With 120 million units of blood being donated each year globally, blood donors are indeed benefactors to humanity. However, poorly screened blood may carry a high potential risk of transmitting blood-borne infections to the recipients. A high seroprevalence of transfusion transmitted infections (TTIs) in donated blood is the main blood safety issue. The risk of low blood safety is higher in middle- and low-income countries due to higher prevalence of TTIs among the donors and lax screening.

In 2016, the Global Health Sector Strategy (GHSS) on viral hepatitis called for the elimination of this disease by 2030 by achieving 90% reduction in new cases and 65% reduction in related mortality. The core components of the GHSS strategy are blood and injection safety, HBV vaccination, prevention of vertical transmission of HBV from mothers to children, and horizontal transmission of HBV and HCV via various routes, in addition to identifying and treating existing cases. Effective primary prevention includes ensuring blood safety through screening of blood supplies.

Pakistan and Egypt together account for 80% of the viral hepatitis cases in the Eastern Mediterranean Region (EMR). Pakistan has the second highest global burden of HCV infection, with 5% prevalence (about 8 million people). Regarding HBV, 2.5% of the population is infected with it. Each year, there are 150,000 new cases of HBV and 250,000 new cases of HCV in Pakistan. HCV is a leading TTI in multi-transfused thalassemia major patients; the risk of HIV is rising. High frequency of HCV infection (3.52%) has been reported in blood donors in Hyderabad.

In Pakistan, as in many developing countries, there is a strong reliance on replacement donors and paid donors. Research suggests that this category of donors carry higher TTI risk than voluntary donors. In addition, there is problem of lax screening...
practices at the stage of collection and transfusion. More than 1.5 million units of blood is donated annually in Pakistan. There is high demand of blood due to the prevalence of blood disorders such as thalassemia and hemophilia, in addition to the needs for hemodialysis, pregnancy, surgeries, and accident and emergency cases.

World Health Organization (WHO) mandates that all donated blood should be screened for HIV, HBV, HCV, and syphilis. For specific countries, the WHO mandate stipulates screening for local diseases as well. Thus, all donated blood in Pakistan must be screened for malaria. In this study, we aimed to determine the prevalence of the previously mentioned TTIs among people who donated blood at a tertiary care hospital in Islamabad.

**METHODS**

The data for this retrospective study pertained to the years 2008–2019. We assessed the electronic records of all the blood donors registered at blood transfusion center in a tertiary care hospital in Islamabad. The study was approved by the Institutional Review Board and Ethical Committee of Shifa Tamkeen-e-Millat University (Ref. No. 188-678-2019). Until 2014, blood donors were screened only for HIV and HCV at this facility, but from 2015 onwards HBV, syphilis, and malaria were also added. All blood donors having body weight of ≥ 50 kg were included in the study. Anemic donors (hemoglobin < 12.5 g/dL for females and < 13.5 g/dL for males) were excluded. Exclusion criteria of American Association for Blood banking was followed. Donor records with incomplete data were also excluded.

As per the institution’s practice, former malaria patients were eligible to donate blood three months after completing their anti-malarial treatment. The records revealed that the blood donors were counseled by a staff nurse prior to donation. Each potential donor was required to fill a detailed health history questionnaire. This included demographic information (name, age, sex, marital status, profession, address, and contact numbers). Also included were donor status, current or previous medical illnesses, histories of immunization, dental extraction, surgeries, previous blood transfusions and donations, places traveled, the risk of TTI, previous TTI related results and notifications, and a basic medical assessment report. The blood donors at the tertiary care hospital in Islamabad are routinely screened using gold standard methods i.e., hepatitis B core antigen (HBcAg), HCV, HIV, by nucleic acid amplification technique (NAT) on cobas 6000 series, syphilis by enhanced chemiluminescence immunoassay (ECLIA) on cobas e 601, and anti-plasmodium parasite by immunochromatographic test (ICT).

The collected data was analyzed using SPSS version 21. Descriptive and analytical statistics were applied for qualitative variables like gender, blood group, infection type, etc. The frequency and percentages were calculated for each variable.

| Year | HIV Negative n | HIV Positive n (%) | HCV Negative n | HCV Positive n (%) | Total |
|------|----------------|-------------------|----------------|--------------------|-------|
| 2008 | 135            | 0 (0.0)           | 135            | 0 (0.0)            | 135   |
| 2009 | 5471           | 5 (0.1)           | 5370           | 106 (1.9)          | 5476  |
| 2010 | 7771           | 5 (0.1)           | 7613           | 163 (2.1)          | 7776  |
| 2011 | 8642           | 2 (0.02)          | 8511           | 133 (1.5)          | 8644  |
| 2012 | 9493           | 5 (0.1)           | 9332           | 166 (1.7)          | 9498  |
| 2013 | 11523          | 5 (0.04)          | 11337          | 191 (1.7)          | 11528 |
| 2014 | 12947          | 5 (0.04)          | 12753          | 199 (1.5)          | 12952 |
| 2015 | 14696          | 11 (0.1)          | 14473          | 234 (1.6)          | 14707 |
| 2016 | 13886          | 21 (0.2)          | 13725          | 182 (1.3)          | 13907 |
| 2017 | 12778          | 24 (0.2)          | 12658          | 144 (1.1)          | 12802 |
| 2018 | 11540          | 19 (0.2)          | 11414          | 145 (1.3)          | 11559 |
| 2019 | 11961          | 23 (0.2)          | 11821          | 163 (1.4)          | 11984 |
Between the years 2008 and 2019, \( N = 120\,968 \) potential donors were registered and screened at the blood transfusion center of this tertiary care hospital. Almost all were men (119,808; 99.0%) while the women numbered 1,160 (1.0%). Their ages ranged from 18 to 65 years. Nearly half (47.0%) were younger than 25 years and only 0.3% were older than 56. Most donors (81.1%) were residents of Islamabad city, followed by those from Punjab province (13.8%), Khyber Pakhtunkhwa (3.5%), Azad Kashmir (1.05%), and Gilgit Baltistan (0.1%).

The overall reactive and non-reactive donors with HIV and HCV during 2008–2019 are shown in Table 1. The frequency of HCV was much higher than HIV among the blood donors. The frequency of reactive cases of HIV was highest in 2017 (24; 0.2%), while those of HCV peaked at 234 (1.6%) in 2015. Table 2 shows the year-wise frequency of HBcAg, syphilis, and malaria infections. Table 3 shows that out of 120,968 total tested donors, most prevalent infection was HCV (\( n = 1837, 1.5\% \); 95% CI: 0.423–0.661) followed by syphilis (\( n = 437, 0.8\% \); 95% CI: 1.149–1.432). Compared to HBcAg and malaria, a considerable proportion of donors tested positive for syphilis during 2016–2019 [Table 2]. However, the frequency of syphilis infections decreased over time.

The predominant blood groups of the donors were B+ (37,649; 31.2%), O+ (34,699; 28.8%), and A+ (27,257; 22.5%). In females, HCV infection was most prevalent in the blood group O+; eight cases were of O+ out of 22 HCV positive cases [Table 4]. In males, HCV was the most prevalent TTI infection, followed by syphilis and HIV. HCV and syphilis were most frequently seen in blood group B+ donors while HIV was mostly detected in O+ males. There was no significant association between blood groups and TTIs. However, age of the donor was significantly associated with the frequency of HCV and syphilis.

Table 5 shows gender distribution in different TTIs infections. HIV was positive in 125 male donors and was not detected in females. Similarly, HBcAg and malaria were positive in only males. However, HCV and syphilis positivity was seen in both sexes. Table 6 reveals age-wise positive cases of HIV, HCV, HBcAg, syphilis, and malaria among blood donors. The highest number of HIV positive cases were observed in males < 25 years of age (59; 0.05%). HCV, syphilis, and malaria positive cases were more prevalent in age group 26–35 years. We also analyzed the trend of co-infection (risk of infection by more than one pathogen) among the blood donors. The frequency of co-infection of syphilis with HCV and HIV was 10 (0.02%) and

### Table 2: Year-wise frequency of Hepatitis B core antigen (HBcAg), syphilis, and malaria in blood donors.

| Year | HBcAg | Syphilis | Malaria | Total |
|------|-------|----------|---------|-------|
|      | Negative n | Positive n (%) | Negative n | Positive n (%) | Negative n | Positive n (%) |    |
| 2015 | 1508 | 0 (0.0) | 1508 | 0 (0.0) | 1508 | 0 (0.0) | 1508 |
| 2016 | 13,845 | 1 (0.01) | 13,711 | 135 (1.0) | 13,845 | 1 (0.01) | 13,846 |
| 2017 | 12,797 | 2 (0.02) | 12,691 | 108 (0.8) | 12,798 | 1 (0.01) | 12,799 |
| 2018 | 11,559 | 0 (0.0) | 11,453 | 106 (0.9) | 11,559 | 0 (0.0) | 11,559 |
| 2019 | 11,983 | 0 (0.0) | 11,901 | 82 (0.7) | 11,983 | 0 (0.0) | 11,983 |

### Table 3: Overall frequency of HIV, HCV, HBcAg, syphilis, and malaria among blood donors.

| Variables | Donors screened n | Time span, years | Sero-positive n (%) | 95% CI |
|-----------|-------------------|-----------------|-------------------|-------|
| HIV       | 120,968           | 2008–2019       | 125 (0.1)         | (0.191–0.283) |
| HCV       | 120,968           | 2008–2019       | 1,837 (1.5)       | (0.423–0.661) |
| HBcAg     | 51,695            | 2015–2019       | 3 (0.01)          | (0.95–1.002) |
| Malaria   | 51,695            | 2015–2019       | 2 (0.004)         | –      |
| Syphilis  | 51,695            | 2015–2019       | 437 (0.8)         | (1.149–1.432) |

HCV: hepatitis C virus; HBcAg: Hepatitis B core antigen.
Table 4: The prevalence of transfusion transmitted infections compared with the donors’ sex and blood group.

| Gender | Blood Group | HIV (n = 120968) | HCV (n = 120968) | HBcAg (n = 51695) | Malaria (n = 51695) | Syphilis (n = 51695) |
|--------|-------------|------------------|-----------------|------------------|-------------------|-------------------|
|        |             | Negative | Positive | Total | Negative | Positive | Total | Negative | Positive | Total | Negative | Positive | Total | Negative | Positive | Total |
| Female | A-          | 35       | 0        | 35    | 1       | 34       | 35    | 10       | 0        | 10    | 10       | 0        | 10    | 10       | 0        | 10    |
|        | A+          | 237      | 0        | 237   | 5       | 232      | 237   | 80       | 0        | 80    | 80       | 0        | 80    | 80       | 0        | 80    |
|        | AB-         | 9        | 0        | 9     | 0       | 9        | 9     | 0        | 0        | 0     | 0        | 0        | 0     | 0        | 0        | 0     |
|        | AB+         | 81       | 0        | 81    | 1       | 80       | 81    | 27       | 0        | 27    | 27       | 0        | 27    | 27       | 0        | 27    |
|        | B-          | 40       | 0        | 40    | 1       | 39       | 40    | 10       | 0        | 10    | 10       | 0        | 10    | 10       | 0        | 10    |
|        | B+          | 366      | 0        | 366   | 6       | 360      | 366   | 114      | 0        | 114   | 114      | 0        | 114   | 114      | 0        | 114   |
|        | O-          | 45       | 0        | 45    | 0       | 45       | 45    | 23       | 0        | 23    | 23       | 0        | 23    | 23       | 0        | 23    |
|        | O+          | 387      | 0        | 387   | 8       | 379      | 387   | 121      | 0        | 121   | 121      | 0        | 121   | 121      | 0        | 121   |
| Total  | 1200       | 0        | 1200    | 1178  | 22     | 1200     | 387   | 0        | 387      | 0     | 387      | 0        | 387   | 385      | 2        | 387   |
| Male   | A-          | 2485     | 1        | 2486  | 35     | 2486     | 1160  | 0        | 1160     | 0     | 1160     | 1071     | 0     | 1071     | 0        | 1071  |
|        | A+          | 27008    | 27       | 27035 | 408    | 27035    | 1160  | 1        | 1160     | 1     | 1160     | 1160     | 0     | 1160     | 0        | 1160  |
|        | AB-         | 939      | 1        | 940   | 18     | 940      | 377   | 0        | 377      | 0     | 377      | 377      | 0     | 377      | 0        | 377   |
|        | AB+         | 10367    | 12       | 10379 | 155    | 10379    | 377   | 1        | 377      | 1     | 377      | 15974    | 0     | 15974    | 0        | 15974|
|        | B-          | 3468     | 9        | 3477  | 55     | 3477     | 1408  | 1        | 1409     | 0     | 1409     | 1409     | 0     | 1409     | 0        | 1409 |
|        | B+          | 37353    | 30       | 37383 | 561    | 37383    | 15973 | 1        | 15974    | 1     | 15974    | 15974    | 0     | 15974    | 0        | 15974|
|        | O-          | 3653     | 3        | 3656  | 65     | 3656     | 1548  | 0        | 1548     | 0     | 1548     | 1548     | 0     | 1548     | 0        | 1548 |
|        | O+          | 34371    | 41       | 34412 | 517    | 34412    | 14805 | 2        | 14805    | 2     | 14805    | 14805    | 2     | 14805    | 2        | 14805|
| Total  | 119644     | 124      | 119768  | 117954| 1814   | 119768   | 51305 | 3        | 51308    | 2     | 51308    | 50873    | 435   | 51308    | 435      | 51308|

HCV: hepatitis C virus; HBcAg: Hepatitis B core antigen.

Table 5: Relationship of donors’ sex with prevalence of transfusion transmitted infections.

| Gender | HIV (n = 120968) | HCV (n = 120968) | HBcAg (n = 51695) | Malaria (n = 51695) | Syphilis (n = 51695) |
|--------|------------------|------------------|------------------|-------------------|---------------------|
|        | Negative | Positive | Total | Negative | Positive | Total | Negative | Positive | Total | Negative | Positive | Total | Negative | Positive | Total |
| Female | 1160     | 0        | 1160  | 1138     | 22       | 1160  | 377     | 0        | 377   | 377     | 0        | 377   | 375     | 2        | 377 |
| Male   | 119683   | 125      | 120843| 119808   | 117993   | 1215   | 119808  | 51315    | 3     | 51318   | 51316    | 2     | 51318   | 50883    | 435  |
| Total  | 120843   | 125      | 120968| 119131   | 1837     | 120968| 51692   | 3        | 51695 | 51693   | 2        | 51695 | 51258   | 437      | 51695|

HCV: hepatitis C virus; HBcAg: Hepatitis B core antigen.
DISCUSSION

This retrospective study sought to determine the prevalence of blood TTI, among blood donors in Pakistan. Our subjects were those who donated blood during the period 2008–2019 at a prominent tertiary care hospital in Islamabad. Blood transfusion services (BTS) at this hospital collect > 15,000 blood units every year, which are screened for HCV, HBV, malaria, syphilis, and HIV. In the present study, we have analyzed the frequency of TTIs among the donors to contribute towards formulation of evidence-based policies for improving blood safety at national level.

We analyzed the data of 120,968 donors, who were tested for viral and parasitic pathogens and showed 2.0% positivity for at least one pathogen. Other studies have reported prevalence of TTI up to 5.44% which was much higher than that observed in our study.6,16

Almost half of the donors over the last ten years belonged to the age group < 25 years (56,820; 47%), followed by age groups 26–35 years (47,232; 39%). This is consistent with the studies conducted within and outside Pakistan.2,15,17,18

In this study, 99.0% of the blood donors were male. This result was comparable with several studies from the developing world where the proportion of male donors was significantly higher than females.2,15,17,19,20 The comparatively lower percentage of female blood donors is sometimes attributed to several physiological factors in females like menstruation, lactation, and pregnancy.2 The most common cause of deferral for blood donation in females was reported to be low hemoglobin levels.21

The major influx (81.1%) of donors were from Islamabad which was the local population around the tertiary care facility from where our data were collected. Islamabad is a prosperous urban area and the low percentage of TTIs observed in our study is perhaps due to the literacy rate and awareness about clean blood among the residents compared to other parts of the country. A prospective cohort study in Pakistan over two years from 2013 to 2015 revealed that 64.02% of blood donor population belonged to urban areas while 35.98% belonged to rural areas.15

Considering the year-wise frequency of TTIs in our study population, we did not find any consistently falling or rising trends in positivity over time. HIV positive cases in our study were highest in the year 2017 (24; 0.2%) while 2015 saw the most HCV positive cases (234; 1.6%). The prevalence of HCV cases in our study is comparable to that of another retrospective study conducted at Rehman Medical Institute, Peshawar.16

HCV was the most common TTI (1837; 1.5%) among our participants, followed by syphilis (437; 0.8%). Similar results were reported by Memon et al.,13 where HCV was the most frequent TTI among blood donors (3.52%) followed by syphilis (3.01%).

The frequency of HIV in our data was 0.1% which is comparable with 0.24% reported by Siddiqui et al.,17 and 0.26% by Chandekar et al.19 Nevertheless, our data shows a rising trend in the frequency of HIV positive donors over the last ten years.

Only three (0.01%) donors tested positive for hepatitis B which is attributable to high rates of hepatitis B vaccinations.22,24 This is in sharp contrast with the much higher prevalence of 2.3% reported by Batool et al.,16 and 1.30% by Chandekar et al.19

South Asia is a malaria-endemic region and Pakistan is no exception. Cases in the Punjab province spike during summer, especially post-
monsoon. However, malaria was the least common TTI reported in this study (2 cases; 0.004%), which is consistent with previous studies in Pakistan and in India. The low incidence of malaria in our data can be attributed to the fact that blood donors were not tested for malaria until the year 2015 at the transfusion center of this hospital. Furthermore, malaria has been reported to be more prevalent in rural and low socio-economic settings while most donors in our study were residents of the city of Islamabad.

In terms of TTIs with respect to blood groups of our blood donors, the overall seroreactivity during 2015–2019 the highest in the blood group B+ (365; 0.7%), similar to that reported by Arif et al. The seroreactivity for O+ and A+ blood groups was (336; 0.6%) and (268; 0.5%) respectively. HCV and syphilis were most prevalent in blood group B+, followed by O+ among whom there were also more malaria cases, which was consistent with a previously published study. Our finding that HIV was most prevalent in blood group O+ was in contrast with Memon et al, who reported higher HIV prevalence in individuals with blood group A+. There was no significant association of HbcAg with any blood group in our study as opposed to Memon et al, who reported HbcAg to be more associated with O– blood group.

The near zero prevalence of HIV and HCV co-infection in our study (0.001%) parallels a previous Iranian finding of 0.01% prevalence of such co-infection among the general population. These findings contrast with those of a Western China which found co-infection of HIV/syphilis at 18.9% and HIV/HCV at 5.7%. The number of cases with co-infection of HIV and syphilis and HCV and syphilis were 4 and 10, respectively in our study. Others have reported HIV and hepatitis B as the most common co-infection followed by HIV and syphilis.

This study have some limitations. Firstly, women formed only 1% of our participants. Thus, our data may not reflect the prevalence of TTIs among the female population of Islamabad and its neighboring provinces. Secondly, we have only acquired the data from a single tertiary care hospital situated in the national capital, which makes it less generalizable at national level. In order to map prevalence of TTIs at national level, similar studies are warranted in other urban and semi-urban collection and transfusion centers of the country.

CONCLUSION

The prevalence of TTIs among blood donors in the current study suggests that it continues to be a significant risk to blood safety in Pakistan. B+ is the blood group with the highest prevalence of TTIs. HCV is the most prevalent TTI infection, followed by HIV in males. HCV and syphilis are the most frequent co-infections reported in our study. Many donors were youth below the age of 35 years. This highlights the necessity of following-up all seropositive donors, particularly younger men, to give them specialist treatment and counseling to prevent potentially debilitating infections from being further transmitted to their families and the society.

The prevalence of TTIs reported from other parts of the country is higher than that observed in the current study. This may be because our subjects were mostly residents of a prosperous city. There is a need for strident advocacy supported by strict monitoring to ensure that international screening standards are maintained all stages, in all centers of blood collection, storage, and transfusion, whether big or small, rural, or urban, all across Pakistan.

Disclosure
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REFERENCES

1. World Health Organisation (WHO). Blood Safety and Availability. [cited 7 April, 2022]. Available from: https://apps.who.int/iris/bitstream/handle/10665/255016/9789241565455-eng.pdf?sequence=1.
2. Abdien M, Selim N, Himart S, Hnissi 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 Aug;20(1):617.
3. Noubiap JJ, Joko WY, Nansseu JR, Tene UG, Siaka C. Sero-epidemiology of human immunodeficiency virus, hepatitis B and C viruses, and syphilis infections among first-time blood donors in Edéa, Cameroon. Int J Infect Dis 2013 Oct;17(10):e832-e837.
4. Fong IW. Current Trends and Concerns in Infectious Diseases. Curr Trends Concerns Infect Dis. 2020.
5. 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;9(4):e94528.
6. World Health Organisation (WHO). Global Hepatitis Report, 2017; 2017. [cited 18 August 2021] Available from: https://apps.who.int/iris/bitstream/handle/10665/235016/9789241565455-eng.pdf?sequence=1.
7. Dean CL, Wade J, Roback JD. Transfusion-Transmitted Infections: an Update on Product Screening, Diagnostic Techniques, and the Path Ahead. Kraft CS, ed. J Clin Microbiol. 2018;56(7):e00352-18.
8. Moin A, Fatima H, Qadir TF. Tackling hepatitis...
9. Masood I, Waheed U, Arshad M, Saeed M, Farooq A, Moneeb S, et al. Molecular epidemiology of hepatitis B virus genotypes in blood donors in Islamabad, Pakistan. J Lab Physicians 2019 Jul-Sep;11(3):240-243.
10. Fatima Asif A, Appraisal of National Response to Chronic Hepatitis in Pakistan. J Islam Med Dent Coll 2019;8(1):3-7.
11. EMRO W, WHO EMRO | Prevention and control of hepatitis | Programmes | Pakistan. Emro Who. 2015:20-21.
12. Zaheer HA, Waheed U. Blood safety system reforms in Pakistan. Blood Transfus 2014 Oct;12(4):452-457.
13. Memon FA, Ujjan ID, Memon AI, Shaikh AR, Rao AR, Naz A. Seroprevalence of transfusion transmitted infections among different blood group donors at Blood Bank LUMHS, Hyderabad. Pak J Med Sci 2017 Mar-Apr;33(2):443-446.
14. Saba N, Nasir JA, Waheed U, Aslam S, Mohammad I, Wazeer A, et al. Seroprevalence of Transfusion-Transmitted Infections among Voluntary and Replacement Blood Donors at the Peshawar Regional Blood Centre, Khyber Pakhtunkhwa, Pakistan. J Lab Physicians 2021 Jun;13(2):162-168.
15. Arshad A, Borhany M, Anwar N, Naseer I, Ansari R, Boota S, et al. Prevalence of transfusion transmissible infections in blood donors of Pakistan. BMC Hematol 2016 Nov;16:27.
16. Batool Z, Durrani SH, Tarig S. Association Of ABO And Rh Blood Group Types To Hepatitis B, Hepatitis C, HIV And Syphilis Infection, A Five Year’ Experience In Healthy Blood Donors In A Tertiary Care Hospital. J Ayub Med Coll Abbottabad 2017 Jan-Mar;29(1):90-92.
17. Siddiqui FM, Ahmed N, Oluwatayo O, et al. Prevalence of Transfusion-Transmissible Infections among Voluntary Blood Donors in Tertiary Health-Care Facility in Islamabad, Pakistan. 2019;9(6):9-12.
18. Mohamed Z, Kim JU, Magesa A, Kasubi M, Feldman SF, Chevalier S, et al. High prevalence and poor linkage to care of transfusion-transmitted infections among blood donors in Dar-es-Salaam, Tanzania. J Viral Hepat 2019 Jun;26(6):750-756.
19. Chandekar SA, Amonkar GP, Desai HM, Valvi N, Puranik GV. Seroprevalence of transfusion transmitted infections in healthy blood donors: A 5-year Tertiary Care Hospital experience. J Lab Physicians 2017 Oct-Dec;9(4):283-287.
20. Afraf 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 Journal of Pathology and Oncology 2021;8(2):271–275.
21. Mast AE. Low hemoglobin deferral in blood donors. Transfus Med Rev 2014 Jan;28(1):18-22.
22. Waheed U, Khan H, Satti HS, Ansari MA, Malik MA, Zaheer HA. Transfusion transmitted infections among blood donors of a teaching hospital in Islamabad, Pakistan. Ann Pak Inst Med Sci. 2012;8(4):236-239.
23. Safic Stanic H, Babic I, Maslovic M, Dogic V, Bingulac-Popovic J, Miletic M, et al. Three-year experience in NAT screening of blood donors for transfusion transmitted viruses in Croatia. Transfus Med Hemother 2017 Nov;44(6):415-420.
24. Yaseen H, Hasnain S. Epidemiology and risk factors of transfusion transmitted infections in thalassemia major: a multicenter study in Pakistan. Hematol Transfus Cell Ther 2019 Oct - Dec;41(4):316-323.
25. Qureshi NA, Fatima H, Afzal M, Khattak AA, Nawaz MA. Occurrence and seasonal variation of human Plasmodium infection in Punjab Province, Pakistan. BMC Infect Dis 2019 Nov;19(1):935.
26. Alemu G, Mama M. Assessing ABO/Rh blood group frequency and association with asymptomatic malaria among blood donors attending arba minch blood bank, South Ethiopia. Malar Res Treat 2016;2016:8043768.
27. Farshadpour F, Taherkhani R, Tajbakhsh S, Gholizadeh Tangestani M, Hajjani G, Sharifi N, et al. Prevalence and trends of transfusion-Transmissible viral infections among blood donors in south of Iran: An Eleven-Year retrospective study. PLoS One 2016 Jun;11(6):e0157615.
28. Yang T, Chen Q, Li D, Wang T, Gou Y, Wei B, et al. High prevalence of syphilis, HBV, and HCV co-infection, and low rate of effective vaccination against hepatitis B in HIV-infected patients in West China hospital. J Med Virol 2018 Jan;90(1):101-108.