Alkshan A, Qasem L, Sohaibani M. Prevalence of HBsAg and Anti-HCV in Saudi blood donors. Ann Saudi Med 1998 Jan-Feb;18(1):60-2. (PMID: 17341920)

33. Alshayea AI, Eid GE, El-Hazmi MM, Alhetheel AF. Prevalence and characterization of occult hepatitis B infection among blood donors in central Saudi Arabia. Saudi Med J 2016 Oct;37(10): 1114-9. (PMID: 27652363)

34. Alabdallat NG, Bin Dukhyil A. Significance of HBV NAT among HBS antigen-negative blood donors in Saudi Arabia. Lab Med 2018 Oct 11;49(4):342-6. (PMID: 29767761)

35. Al Majid F. Prevalence of Transfusion-Transmissible Infections among Blood Donors in Riyadh: A Tertiary Care Hospital-Based Experience. J Nat Sci Med 2020;3:247-51. https://journals.lww.com/jnsm/fulltext/2020/03040/prevalence_of_transfusion_transmissible_infections.4.aspx

36. Alqahtani S, Alsagaby S, Mir S, et al. Seroprevalence of viral hepatitis B and C among blood donors in the northern region of Riyadh province, Saudi Arabia. Healthcare (Basel) 2021 Jul 24;9 (8):934. (PMID: 34442071)

37. Mubaraki MA, Almuayrifi HA, Hafiz TA, et al. Prevalence of residual risks of the transfusion-transmitted infections in Riyadh hospitals: A two-year retrospective study. Open Chem 2023;21: 20220351. https://doi.org/10.1515/chem-2022-0351

38. Al-Ghonaim M, Abdel-Ghaffar MH, Alnomasy SF, Thalji MR, Khan FR. Prevalence of viral hepatitis among population of AL-Quwayiyah Governorate, Saudi Arabia. World J Pharm Res 2012; 1(4):1212-22. https://www.wjpr.net/abstract_file/150

39. Al-Bahrani A, Panhotra BR. Prevalence of HBsAG and anti-HCV antibodies in blood donors of the Al-Hasa region of Saudi Arabia. Ann Saudi Med 2001;21:234-5. https://www.annsaudimed.net/doi/pdf/10.5144/0256-4947.2001.234

40. Panhotra BR, Al-Bahrani A, Ul-Hassan Z. Epidemiology of antibody to hepatitis B core antigen screening among blood donors in Eastern Saudi Arabia. Need to replace the test by HBV DNA testing. Saudi Med J 2005 Feb;26(2):270-3. (PMID: 15770304)

41. Morsi HA. Routine Use of Mini-Pool Nucleic Acid Testing (MP-NAT) Multiplex Assay for Sero-Negative Blood Donors. J Egypt Soc Haematol Res 2011;7:59-63. https://eshr.edu.eg/wp-content/uploads/2023/04/4-Routine-Use-of-Mini-Pool-Nucleic-Acid-Testing-MP-NAT.-sep2011-27-31.pdf

42. Al-Turaifi H. Evaluation of nucleic acid testing for blood donors: One year study. Int J Blood Transfus Immunohematol 2015;5:19-25. https://www.ijbti.com/archive/2015-archive/100018IJBTIHA2015-al-turaifi/100018IJBTIHA2015-al-turaifi-full-text.php

43. Alzahrani FM, Muzaheed, 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 Jan;39 (1):81-5. (PMID: 30215234)

44. Altayar MA, Jalal MM, Kabrah A, 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 Jun 27;58(7):857. (PMID: 35888577)

45. Elbjeirami WM, Arsheed NM, Al-Jedani HM, et al. Prevalence and Trends of Common Transfusion Transmitted Infections Using Serological and Nucleic Acid Markers in Saudi Blood Donors. J Blood Disord Transfus 2015;6:1-9. https://www.walshmedicalmedia.com/open-access/prevalence-and-trends-of-common-transfusion-transmitted-infections-using-serological-and-nucleic-acid-markers-in-saudi-blood-donors-2155-9864-1000280.pdf

46. Albshri MH, Ghoth AA, Mutwalli AA, et al. The Prevalence of Transfusion-Transmitted Infections and Nucleic Acid Testing Among Blood Donors in Makkah, Saudi Arabia. Clin Lab 2024 Nov;70(11). (PMID: 39506595)

47. Minshawi F, Abdulshakoor AA, Alwakil EM, et al. Seroprevalence of transfusion-transmitted infections among blood donors in Makkah, Saudi Arabia. J Infect Dev Ctries 2024 Jun 30;18(6): 957-63. (PMID: 38991002)

48. Fageeh WM. Should We Screen for HIV in Saudi Arabia? JKAU Med Sci 2010;17(3):45-54. https://api.semanticscholar.org/CorpusID:54584122

49. Redwan N, Ahmed M, Barnawi M. Prevalence Study of Hepatitis B virus (HBV) Infection by Serological techniques in Jeddah, Saudi Arabia. Life Sci J 2012;9(4):5442-8. https://www.lifesciencesite.com/lsj/life0904/805_14106life0904_5442_5448.pdf

50. Bamaga MS, Azahar EI, Al-Ghamdi AK, Al-Enzi FQ, Farahat FM. Nucleic acid amplification technology for hepatitis B virus, and its role in blood donation screening in blood banks. Saudi Med J 2009 Nov;30(11):1416-21. (PMID: 19882053)

51. Aljarbou AN. Current prevalence of HBV and HCV seropositivity: The initiative for attentiveness and deterrence of viral hepatitis in the Qassim region of Saudi Arabia. J Antivirals Antiretrovir 2012;4:75-9. https://www.longdom.org/open-access/current-prevalence-of-hbv-and-hcv-seropositivity-the-initiative-for-attentiveness-and-deterrence-of-viral-hepatitis-in-the-qassim-region-of-saudi-arabia-1948-5964.1000049.pdf

52. Ibrahim E, Bin-Dajem S, Heijan A, et al. Hepatitis B Vaccine Reduced the Prevalence of Antibodies to Hepatitis B Core Antigen in Blood Donors in Aseer Region, Saudi Arabia. Egypt Acad J Biol Sci 2014;6:13-22. https://eajbsc.journals.ekb.eg/article_16043.html

53. Alshehri A. Hepatitis B and C Viruses incidence, the Risk Factors of Hepatocellular carcinoma, is low in Aseer Region, Saudi Arabia. Egypt Acad J Biol Sci 2013;5:7-18. https://eajbsc.journals.ekb.eg/article_16103_ad12aa19ae1c2647af65719ecabbfc48.pdf

54. 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 Apr;45(4):414-23. (PMID: 38657987)

55. AlMutairi HH, AlAhmari MM, Al-Zahran BH, et al. Prevalence of serological markers and nucleic acid for blood-borne viral infections in blood donors in Al-Baha, Saudi Arabia. J Infect Dev Ctries 2016 Jun;10(6):619-25. (PMID: 27367011)

56. Sallam T, El-Bingawi H, Alzahrani K, Alzahrani B, Alzahrani A. Prevalence of hepatitis B and hepatitis C viral infections and impact of control program among blood donors in Al-Baha region, Saudi Arabia. Saudi J Heal Sci. 2020;9:56-60. https://journals.lww.com/sjhs/fulltext/2020/09010/prevalence_of_hepatitis_b_and_hepatitis_c_viral.10.aspx

57. Mahaba H, El-Tayeb A, Elbaz H. The prevalence of antibodies to hepatitis C virus in Hail region, Saudi Arabia. J Egypt Public Health Assoc 1999;74(1-2):69-80. (PMID: 17216953)

58. Sarah Y, Sabry A, Maryam A. Seropositivity of TTIs among blood donors in Hail, Saudi Arabia, from 2014 to 2015. Asian Pacific J Trop Dis 2016;6:141-6. https://doi.org/10.1016/S2222-1808(15)61000-3

59. Alcantara J, Alenezi F, Haj-Ali O. Seroprevalence and trends of markers of transfusion transmissible infections among blood donors: a 3-year hospital based-study. Int J Community Med Public Health 2018;5:5031-5. https://doi.org/10.18203/2394-6040.ijcmph20184773

60. Kurdi M, Abughararah M, Mulike M, Yamani O, Bugdady M, Noor M. Molecular detection of hepatitis B virus (HBV) among voluntary ELISA positive blood donors in Almadinah Almunawwarah. J Taibah Univ Med Sci 2014;9:166-70. http://dx.doi.org/10.1016/j.jtumed.2014.01.002

61. 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;14:1065-76. https://dx.doi.org/10.13005/bpj/2210

62. Al-Raddadi RM, Dashash NA, Alghamdi HA, et al. Prevalence and predictors of hepatitis B in Jeddah city, Saudi Arabia: A population-based seroprevalence study. J Infect Dev Ctries 2016 Oct; 10(10):1116-23. (PMID: 27801375)