

## Seroprevalence of Transfusion Transmitted Infection among Blood Donor at a Tertiary Level Hospital of Bangladesh: One Year Retrospective Study

Dr. Md. Adnan Hasan Masud<sup>1\*</sup>, Dr. Zia Uddin Ahmed<sup>2</sup>, Dr. Khan Anisul Islam<sup>3</sup>, Dr. Md. Khairul Islam<sup>4</sup>, Dr. Farah Anjum Sonia<sup>5</sup>, Dr. Atiar Rahman<sup>6</sup>, Dr. Habibur Rahman<sup>7</sup>

<sup>1</sup>Assistant Professor, Department of Hematology, BSMMU, Dhaka, Bangladesh

<sup>2</sup>Associate Consultant, Department of Transfusion Medicine, BRB Hospitals Ltd, Dhaka, Bangladesh

<sup>3</sup>Assistant Professor, Department of Transfusion Medicine, BSMMU, Dhaka, Bangladesh

<sup>4</sup>Assistant Professor, Department of Transfusion Medicine, NITOR, Dhaka, Bangladesh

<sup>5</sup>Assistant Professor, Department of Transfusion Medicine, NITOR, Dhaka, Bangladesh

<sup>6</sup>Associate Professor, Department of Transfusion Medicine, BSMMU, Dhaka, Bangladesh

<sup>7</sup>Assistant Professor, Department of Transfusion Medicine, ShSMC, Dhaka, Bangladesh

DOI: <https://doi.org/10.36348/sjimps.2024.v10i09.009>

| Received: 10.08.2024 | Accepted: 17.09.2024 | Published: 21.09.2024

\*Corresponding author: Dr. Md. Adnan Hasan Masud

Assistant Professor, Department of Hematology, BSMMU, Dhaka, Bangladesh

### Abstract

**Background:** A transfusion transmitted infection (TTI) is an infection that is transmitted from person to person through parental administration of blood and blood products. The magnitude of transfusion transmitted infection (TTI) varies from country to country depending on TTI's load in that particular population. Measuring their severity their severity WHO (World Health Organization) has recommended pre transfusion blood test for Human Immunodeficiency virus (HIV), Hepatitis B Virus (HBV), Hepatitis C virus (HCV) and Syphilis as mandatory. The aim of the study was to assess the trend and prevalence of TTI among blood donors in BRB Hospitals Limited. **Method:** A retrospective cross-sectional study was conducted by reviewing the record from 2022 to 2023 at BRB hospitals limited Transfusion Medicine department. All blood donors who presented to the blood bank and screened for TTI during study period were included. Data was collected, entered and analyzed using Microsoft Excel 2007. The descriptive statistics were determined in means of percentage. Chi-square was used for trend analysis and p-value was used to declare the statistical significance between variable. **Result:** The study included a total of 5074 donors-4,920 (97%) male and 154 (3%) female. Of them 3,840 (76.3%) were directed donor while 1,204 (23.7%) were replacement donor. An overall TTI prevalence rate of 0.95%. The prevalence of HBV, HCV, HIV and Syphilis was 0.5%, 0.1%, 0.07% and 0.2%. **Conclusion:** Methods to ensure a safety blood supply should be encountered. For that screening with a better selection of donor and used of screening tests including nucleic acid testing technology should be implemented.

**Keywords:** Transfusion transmitted infection, Hepatitis B Virus, Syphilis.

**Copyright © 2024 The Author(s):** This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY-NC 4.0) which permits unrestricted use, distribution, and reproduction in any medium for non-commercial use provided the original author and source are credited.

## INTRODUCTION

Blood transfusion is a life-saving intervention and millions of lives are saved each year globally through this procedure. However, blood transfusions are associated with certain risks which can lead to adverse consequences. It may cause acute or delayed complications and carries the risk of the transmission of infections]. According to the World Health Organization (WHO), 118.2 million blood donations are collected globally with 58% in low- and middle-income countries [1].

Blood transfusion is a therapeutic procedure, as there is no genuine substitution. But contaminated blood transfusion can transmit infectious diseases and can be fatal instead of saving life [2]. Transfusion of infected blood and blood components increases the likelihood of morbidity and mortality related to blood transfusion. This has very in-depth consequences, both for the patient and the families and their communities. Even though blood donation can improve the quality of patients' lives, it remains one of the main sources of the transmission of infectious agents. Transfusion-transmitted infections (TTIs) are still a leading concern for the patients, physicians, and policymakers who wish to see a safe

**Citation:** Md. Adnan Hasan Masud, Zia Uddin Ahmed, Khan Anisul Islam, Md. Khairul Islam, Farah Anjum Sonia, Atiar Rahman, Habibur Rahman (2024). Seroprevalence of Transfusion Transmitted Infection among Blood Donor at a Tertiary Level Hospital of Bangladesh: One Year Retrospective Study. *Saudi J Med Pharm Sci*, 10(9): 697-703.

blood supply. The TTIs mainly include human immunodeficiency virus (HIV), hepatitis B virus (HBV), hepatitis C virus (HCV), *Treponema pallidum* (causative agent of syphilis), and malaria parasite [3]. The WHO recommends that all blood donations must be tested for these five infectious agents. Evaluation of data on the prevalence of transfusion transmissible infections (TTIs) namely HIV, HBV, HCV and syphilis antibodies among blood and plasma donors permit an assessment of the occurrence of infections in the blood donor population and consequently the safety of the collected donations. It also gives an idea of the epidemiology of these diseases in the community. Transfusion associated infections continue to be a big threat [4].

Transfusion transmissible infections can be classified as viral, bacterial and parasitic infections. The most commonly encountered transfusion infection is of viral origin. In many cases, post transfusion diseases have been caused by human immunodeficiency virus (HIV), hepatitis B and C virus [5]. Prevalence of HBV infection varies greatly in different parts of the world. The World Health Organization (WHO) has classified HBV prevalence into high endemicity (>8%), intermediate (2–7%) and low endemicity (<2 %) [6].

Worldwide about 350 million people have chronic hepatitis B virus (HBV) infection, and about 125 million have been infected with hepatitis C virus (HCV), putting viral HBV and HCV infection among the world's greatest infectious disease problems. These diseases are therefore important candidates for public health measures aimed at prevention, early diagnosis and treatment [7].

Transfusion transmissible infections can be classified as viral, bacterial and parasitic infections. The most commonly encountered transfusion infection is of viral origin. In many cases, post transfusion diseases have been caused by human immunodeficiency virus (HIV), hepatitis B and C virus [8]. Prevalence of HBV infection varies greatly in different parts of the world. The World Health Organization (WHO) has classified HBV prevalence into high endemicity (>8%), intermediate (2–7%) and low endemicity (<2 %) [9].

The discovery of (TTIs) has heralded a new era in blood transfusion practice worldwide with emphasis on two fundamental objectives, safety and protection of human life. Blood safety remains an issue of major concern in transfusion medicine in Bangladesh. Estimating the prevalence of TTIs, namely HBV, HCV, HIV and syphilis antibodies or antigen, among blood donors can reveal the problem of unnoticeable infections in healthy-looking members of the general population and also provide data that is important in formulating the strategies for improving the management of a safe blood supply. In addition it can give us a guide to the magnitude of some sexually transmitted infections in the community.

In Bangladesh, the main source of blood donation is replacement donors and most of them are patient's relatives or friends. Proper screening of blood and selection of the donors is very important to insure a safe blood supply. It is mandatory to test each donor's blood for syphilis by a Venereal Disease Reference Laboratory (VDRL), and for HBsAg, anti-HCV, and anti-HIV. Available data on the sero prevalence and distribution of these blood borne pathogens is not available or no study has been done. The purpose of this study was to estimate the prevalence of serological markers of HBV, HCV, HIV, and syphilis antibodies among blood donors in BRB Hospitals Limited Transfusion Medicine in Dhaka, Bangladesh.

## METHODS

### Study area

The data was collected from the Transfusion Medicine of BRB Hospitals Limited. BRB Hospitals Limited is situated in Dhaka; Bangladesh provides health services to the local as well as for population coming from different zone of the region.

### Study design

It was Transfusion Medicine based retrospective analysis of consecutive blood donors' summary monthly records from January 2022 to December 2023 (1 year) conducted at BRB Hospitals Limited (Transfusion Medicine).

### Study population

Blood donors attended the BRB Hospitals Limited Transfusion Medicine department during 1 year period and those screened for hepatitis B surface antigen, hepatitis C, HIV and syphilis antibodies.

### Study Variable

The dependent variable of this study was HIV, HBsAg, HCV, and syphilis test result, whereas the independent variable were sex, age.

### Laboratory tests

During 1 years blood sample was collected and tested in the BRB Hospitals Limited Transfusion Medicine Department. 3 ml donor sample was collected in EDTA tube and centrifuged for 10 min at 3000 rpm. Then HBsAg, Anti HCV, Anti HIV, HIV p24 antigen and Syphilis antibody was tested by Architect 1000 SR (Abbott, USA) that has a sensitivity and specificity of more than 99%.

### Statistical Analysis

The data was collected, entered and analyzed using Microsoft Excel 2007. The data were double entered; validated for data entry errors and subsequently analyzed. We presented our data in the form of tables. The descriptive statistics were determined in means of percentages. Chi square was used for trend analysis and *P* value was used to calculate statistical significances.

## Ethical Issues

The study was approved by our institutional ethical committee of BRB Hospitals Limited. Blood donor was selected based on Safe blood transfusion law, 2002 and written consent for serological tests was taken from all blood donors.

## RESULT

### Socio-demographic characteristics:

Starting from January 2023 to December 2023, the total numbers of donor gave blood were 5074. Among the donors visited BRB Transfusion Medicine department over past 1 year, male constitutes the majority 4920 (97%) of the donors, while females make up 154 (3%). The most common age group of donors was

found to be 26–35 years (40.9 %) followed by age group of 36–45 years (30%), while the least age group was >55 (0.2%). Majority 3840 (76.3%) of donors were directed donors, while replacement donors constitutes 23.7% (Table 1).

### Trends of transfusion transmissible infection

Out of 5074 blood units collected, 48 units that tested positive for any of the TTI tested giving an overall positivity rate .95%. No co-infection reported during this study period. Of all the TTI, hepatitis B form majority of infection 26/5074 (.5%), followed by Syphilis 12 (0.2%), while the least percentage was HCV and HIV 6 (0.1%), 4 (0.07%) respectively. There was statistically significant (Chi square = 26.28 P value <0.0001) change in sero-positivity in 2023 (Table 2).

**Table 1: Socio-demographic characteristics of blood donor at BRB Hospitals Limited, Transfusion Medicine department from January 2023 to December 2023**

Age group (years)	Number of donated	Percentage (%)
16-25	954	18.8 %
26-35	2073	40.9%
36-45	1522	30%
46-55	517	10.2%
>55	08	0.2%
Total	5074	100%
<b>Sex</b>		
Male	4920	97%
Female	154	3%
Total	5074	100%
<b>Type of Donor</b>		
Directed	3870	76.3%
Replacement	1204	23.7%
Total	5074	100%

**Table 2: Distribution of Transfusion Transmitted infection frequency at BRB Hospitals Limited Transfusion Medicine Department (n=5074)**

Types of TTI	Number	Percentage
HBsAg	26	0.5%
HCV	06	0.1%
HIV	04	0.07%
Syphilis	12	0.2%
Total	48	.95%

## DISCUSSION

Transfusion of blood and blood components is a life-saving intervention and supports countless patients globally. At the same time, however, transfusion of contaminated blood has a key role in the transmission of blood-borne infectious agents. In low-income countries, the prevalence of TTIs is relatively high and quite far from achieving a zero-risk level [10]. The likelihood of TTI transmission in the transfusion of every blood unit is estimated to be approximately 1% [11]. This estimation is a relatively high rate for transmission of blood-borne diseases because some of these infections are severe, life-endangering ones that are incurable or have a difficult treatment process. Thus, TTIs are an important challenge for blood transfusion services across

the globe and require defined precautions. There is a direct connection between the economic situation of countries and TTI prevalence. Countries with higher incomes can more easily offer preventive and vaccination programs for the public than countries with lower incomes [1, 12]. During the last two decades, vaccination for HBV has greatly reduced the rate of TTIs in different countries. Education is another vital factor that can considerably decrease the rate of TTIs among blood donors, mostly by decreasing risky behaviors [13].

HBV is highly contagious and easily transmitted from one individual to another by transfusion during birth, by unprotected sex and by sharing needles. Syphilis can be spread by sexual contact, blood

transfusion and by vertical transmission. Due to the nature of blood born virus, HCV is widely recognized as a major causative agent for post transfusion non-A, non-B hepatitis. Other less common routes of transmission are sexual intercourse and mother to child transfer [14].

In case of HIV, transmission during window period is possible even if each unit is tested for HIV antibodies. The possibility of window period transmission would be minimized if blood is collected from low risk targeted general public [15]. However, blood safety remains an issue of major concern in transfusion medicine. However, HBV and HIV can also be transmitted from person to person contact, especially HBV which is transmittable from tears, urine, etc.

The course of HBV infection depends on many factors that can influence the immune system including age at infection and host genetic factors and genetic variability of viruses [16]. There are various HBV subtypes, subgenotypes, and escape mutants which cause public health concern through re infection and occult infection. This is particularly true in Asia with its intermediate to high rates of chronic infection. These HBV isolates may escape detection and enter the blood supply. To lower the seroprevalence, there should be stringent donor selection criteria, blood donation by regular volunteer donors, effective donor education and counseling of seropositive donors. To make aware the general public about the highly infectious nature of these infections and its mode of transmission, special intervention programs should be planned [17]. Similarly, post transfusion HBV infection rate is high due to the fact that HBV circulates at very low and undetectable level for screening assays. It is, therefore, necessary to find out the tests which detect the presence of Hepatitis B during the window period. Nucleic acid testing (NAT) assays are very useful in this situation which has considerably shortened the window period. However, the cost of this assay is high which makes it unaffordable for many centers [18]. There is 1% chance of transfusion-associated problems including TTI with each unit of blood [19]. In the current study, we established that the overall collective prevalence of TTIs in donated blood was .95%. When compared globally, studies from Nigeria(14.96%) [20], Albania (7.4%) [21], Ethiopia (11.5%) [22] and Sudan (20.1%) [23] reported a higher overall TTI prevalence rate comparatively. Whereas studies from Qatar (1.85%) [24], India (0.6%) [25], Pakistan (4%) [26] Eritrea (3.6%) [27], Saudi Arabia (0.80%) [28] and Iran (0.25%) [29] have reported a lower prevalence rate compared with our findings.

The overall prevalence of hepatitis B in our study was 0.5%. This finding may indicate the likelihood that the prevalence of HBV in the general healthy population is relatively low. Our findings were on the lower side when compared with studies from Sudan

(11.7%) [23] and Tanzania (8.8%) [30] and slightly higher from Iran (0.13%) [31], Brazil (1.63%) [32].

According to the present study, the overall frequency of hepatitis C was 0.1%. When compared with global studies, the prevalence was lower when compared with those reported from Egypt (4.3%) [33], Kenya (3.21%) [34] and Sudan (3.4%) [35] while it was higher when compared with studies from Iran (0.07%) [31], Ethiopia (0.6%) [12], Saudi Arabia (0.40%) [36] and India (0.06%) [28].

The overall prevalence of HIV in the present study was 0.07%. Similarly, studies from Iran (0.002%) [31], Saudi Arabia (0.13%) [36], Libya (0.014%) [37] and Egypt (0.00%) [38] reported a low prevalence of HIV comparatively. Our findings were on the lower side when compared with studies from Ethiopia (2.6%) [39], Cameroon (4.44%) [40] and South Africa (1.13%) [41].

The positivity of syphilis in our study was 0.2%. Studies from several African countries have observed a high prevalence, for instance, Burkina Faso (1.5%) [42], Nigeria, (3.1%) [20] and Angola (20.0%) [43] while data from developed countries indicate a low prevalence comparatively, Qatar (0.43) [24], Iran (0%) [31], United States of America (0.16%) [44] and Italy (0.031%) [45].

## CONCLUSION

Although the current trends of TTIs are fluctuating from year to year, the high prevalence necessitates additional studies to detect the main risk factors and formulate intervention strategies. To limit the risk of TTIs recommendations include the promotion of voluntary blood donation, sensitization, and recruitment of more female donors, screening of donated blood through highly sensitive screening assay, and further research utilizing nucleic acid technology. The current data generated is expected to support the policymakers to prepare a plan of action and introduce the concept of good governance in blood establishments. As blood donors are considered to represent a healthy population, the prevalence of TTIs in donors is a clear indication of these infectious agents in our population.

## LIMITATIONS

In the present study, blood donors' samples were screened through serological testing. However, the screened seronegative donations are still at risk for hepatitis B, hepatitis C, and HIV transmission and thus, need for a sensitive screening test arises to decrease this possible risk. The introduction of nucleic acid testing (NAT) in addition to serological screening reduces the risk of TTI transmission by narrowing the window period in early-stage infection. Consequently many developed countries have introduced NAT as a mandatory measure in the routine blood donor screening.

## REFERENCE

- World Health Organization. Global status report on blood safety and availability 2016. Available at: <https://apps.who.int/iris/bitstream/handle/10665/254987/9789241565431-eng.pdf?sequence=1>. Accessed July 27, 2023.
- Fessehaye, N., Naik, D., & Fessehaye, T. (2011). Transfusion transmitted infections—A retrospective analysis from the National Blood Transfusion Service in Eritrea. *Pan African Medical Journal*, 9(1), 40-46.
- World Health Organization. Global status report on blood safety and availability 2016. Available at: <https://apps.who.int/bitstream/handle/10665/254987/9789241565431-eng.pdf?sequence=1>. Accessed July 27, 2023.
- Bhawani, Y. R. P., & Sudhakar, V. (2010). Seroprevalence of transfusion transmissible infections among blood donors in a tertiary care hospital of Andhra Pradesh. *Biol Med*, 2(4), 45-48.
- Amiweru, C. E., Prescott, R. J., George, O. A., Joy, N. I., & Aisha, M. (2013). Seroprevalence of transfusion transmissible infections among blood donors attending the Federal Medical Centre, Bida. *IJMBR*, 1(1), 1-7.
- Quadri, S. A., Dadapeer, H. J., Arifulla, K. M., & Khan, N. (2013). Prevalence of hepatitis B surface antigen in hospital based population in Bijapur, Karnataka. *Al Ameen J Med Sci*, 6(2), 180-182.
- Wasfi, O. A. S., & Sadek, N. A. (2011). Prevalence of hepatitis B surface antigen and hepatitis C virus antibodies among blood donors in Alexandria, Egypt. *EMHJ-Eastern Mediterranean Health Journal*, 17(3), 238-242.
- Amiweru, C. E., Prescott, R. J., George, O. A., Joy, N. I., & Aisha, M. (2013). Seroprevalence of transfusion transmissible infections among blood donors attending the Federal Medical Centre, Bida. *IJMBR*, 1(1), 1-7.
- Quadri, S. A., Dadapeer, H. J., Arifulla, K. M., & Khan, N. (2013). Prevalence of hepatitis B surface antigen in hospital based population in Bijapur, Karnataka. *Al Ameen J Med Sci*, 6(2), 180-182.
- World Health Organization. Blood safety and availability fact sheet. 2020. Available at: <https://www.who.int/newsroom/factsheets/detail/blood-safety-and-availability>. Accessed August 27, 2022.
- Dhar, G., Sarkar, A. P., Sen, S., Ghosh, S., Mukhopadhyay, B. B., & Ghosh, T. K. (2013). Patterns of infective sero positivity among blood donors in a rural medical college regional blood transfusion centre: a retrospective study. *Nepal Journal of Medical Sciences*, 2(1), 3-8.
- Shiferaw, E., Tadilo, W., Melkie, I., & Shiferaw, M. (2019). Sero-prevalence and trends of transfusion-transmissible infections among blood donors at Bahir Dar district blood bank, northwest Ethiopia: a four year retrospective study. *PLoS one*, 14(4), e0214755.
- Gonçalez, T. T., Sabino, E. C., Salles, N. A., De Almeida-Neto, C., Mendrone-Jr, A., Dorlhiac-Laccer, P. E., ... & Schreiber, G. B. (2010). The impact of simple donor education on donor behavioral deferral and infectious disease rates in São Paulo, Brazil. *Transfusion*, 50(4), 909-917.
- Tafari, S., Prato, R., Martinelli, D., Melpignano, L., De Palma, M., Quarto, M., & Germinario, C. (2010). Prevalence of Hepatitis B, C, HIV and syphilis markers among refugees in Bari, Italy. *BMC infectious diseases*, 10, 1-5.
- Azarkeivan, A., Nasiritoosi, M., Kafiabad, S. A., Maghsudlu, M., Hajibeigi, B., & Hadizadeh, M. (2011). Evaluation of new cases of HCV infection in thalassaemia patients for source of infection. *Asian journal of transfusion science*, 5(2), 132-135.
- Kumar, K., Kumar, M., Rahaman, S. H., Singh, T. B., Patel, S. K., & Nath, G. (2011). Distribution of Hepatitis B virus genotypes among healthy blood donors in eastern part of North India. *Asian journal of transfusion science*, 5(2), 144-149.
- Makroo, R. N., Chowdhry, M., Bhatia, A., Arora, B., & Rosamma, N. L. (2012). Hepatitis B core antibody testing in Indian blood donors: A double-edged sword!. *Asian Journal of Transfusion Science*, 6(1), 10-13.
- Durro, V., & Qyra, S. (2011). Trends in prevalence of hepatitis B virus infection among Albanian blood donors, 1999-2009. *Virology Journal*, 8, 1-6.
- Pallavi, P., Ganesh, C. K., Jayashree, K., & Manjunath, G. V. (2011). Seroprevalence and trends in transfusion transmitted infections among blood donors in a university hospital blood bank: a 5 year study. *Indian Journal of Hematology and blood transfusion*, 27, 1-6.
- Okoroïwu, H. U., Okafor, I. M., Asemota, E. A., & Okpokam, D. C. (2018). Seroprevalence of transfusion-transmissible infections (HBV, HCV, syphilis, and HIV) among prospective blood donors in a tertiary health care facility in Calabar, Nigeria; an eleven years evaluation. *BMC Public Health*, 18(1), 645.
- Durro, V., Koraqi, A., & Saliassi, S. (2010). Trends in the prevalence of transfusion-transmissible infections among blood donors in Albania. *Clinical laboratory*, 56(11-12), 591-595.
- Mohammed, Y., & Bekele, A. (2016). Seroprevalence of transfusion transmitted infection among blood donors at Jijiga blood bank, Eastern Ethiopia: retrospective 4 years study. *BMC research notes*, 9, 1-6.
- Mohammed, B. A., Badneen, M. A., Gibreel, M. O., & Othman, S. A. (2019). Prevalence of transfusion-transmissible infections among blood donors in Port Sudan. *The Egyptian Journal of Haematology*, 44(1), 72-76.
- Aabdien, M., Selim, N., Himatt, S., Hmissi, S., Merenkov, Z., AlKubaisi, N., ... & Al-Kaabi, S. (2020). Prevalence and trends of transfusion

- transmissible infections among blood donors in the State of Qatar, 2013–2017. *BMC infectious diseases*, 20(1), 1-9.
25. Fernandes, H., D'souza, P. F., & D'souza, P. M. (2010). Prevalence of transfusion transmitted infections in voluntary and replacement donors. *Indian Journal of Hematology and blood transfusion*, 26, 89-91.
  26. Siraj, N., Achila, O. O., Issac, J., Menghisteab, E., Hailemariam, M., Hagos, S., ... & Tesfamichael, D. (2018). Seroprevalence of transfusion-transmissible infections among blood donors at National Blood Transfusion Service, Eritrea: a seven-year retrospective study. *BMC infectious diseases*, 18(1), 1-9.
  27. Siraj, N., Achila, O. O., Issac, J., Menghisteab, E., Hailemariam, M., Hagos, S., ... & Tesfamichael, D. (2018). Seroprevalence of transfusion-transmissible infections among blood donors at National Blood Transfusion Service, Eritrea: a seven-year retrospective study. *BMC infectious diseases*, 18(1), 264.
  28. Almainan, A. A., & Almainan, S. H. (2018). Evaluation of Blood Donors and transfusion transmitted infections and their association with ABO and Rh Blood groups in Unaizah, Saudi Arabia: A retrospective study. *Int J Med Res Health Sci*, 7(3), 143-150. Available at <https://www.ijmrhs.com/medical-research/evaluation-of-blood-donors-and-transfusion-transmitted-infectionsand-their-association-with-abo-and-rh-blood-groups-in-.pdf>
  29. Farshadpour, F., Taherkhani, R., Tajbakhsh, S., Gholizadeh Tangestani, M., Hajjani, G., Sharifi, N., ... & Nejadbolckheyr, A. (2016). Prevalence and trends of transfusion-transmissible viral infections among blood donors in south of Iran: an eleven-year retrospective study. *PloS one*, 11(6), e0157615.
  30. Matee, M. I., Magesa, P. M., & Lyamuya, E. F. (2006). Seroprevalence of human immunodeficiency virus, hepatitis B and C viruses and syphilis infections among blood donors at the Muhimbili National Hospital in Dar Es Salaam, Tanzania. *BMC public health*, 6, 1-6.
  31. Niazkar, H. R., Dorgalaleh, A., & Rad, F. (2020). First-time blood donors are double-edged swords for blood transfusion centers: a retrospective study in Southwest Iran. *Turkish Journal of Hematology*, 37(1), 30-35.
  32. Pessoni, L. L., Aquino, É. C. D., & Alcântara, K. C. D. (2019). Prevalence and trends in transfusion-transmissible infections among blood donors in Brazil from 2010 to 2016. *Hematology, transfusion and cell therapy*, 41(4), 310-315.
  33. Saeed, M., Hussain, S., Rasheed, F., Ahmad, M., Arif, M., & MT, H. R. (2017). Silent killers: Transfusion Transmissible Infections-TTI, among asymptomatic population of Pakistan. *JPMA. The Journal of the Pakistan Medical Association*, 67(3), 369-374.
  34. Onyango, C. G., Ogonda, L., Guyah, B., Okoth, P., Shiluli, C., Humwa, F., & Opollo, V. (2018). Seroprevalence and determinants of transfusion transmissible infections among voluntary blood donors in Homabay, Kisumu and Siaya counties in western Kenya. *BMC research notes*, 11(1), 1-6.
  35. Bazie, E. A., Ali, M. A., Hamza, H. B., Magzoub, O. S., Salih, M. S., & Haroun, B. E. (2015). Seroprevalence of viral transfusion-transmissible infections among blood donors at Kosti Teaching Hospital, White Nile State/Sudan. *Int J Curr Microbiol App Sci*, 4(5), 1132-1138. Available at <https://www.ijcmas.com/vol-4-5/Elsharif%20Ahmed%20Bazie,%20et%20al.pdf>
  36. Alaidarous, M., Choudhary, R. K., Waly, M. I., Mir, S., Dukhyil, A. B., Banawas, S. S., & Alshehri, B. M. (2018). The prevalence of transfusion-transmitted infections and nucleic acid testing among blood donors in Majmaah, Saudi Arabia. *Journal of infection and public health*, 11(5), 702-706.
  37. Ali, M. S., Qowaider, S. R., & Moftah, S. A. (2014). Seroprevalence rates of transfusion-transmitted infections among blood donors in northeast of Libya. *J Sci Humanit*, 19, 1-7.
  38. Nada, H. A., & Atwa, M. (2013). Seroprevalence of HBV, HCV, HIV and syphilis markers among blood donors at Suez Canal University Hospital Blood Bank. *Blood Disord Transfus*, 5, 177.
  39. Negash, M., Ayalew, M., Geremew, D., & Workineh, M. (2019). Seroprevalence and associated risk factors for HIV, Hepatitis B and C among blood Donors in South Gondar District blood Bank, Northwest Ethiopia. *BMC infectious diseases*, 19(1), 1-10.
  40. Fouelifack Ymele, F., Keugoung, B., Fouedjio, J. H., Kouam, N., Mendibi, S., & Dongtsa Mabou, J. (2012). High rates of Hepatitis B and C and HIV Infections among blood donors in Cameroon: A proposed blood screening algorithm for blood donors in resource-limited settings. *Journal of blood transfusion*, 2012(1), 458372.
  41. Vermeulen, M., Swanevelde, R., Chowdhury, D., Ingram, C., Reddy, R., Bloch, E. M., ... & Murphy, E. L. (2017). NHLBI Recipient Epidemiology and Donor evaluation Study-III (REDS-III) International Component. Use of blood donor screening to monitor prevalence of HIV and hepatitis B and C Viruses, South Africa. *Emerg Infect Dis*, 23(09), 1560-1563.
  42. Bisseye, C., Sanou, M., Nagalo, B. M., Kiba, A., Compaoré, T. R., Tao, I., & Simporé, J. (2014). Epidemiology of syphilis in regional blood transfusion centres in Burkina Faso, West Africa. *Pan African Medical Journal*, 16(1), 69.
  43. Quintas, E., Cogle, A. C., Dias, C. C., & Sebastiao, A. (2018). Prevalence of syphilis in blood donors in Angola from 2011 to 2016. *Clin Med Rep*, 2, 1-4. Available at <https://www.oatext.com/pdf/CMR-2-119.pdf>

44. Kane, M. A., Bloch, E. M., Bruhn, R., Kaidarova, Z., & Murphy, E. L. (2015). Demographic determinants of syphilis seroprevalence among US blood donors, 2011–2012. *BMC infectious diseases*, 15, 1-9.
45. Drago, F., Cogorno, L., Ciccarese, G., Strada, P., Tognoni, M., Rebola, A., & Parodi, A. (2014). Prevalence of syphilis among voluntary blood donors in Liguria region (Italy) from 2009 to 2013. *International Journal of Infectious Diseases*, 28, 45-46.