Transfusion and Apheresis Science 53 (2015) 308–314

Contents lists available at ScienceDirect

Transfusion and Apheresis Science

journal homepage: www.elsevier.com/locate/transci

Hepatitis B, Hepatitis C, Human immunodeficiency virus and syphilis frequency among blood donors: A single center study

Sule Menziletoglu Yildiz [a,*], Aslihan Candevir [b], Filiz Kibar [c], Gulser Karaboga [a], Ferda Tekin Turhan [d], Cem Kis [e], Suleyman Dincer [f], Birol Guvenc [a,d,e]

[a] Blood Bank, Faculty of Medicine, Balcali Hospital, Cukurova University, Saricam, Adana 01330, Turkey
[b] Division of Infectious Diseases, Faculty of Medicine, Balcali Hospital, Cukurova University, Saricam, Adana 01330, Turkey
[c] Department of Microbiology, Faculty of Medicine, Balcali Hospital, Cukurova University, Saricam, Adana 01330, Turkey
[d] Hemapheresis, Stem Cell and Cryopreservation Unit, Balcali Hospital, Cukurova University, Saricam, Adana 01330, Turkey
[e] Department of Internal Medicine, Division of Hematology, Balcali Hospital, Cukurova University, Saricam, Adana 01330, Turkey
[f] Hisar Intercontinental Hospital, Umraniye, Istanbul 34768, Turkey

ARTICLE INFO

Article history:
Received 17 March 2015
Received in revised form 20 May 2015
Accepted 28 May 2015

Keywords:
Blood donors
Hepatitis B
Hepatitis C
Human immunodeficiency virus
Syphilis
Transfusion-transmitted infections

ABSTRACT

We aimed to provide updated results for seroprevalence of hepatitis B, hepatitis C viruses while presenting first data for human immunodeficiency virus and syphilis seropositivity amongst blood donors in Adana, Turkey. Screening and confirmatory test results of 62,461 donors were evaluated. HBsAg, anti-HCV, anti-HIV1/2 and syphilis seropositivity was 1.92%, 0.48%, 0.20%, 0.18% respectively, based on screening tests, and 1.66%, 0.05%, 0.003%, 0.10% respectively, according to confirmatory tests. Transfusion-transmitted infections (TTI) was more prevalent in low-educated donors. HBsAg and syphilis seropositivity rates were higher in married subjects. We found that the prevalence of HBV and HCV was significantly decreased in the last two decades in Adana. Importantly, this study provides first data in HIV and syphilis seropositivity rates among blood donors in our region and both HIV and syphilis seroprevalences were found to be low compared to many regions of Turkey. However, considering the fact that increasing number of immigrants may change prevalences and trends of TTI both in Adana and in Turkey, strict monitorization and yearly reporting of TTI rates seem necessary to be able to take proactive measures.

© 2015 Elsevier Ltd. All rights reserved.

1. Introduction

Blood transfusion is one of the most important therapeutic tools in the modern medicine. However, it carries potential risks of serious side effects for the recipient. It has been long known that wide variety of viral, bacterial and parasitic agents can be transmitted through blood transfusion [1]. The human immunodeficiency virus (HIV), hepatitis B virus (HBV), hepatitis C virus (HCV) and other blood borne viruses are still the most common causes of morbidity and mortality around the world, particularly in developing countries [2]. Hence, the World Health Organization (WHO) recommends that screening all donated blood for transfusion-transmitted infections (TTIs) like HBV, HCV, HIV and syphilis should be mandatory [3].

In the last few decades, a significant progress has been made in blood safety all over the world. Preventive measures such as implementing of routine screening tests in blood banks, improvements in donor selection criteria, attempts to establish a voluntary unpaid donor population, pathogen inactivation technology, and the development of highly sensitive screening tests remarkably decreased the frequency of TTIs. In addition to these, nucleic acid amplification testing (NAT) has made an important contribution

* Corresponding author. Cukurova University Blood Bank, Cukurova University, Faculty of Medicine, Balcali Hospital, Saricam, Adana 01330, Turkey. Tel.: +903223386060/3027; fax: +903223386938.
E-mail address: suleyildiz01@yahoo.com (S.M. Yildiz).

http://dx.doi.org/10.1016/j.transci.2015.05.022
1473-0502/© 2015 Elsevier Ltd. All rights reserved.

to the concept of blood transfusion safety [4]. However, the TTI risk is still quite high in low-income and some of middle-income countries including Turkey because of the costs of advanced testing methods, difficulties in finding voluntary and unpaid blood donors, relatively weak public awareness about TTIs and other limiting factors [4–6].

In Turkey, screening of donated bloods for hepatitis B surface antigen (HBsAg), syphilis and malaria became mandatory in 1983. Afterwards, in 1987 anti-HIV, and in 1996 anti-HCV was added to the mandatory screening test panel [7]. Since 1997, however, routine screening for malaria has not been performed except for high-risk donors. In the same year, in order to protect both the recipients and the donors, blood banks were obligated to use donor history questionnaires (DHQ) by the Turkish Ministry of Health. Furthermore, from the beginning of 2000s, many blood banks have started to implement donor recruitment programs, thus the amount of paid and military donors in the donor pool decreased. Outcomes of these measures can be clearly seen in the data of the Turkish Red Crescent (TRC) blood center: The rate of HBsAg seropositivity among blood donors was 6.7% in 1985 and 4.7% in 1995, whereas HBsAg seroprevalence was reported as 2.1%, 1.7% 1.1%, and 0.6% in 2004, 2008, 2010 and in 2012, respectively [8]. Nevertheless, a relatively significant difference in the frequency of TTI agents among blood donors has been reported in different geographical regions, especially between eastern and western parts of Turkey [9–11]. The prevalence of HBsAg in north, west and central Anatolia as well as in the Mediterranean region has been reported around 2.5% while it can reach up to 4.2% in the eastern and southeastern Anatolian regions [9].

Adana is the largest city of the Mediterranean region and the fifth most populous city in Turkey. Hereditary blood diseases, mainly sickle cell disease and thalassemia, are still very common in Cukurova district where Adana is located [12,13]. Therefore, transfusion of blood and blood products is a widely used and important therapeutic approach in this area. Moreover, owing to its specific location, Adana lies on the transit route from eastern part to western part of Turkey for internal immigrants some of which then settle. In addition, the number of immigrants coming from Middle Eastern countries has increased steadily in recent years [14].

Studying the prevalence of TTI agents among blood donors and their trends over time not only has a great impact on the safety and quality of transfusion practices, but can also be used to determine potential risks for general population and to take necessary measures [6]. Furthermore, considering that the latest data on the rate of TTI frequency among blood donors in this region was published in 2003 [15], and in the light of information mentioned earlier that directly influence the prevalence of TTI agents in general population and consequently in blood donors, a revision appeared necessary to us for this region of Turkey. In this study, we retrospectively analyzed the results of screening and confirmation tests in order to provide updated information on the seroprevalence of HBV, HCV, HIV and syphilis among blood donors in this region and to compare our results with those reported from different parts of Turkey.

2. Materials and methods

A total of 63,879 donors applied to our Blood Bank from January 2007 to June 2009. Of all applicants, 62,508 healthy donors were screened for HBV, HCV, HIV-1/2 and syphilis. Results of 62,461 donors were available and retrospectively analyzed. Autologous donations were not included in the study.

2.1. Donor eligibility and selection

All donors were asked to fill and sign a standard DHQ which contains information about donor's identity, address as well as questions regarding various risk factors, such as disease history, medical interventions (surgery, infection, vaccines, drugs, etc.), sexually transmitted diseases, pregnancy, miscarriage, and personal lifestyle (tattoo, piercing, alcohol or drug use, travels, etc.). A qualified blood bank staff responsible of donor selection processes evaluated DHQs carefully. After vital signs of suitable donors were measured by a nurse, blood samples were collected into EDTA containing tubes and whole blood count analyses were performed. A blood bank physician reviewed all the information and subsequently whole blood was collected from eligible donors by phlebotomy.

2.2. Screening and confirmatory tests

Approximately 3 ml of blood from each donor was collected for screening and confirmatory tests. HBsAg, anti-HCV, and anti-HIV-1/2 were screened by microparticle enzyme immunoassay method (Vitros ECI Q, Ortho-Clinical Diagnostics, USA), while syphilis was screened by rapid plasma reagin (RPR) test method (Omega Diagnostics, Scotland, UK) based on the manufacturers' recommendations. Samples at or above the threshold value for given test were considered reactive and the tests were repeated twice. In case of repeatedly positive results in two out of three analyses, confirmatory testing was performed.

Confirmatory tests included neutralization assay for HBsAg (Vitros HBsAg Confirmatory Assay, Vitros ECI Q, Ortho-Clinical Diagnostics, USA), line immunoassay (LIA) for anti-HCV and anti-HIV-1/2 (Inno-Lia™ HCV Score and Inno-Lia™ HIV I/II Score, Innogenetics, Ghent, Belgium), and Treponema pallidum hemagglutination (TPHA) test (Omega Diagnostics Scotland, UK) for syphilis. Interpretations for the results of the confirmatory assays were made in accordance with the manufacturers' recommendations.

2.3. Statistical analysis

HBsAg, anti-HCV, anti-HIV-1/2 and syphilis seropositivity rates among blood donors were assessed according to gender, education, marital status, donor type (replacement vs. family vs. voluntary donors) and blood group. Data were analyzed using the SPSS version 17.0, and statistical significance was defined as $p < 0.05$.

Table 1
Demographic characteristics of blood donors (n = 62,461).

Parameter		Number of donors	%
Mean age (years)	33.2 ± 9.1		
Gender	Male	61,517	98.5
	Female	944	1.5
Donor Type	Family donor	36,974	59.2
	Replacement	23,274	37.3
	Volunteer unpaid	2213	3.5
Marital Status	Married	37,360	59.8
	Single	25,101	40.2
Level of Education	Primary school	19,937	31.9
	Secondary school	9947	15.9
	High school	17,738	28.4
	Graduate/Undergraduate	14,122	22.6
	Unknown	717	1.15
Occupation	Laborer	19,210	30.8
	Unemployed (no regular job)	12,705	20.3
	Officer	10,668	17.1
	Self employed	9913	15.9
	Student	6072	9.7
	Unknown	2460	3.9
	Housewife	922	1.5
	Soldier	511	0.82

3. Results

Of 62,461 donors, 98.5% were male and 1.5% were female. The mean age was 33.2 ± 9.1 years. The most common blood group was A Rh (+) and detected in 35.1% of donors whereas AB Rh (−) group was detected in only 0.7% of donors. The percentage of voluntary donors was only 3.5%, while 37.3% were replacement donors and the remaining 59.2% were family donors. The number of married donors was 37,360 (59.8%). 31.9% of donors graduated from primary school and 30.8% stated their work status as laborer (Table 1). Information about the number of first-time donors was not available since this was a retrospective study.

According to the screening test results, the rates of seropositivity for HBsAg, anti-HCV, anti-HIV-1/2 and syphilis were found to be 1.92%, 0.48%, 0.20% and 0.18% respectively (Table 2). There was no statistically significant difference in any marker between males and females ($p > 0.05$). When donors with positive screening tests results were analyzed in terms of educational level, the highest and the lowest HBsAg seropositivity rates were detected in primary school and university graduates, respectively ($p < 0.001$). No significant correlation was observed between anti-HIV-1/2 positivity and educational level ($p = 0.082$), whereas the frequency of anti-HCV ($p = 0.032$) and syphilis seropositivity ($p < 0.001$) was significantly higher in primary and secondary school graduates compared to the donors with higher education HBsAg and syphilis positivity rates were significantly higher in married donors ($p = 0.022$ and $p = 0.002$, respectively). Interestingly, the rates of HBsAg seropositivity in voluntary donors were higher than the other donor types ($p = 0.014$). Additionally, when screening test results were analyzed in accordance with the blood types, HBsAg seropositivities were detected in 3.0% of B Rh (−) donors and in 2.5% of AB Rh (+) donors whereas only in 1.8% of AB Rh (−) and 0 Rh (+) donors were positive for HBsAg ($p = 0.034$). There was no statistically significant relationship between other markers and blood groups ($p > 0.05$).

With the confirmatory test results, 86.4% of HBsAg, 61.7% of syphilis, 11% of anti-HCV, and 1.6% of anti-HIV-1/2 seropositivity were confirmed. As a result, seropositivity rates for HBsAg, anti-HCV, anti-HIV-1/2 and syphilis were determined as 1.66%, 0.05%, 0.003% and 0.11%, respectively (Table 3).

4. Discussion

In this study, the seroprevalence of HBsAg, anti-HCV, anti-HIV-1/2 and syphilis among blood donors in Adana, Turkey were studied and the results were compared both with historical data of Adana as well as with the most recent results of the other regions of Turkey. Considering that the latest data of this region were published at the beginning of 2000s (Table 4) [15–18], this study is expected to fill an important gap in the literature.

It is estimated that over 100 million units of blood are donated annually around the world [19]. Especially in the last 50 years, significant progress in blood transfusion safety was achieved and TTI incidence has dramatically decreased almost in every region of the world [20]. However, according to the WHO report published in 2011, the median prevalence of TTIs in low and middle-income countries was significantly higher compared to countries with high-income levels [5].

HBV infection has a worldwide distribution, but its frequency varies greatly throughout different geographic

Table 2
Screening tests results.

Number of samples	HBsAg positivity		Anti-HCV positivity		Anti-HIV-1/2 positivity		Syphilis positivity	
	Number	%	Number	%	Number	%	Number	%
62,461	1203	1.92	301	0.48	127	0.2	115	0.18

Table 3
Confirmatory tests results.

Number of samples	HBsAg positivity		Anti-HCV positivity		Anti-HIV-1/2 positivity		Syphilis positivity	
	Number	%	Number	%	Number	%	Number	%
62,461	1038	1.66	33	0.05	2	0.003	71	0.11

Table 4
HBsAg, HCV, HIV and Syphilis seropositivity rates according to screening tests among blood donors in Adana.

City	Year	Number of donors	HBsAg (%)	Anti-HCV (%)	Anti-HIV-1/2 (%)	VDRL/RPR (%)	References
Adana	1988–1995	65,068	7.93	NR[a]	NR	NR	Kilic et al., 1996 [16]
Adana	1991–1995	53,966	NR	0.54	NR	NR	Kilic et al. 1996 [16]
Adana	1992–1993	8785	6.58	0.51	NR	NR	Dundar et al. 1994 [17]
Adana	2000	Data not shown	4.52	NR	NR	NR	Dilek et al. 2007 [18]
Adana	1999–2002	19,644	0.88	0.16	NR	NR	Turunc et al. 2003 [15]
Adana	**2007–2009**	**62,461**	**1.92**	**0.48**	**0.2**	**0.18**	**Menziletoglu Yildiz** et al. **(current study)**

[a] NR: Not reported.

regions. According to the 2010 annual report of the European Centre for Disease Prevention and Control (ECDC), there are over two billion people infected with HBV around the world, of these more than 350,000,000 are chronic HBV patients [21]. Turkey belongs to the middle-endemic area in terms of HBV prevalence [10]. In addition, the ECDC 2010 report demonstrated that among all European countries, Turkey had the highest number of HBV-infected people (>3.5 million) and the HBV prevalence in general population of Eastern Turkey was reported 7% [21].

In our study, HBsAg seropositivity was detected in 1.92% of blood donors based on the screening test results and 1.66% according to the confirmatory test results. Recent publications have shown that HBsAg seropositivity rate among blood donors in east and south-east parts of Turkey varies between 2.55% and 3.17%, while between 1.07% and 1.38% in Central and Western Anatolia respectively and from 1.26% to 2.2% in the Mediterranean region which also cover Adana (Table 5) [10,11,18,22–34]. When compared with these results, HBsAg seropositivity rate found in our study was in the similar range with that reported in previous studies from the neighbor districts of the Mediterranean region [22–25]. Besides, as it was emphasized earlier, Adana is an important transition point between east and west parts of Turkey, and it is known that the rate of HBsAg seropositivity is markedly increasing from the west to the east [9,10], it can be considered reasonable that our results fall between the results given for western and eastern cities of Turkey. Moreover, a recent study conducted by the TRC and co-institutes showed that the HBsAg seropositivity among blood donors was 4.19% around Turkey while it was 4.21% in Adana between 1989 and 2004 (a total of 6,240,130 donors) [10]. Also, some earlier studies conducted in Adana revealed that the seroprevalence of HBsAg in blood donors was 7.93% between 1988 and 1995, 4.52% in 2000, and finally 0.88% in 1999–2002 [15,16,18]. Taken together with our current findings, we can suggest that there has been a gradual decrease in HBsAg seroprevalence among blood donors of Adana in the last two decades.

Approximately 150 million people worldwide are chronic HCV carriers, and more than 350,000 people are estimated to die from HCV-related liver diseases each year globally. According to the ECDC 2010 report, there are 9 million people chronically infected with HCV in Europe, including Turkey [21]. Same report also indicates that Turkey falls into the middle-endemic area (>1% and ≤2%) in terms of HCV prevalence. The number of anti-HCV positive subjects in general population in Turkey was reported to be over 1 million while HCV seropositivity rate has been reported as 1.5% [21].

In our study, anti-HCV seropositivity rate in blood donors was detected as 0.48% and 0.05% based on the screening and confirmatory test results, respectively. In order to evaluate the HBsAg and anti-HCV prevalence on the national scale, the TRC reviewed data from 22 different blood banks around Turkey, including Adana, in the period of 1989 and 2004.

Table 5
HBsAg, HCV, HIV and Syphilis seroprevalence among blood donors in different centers of Turkey.

Geographical region	City	Study period	Number of donors	HBsAg (%)	anti-HCV (%)	anti-HIV -1/2 (%)	VDRL/ RPR (%)	References
Mediterranean	Hatay	2003–2004	12,313	2.02	0.52	0.02	0.03	Ocak et al. 2005 [22]
Mediterranean	Isparta	2000–2007	51,361	1.1	0.44	0.09	0.08	Kaya et al. 2009 [23]
Mediterranean	K.maraş	2003–2005	4107	1.26	0.24	NR[a]	NR	Gul et al. 2006 [24]
Mediterranean	Mersin	2006–2008	691	2.2	0.4	0.2	0.1	Oner et al. 2011 [25]
Marmara	Istanbul-1	Jan–Dec 2007	72,695	1.76	0.07	0.008	NR	Acar et al. 2010 [26]
Marmara	Istanbul-2	1998–2008	75,747	2.83	0.40	0.001	0.16	Uluturk et al. 2010 [27]
Marmara	Istanbul-3	2003–2012	51,120	2.03	0.44	0.06	0.33	Sanli et al. 2013 [28]
Black sea	Tokat	2003–2010	15,696	1.29	0.16	0	0.02	Bulut et al. 2012 [29]
Aegean	Afyon	2001–2010	37,343	1.38	0.35	0.02	0.04	Altindis et al. 2011 [30]
Aegean	Izmir	2004–2010	80,454	1.31	0.38	0.002	0.04	Uzun et al. 2013 [11]
Central Anatolia	Ankara	1996–2010	220,841	1.07	0.39	NR	NR	Dilsiz et al. 2012 [31]
Central Anatolia	Konya	2005–2012	165,006	1.3	0.4	NR	NR	Feyzioglu et al. 2012 [32]
Eastern Anatolia	Erzurum	2000–2011	204,000	3.14	0.92	1.06	2.33	Celebi et al. 2012 [33]
Eastern Anatolia	Van	1995–2003	39,002	2.55	0.17	0.036	0.57	Dilek et al. 2007 [18]
Southeastern Anatolia	Diyarbakir	2000–2010	266,035	3.17	0.64	0.0004	0.07	Dayan et al. 2013 [34]
Turkey		1989–2004	6,240,130	4.19	0.38	NR	NR	Emekdas et al. 2006 [10]

[a] NR: Not reported.

In Turkey, screening for anti-HCV in blood donors has become mandatory since 1996; therefore, anti-HCV seroprevalence of this study reflected results from 2,486,887 blood donors between 1996 and 2004. In this study, the overall rate of anti-HCV seropositivity was reported 0.38% and 0.52% in Turkey and in Adana, respectively [10]. Furthermore, the rate of anti-HCV seropositivity in various provinces of the Mediterranean region was reported to vary between 0.24% [24] and 0.52% [22] (Table 5). When compared with screening test results, data of our study seem to be consistent with that reported from other studies of Mediterranean region [22–25]. On the other hand, there are few published data concerning anti-HCV seroprevalence of blood donors in Adana. Dundar et al. [17] screened a total of 8785 blood donors in Adana, and found that anti-HCV seroprevalence was 0.51% between 1992 and 1993. According to Kilic et al. study [16], anti-HCV positivity rate was 0.54% between 1991 and 1995, which provided data of 53,966 donors. In another study, covering the years 1999–2002, Turunc et al. reported a 0.16% seropositivity rate for anti-HCV in 19,644 blood donors in Adana [15]. Lower anti-HCV seroprevalence rate in Turunc et al.'s study may be explained by the comparatively low number of donors, demographic or socio-economic status of donor population and the sensitivity of the screening test assays. Considering all together, however, we can argue that there has been a mild decrease in terms of anti-HCV prevalence in blood donors in Adana region since 2004.

Starting from 1985, screening for anti-HIV in blood donors has become a common practice in blood banks in the world, due to identification of HIV as a causative agent of AIDS and as a transfusion-transmitted virus [1]. Similarly, anti-HIV-1/2 has become a part of mandatory screening test panel in blood banks in our country since 1987 [7]. HIV seroprevalence in blood donors in high income countries is around 0.003%, while it is 0.1% and 0.6% in the middle and low-income countries, respectively [19]. Yearly health statistics reports published by the Turkish Ministry of Health showed that the incidence of AIDS in general population was 0.07/100.000 in 2002, while 0.12/100.000 in 2013 [35].

In our study, HIV seropositivity rate was found 0.20% (n = 127) in blood donors, although positive results was confirmed only in two donors (0.003%). When analyzing studies investigating the HIV seroprevalence among blood donors between 1998 and 2012 in different parts of Turkey, it can be seen that the HIV seropositivity rate varied between 0.0004% and 1.06% (Table 5). Moreover, in the Mediterranean region where Adana locates, HIV seroprevalence based on screening test results has been reported in the range of 0.02–0.20% between 2000 and 2008, meaning that our result was at upper limit of the range (Table 5). However, given that other studies did not provide their confirmatory test results, it was not possible to compare our data with that respect. Besides, as can be seen in Table 4, no published data were found in the literature concerning HIV seroprevalence in blood donors in Adana. Therefore, our study can be regarded as the first research that reported the incidence of HIV among blood donors from this region. Nonetheless, taking into consideration of the fact that anti-HIV-1/2 seropositivity rate was 0.003% based on our confirmatory test results, we can suggest that anti-HIV-1/2 seroprevalence was lower compared to those reported from many regions in Turkey (Table 5).

After syphilis has become a part of routine screening tests in blood banks and implementing of refrigerator storage of blood and blood products in routine practice, the number of transfusion-transmitted syphilis cases was considerably decreased [1,36]. Thus, the need of routine syphilis screening in blood donors is controversial in current practice. However, WHO still recommends screening of syphilis in blood donors all over the world [1,5]. Indeed, syphilis has the highest prevalence among TTI agents with a seropositivity rate of up to 25% in blood donors in developing countries [37]. Furthermore, *T. pallidum* prevalence has been increasing over the last two decades in both general population and blood donors in some European countries. It has been suggested that this might be associated with the increase in HIV incidence in these countries [37].

Screening of syphilis in blood donors has been mandatory in Turkey since 1983, and reported seropositivity rates for this agent in the studies conducted between the years of 1995 and 2012 vary between 0.02% and 2.33% (Table 5). However, a significantly elevated frequency in selected subjects (registered sex workers, prisoners, homosexuals, etc.) has been reported in a range of 0.25% and 55% [38]. In our study, syphilis positivity rate has been detected as 0.18% based on screening test results, and as 0.11% after confirmatory tests were performed. Hence, based on screening tests results, syphilis seroprevalence found in our study is slightly higher than those reported for other cities in Mediterranean Region, which were between 0.08% and 0.1% (Table 5). This difference may be explained by the use of more sensitive methods and partly by temporary or permanent settlement of immigrants from various Middle Eastern countries since the 1990s. Additionally, the fact that low number of donors were evaluated in other studies, except Kaya et al.'s report [23], can be another reason for this difference. Similar to HIV, previous studies reporting the frequency of TTI agents among blood donors in Adana did not show any data regarding syphilis seroprevalence (Table 4). Therefore, results presented in our study are the first published data concerning syphilis seropositivity in our region.

There was no statistically significant relationship between the seroprevalence of TTI factors and gender ($p > 0.05$). However, considering that the percentage of female donors was only 1.5%, this may not reflect the true situation. We have noticed a statistically significant association between HBV, HCV, syphilis seropositivity rates and educational level of blood donors. That is HBsAg, anti-HCV and syphilis were more prevalent in primary or secondary school graduates. There are some other reports indicating an important correlation between TTI positivity and educational level in blood donors [6,39,40]. Blood donors with positive HBV and syphilis markers also showed significant association with marital status in our study with higher seropositivity rates in married donors. Although there are conflicting data on the relationship between marital status and the rate of TTI seropositivity in the literature, several articles also reported higher positivity rates in married donors [6,41,42]. Interestingly, we have found that HBsAg seroprevalence was significantly higher among volunteer donors compared to family and replacement donors. It is well known that

collecting blood from voluntary, non-remunerated donors is associated with increased safety in blood transfusion [3] and there are numerous studies indicating that the positive results in TTI agents among blood donors were considerably lower in voluntary unpaid donor population [43–46]. Nevertheless, Allain et al. found no statistically significant differences between family and voluntary donors in terms of TTI positivity rates [47]. Moreover, Sarkodie et al. reported that HBsAg seropositivity was equally high in young volunteers and older replacement donors [48]. Similarly, Abdel Messih et al.'s study [43] showed that there was no statistically significant difference in the prevalence of TTI agents between family replacement and voluntary donors among the young age group. Since we have not analyzed our results according to different age groups, we cannot know whether the high rate of HBsAg seropositivity in volunteer donors was associated with younger age in our study.

This study, which was conducted with an aim of updating the prevalence of HBsAg, anti-HCV, HIV-1/2, and syphilis among blood donors in the fifth largest city of Turkey, may not reflect the real situation in general population. Nevertheless, we believe that our data might contribute to a better understanding of epidemiology of TTI-related diseases in our region. When we reviewed all available data, including the current study, reporting the frequency of TTI agents in blood donors in Adana, it can be seen that there has been a sharp decline in terms of HBsAg positivity rate while a slight decrease in the rate of anti-HCV positivity from 1990s to 2007 as expected. Factors believed to contribute to this decrease include introduction of DHQ forms, strict regulations and improvements in donor selection process, certification programs implemented by the Turkish Ministry of Health with an attempt to improve staff knowledge and competencies in blood banks, efforts to improve public awareness in TTIs, decline in the number of military donors in donor pool, and expansion of vaccination policies throughout Turkey. Furthermore, as stated earlier, previous publications from this region did not include any data on anti-HIV-1/2 or syphilis seropositivity rates, thus future studies are required in order to determine changes and trends in the seroprevalence of anti-HIV-1/2 and syphilis among blood donors in Adana.

Last but not least, increasing number of immigrants from Middle Eastern countries may have a significant influence on the prevalence of TTI agents both in Adana and around Turkey in the near future, if not already. Hence, developing institutional as well as national policies, practices, strategies, and taking early precautions in collaboration with the Turkish Ministry of Health, non-governmental organizations and other regional blood banks seem to us crucial to prevent undesirable consequences in the context of transfusion-transmitted infections and to enhance current levels of transfusion quality and safety in this region.

References

[1] Perkins HA, Busch MP. Transfusion-associated infections: 50 years of relentless challenges and remarkable progress. Transfusion 2010;50(10):2080–99.

[2] Kafi-abad SA, Rezvan H, Abolghasemi H, Talebian A. Prevalence and trends of human immunodeficiency virus, hepatitis B virus, and hepatitis C virus among blood donors in Iran, 2004 through 2007. Transfusion 2009;49(10):2214–20.

[3] Dhingra N. Screening donated blood for transfusion transmissible infections. Geneva: World Health Organization; 2010.

[4] Bihl F, Castelli D, Marincola F, Dodd RY, Brander C. Transfusion-transmitted infections. J Transl Med 2007;5:25.

[5] Global Database on Blood Safety. Summary Report 2011. World Health Organization; 2011.

[6] 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;9(4):e94528.

[7] Heper Y. Microbiological screening tests in transfusion. J Antimicrob Chemother 2007;21:146–52.

[8] Tosun S. The changing viral hepatitis epidemiology in our country. ANKEM Derg 2013;27:128–34.

[9] Toy M, Onder FO, Wormann T, Bozdayi AM, Schalm SW, Borsboom GJ, et al. Age- and region-specific hepatitis B prevalence in Turkey estimated using generalized linear mixed models: a systematic review. BMC Infect Dis 2011;11:337.

[10] Emekdas G, Saban C, Oral O, Cigdem A, Armagan A. Trends in hepatitis B and hepatitis C virus among blood donors over 16 years in Turkey. Eur J Epidemiol 2006;21(4):299–305.

[11] Uzun B, Gungor S, Demirci M. Seroprevalence of transfusion transmissible infections among blood donors in western part of Turkey: a six-year study. Transfus Apher Sci 2013;49(3):511–5.

[12] Guvenc B, Canataroglu A, Unsal C, Yildiz SM, Turhan FT, Bozdogan ST, et al. β-Thalassemia mutations and hemoglobinopathies in Adana, Turkey: results from a single center study. Arch Med Sci 2012;8(3):411–4.

[13] Guvenc B, Canataroglu A, Unsal C, Yildiz SM, Turhan FT, Bozdogan ST, et al. β-Globin chain abnormalities with coexisting α-thalassemia mutations. Arch Med Sci 2012;8(4):644–9.

[14] Saatci E, Akpinar E. Assessing poverty and related factors in Turkey. Croat Med J 2007;48(5):628–35.

[15] Turunc T, Sezgin N, Uncu H, Demiroglu YZ, Arslan H. Kan donörlerinde hepatit B ve hepatit C seroprevalansı. Viral Hepatit Derg 2003;8:171–3.

[16] Kilic NB, Dundar IH. HBsAg and anti-HCV positivity in blood donors in Cukurova Region. Viral Hepatit Derg 1996;2:119–22.

[17] Dündar IH, Yaman A, Çetiner S, Kılıç NB, Apan TZ. Kan donörlerinde ve random seçilmiş hasta örneklerinde muhtelif hepatit markerlarının sıklığı. Turk Mikrobiyol Cem Derg 1994;24:236–9.

[18] Dilek I, Demir C, Bay A, Akdeniz H, Oner AF. Seropositivity rates of HBsAg, anti-HCV, anti-HIV and VDRL in blood donors in Eastern Turkey. Turk J Hematol 2007;24(1):4–7.

[19] Blood safety and availability, World Health Organization, Fact sheet N°279 Updated June 2; 2014.

[20] Dwyre DM, Fernando LP, Holland PV. Hepatitis B, hepatitis C and HIV transfusion-transmitted infections in the 21st century. Vox Sang 2011;100(1):92–8.

[21] European Centre for Disease Prevention and Control (ECDC). Hepatitis B and C in the EU neighbourhood: prevalence, burden of disease and screening policies. ECDC technical report, Stockholm, September; 2010.

[22] Ocak S, Duran N, Savas L, Onlen Y, Dibek MA. Hatay bolgesindeki kan donorlerinde HBV, HCV, HIV ve VDRL seropozitifligi. Viral Hepatit Derg 2005;10:49–53.

[23] Kaya S, Alanoglu G, Polat M, Sipahi T. Suleyman Demirel Universitesi Tip Fakultesi Kan Merkezi'nin 2000–2007 yillari tarama test sonuclari. SDU Tip Fak Derg 2009;16(2):13–5.

[24] Gul M, Ciragil P, Aral M, Dogramaci N. Gonullu ve gonullu olmayan kan donorlerinde HBV, HCV, HIV ve sifiliz tarama test sonuclarinin degerlendirilmesi. Turk Mikrobiyol Cem Derg 2006;36(1):35–9.

[25] Oner S, Yapici G, Sasmaz CF, Kurt AO, Bugdayci R. Hepatitis B, hepatitis C, HIV, and VDRL seroprevalence of blood donors in Mersin, Turkey. Turk J Med Sci 2011;41(2):335–41.

[26] Acar A, Kemahli S, Altunay H, Kosan E, Oncul O, Gorenek L, et al. HBV, HCV and HIV seroprevalence among blood donors in Istanbul, Turkey: how effective are the changes in the national blood transfusion policies? Braz J Infect Dis 2010;14(1):41–6.

[27] Uluturk R. The evaluation of the routine screening tests in blood donors for eleven years. Turk Mikrobiyol Cem Derg 2010;40(1):41–7.

[28] Sanli K, Sari NG, Hatipoglu N. Evaluation of 10-year screening test results in blood donors consulted to our blood center. JOPP Derg 2013;5(3):136–41.

[29] Bulut N, Yenisehirli G, Bulut Y. Seroprevalence of hepatitis B, hepatitis C, HIV and syphilis in blood donors in Tokat. Viral Hepatit Derg 2012;18(1):11–4.

[30] Altindis M, Aslan S, Kalayci R. Kan vericilerde HBsAg, anti-HCV, anti-HIV ve sifilis seroprevalansi. Sakarya Med J 2011;1(1):22–6.
[31] Dilsiz G, Yenicesu I, Belen FB, Celik B, Ozturk G. Trends in hepatitis B and hepatitis C virus seropositivity among blood donors over 15 years screened in the blood bank of a university hospital. Transfus Apher Sci 2012;47(1):95–100.
[32] Feyzioglu B, Gundem S, Ozdemir M, Kocabas R, Baykan M. Seroprevalence of hepatitis B and hepatitis C in blood donors in the Konya Region. Eur J Basic Med Sci 2012;2(3):74–8.
[33] Celebi D, Celebi O, Altoparlak U, Kok AN. Kan Donorlerinde HBsAg, anti-HCV, anti-HIV, sifiliz seroprevalansi ve Macro-ELISA sonuclarinin optik dansite degerleri ile dogrulama testlerinin karsilastirilmasi. Turk Mikrobiyol Cem Derg 2012;42(4):137–41.
[34] Dayan S, Tekin A, Tekin R, Dal T, Hosoglu S, Yazgan UC, et al. HBsAg, anti-HCV, anti-HIV-1/2 and syphilis seroprevalence in healthy volunteer blood donors in southeastern Anatolia. J Infect Dev Ctries 2013;7(9):665–9.
[35] T.C. Sağlik Bakanliği. Sağlik İstatistikleri Yilliği 2013. Ankara: Sentez Matbaacılık ve Yayıncılık; 2014 ISBN: 978-975-590-508-2.
[36] Vera L, Milka D, Nurith SL, Eilat S. Prevalence and incidence of syphilis among volunteer blood donors in Israel. J Blood Transfus 2014; 154048.
[37] Tagny CT. Syphilis and Blood Safety in Developing Countries. In: Dr. Sato NS, editor. Syphilis – Recognition, Description and Diagnosis. ISBN: 978-953-307-554-9.
[38] Akin L. Türkiye'de Cinsel Yolla Bulasan Enfeksiyonların Epidemiyolojisi. Turkiye Klinikleri J Med Sci 2006;26:655–65.
[39] 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;12(5): 495–9.
[40] Kane MA, Bloch EM, Bruhn R, Kaidarova Z, Murphy EL. Demographic determinants of syphilis seroprevalence among U.S. blood donors, 2011–2012: a retrospective data analysis. BMC Infect Dis 2015; 15:63.
[41] Li C, Xiao X, Yin H, He M, Li J, Dai Y, et al. Prevalence and prevalence trends of transfusion transmissible infections among blood donors at four Chinese regional blood centers between 2000 and 2010. J Transl Med 2012;10:176.
[42] Khodabandehloo M, Roshani D, Sayehmiri K. Prevalence and trend of hepatitis C virus infection among blood donors in Iran: a systematic review and meta-analysis. J Res Med Sci 2013;18(8):674–82.
[43] Abdel Messih IY, Ismail MA, Saad AA, Azer MR. The degree of safety of family replacement donors versus voluntary non-remunerated donors in an Egyptian population: a comparative study. Blood Transfus 2014;12(2):159–65.
[44] Diarra A, Kouriba B, Baby M, Murphy E, Lefrere JJ. HIV, HCV, HBV and syphilis rate of positive donations among blood donations in Mali: lower rates among volunteer blood donors. Transfus Clin Biol 2009;16(5–6):444–7.
[45] Sharma RR, Cheema R, Vajpayee M, Rao U, Kumar S, Marwaha N, et al. Prevalence of markers of transfusion transmissible diseases in voluntary and replacement blood donors. Natl Med J India 2004;17(1):19–21.
[46] Kimani D, Mwangi J, Mwangi M, Bunnell R, Kellogg TA, Oluoch T, et al. Blood donors in Kenya: a comparison of voluntary and family replacement donors based on a population-based survey. Vox Sang 2011;100(2):212–8.
[47] Allain JP, Sarkodie F, Asenso-Mensah K, Owusu-Ofori S. Relative safety of first-time volunteer and replacement donors in West Africa. Transfusion 2010;50(2):340–3.
[48] Sarkodie F, Adarkwa M, Adu-Sarkodie Y, Candotti D, Acheampong JW, Allain JP. Screening for viral markers in volunteer and replacement blood donors in West Africa. Vox Sang 2001;80(3):142–7.