

ORIGINAL ARTICLE**Seroprevalence and Trend of HBV, HCV, and HIV Infections among Blood Donors of Fars Province, Iran (2006-2018)**Mojtaba Azadbakht^{1&}, Masoud Torabi Ardakani^{1&}, Marziyeh Delirakbariazar², Leila Kasraian¹, Azad Khaledi^{3,4}, Hossein Foruozandeh^{5,6*}, Alireza Salah¹, Fahimeh Maleki^{1,7*}, Mohsen Eshraghi^{8**}**OPEN ACCESS**

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Affiliation and Correspondence:

¹Blood Transfusion Research Center, High Institute for Research and Education in Transfusion Medicine, Iran

²Tabriz University of Medical Sciences, Iran

³Department of Microbiology and Immunology, Faculty of Medicine, Kashan University of Medical Sciences, Iran

⁴Infectious Diseases Research Center, Faculty of Medicine, Kashan University of Medical Sciences, Kashan, IR Iran

⁵Cellular and Molecular Research Center, Gerash University of Medical Sciences, Iran

⁶Blood Transfusion Research Center, High Institute for Research and Education in Transfusion Medicine, Iran

⁷Paramedical School, Shiraz University of Medical Sciences

⁸Department of Thoracic Surgery, Qom University of Medical Sciences, Iran

*Email: hosainforuozandeh@yahoo.com

**Email:

Mohsen_eshraghi_188@yahoo.com

&They both are first author.

ABSTRACT

BACKGROUND: Blood transfusion is a life-saving procedure; millions of lives are saved each year. However, blood transfusions are associated with certain risks that can lead to adverse consequences. This study aimed to survey the prevalence and trend of hepatitis B virus (HBV), hepatitis C virus (HCV), and Human immunodeficiency virus (HIV) among blood donors of Fars province, Iran (2006-2018).

METHODS: This retrospective cross-sectional study was conducted by reviewing the records of the blood transfusion organization of Fars province. A total of 1952478 blood units were screened for transfusion-transmitted infections (TTIs). Then, data were entered into SPSS software (Negare. version 25). Chi-square test was used to compare the sof TTIs among blood donors. Chi-square test for trend was used to analyze the variations in trends of TTIs during this period. Finally, p-values less than 0.05 were considered statistically significant. GraphPad Prism software was used for the depiction of the graphs.

RESULTS: Among the 1952478 blood donations within the 13-years, 4479(0.229 %) of donors were HBsAg, HCV Ab, and HIV Ag-Ab positive. The seroprevalence of HBV, HCV, and HIV was 2684(0.137%), 1703(0.087 %), and 92(0.0047%), respectively.

CONCLUSION: The current study showed that the overall prevalence of TTIs among blood donors was low and had a descending trend over the years of study.

KEYWORDS: HIV, hepatitis B virus, HIV Seroprevalence, Blood transfusion

INTRODUCTION

Blood transfusion is a life-saving procedure, and millions of lives are saved each year. However, blood transfusions are associated with certain risks that can lead to adverse consequences. It may cause acute or delayed complications and carries the risk of the transmission of infections that might be fatal rather than that of saving life (1). The discovery of transfusion-transmissible infections (TTIs) has heralded a new era in blood transfusion medicine worldwide with the emphasis on two fundamental

objectives: safety, and protection of human life (2). TTIs; namely, hepatitis B virus (HBV), hepatitis C virus (HCV), Human Immunodeficiency Virus (HIV), and syphilis are major challenges to blood transfusion services. These viruses create a big challenge for blood safety because of their prolonged viraemia, carrier, latent state and chronic state, and life-threatening complications.

The World Health Organization (WHO) reported that 37.9 million [32.7 million-44.0 million] people globally were living with HIV at the end of 2018. Also, an estimated 0.8% [0.6-0.9%] of adults aged 15-49 years are living with HIV worldwide (3). In Iran, the prevalence of HIV and other blood-borne viral infections is relatively low in the general population (4). The HIV prevalence in different subgroups varied from 0.00% in the general population to 17.25% in intravenous drug abusers (5). HBV is extremely contagious and relatively easy to transmit from infected individuals to others through some ways like birth, unprotected sex, blood transfusion, and also sharing needles. In various areas of the world, the incidence of HBV infection varied from 0.1 to 20%(6). Iran was categorized among countries with low-intermediate HBV prevalence, where its prevalence was reported between 2-4% in the general population (7). Also, the worldwide prevalence of HCV infection among HCV blood donors varies from 0.4% to 19.2% (8).

Because of the risk of infected donations despite screening tests, HBV, HCV, and HIV are considered as one of the major challenges of blood safety globally. Thus, it is necessary to survey the prevalence and trend of TTIs in blood donors to estimate the infectious risk through blood transfusion and the effectiveness of safety measures that were taken in Fars BTO. Thus, this study aimed to survey the seroprevalence and trend of HBV, HCV, and HIV infections among blood donors of Fars province, Iran, between 2006 to 2018.

METHODS AND MATERIALS

This retrospective, cross-sectional study on the TTIs was conducted at Blood Transfusion Organization of Fars, Iran. Fars province is one of the thirty-one provinces of Iran which is located in the south of the country and has an area of 122,400

km². In 2011, this province had a population of about 4.6 million people (9). A total of 1,952,478 blood donations carried out in blood centers of Fars province between 1 January 2006 and 31 December 2018 were included in this study. The identical standard measures were used for blood donor recruitment, selection, deferral and laboratory tests in all centers of Blood Transfusion. Blood donors were volunteers, and their eligibility for donation was determined by the history and physical and hematological examinations before blood donation. For screening infectious diseases, the samples were collected in pilot test tubes at the time of blood donation. They were examined in the screening laboratory of the Shiraz Blood Transfusion Organization.

HBsAg, HCV-Ab, and HIV Ag-Ab positivity: Testing for HBsAg, anti-HCV, and anti-HIV was performed using the kits listed in Table 1 according to the manufacturer's instructions and all the standard protocols were followed. All initial positive results were checked by performing a double check test using the same assay on the same pilot. Confirmatory or supplemental tests such as western blot for HIV, neutralization for HBV and confirmatory recombinant immunoblot assay (RIBA) for HCV were performed on the blood samples of blood units (Tables 2, 3).

Then, the records including data on the donation type and date, demographic characteristics such as age, gender, marital status and results of serologic tests were extracted from statistical software of Blood Transfusion Organization (Negara). It should be noted that the donors were classified into three groups: "First-time donor" was referred to a person who had not a history of blood donation. "Regular donor" referred to anyone who donated blood at least twice a year, and "Repeatdonor" was a person who had a history of previous donations, but the interval between two donations was longer than a year.

Statistical analysis: Data were entered into SPSS software (Negare. version 25). All data were prepared as frequencies and percentages for basic descriptive statistics. The yearly seroprevalence of TTIs was provided for all the study populations and different socio-demographic characteristics. Chi-square test was used to compare the sof TTIs among blood donors. Chi-square test for trend was

used to analyze the variations in trends of TTIs during this period. Finally, p-values less than 0.05 was considered statistically significant. GraphPad Prism software was used for the depiction of the graphs.

Ethical considerations

This study was approved by the ethics committee of Gerash University of Medical Sciences, Gerash, Iran with reference number IR.GERUMS.REC.1398.005

RESULTS

Characteristics of Donors: Throughout the study, 1952478 donations were collected between 1 January 2006 and 31 December 2018. The number of donations progressively increased from 137458 in 2006 to 158028 in 2018. Among the blood donors, 1,853,118(94.9%) and 99,360(5.08%) were males and females, respectively.

Findings of HBsAg, HCV-Ab, and HIV Ag-Ab positivity: The results of serological screening tests for HBV, HCV and HIV infections showed that the prevalence was 2684(0.137 %) for HBsAg, 1703(0.087 %) for anti-HCV, and 92(0.0047%) for HIV. Briefly, HBS had the highest prevalence, while HIV had the lowest one. The distribution of seroprevalences of HBsAg, anti-HCV, and anti-HIV 1/2 antibodies according to the years is shown

in Table 1 and Figures 1,2 and 3. Also, the demographic characteristics of the viral infectious positive blood donors are shown in Table 1.

The results of blood donation showed that although the blood donation rate increased during this period, the prevalence of HBs Ag among blood donors during this period had a downward trend. This decline was almost the same in initial, double checks and confirmatory tests. Also, the highest prevalence of HBs Ag was observed in the range of 31 to 50 years old. Regarding HCV, this trend is also descending and the highest levels of infection were reported in the people aged 26 to 40 years. The trend of HIV infection frequency was relatively fluctuating, as it had an increasing pattern from 2006 to 2009, but showed a descending trend after 2009. Also, donors between 26 to 35 years old had the highest levels of HIV infection. The trend of prevalence rates of HBS, HCV, and HIV from 2006 to 2018 is shown in Figs1-3. Considering the related risk factors such as gender, marital status, and type of donors, it was revealed that the prevalence of these infections among males was higher than among females, and it was higher among married people compared to single ones. Finally, the prevalence among the first time donors was significantly higher than than the ones among regular and repeat donors (Table 1).

Table 1: Yearly seroprevalence of confirmed HBV, HCV, and HIV infections according to socio-demographic characteristics of blood donors of Fars province, Iran, between 2006 and 2018.

Total	Test	Total No. Positive	Female No (%)	Male No (%)	First time donor No (%)	repeat donor Male (%) No	Regular donor (No) (%) ale					
								HBsAg	2684	180 (6.7 %)	2504(93.3%)	2341(87.22%)
	HCV	1703	40 (2.35 %)	1663(97.71%)	1466(86.08%)	132 (7.75 %)	105(6.17 %)					
	HIV	92	10 (10.87 %)	82 (89.13 %)	70 (76.09 %)	17 (18.48 %)	5 (5.43 %)					
Prevalence of infections according to age												
Total blood donation	Test	Total No. Positive	Age groups									
			20≥	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61≤
1952478	HBsAg	2684 (0.137 %)	123	304	311	318	322	340	335	273	131	36
	HCV	1703 (0.087 %)	32	147	351	366	258	165	125	89	40	4
	HIV	92 (0.0047%)	4	11	19	26	12	9	4	0	1	0

Table 2: The kits used in donor screening, 2006-2018.

year	HBsAg Screening test kit	Anti-HCV Screening test	HIV Ag-Abs Screening test kit
2018	EnzygnostHBsAg 6.0 Siemens	Monolisa Anti-HCV Plus v3 Biorad	HIV Ag-Ab Ultra Biorad
2017	Enzygnost HBs Ag 6.0 Siemens	EIAgen HCV Ab V4 Adaltis Monolisa Anti-HCV Plus v3 Biorad	Enzygnost HIV Integral 4 Siemens HIV Ag-Ab Ultra Biorad
2016	EnzygnostHBsAg 6.0 Siemens	EIAgen HCV Ab V4 Adaltis Enzygnost Anti HCV 4 Siemens	EIAgen Detect HIV4 Total Screening Adaltis Enzygnost HIV Integral 4 Siemens
2015	EnzygnostHBsAg 6.0 Siemens Murex HBsAg Version 3.0 Diasorin	EIAgen HCV Ab V4 Adaltis Enzygnost Anti HCV 4 Siemens HCV Ultra Biomedical	EIAgen Detect HIV4 Total Screening Adaltis
2014	EnzygnostHBsAg 6.0 Siemens Murex HBsAg Version 3.0 Diasorin	HCV Ultra Biomedical Innotest HCV Ab IV Murex Anti HCV Antibody V4	EIAgen Detect HIV4 Total Screening Adaltis HIV Ag-AbBiomerieux Murex HIV Ag-Ab
2013	EnzygnostHBsAg 6.0 Siemens HBsAg Ultra Biorad	HCV Ultra Biomedical	HIV Ag-AbBiomerieux
2012	EnzygnostHBsAg 6.0 Siemens HBsAg Ultra Biorad	HCV Ultra Biomedical	HIV Ag-AbBiomerieux
2011	EnzygnostHBsAg 6.0 Siemens HBs Ag -Dade Behring	HCV Ab Ultra Biomedical	HIV Ag-AbBiorad- HIV Ag-AbBiomerieux
2010	HBs Ag -Dade Behring	HCV Ab Ultra Biomedical HCV Ab Ortho	HIV Ag-AbBiorad- HIV Ag-AbBiomerieux
2009	HBs Ag -Dade Behring	HCV Ab Ortho	HIV Ag-AbBiorad- HIV Ag-AbBiomerieux
2008	HBs Ag -Dade Behring	HCV Ab Ultra Biomedical HCV Ab Ortho	HIV Ag-AbBiorad- HIV Ag-AbBiomerieux
2007	HBs Ag -Dade Behring	HCV Ab Ultra Biomedical	HIV Ag-AbBiomerieux
2006	HBs Ag -Dade Behring	HCV Ab Ultra Biomedical	HIV Ag-AbBiorad-

Table 3: The kits used in donor screening (Confirmatory), 2006-2018

year	HBs Ag Confirmatory test	HCV RIBA	HIV Western Blot
2018	Anti HBc Monoclonal SimenseEnzygost	HCV Blot Riba MP diagnostic	HIV Blot MP Diagnostic
	Anti HbsAg Confirmatory SimenseEnzygost	Inno-LIA HCV Score Fujirebio	Inno-LIA HIV I-II Score Fujirebio
2017	Anti HBc Monoclonal SimenseEnzygost	HCV Blot Riba MP diagnostic	HIV Blot MP Diagnostic
	Anti HbsAg Confirmatory SimenseEnzygost	Inno-LIA HCV Score Fujirebio	Inno-LIA HIV I-II Score Fujirebio
2016	Anti HBc Monoclonal SimenseEnzygost	HCV Blot Riba MP diagnostic	HIV Blot MP Diagnostic
	HBcSimenseEnzygnost	Inno-LIA HCV Score Fujirebio	Inno-LIA HIV I-II Score Fujirebio
2015	Murex Hbs Ag Confirmatory	HCV Blot Riba MP diagnostic	HIV Blot MP Diagnostic
	Murex HBc Total HBcSimenseEnzygnost		Inno-LIA HIV I-II Score Innogenetics
2014	Murex Hbs Ag Confirmatory	HCV Blot Riba MP diagnostic	HIV Blot MP Diagnostic
	Murex HBc Total HBcSimenseEnzygnost	Inno-LIA HCV Score Fujirebio	
2013	Anti HbsAg Confirmatory SimenseEnzygost	HCV Blot Riba MP diagnostic	HIV Blot MP Diagnostic
	HBcSimenseEnzygnost		Inno-LIA HIV I-II Score Innogenetics
2012	HBcSimenseEnzygnost	HCV Blot Riba MP diagnostic	HIV Blot MP Diagnostic
			Inno-LIA HIV I-II Score Innogenetics
2011	Anti HBc PLUS Biorad HBcSimenseEnzygnost	HCV Blot Riba MP diagnostic	HIV Blot MP Inogenetic
		Inno-LIA HCV Score INNOGENETICS	HIV Blot MP Inogenetic
2010	Anti HBc PLUS Biorad	HCV Blot Riba MP diagnostic	HIV Blot MP Diagnostic
		Inno-LIA HCV Score INNOGENETICS	
2009	Anti HbsAg Confirmatory SimenseEnzygost	HCV Blot Riba MP diagnostic	HIV Blot MP Diagnostic
	HBcAb- BiomeruxHepanostica	Inno-LIA HCV Score INNOGENETICS	Inno-LIA HIV I-II Score Innogenetics
2008	Anti HbsAg Confirmatory test Dade Behring	HCV Blot Riba MP diagnostic	HIV Blot MP Diagnostic
	HBcAb- BiomeruxHepanostica	Inno-LIA HCV Score INNOGENETICS	Inno-LIA HIV I-II Score Innogenetics
2007	Anti HbsAg Confirmatory test Dade Behring	HCV Blot Riba MP diagnostic	HIV Blot MP Diagnostic
	HBcAb- BiomeruxHepanostica	Inno-LIA HCV Score INNOGENETICS	Inno-LIA HIV I-II Score Innogenetics
2006	Anti HbsAg Confirmatory test Dade Behring	HCV Blot Riba MP diagnostic	HIV Blot MP Diagnostic
	HBcAb- BiomeruxHepanostica	Inno-LIA HCV Score INNOGENETICS	

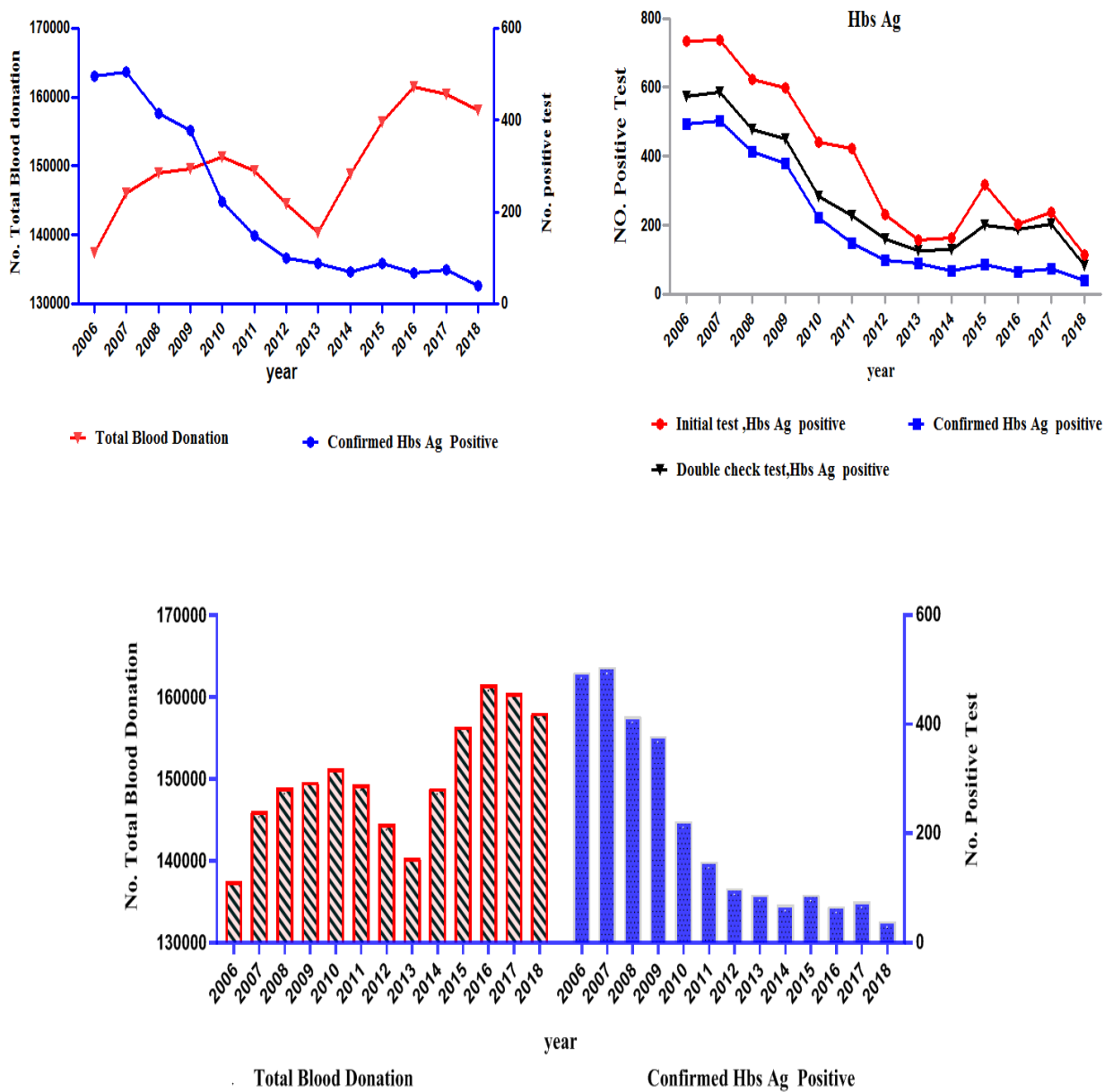


Figure 1: Prevalence and trend of the initial, double check and confirmatory test of HBsAg infection among blood donors of Fars province, Iran, between 2006 to 2018

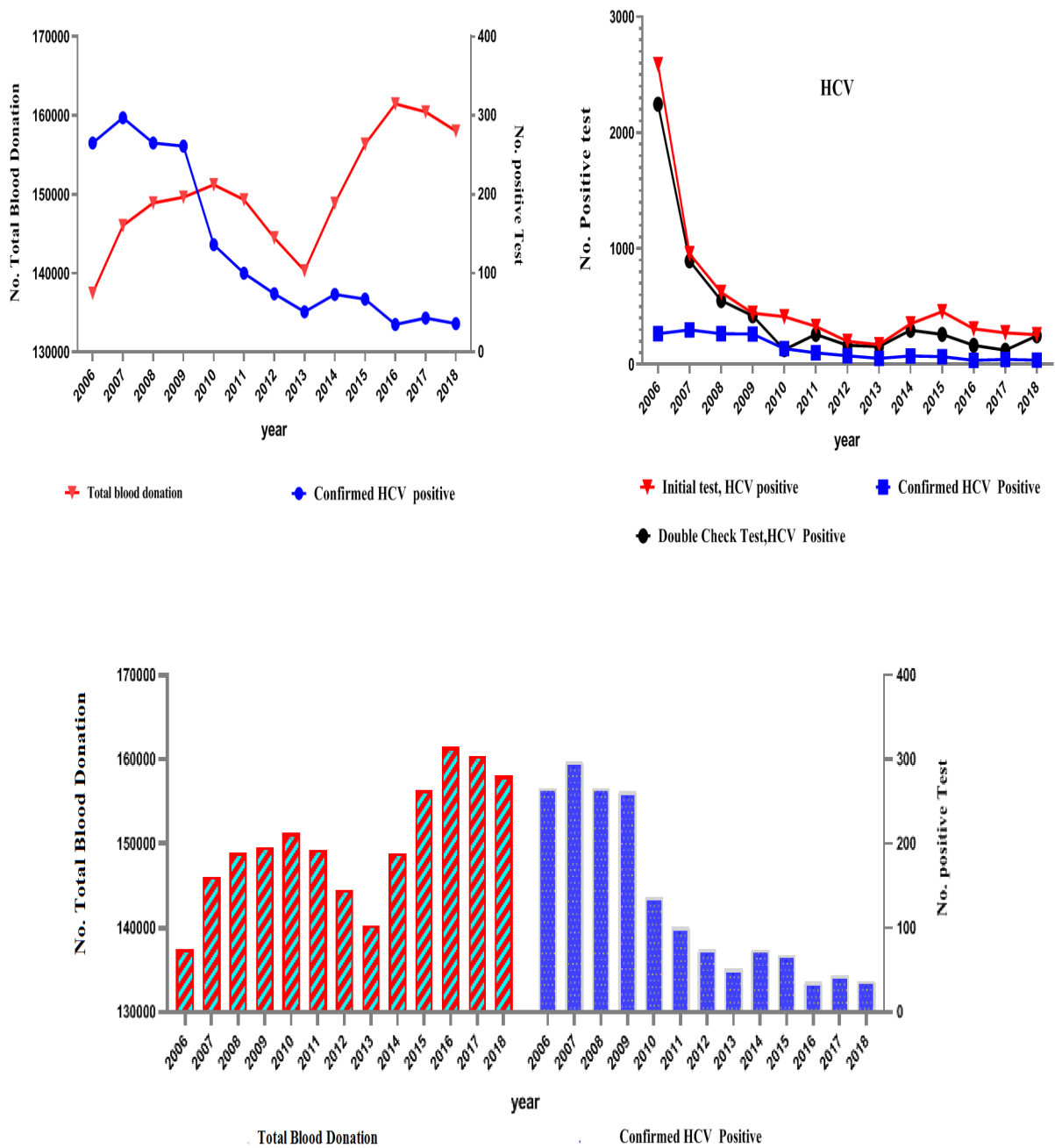


Figure 2: Prevalence and trend of the initial, double check and confirmatory test of HCV infection among blood donors of Fars province, Iran, from 2006 to 2018

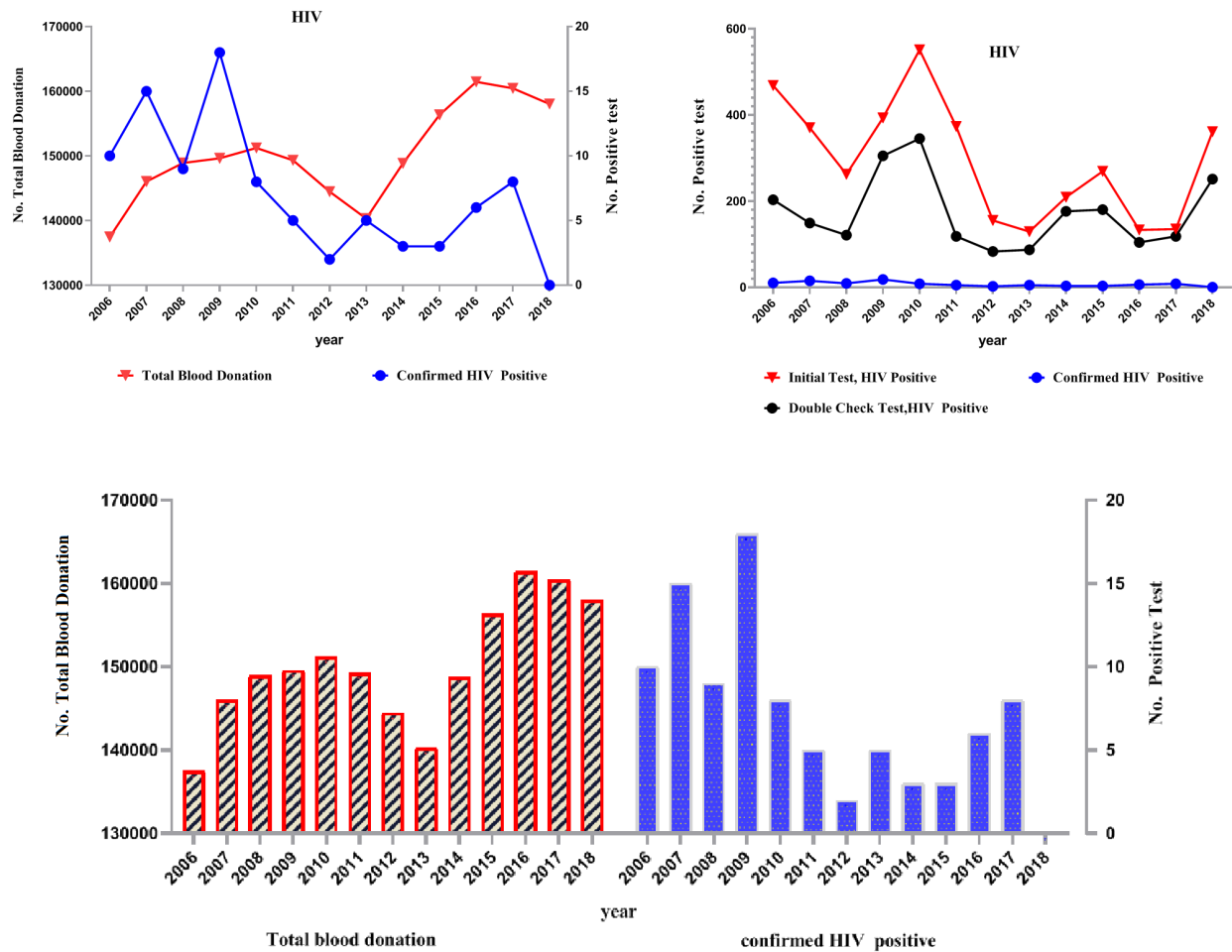


Figure 3: Prevalence and trend of the initial, double check, and confirmatory test of HIV infection among blood donors of Fars province, Iran, from 2006 to 2018

DISCUSSION

Although blood transfusion is an integral part of medical therapy which can save millions of lives worldwide each year, it has a life-threatening hazard, too. Thus, proper selection of donors and sensitive screening tests of all donated blood is essential to decrease this risk to the minimum (10). Providing a safe and sufficient blood supply is one of the most important aims of any blood transfusion organization. For preventing transmission of viral infections, strict screening of all blood donations is necessary. In Iran, serological screening of all donated blood is obligatory for HBV, HCV, and HIV(11). Monitoring the trend of viral infections in the blood donor population over time reveals the efficacy of safety measures that were implanted by blood

transfusion centers (12). Thus, the current study was conducted to find out the prevalence and trend of HBV, HCV, and HIV infections in all blood donations of Fars province from 2006 to 2018. Our findings demonstrated a very low prevalence of TTIs among blood donors. The overall prevalence of TTIs among blood donors of Fars province was 0.229% (n=4479) that was lower than the donors of Tehran province during 2005 to 2011 with the prevalence of 0.506% (13), and donors of Kerman province in 2009-2013 with the prevalence of 0.316% (14). However, it was higher than Kohgiluyeh and Boyer-Ahmad province donors in 2005-2014 with a prevalence of 0.204% (15). In the present study, the seroprevalences of HBV was 0.137 % which is lower than the previous study conducted by Kasraian et al. in Fars province

between 2002 and 2005, which shows the effectiveness of the safety measures which were established over time (16). Also, the prevalence of HBV in our study was lower than other studies reporting from different regions of Iran, such as Bushehr province from 2004 to 2014 with a prevalence of 0.15 (17), Tehran's Blood Transfusion Center from 2005 to 2011 with a prevalence of 0.38%(13), and Tehran Blood Transfusion Center from 2003 to 2005 with a prevalence of 0.6%(18). Other previous studies have also shown that the prevalence of HBV among blood donors in Fars province was very low; for example, a study that evaluated the prevalence of hepatitis B virus infection among blood donors of Fars province between 1998-2007 showed the lowest prevalence of HBV among blood donors (19). This difference in the prevalence of HBV infection may be due to the differences in social behaviors, culture, lifestyle, socioeconomic status, the geographical distribution of the infection, and the level of awareness in different regions of our country. The prevalence of HBV in the present study was also lower than many countries such as Eastern Turkey (2.55%) (20), Pakistan (1.46%-2.99%) (21), India (1.96%) (22), Mali (13.9%) (23), China (0.87%) (24), and Mongolia (8.1%) (25). However, it was higher than other studies from Italy (0.0069%) (26), and Canada (0.007%-0.06%) (27).

Furthermore, the present study showed that the prevalence of HBV amongst blood donors had a descending trend in this period, and significantly decreasing from 0.36% in 2006 to 0.024% in 2018. Such a decline may be due to improvement in donor recruitment, strict donor selection criteria during the pre-donation examination, and use of blood transfusion databases (19). Also, the prevalence of HBV infection decreased dramatically in the Iranian population during the last decade. Improvement of the people's knowledge about HBV risk factors, preventive measures, national vaccination program since 1993 for all neonates, and vaccination of teenagers and high-risk groups can be the cause of this reduction (28).

Our findings also indicated that HBV was more prevalent among the age range of 26-50

years. This is in agreement with other studies, which have shown a remarkable association between higher HBV prevalence and older ages (24, 27, 29). This is due to engagement in high-risk behaviors over time and increasing exposure to HBV with age.

The results of our study indicated that the overall seroprevalences of HCV was 0.087% between blood donors of Fars province which was lower than other studies conducted on Iranian blood donors such as 0.1% in Bushehr Province between 2004-2014(17), 0.13% in Iranian blood donors during 2004-2007 (12), 0.1% in Iranian blood donors from 2003 to 2005 (18), and 0.11% in blood donors of Tehran province from 2005-2011(13). Different results on the prevalence of HCV infection among the Iranian blood donors may be due to the study periods, the sample size, the geographical regions, risk factors, and the sensitivity of HCV kits which were used (30). In comparison with countries in this geographical region, we have the lowest prevalence of HCV infection. The HCV prevalence in the present study is lower compared to many countries such as Pakistan (3.01%-4.99%) (21), Eastern Turkey (0.17%) (20), Mali (3.3%) (23), China (0.86%) (24), and Kurdistan Region of Iraq (0.2%) (31), while the prevalence was higher than Australia (0.01%) (32), and Italy (0.0016%) (26). The wide variation of HCV seroprevalence in different parts of the world may be due to the population risks, health status, public awareness, use of different generations of ELISA test kits, the criteria of positivity, types of donors, quality of donor screening, and selection procedure in those regions(33).

The highest HCV seroprevalence was observed among donors aged 26 to 35 years. The late positivity of anti-HCV may be due to exposure to its risk factors at an older age (34). Also, the results of this study indicated that the prevalence of HCV infection among blood donors in Fars province had a significant and impressive decline from 0.186% in 2006 to 0.0228% in 2018. The reasons for this decline were the implementation of more restrictive guidelines on physical examination before donation and the application of more sensitive HCV test kits for screening the blood by

Iran Blood Transfusion Centers (35). Furthermore, the public has become more aware of the routes of transmission of HCV infection in recent years.

In the present study, the prevalence of HIV infection among blood donors was 0.0047%, which was lower than a study conducted on Iranian blood donors, such as 0.0053% in Tehran Province between 2005-2011 (13). However, it was higher than Kohgiluyeh and Boyer-Ahmad province with a prevalence of 0.0016% (15).

Moreover, the prevalence of HIV is low compared to other parts of the world such as Eastern Turkey with 0.036% (20), Mangalore with 0.1% (36), Eastern Ethiopia with 0.1 % (37), China with 0.31% (24), and Mali with 2.6% (23), but it was higher than the results reported from Australia (0.0003%) (32), Italy (0.00019%) (26), and Mongolia (0%) (25).

Also, evaluating the prevalence of HIV infection among the blood donors showed a fluctuating and descending trend in this period from 0.0072% in 2006 to 0% in 2018. The government of Iran is committed to the provision of universal access to HIV prevention (free condom, education, HIV testing), and antiviral therapy services for all at-risk or affected populations as outlined in the 4th National AIDS Strategic Plan 2015–19 (6). These health policies and interventions led to the reduction of main blood-borne infections in Iran (38).

The present study showed a higher prevalence of HBV, HCV, and HIV infections among first-time donors compared to regular and repeat donors. These findings are consistent with those of other studies showing that the prevalence of viral infections was higher among first-time donors(39). The reason may be the denial of high-risk behavior at pre-donation screening or the donation of blood for HIV check-up. The lower prevalence of TTIs in repeat and regular blood donors may be due to the acquisition of information about the importance of safe blood in the previous donation, having a negative test in pervious donations and the lower probability of engagement in high-risk behavior (16).

In our study, the seroprevalence of TTIs was lower among female donors compared to male ones. This finding is in the same line with previous studies reported from other areas of the world (12,

37, 40). It may be due to a low number of females donating blood; therefore, fewer females are screened compared to males. Moreover, the lower contribution of women in social activities and high-risk behaviors such as multiple sex relationships and intravenous drug use have a role in these gender differences (17, 37).

Our findings revealed that the prevalence of TTIs was higher in married donors. It may be due to family problems and sexual reasons reported in other studies (13).

Also, our findings indicated that the prevalence of HBV was significantly higher than that of HCV and HIV. Similar findings have also been reported from previous studies (12, 18). It may be due to more contagiousness of HBV risky sexual activities compared to HCV and HIV. However, HCV was transmitted mainly through transfusion of blood or blood products, intravenous drug abuse, and needle sharing(38, 40). Our study also demonstrated that despite an increase in the total blood donation from 2006 to 2018, the seroprevalence of HBV, HCV, and HIV has declined in blood donors. The implementation of some procedures in the Iran Blood Transfusion Organization might have led to the reduction of the TTIs in blood units. One of these procedures was implementing confidential unit exclusion (CUE) since 2002 for the identification and elimination of high-risk donors. Other safety measures were; data registry of all blood donors by computerized software and uniform donor deferral criteria, which has been implemented since 1997. Also, validating all procedures across the country and screening of first-time volunteer donors in 2017 and 2018 have had an important role in reduction of TTIs over time (17, 19). Also, in the last decade, educational efforts of IBTO to increase the public's knowledge on TTIs and routes of transmission of TTIs have had a considerable role in reducing these infections in the donor population (19, 30).

The results of the present study showed that the overall prevalence of TTIs among blood donors of Fars Province was low and has been steadily reduced over time. It reveals that donor screening and selecting policy established by Fars blood transfusion centers have been effective in recent years.

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