



Prevalence of HBV and HCV Infections in Iranian Blood Donors; An Updated Systematic Review and Meta-Analysis

Leila Kasraian^{1,2}, Mohammad Hossein Imanieh^{3,*}, Reza Tabrizi^{4,5}, Reza Shahriarirad⁶,
Amirhossein Erfani⁶, Sahar Hosseini⁶

1. Blood Transfusion Research Center, High Institute for Research and Education in Transfusion Medicine, Tehran, Iran
2. Iranian Blood Transfusion Organization, Shiraz, Iran
3. Gastroenterohepatology Research Center, Shiraz University of Medical Sciences, Shiraz, Iran
4. Non-Communicable Diseases Research Center, Fasa University of Medical Sciences, Fasa, Iran
5. Health Policy Research Center, Institute of Health, Shiraz University of Medical Sciences, Shiraz, Iran
6. Student Research Committee, Shiraz University of Medical Sciences, Shiraz, Iran

*** Corresponding Author:**

Mohammad Hossein Imanieh, MD
Gastroenterohepatology Research Center, Nemazee Hospital Nemazee square, Shiraz University of Medical Sciences, Shiraz, Iran
Telefax: + 98 71 36474316
Email: imanieh@sums.ac.ir

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ABSTRACT

BACKGROUND

Awareness of the prevalence of hepatitis B (HBV) and hepatitis C virus (HCV) infections, as blood transmitted infections, among blood donors can help policymakers improve the guidelines, share experiences, and estimate the blood safety over the country and in the region. We aimed to determine the prevalence of HBV and HCV infection in Iranian blood donors based on the present published literature.

METHODS

A meta-analysis was carried out based on the results of an electronic literature search in the international and national databases for all articles published until October 2020. We selected studies that had appropriate sampling and valid statistical analysis as well as proper measurement methods. The heterogenic indices of the studies were determined using Cochran's (Q) and I-square (I²) tests. According to the heterogeneity results, a fixed or random-effects model was implemented to estimate the pooled prevalence of HBV and HCV. Meta-regression was conducted to explore the suspected sources of heterogeneity.

RESULTS

We included 61 and 58 eligible studies related to HBV and HCV, respectively. The pooled prevalence of HBV was 0.57% (95% confidence interval (CI): 0.47 – 0.67, I²: 99.9%) among the blood donors. The range of prevalence rates of HBV was between 0.10% and 2.34% in different areas of Iran. The pooled prevalence of HCV was 0.22% (95% CI: 0.20 – 0.24, I²: 98.64%) in blood donors, which varied between 0.02% and 1.09% in separate locations. Subgroup and meta-regression analyses revealed that the year of publication, geographical location, and quality of the studies probably generated the heterogeneity.

CONCLUSION

The prevalence of HBV and HCV decreased steadily in Iranian blood donors during the past two decades. It should be asserted that most of the health policies and safety measures taken in recent years in Iran have been effective and promising.

KEYWORDS:

Hepatitis B, Hepatitis C, Prevalence, Blood donation, Blood donor

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INTRODUCTION

Estimations report that 257 million and 71 million people suffer from chronic hepatitis B (HBV) and C viruses (HCV), respectively. About 1.34 million deaths were attributed to chronic infection with HBV and HCV in 2015 worldwide, most of which was due to complications of long-standing hepatitis such as liver cirrhosis and hepatocellular carcinoma (HCC).^{1,2} Both viruses can be transmitted through contact with infected blood or blood products. While the world health organization (WHO) recommended screening of all blood donations for evidence of infections such as viral hepatitis, blood safety has been determined as a major public health priority since 2000.^{2,3} Careful selection of people who tend to donate blood became a crucial part of the management of blood safety, and the strategy of recruiting voluntary non-remunerated donors (VNRDs) and encouraging them to become regular donors has led to an improvement in blood safety.^{4,5}

In Iran, the screening of blood donors for hepatitis B surface antigen (HBsAg) has become mandatory since the foundation of the Iranian Blood Transfusion Organization (IBTO) in 1974.⁶ As a national public health promotion program started in 1993, vaccination of neonates against HBV infection has changed the epidemiology of the infection in the country.⁷ The estimated prevalence of HBsAg in the general population of Iran is 2.2%, and the infection is more common among men than women (3% vs. 1.7%).⁸ In Iran, the government pays the costs of collection, preparation, preservation, and distribution of blood and its products. VNRDs provide 100% of blood donations; hence, patients receive the blood products free of charge.⁹ According to the literature, the pooled prevalence of HBsAg in blood donors of Iran was estimated to be 0.58%.³

HCV infection is often asymptomatic or has mild symptoms during the acute phase of infection. The infection becomes chronic in most cases and is a major risk factor for developing cirrhosis and HCC.¹⁰ Viral variability and great adaptation ability are certain challenges for HCV vaccine development.¹¹ Before the early 1990s, the main risk factors for transmission of HCV infection were blood transfusion, intravenous drug use, and unsafe injection procedures.¹⁰ In Iran, screening of all blood donors for anti-HCV antibody (Ab) has been performed since 1996.¹²

This has changed the principal route of HCV transmission from blood transfusion to intravenous drug use, and by considering the growth in the number of people who inject drugs, the prevalence of HCV infection is increasing in the country.¹³ Previous reports estimated the prevalence of anti-HCV Ab in the general population of Iran to be approximately 0.6%.¹⁴ The pooled prevalence of anti-HCV in blood donors was also 0.5%.¹⁵

The objective of the present study was to review the articles on the prevalence of HBV and HCV infections in Iranian blood donors to make an updated estimation of the burden of these infections in this population.

MATERIALS AND METHODS

Search Strategy

The current meta-analysis was performed according to the criteria of the PRISMA guidelines.¹⁶ An electronic systematic search algorithm in the international databases, including PubMed, Scopus, Embase, and Google scholar, was adopted for articles published until October 2020 using the following keywords: (“blood donor” OR “blood donation” OR “bloodborne pathogens” OR “blood transfusion” OR “transfusion-transmitted infection”) AND (“prevalence” OR “epidemiology”) in combination with (“Iran”) and also (“hepatitis B” OR “HBV” OR “hepatitis C” OR “HCV”) for hepatitis B and hepatitis C as keywords for titles and/or abstracts in a medical subject headings (MeSH) word search. The Google scholar and Iranian databases, including Scientific Information Database (SID) and Magiran were searched for published articles in the Persian language with Persian equivalents of the aforementioned keywords. References of the reviews, systematic reviews and meta-analyses, and relevant retrieved articles were searched to increase the sensitivity.

Eligibility Criteria and Study Selection

Studies that recruited Iranian blood donors, published in Persian or English languages, were used for the current review article. All included studies must measure and report the prevalence of individuals with positive HBsAg and/or anti-HCV tests. The seropositive results must be confirmed by HBsAg confirmatory assay and recombinant immunoblot assay (RIBA) test for HBV and HCV diagnosis, respectively. The exclusion criteria were (1) no accessible

full text or insufficient statistical information about the prevalence and the number of the infected cases; (2) studies performed exclusively on the specific blood donors' population (i.e., recruitment of only HBV/HCV positive blood donors).

Data Collection and Quality Assessment

One reviewer (LK) extracted the data and double-checked for the following items: authors' names, publication year, study period, location, sample size, the prevalence of HCV and HBV, and blood donation status (first time, lapsed, and regular blood donor). In case there was ambiguity about the information extraction, the problem was resolved by the other author as well (MHI).

After determining the relevant articles, two of the authors (SH and MHI) assessed the quality of the studies by an adapted version of the Newcastle-Ottawa Quality Scale (NOS) for cross-sectional studies.¹⁷ This scale consists of seven items in three distinct categories, including selection, comparability, and outcome. A star scoring system is predicted for each item to provide a semi-quantitative evaluation of the study quality ranging from 0 to 9. Studies with <7 stars were defined as low quality and 7 or more than 7 stars as high quality.

Statistical analysis

Meta-analysis was conducted using Metaprop command in STATA version 14.0 (Stata Corp., College Station, TX, USA).¹⁸ Due to the closeness of the prevalence of HBV and HCV to zero, Freeman-Tukey double arcsine transformation was employed; also, a 95% confidence interval was computed by using the exact binomial method. Cochran Q test and I-square (I²) were employed to assess the heterogeneity. Whenever heterogeneity of the study was significant (Cochran Q p -value < 0.1 and I² ≥ 50%), a random effect meta-analysis was used; otherwise, a fixed effect meta-analysis was applied to combine the prevalence. Meta-regression analyses were conducted for continuous variables, including the date of publication and total sample size among the studies to explore the source of heterogeneity. Besides, we performed sensitivity analyses using leave-one-out to examine the effects of one by one included studies on the stability of the pooled effect sizes.

RESULTS

In the electronic search in PubMed, Scopus, Embase, and other sources, 144, 224, 427, and 7743 articles were identified, respectively. After narrowing down the search strategy and removing repetitive material due to overlapping contents of the databases, 2968 documents remained. In the next step and thorough screening of the titles and abstracts, duplicated studies (1675) and irrelevant ones (1216) were excluded. Ultimately, the remaining 77 full-text articles were examined, and after omitting 12 papers, 65 articles^{6,19-82} met the inclusion criteria, including 61 studies for hepatitis B and 58 studies for hepatitis C (7, 4, and 54 studies were reporting HBV, HCV, and the prevalence of both viruses, respectively). Only cross-sectional and case-control studies were selected for final analysis, and case reports, case series, and letters were omitted. The step-by-step study identification and selection process based on literature findings are presented in figure 1. The basic characteristics of the included studies are summarized in table 1.

Hepatitis B

The total sample size that were included in the meta-analysis was 27,672,938 ranging from 441⁴³ to 14,599,783.⁶ 16^{22, 23, 25, 26, 29, 37, 38, 58, 65, 68, 69, 71-73, 77, 82, 14} 22,^{23, 25, 26, 29, 37, 38, 54, 58, 69, 71-73, 77}, and 11^{22, 23, 26, 29, 37, 38, 58, 69, 71, 72, 77} studies had reported the prevalence of HBV among the first time (1,877,630 donors ranging from 2,664 to 1,137,582), lapsed (1,719,389 donors ranging from 2,864 to 914,026), and regular (1,681,469 donors ranging from 728 to 1,002,984) blood donors, respectively.

15 studies^{22-27, 29, 31, 35, 39, 45, 69, 73, 76, 81} had provided the number of HBV cases (15,733 HBV cases ranging from 11 to 9,944) among male donors (5,035,693 male donors ranging from 2,787 to 2,240,419); and, 15 studies^{22-27, 29, 31, 35, 39, 45, 69, 73, 76, 81} had provided number of HBV cases (1,121 HBV cases ranged from 0 to 704) among female donors (332,793 female donors ranging from 213 to 172,856).

Using a random-effects model based on 61 studies, the pooled prevalence of HBV was 0.57% (95% CI: 0.47 – 0.67) among blood donors (figure 2A). According to the significant heterogeneity (I²: 99.9%, p < 0.001), additional analyses were conducted. Meta-regression analysis results showed that factors such as the date of publication (β = -0.05,

Table 1: The basic characteristics of the included studies

| Authors | Year | Province | For HBV | | For HCV | |
|--|------|-------------------------|---------|----------|---------|---------|
| | | | No. HBV | Total | No. HCV | Total |
| Afzali et al ¹⁹ | 2002 | Esfahan | 273 | 44004 | 477 | 43731 |
| Aghajanipoor et al ²⁰ | 2006 | Ardebil | 213 | 16789 | 79 | 16576 |
| Aghamohammadi et al ²¹ | 2014 | Mazandaran | 297 | 125001 | 32 | 124704 |
| Alaei et al ²² | 2019 | Mazandaran | 174 | 132124 | | |
| Amini Kafi-abad et al #1 ⁶ | 2009 | Iran | 140367 | 14740150 | | |
| Amini Kafi-abad et al #2 ²³ | 2009 | Iran | 10648 | 2423923 | 3146 | 2413275 |
| Arab et al ²⁴ | 2006 | Kerman | 162 | 15535 | | |
| Attarchi et al ²⁵ | 2006 | Tehran | 166 | 26811 | 42 | 26645 |
| Azadbakht et al ²⁶ | 2020 | Fars | 2684 | 1955162 | 1703 | 1952478 |
| Bani Aghil et al ²⁷ | 2010 | Golestan | 1271 | 129469 | 161 | 128198 |
| Boustani et al ²⁸ | 2017 | Ilam | 102 | 72629 | 27 | 72527 |
| Bozorgi et al ³⁰ | 2006 | Qazvin | 218 | 48334 | 73 | 48116 |
| Bozorgi et al ²⁹ | 2012 | Qazvin | 47 | 20638 | 35 | 20591 |
| Dargahi et al ³¹ | 2012 | Ardebil | 94 | 26595 | 6 | 26501 |
| Delavari et al ³² | 2005 | Kerman | | | 59 | 15252 |
| Doosti et al ³³ | 2009 | Chaharmahal & Bakhtiari | 200 | 11400 | 76 | 11200 |
| Ebrahimian et al ³⁴ | 2011 | Esfahan | 1066 | 543771 | 670 | 542705 |
| Emamghorashi et al ³⁵ | 2006 | Fars | 11 | 3011 | 9 | 3000 |
| Esmaceli et al ³⁶ | 2007 | Bushehr | 72 | 19699 | 47 | 19627 |
| Esmaceli et al ³⁷ | 2009 | Bushehr | 48 | 20342 | 42 | 20294 |
| Etminan et al ³⁸ | 2019 | Kerman | 359 | 355507 | 139 | 355148 |
| Farshadpour et al ³⁹ | 2016 | Khuzestan | 440 | 293894 | 295 | 293454 |
| Ghafouri et al ⁴⁰ | 2011 | South Khorasan | 210 | 42862 | 13 | 42652 |
| Ghavanini et al ⁴¹ | 2000 | Fars | 85 | 7964 | 47 | 7879 |
| Ghodsi Garamaleki et al ⁴² | 2019 | East Azarbaijan | 279 | 216283 | | |
| Habibzadeh et al ⁴³ | 2004 | Ardebil | 6 | 447 | 1 | 441 |
| Hedayati-Moghaddam et al ⁴⁴ | 2019 | Khorasan Razavi | 227 | 58276 | 34 | 58049 |
| Javadzadeh Shahshahani et al ⁴⁵ | 2013 | Yazd | 667 | 255427 | 239 | 254760 |
| Karimi et al ⁴⁶ | 2008 | Chaharmahal & Bakhtiari | 38 | 32162 | 74 | 32124 |
| Kasraian et al ⁴⁷ | 2007 | Fars | 2499 | 510030 | 723 | 507531 |
| Kasraian et al ⁴⁸ | 2008 | Fars | | | 203 | 93987 |
| Kasraian et al ⁴⁹ | 2010 | Fars | 763 | 203761 | 391 | 202998 |
| Kasraian et al ⁵⁰ | 2012 | Fars | 263 | 96909 | | |
| Kazeminejad et al ⁵¹ | 2005 | Golestan | 886 | 39806 | 74 | 38920 |
| Khedmat et al ⁵² | 2009 | Tehran | 5976 | 1010865 | 963 | 1004889 |
| Maghsoodlu et al ⁵³ | 2018 | Kurdistan | 568 | 198136 | 103 | 197568 |
| Mahdavian et al ⁵⁴ | 2006 | Markazi | 80 | 11695 | 33 | 11615 |
| Maleki et al ⁵⁵ | 2014 | Ilam | 29 | 4034 | 11 | 4005 |
| Mansour Ghanaei et al ⁵⁶ | 2008 | Gilan | 997 | 222505 | 709 | 221508 |

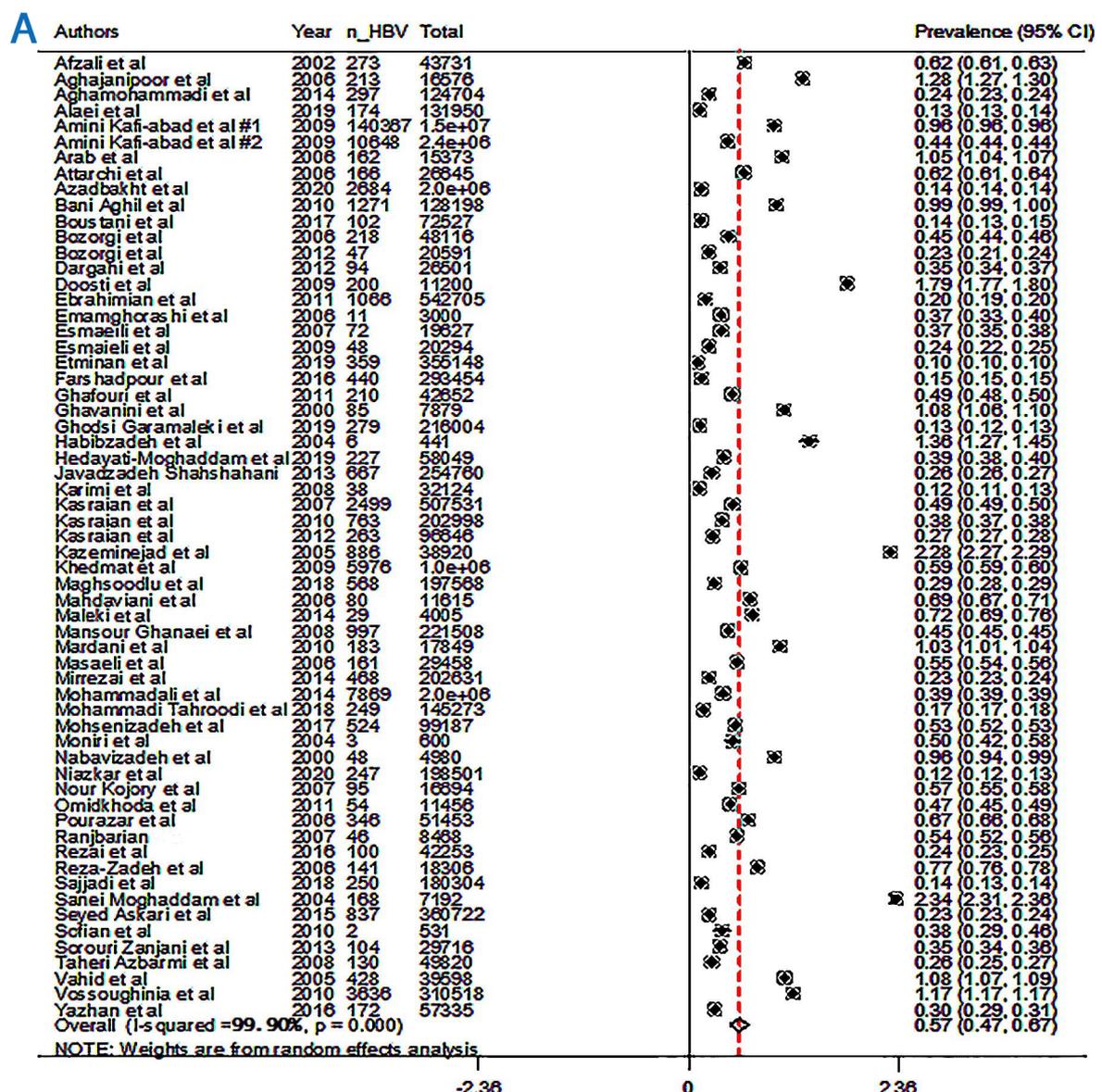
| Authors | Year | Province | For HBV | | For HCV | |
|--|------|----------------------------|---------|---------|---------|---------|
| | | | No. HBV | Total | No. HCV | Total |
| Mardani et al ⁵⁷ | 2010 | Qom | 183 | 18032 | 47 | 17849 |
| Masaeli et al ⁵⁸ | 2006 | Esfahan | 161 | 29619 | 72 | 29458 |
| Mirrezai et al ⁵⁹ | 2014 | Tehran | 468 | 203099 | 66 | 202631 |
| Mohammadali et al ⁶⁰ | 2014 | Tehran | 7869 | 2034497 | 2280 | 2026628 |
| Mohammadi Tahroodi et al ⁶¹ | 2018 | Ilam | 249 | 145522 | 66 | 145273 |
| Mohsenizadeh et al ⁶² | 2017 | Kerman | 524 | 99711 | 409 | 99187 |
| Moniri et al ⁶³ | 2004 | Esfahan | 3 | 603 | 3 | 600 |
| Nabavizadeh et al ⁶⁴ | 2000 | Kohgiluyeh and Boyer-Ahmad | 48 | 5028 | 1 | 4980 |
| Niazkar et al ⁶⁵ | 2020 | Kohgiluyeh and Boyer-Ahmad | 247 | 198748 | 134 | 198501 |
| Nour Kojory et al ⁶⁶ | 2007 | Mazandaran | 95 | 16789 | 15 | 16694 |
| Omidkhoda et al ⁶⁷ | 2011 | Tehran | 54 | 11510 | 12 | 11456 |
| Pourazar et al ⁶⁸ | 2006 | Esfahan | 346 | 51799 | 142 | 51453 |
| Ranjbarian ⁶⁹ | 2007 | Hamedan | 46 | 8514 | | |
| Rezaie et al ⁷⁰ | 2016 | Semnan | 100 | 42353 | 26 | 42253 |
| Reza-Zadeh et al ⁷¹ | 2006 | Hamedan | 141 | 18447 | 78 | 18306 |
| Sajjadi et al ⁷² | 2018 | Kohgiluyeh and Boyer-Ahmad | 250 | 180554 | 115 | 180304 |
| Sanei Moghaddam et al ⁷³ | 2004 | Sistan and Balouchestan | 168 | 7360 | 75 | 7192 |
| Seyed Askari et al ⁷⁴ | 2015 | Kerman | 837 | 361559 | 292 | 360722 |
| Sofian et al ⁷⁵ | 2010 | Markazi | 2 | 533 | 1 | 531 |
| Sorouri Zanjani et al ⁷⁶ | 2013 | Zanjan | 104 | 29820 | 33 | 29716 |
| Taheri Azbarmi et al ⁷⁷ | 2008 | Gilan | 130 | 49950 | 91 | 49820 |
| Tajbakhsh et al ⁷⁸ | 2007 | Chaharmahal and Bakhtiari | | | 69 | 11472 |
| Vahid et al ⁷⁹ | 2005 | Qazvin | 428 | 40026 | | |
| Vossoughinia et al ⁸⁰ | 2010 | Razavi Kho-rasan | 3636 | 314154 | 311 | 310518 |
| Yazhan et al ⁸¹ | 2016 | Razavi Kho-rasan | 172 | 57507 | 13 | 57335 |
| Zalei et al ⁸² | 2017 | Kermanshah | | | 1 | 470 |

470 to 1,137,582), lapsed (1,640,069 donors ranging from 3,463 to 914,026), and regular (1,645,494 donors ranged from 728 to 1,002,984) blood donors, respectively.

13 studies ^{23,25-27,29,31,35,39,45,73,76,78,81} had provided the number of HCV cases (5,654 HCV cases ranging from 6 to 3,071) among male donors (4,897,025 male donors ranging from 2,787 to 2,240,419), and another 13 studies ^{23,25-27,29,31,35,39,45,73,76,78,81} had provided the number of HCV cases (172 HCV cases ranged from 0 to 75) among female donors

(327,142 female donors ranging from 213 to 172,856).

Using a random-effects model based on 58 studies, we found that the pooled prevalence of HCV was 0.22% (95% CI: 0.20 – 0.24) in blood donors (figure 2B). There was significant inter-study heterogeneity across the included studies (I²: 98.64%, $p < 0.001$). Meta-regression analysis results indicated that the date of publication ($\beta = -0.02$, $p < 0.001$) was associated with HCV prevalence (figure 3 B), but the total sample size did not show a significant impact

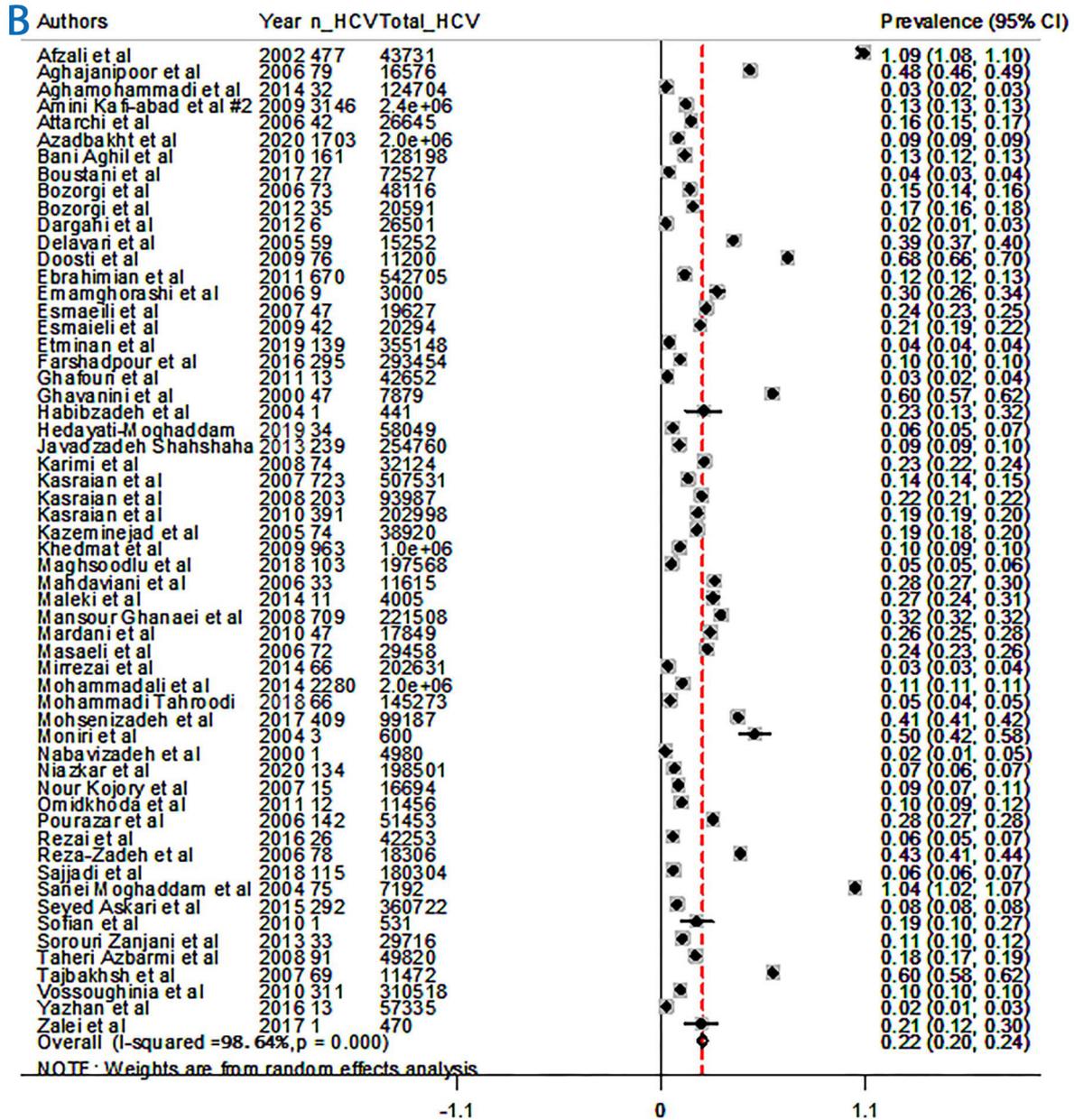


I² (variation in ES attributable to heterogeneity) = **99.90%**
 Estimate of between-study variance Tau² = **0.00**
 Test of ES=0 : z= **17.54** p = **0.00**
. drop _ES - _WT

Fig.2 A: The forest plot of pooled HBV

($\beta = -0.00, p = 0.115$). The findings of sensitivity analysis for HCV showed that the highest pooled prevalence of HCV was 0.22% (95% CI: 0.20 - 0.25) after exclud-

ing the study by Yazhan and colleagues.⁸¹ Also, the lowest pooled prevalence of HCV was 0.20% (95% CI: 0.18 - 0.22) after excluding the study by Afzali and co-workers.¹⁹ The



Heterogeneity $\chi^2 = 4205.96$ (d.f. = 57) $p = 0.00$
 I^2 (variation in ES attributable to heterogeneity) = **98.64%**
 Estimate of between-study variance $\tau^2 = 0.00$

Test of $ES=0$: $z = 25.55$ $p = 0.00$

Fig.2 B: The forest plot of pooled HCV prevalence

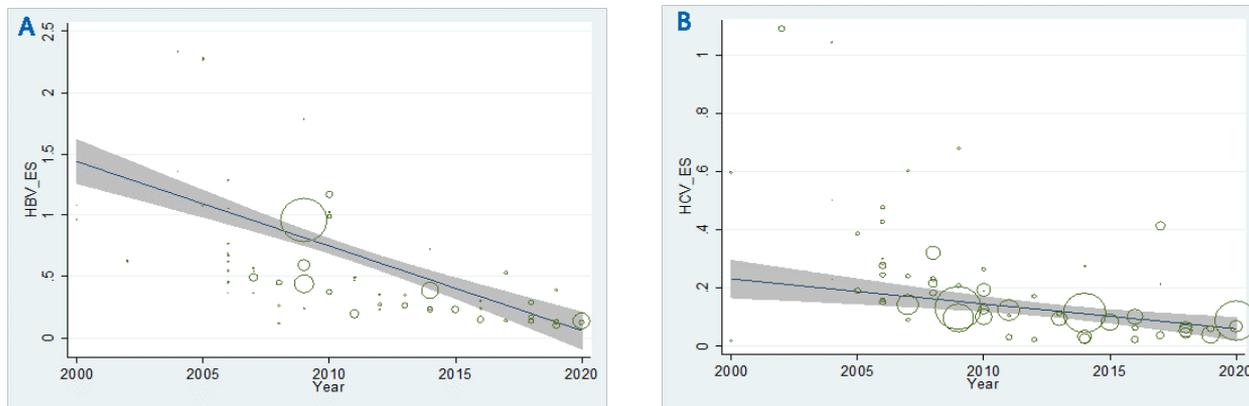


Fig. 3 A-B: Line graph of fitted values plotted using meta-regression against year for HBV (A) and HCV (B) prevalence

Table 2: The pooled prevalence of HBV and HCV based on blood donors’ condition, sex, and quality of studies

| Variables | HBV | | HCV | | |
|-------------------|-------------------------|-----------------------------|-------------------------|-----------------------------|---------------------|
| | No. of included studies | Pooled effect size (95% CI) | No. of included studies | Pooled effect size (95% CI) | |
| Donors’ condition | First time blood donors | 15 | 1.06 % (0.90-1.22) | 14 | 0.43 % (0.37- 0.48) |
| | Lapsed blood donors | 14 | 0.19 % (0.14-0.24) | 12 | 0.13 % (0.10- 0.17) |
| | Regular blood donors | 10 | 0.33 % (0.27-0.39) | 9 | 0.28 % (0.24- 0.33) |
| Sex | Male | 15 | 0.57 % (0.44-0.70) | 13 | 0.22 % (0.19- 0.25) |
| | Female | 15 | 0.44 % (0.45-0.53) | 13 | 0.23 % (0.16-0.30) |
| Quality status | Low quality | 23 | 0.75 % (0.51-0.99) | 23 | 0.33 % (0.20-0.46) |
| | High quality | 38 | 0.46 % (0.34-0.59) | 35 | 0.15 % (0.13-0.17) |

results of the subgroup analyses are presented in table 2.

Quality assessment

High-quality studies related to the prevalence of HBV and HCV among blood donors were 38 and 35, respectively. The results of subgroup analyses according to the quality of studies are summarized in table 2. Quality indicators of different studies and details of the scoring method are also presented in table S1.

DISCUSSION

The first global health sector strategy (GHSS) on viral hepatitis was prepared in May 2016 by the World Health Assembly, the decision-making body of WHO. The program requires the members to eliminate viral hepatitis as a public health threat by 2030 aiming to reduce new infections by 90% and mortality by 65%. Blood and injection safety is the core of the intervention of the elimination program.²

HBV and HCV were responsible for 96% of all mortality

causes related to hepatitis. In addition, most hepatitis deaths in 2015 were commonly attributed to cirrhosis (720,000 deaths) and HCC (470,000 deaths). The global prevalence of HBV infection was 3.5% in the general population, and about 257 million persons have chronic infection with HBV. WHO African region and the Western Pacific region have the highest reported prevalence of HBV.² Blood donors are among the high-risk populations with an increased incidence of HBV infection. WHO recommends screening of all blood donations for evidence of infections such as HBV.³ Blood transfusion is an uncommon event in a person’s life; hence, contaminated transfusion is not a major source of viral hepatitis transmission compared with other risk factors such as unsafe injections.^{83,84} However, WHO actively recruits VNRDs for the promotion of blood safety because paid donors had a higher prevalence of blood-borne pathogens.^{5,85}

Regarding the result of the present investigation, the pooled prevalence of HBV was 0.57% among blood donors, which was in the range of the previous report. Babanejad

Table S1: Quality Indicators from Newcastle-Ottawa Scale

| | Authors | Year | 1 | 2 | 3 | 4A | 4B | 5A | 5B | 6 | 7 | Stars | Quality |
|----|-----------------------------------|-------|---|---|---|----|----|----|----|---|---|-------|---------|
| 1 | Afzali et al (1) | 2002 | * | * | * | | | * | * | | | 5 | Low |
| 2 | Aghajanipoor et al (2) | 2006 | * | * | * | | | * | * | * | | 6 | Low |
| 3 | Aghamohammadi et al (3) | 2014 | * | * | * | | | * | * | * | * | 7 | High |
| 4 | Alaei et al (4) | 2019 | * | * | * | | | * | * | * | * | 7 | High |
| 5 | Amini Kafi-abad et al #1 (5) | 2009a | * | * | * | | | * | * | * | * | 7 | High |
| 6 | Amini Kafi-abad et al #2 (6) | 2009b | * | * | * | | | * | * | * | * | 7 | High |
| 7 | Arab et al (7) | 2006 | * | * | * | | | * | * | * | | 6 | Low |
| 8 | Attarchi et al (8) | 2006 | * | * | * | | | * | * | * | | 6 | Low |
| 9 | Azadbakht et al (9) | 2020 | * | * | * | | | * | * | * | * | 7 | High |
| 10 | Bani Aghil et al (10) | 2010 | * | * | * | | | * | * | * | * | 7 | High |
| 11 | Boustani et al (11) | 2017 | * | * | * | | | * | * | * | * | 7 | High |
| 12 | Bozorgi et al (12) | 2006 | * | * | * | | | * | * | * | * | 7 | High |
| 13 | Bozorgi et al (13) | 2012 | * | * | * | | | * | * | * | * | 7 | High |
| 14 | Dargahi et al (14) | 2012 | * | * | * | | | * | * | | | 5 | Low |
| 15 | Delavari et al (15) | 2005 | * | * | * | | | * | * | | * | 6 | Low |
| 16 | Doosti et al (16) | 2009 | * | * | * | | | * | * | | * | 6 | Low |
| 17 | Ebrahimian et al (17) | 2011 | * | * | * | | | * | * | * | * | 7 | High |
| 18 | Emamghorashi et al (18) | 2006 | * | * | * | | | * | * | * | | 6 | Low |
| 19 | Esmaceli et al (19) | 2007 | * | * | * | | | * | * | * | | 6 | Low |
| 20 | Esmaceli et al (20) | 2009 | * | * | * | | | * | * | * | | 6 | Low |
| 21 | Etminan et al (21) | 2019 | * | * | * | | | * | * | * | * | 7 | High |
| 22 | Farshadpour et al (22) | 2016 | * | * | * | | | * | * | * | * | 7 | High |
| 23 | Ghafouri et al (23) | 2011 | * | * | * | | | * | * | * | * | 7 | High |
| 24 | Ghavanini et al (24) | 2000 | * | * | * | | | * | * | * | * | 7 | High |
| 25 | Ghods Garamaleki et al (25) | 2019 | * | * | * | | | * | * | | | 5 | Low |
| 26 | Habibzadeh et al (26) | 2004 | * | | * | | | * | * | | | 4 | Low |
| 27 | Hedayati-Moghaddam et al (27) | 2019 | * | * | * | | | * | * | * | | 6 | Low |
| 28 | Javadzadeh Shahshahani et al (28) | 2013 | * | * | * | | | * | * | * | * | 7 | High |
| 29 | Karimi et al (29) | 2008 | * | * | * | | | * | * | | * | 6 | Low |
| 30 | Kasraian et al (30) | 2007 | * | * | * | | | * | * | * | * | 7 | High |
| 31 | Kasraian et al (31) | 2008 | * | * | * | * | * | * | * | * | * | 9 | High |
| 32 | Kasraian et al (32) | 2010 | * | * | * | | | * | * | * | * | 7 | High |
| 33 | Kasraian et al (33) | 2012 | * | * | * | | | * | * | * | * | 7 | High |
| 34 | Kazeminejad et al (34) | 2005 | * | * | * | | | * | * | | * | 6 | Low |
| 35 | Khedmat et al (35) | 2009 | * | * | * | | | * | * | * | * | 7 | High |
| 36 | Maghsoodlu et al (36) | 2018 | * | * | * | | | * | * | * | * | 7 | High |
| 37 | Mahdaviani et al (37) | 2006 | * | * | * | | | * | * | * | * | 7 | High |
| 38 | Maleki et al (38) | 2014 | * | * | * | | | * | * | * | * | 7 | High |
| 39 | Mansour Ghanaei et al (39) | 2008 | * | * | * | | | * | * | * | * | 7 | High |
| 40 | Mardani et al (40) | 2010 | * | * | * | | | * | * | * | * | 7 | High |
| 41 | Masacli et al (41) | 2006 | * | * | * | | | * | * | * | * | 7 | High |
| 42 | Mirrezaei et al (42) | 2014 | * | * | * | * | * | * | * | * | * | 9 | High |
| 43 | Mohammadali et al (43) | 2014 | * | * | * | | | * | * | * | * | 7 | High |

| | Authors | Year | 1 | 2 | 3 | 4A | 4B | 5A | 5B | 6 | 7 | Stars | Quality |
|----|-------------------------------|------|---|---|---|----|----|----|----|---|---|-------|---------|
| 44 | Mohammadi Tahroodi et al (44) | 2018 | * | * | * | | | * | * | | * | 6 | Low |
| 45 | Mohsenizadeh et al (45) | 2017 | * | * | * | | | * | * | * | * | 7 | High |
| 46 | Moniri et al (46) | 2004 | * | | * | | | * | * | * | | 5 | Low |
| 47 | Nabavizadeh et al (47) | 2000 | * | * | * | | | * | * | | | 5 | Low |
| 48 | Niazkar et al (48) | 2020 | * | * | * | | | * | * | * | * | 7 | High |
| 49 | Nour Kojory et al (49) | 2007 | * | * | * | | | * | * | * | * | 7 | High |
| 50 | Omidkhoda et al (50) | 2011 | * | * | * | * | * | * | * | * | * | 9 | High |
| 51 | Pourazar et al (51) | 2006 | * | * | * | | | * | * | * | * | 7 | High |
| 52 | Ranjbarian (52) | 2007 | * | * | * | | | * | * | * | | 6 | Low |
| 53 | Rezaie et al (53) | 2016 | * | * | * | | | * | * | * | * | 7 | High |
| 54 | Reza-Zadeh et al (54) | 2006 | * | * | * | | | * | * | | | 5 | Low |
| 55 | Sajjadi et al (55) | 2018 | * | * | * | | | * | * | * | * | 7 | High |
| 56 | Sanei Moghaddam et al (56) | 2004 | * | * | * | | | * | * | * | | 6 | Low |
| 57 | Seyed Askari et al (57) | 2015 | * | * | * | | | * | * | * | * | 7 | High |
| 58 | Sofian et al (58) | 2010 | * | | * | | | * | * | * | * | 6 | Low |
| 59 | Sorouri Zanjani et al (59) | 2013 | * | * | * | | | * | * | | * | 6 | Low |
| 60 | Taheri Azbarmi et al (60) | 2008 | * | * | * | | | * | * | | * | 6 | Low |
| 61 | Tajbakhsh et al (61) | 2007 | * | * | * | | | * | * | * | | 6 | Low |
| 62 | Vahid et al (62) | 2005 | * | * | * | * | * | * | * | * | * | 9 | High |
| 63 | Vossoughinia et al (63) | 2010 | * | * | * | * | | * | * | * | | 7 | High |
| 64 | Yazhan et al (64) | 2016 | * | * | * | | | * | * | * | * | 7 | High |
| 65 | Zalei et al (65) | 2017 | * | | * | | | * | * | * | * | 6 | Low |

and colleagues reported that the pooled prevalence of HBsAg in blood donors in the WHO Eastern Mediterranean Region (EMRO) and exclusively in Iran was 1.99% and 0.58%, respectively.³ Throughout the last two decades, HBV prevalence was declined in Iran as a result of designing and running a national vaccination program in infants, mandatory screening of pregnant women, proper treatment of newborns delivered by infected mothers, increasing the knowledge of people toward the routes of HBV transmission and its risk factors, and finally vaccination of high-risk groups especially health care workers.^{8,86-88} Previous reports reveal that Iran is classified as one of the countries with a low–intermediate prevalence of HBV (2–4.9%).⁸⁹ Since many positive cases with viral hepatitis are excluded from donating blood, the prevalence of HBsAg in blood donors is not an indicator of the prevalence among the whole population. This means that the donor population is representative of low-risk individuals prone to viral hepatitis infection via specific means, including contamination of the equipment or other means that are usually underestimated.^{3,13,86}

It is suggested that 1.75 million new HCV infections occurred worldwide in 2015, and the global prevalence of this infection is about 1%, according to the literature.² The incidence and prevalence rates of HCV infection were reported to be 62.5 per 100000 (total number: 409000) and 2.3% (total number: 15 million) in EMRO, respectively. Although the prevalence of HCV is lower than HBV, the infection is distributed more heterogeneously in Iran than in the world.² The prevalence of HCV in Iran has been reported to be 0.6% in the general population.¹⁴ Therefore, Iran could be categorized as a low-prevalent country for HCV infection.⁹⁰ Moreover, Iran has the lowest rate of HCV infection compared with most of the other countries in the Middle-East region.^{13,15} However, a recent increase was seen in the patients affected by HCV infection, and probably this type of hepatitis will replace HBV in the near future as the most common cause of the chronic liver disease.^{91,92} We conclude that the pooled prevalence of HCV is 0.22% among blood donors in Iran, which is much lower than previous studies in which 0.5% of blood donors were infected with HCV.¹⁵

The present study shows that the prevalence of HBV in Iran is non-uniformly distributed. This was ranged between 0.1% in Kerman to 2.34% in Sistan and Baluchestan provinces, both located in the southeastern part of the country.^{38,73} Another result of the current analysis is the relatively heterogeneous dispersion of HCV prevalence from 0.02% in Khorasan Razavi and Kohgiluyeh and Boyer-Ahmad provinces, located in central-western and northeastern parts of Iran to 1.09% in Esfahan, in the center of Iran.^{19,64,81} This might be due to significant differences in the quality of public health, habits, risk factors, and lifestyles in various geographical regions.¹⁵ The year of publication of data and the geographical location were also probable sources of heterogeneity among high-risk groups infected with both HBV and HCV.^{93,94}

In the end, some limitations of this study should be mentioned. First, over one-third of the studies included in this review had low quality. Second, the reported age of the individuals was diverse, so we were not able to report the findings by age classification. It is suggested that future studies focus on standardized formulae for sample size calculation and report of definite age groups for better estimation of the prevalence of viral hepatitis in blood donors to inform policymakers and public health providers.

CONCLUSION

The results of the present study indicate that the prevalence of HBV and HCV decreased steadily among blood donors in Iran during the past two decades. The policies toward controlling the prevalence of viral hepatitis seem to be relatively efficient, although lowering the rate is still an important concern.

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Statement of Ethics

The protocol of this study was approved by the Ethics Committee, managed by Prof. S.Z. Tabei, at Shiraz University of Medical Sciences, Shiraz, Iran.

Disclosure Statement

The authors declare that they have no competing interests. All the expenditure was provided by the authors, and nothing was received from any other source or organization.

Authors' Contribution

LK and SH gathered the data and extracted the data out of the papers, and classified them for analysis. RT performed the data analysis and prepared the results of the paper out of raw data. SH, RSR, AE, and MHI prepared the draft, edited it, and finalized the paper. All authors reviewed the final draft of the paper.

ETHICAL APPROVAL

There is nothing to be declared.

CONFLICT OF INTEREST

The authors declare no conflict of interest related to this work.

REFERENCES

1. Stasi C, Silvestri C, Voller F, Cipriani F. The epidemiological changes of HCV and HBV infections in the era of new antiviral therapies and the anti-HBV vaccine. *J Infect Public Health* 2016;**9**:389-95. doi: 10.1016/j.jiph.2015.05.004.
2. WHO. Global Hepatitis Report 2017. Geneva: World Health Organization; 2017. Licence: CC BY-NC-SA. 2017;3.
3. Babanejad M, Izadi N, Najafi F, Alavian SM. The HBsAg Prevalence among blood donors from Eastern Mediterranean and Middle Eastern countries: a systematic review and meta-Analysis. *Hepat Mon* 2016;**16**:e35664. doi: 10.5812/hepatmon.35664.
4. WHO-Expert-Group. Expert Consensus Statement on achieving self-sufficiency in safe blood and blood products, based on voluntary non-remunerated blood donation (VN-RBD). *Vox Sang* 2012;**103**:337-42. doi: 10.1111/j.1423-0410.2012.01630.x.
5. Asenso-Mensah K, Achina G, Appiah R, Owusu-Ofori S, Allain JP. Can family or replacement blood donors become regular volunteer donors? *Transfusion* 2014;**54**:797-804. doi: 10.1111/trf.12216.

6. Amini Kafi-Abad S, Rezvan H, Abolghasemi H. Trends in prevalence of hepatitis B virus infection among Iranian blood donors, 1998–2007. *Transfus Med* 2009;**19**:189-94. doi: 10.1111/j.1365-3148.2009.00935.x.
7. Alavian SM, Fallahian F, Lankarani KB. The changing epidemiology of viral hepatitis B in Iran. *J Gastrointest Liver Dis* 2007;**16**:403-6.
8. Salehi-Vaziri M, Sadeghi F, Hashiani AA, Fesharaki MG, Alavian SM. Hepatitis B virus infection in the general population of Iran: an updated systematic review and meta-analysis. *Hepat Mon* 2016;**16**:e35577. doi: 10.5812/hepatmon.35577.
9. Cheraghali A. Overview of blood transfusion system of Iran: 2002-2011. *Iran J Public Health* 2012;**41**:89-93.
10. European-Association-for-Study-of-Liver. EASL Clinical Practice Guidelines: management of hepatitis C virus infection. *J Hepatol* 2014;**60**:392-420. doi: 10.1016/j.jhep.2013.11.003.
11. Lorenzo CD, Angus AG, Patel AH. Hepatitis C virus evasion mechanisms from neutralizing antibodies. *Viruses* 2011;**3**:2280-300. doi: 10.3390/v3112280.
12. Amiri FB, Mostafavi E, Mirzazadeh A. HIV, HBV and HCV coinfection prevalence in Iran-a systematic review and meta-analysis. *PLoS One* 2016;**11**:e0151946. doi: 10.1371/journal.pone.0151946. eCollection 2016.
13. Taherkhani R, Farshadpour F. Epidemiology of hepatitis C virus in Iran. *World J Gastroenterol* 2015;**21**:10790-810. doi: 10.3748/wjg.v21.i38.10790.
14. Mirminachi B, Mohammadi Z, Merat S, Neishabouri A, Sharifi AH, Alavian SH, et al. Update on the prevalence of hepatitis C virus infection among Iranian general population: a systematic review and meta-analysis. *Hepat Mon* 2017;**17**:e42291. doi: 10.5812/hepatmon.42291.
15. 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**:674-82.
16. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med* 2009;**6**:e1000097. doi: 10.1371/journal.pmed.1000097.
17. Bigna JJ, Amougou MA, Asangbeh SL, Kenne AM, Nansseu JR. Seroprevalence of hepatitis C virus infection in Cameroon: a systematic review and meta-analysis. *BMJ Open* 2017;**7**:e015748. doi: 10.1136/bmjopen-2016-015748.
18. Nyaga VN, Arbyn M, Aerts M. Metaprop: a Stata command to perform meta-analysis of binomial data. *Arch Public Health* 2014;**72**:39. doi: 10.1186/2049-3258-72-39. eCollection 2014.
19. Afzali H, Taghavi-Ardakani A, Vali G. Sero-epidemiology of hepatitis B and C in blood donors in Kashan 1375-1380 (1996-2001) (in Persian). *Feyz* 2002;**6**:43-50.
20. Aghajani-poor K, Zandieh T. Seroepidemiological investigation of hepatitis B,C and HIV virus in safe blood donors of Babol Blood Transfusion Center. *Sci J Iran Blood Transfus Organ* 2006;**2**:339-41.
21. Aghamohamadi A, Montazeri M, Akbari M. Prevalence of hepatitis B and hepatitis C in blood donors at Semnan province from 2008 to 2011. *Faslnamehi Kumish* 2014;**15**:162-7.
22. Alaei M, Zadsar M, Pouriani E. The prevalence and probable risk factors of HbsAg positive blood donors in Mazandaran province in 2013. *Sci J Iran Blood Transfus Organ* 2019;**16**:241-50.
23. Amini Kafi-abad S, 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**:2214-20. doi: 10.1111/j.1537-2995.2009.02245.x.
24. Arab M, Abas-zadeh A, Pourabuli B, Soleimanizadeh L, Shahsavari M, Javadi M. Prevalence of HBsAg positivity in blood donors in Bam, 1999-2002. *Sci J Iran Blood Transfus Organ* 2006;**3**:277-80.
25. Attarchi Z, Ghafouri M, Hajibaygi B, Assari S, Alavian SM. Donor deferral and blood-borne infections in blood donors of Tehran. *Sci J Iran Blood Trans Organ* 2006;**2**:353-64.
26. Azadbakht M, Ardakani MT, Delirakbariazar M, Kasraian L, Khaledi A, Forouzandeh H, et al. Seroprevalence and Trend of HBV, HCV, and HIV Infections among Blood Donors of Fars Province, Iran (2006–2018). *Ethiop J Health Sci* 2020;**30**:397-407. doi: 10.4314/ejhs.v30i3.11.
27. Bani Aghil SS, Abbasi S, Arab M, Seyedein MS. The Prevalence of HCV, HBV, HIV in Blood Donors of Golestan Province, (2006-2008). *Med Lab J* 2009;**3**:1-5.
28. Boustani H, Anvari E, Saiadi Sartang S, Omidi M, Rostami E, Mohamadi Z. Prevalence of HIV, hepatitis B and C infections among volunteer blood donors at the blood transfusion center of Ilam city, Iran. *J Basic Res Med Sci* 2017;**4**:4-8. doi: 10.18869/acadpub.jbrms.4.2.4 .
29. Bozorgi SH, Ramezani H, Nooranipour M, Ahmadi M, Baghernejad A, Mostajeri A, et al. Risk factors of viral hepatitis: yet to explore. *Transfus Apher Sci* 2012;**47**:145-9. doi: 10.1016/j.transci.2012.06.023.
30. Bozorgi S, AhmadzadAsl M, Ramezani H, Kargarfard H, Alavian S. Study of Viral Infections Prevalence in Blood Donors of Qazvin Province in Different Time Intervals and During Bam Earthquake. *Govaresh* 2006;**11**:242-8.
31. Dargahi F, Amani F, Habibzadeh S, Ezzati M, Sadri Z. The epidemiology of HCV, HBV, HIV, in blood donors in Ardabil province in 1389 (2010) (In Persian). *Caduceus* 2012;**2**:31-8.
32. Delavari M, Tabatabaie S, Sheikh Bardsiri H, Maarefdust Z, Zandieh T. The prevalence of Hepatitis C and its related factors among blood donors of Kerman Blood Center. *Sci J Iran Blood Transfus Organ* 2006;**2**:269-71.
33. Doosti A, Amini-Bavil-Olyae S, Tajbakhsh E, Adeli A, Mahboudi F. Prevalence of viral hepatitis and molecular analysis of HBV among voluntary blood donors in west Iran. *New Microbiol* 2009;**32**:193-8.
34. Ebrahimian Z, Fazilati M, Akbari N, Hariri MM, Fatehifar MR. Correlation of deferral rate with the frequency rate of viral markers of HBV, HCV and HIV in blood supplies

- during 2004 to 2009. *Sci J Iran Blood Transfus Organ* 2011;**8**:130-6.
35. Emamghoreishi F, Fathi GH, Mohtashami A. Evaluation of demographic characteristics and hepatitis B,C and HIV prevalence among blood donors in Jahrom. *Sci J Iran Blood Transfus Organ* 2006;**2**:373-8.
 36. Esmaili H, Hajiani G, Esmailie M, Monkhian A, Azizzadeh M, Hamidia Z. Evaluation of infection with hepatitis B, C, HIV and syphilis among blood donors in Bushehr province in 2005. *Iran J Infect Dis Trop Med* 2007;**12**:85-6.
 37. Esmaili H, Hajiani G, Mankhian A, Pourmehdi Broujeni M. Seroepidemiological survey of hepatitis B, C, HIV and syphilis among blood donors in Bushehr-Iran (in Persian). *Iran South Med J* 2009;**11**:183-90.
 38. Etmnan A, Naghibzadeh-Tahami A, Askari S. The association between the prevalence of transfusion transmitted infections and characteristics of infected blood donors in kerman, Iran. *J Kerman Uni Med Sci* 2019;**26**:377-83.
 39. Farshadpour F, Taherkhani R, Tajbakhsh S, Gholizadeh Tangestani M, Hajiani 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;**11**:e0157615. doi: 10.1371/journal.pone.0157615. eCollection 2016.
 40. Ghafouri M, Ameli M. Comparing prevalence of transfusion transmitted viral infections in various population groups of South Khorasan. *Sci J Iran Blood Transfus Organ* 2011;**7**:242-8.
 41. Ghavanini AA, Sabri MR. Hepatitis B surface antigen and anti-hepatitis C antibodies among blood donors in the Islamic Republic of Iran. *East Mediterr Health J* 2000;**6**:1114-6.
 42. Ghodsi Garamaleki M, Ahmadizadeh C. Prevalence of hepatitis B among blood donors referring to blood transfusion organization: brief report. *Tehran Uni Med J* 2019;**76**:699-702.
 43. Habibzadeh S, Davarnia B, Bazazataei A, Bagherzadeh S, Hamid Kholgh GR. Epidemiological evaluation of transfusion transmitted diseases in Ardabil in Tasoua and Ashoura 2003. *Sci J Iran Blood Transfu Organ* 2005;**1**:55-60.
 44. Hedayati-Moghaddam MR, Foomani FM, Gowhari Shabgah A. Frequency of Viral Transfusion-Transmitted Infections (TTIs) Among Resident and Pilgrim Blood Donors in Mashhad, 2011. *Int J Infect* 2019;**6**:e87350. doi: 10.5812/iji.87350.
 45. Javadzadeh Shahshahani H, Vaziri M, Mansouri F. Seven years trends in prevalence of transfusion-transmissible viral infections in Yazd blood transfusion organization. *Iran J Ped Hematol Oncol* 2013;**3**:119-24.
 46. Karimi A, Hoseini SM. Seroprevalence of hepatitis B and C virus and HIV markers among blood donors from Shahrekord, Iran (2004-2006). *Kuwait Med J* 2008;**40**:285-7.
 47. Kasraian L, Jahromi T, Ardeshir S. Prevalence of major transfusion transmitted viral infections (HCV, HBV, HIV) in Shiraz blood donors from 2000 to 2005. *Sci J Iran Blood Transfus Organ* 2007;**3**:373-8.
 48. Kasraian L, Tavassoli AR. Prevalence of hepatitis C and its risk factors in blood donors at Shiraz transfusion center. *Fasnamahi Kumish* 2008;**10**:7-12.
 49. Kasraian L, Tavasoli A. Positivity of HIV, hepatitis B and hepatitis C in patients enrolled in a confidential self-exclusion system of blood donation: a cross-sectional analytical study. *Sao Paulo Med J* 2010;**128**:320-3. doi: 10.1590/s1516-31802010000600002.
 50. Kasraian L, Tavassoli A, Shayegan M, Alavian SM. The prevalence and risk factor of hepatitis B and D in Shiraz blood donors. *Afr J Microbiol Res* 2012;**6**:3976-9. doi: 10.5897/AJMR11.822.
 51. Kazeminejad V, Azarhoosh R, Moulana AA, Dehbashi GR. Frequency of hepatitis B, C and HIV in blood donors and patients referring to Gorgan Blood Transfusion Organization (2003). *J Gorgan Univ Med Sci* 2005;**7**:84-6.
 52. Khedmat H, Alavian SM, Miri SM, Amini M, Aboighasemi H, Hajibeigi B, et al. Trends in Seroprevalence of Hepatitis B, Hepatitis C, HIV, and Syphilis Infections in Iranian Blood Donors from 2003 to 2005. *Hepat Mon* 2009;**9**:24-8.
 53. Maghsoodlu M, Salehifar P, Rahimzadeh P, Babahajian W, Mohammadi S, Babahajian S, et al. Prevalence and Trends of Transfusion-Transmissible Infections and Study of Confidential Unit Exclusion among Blood Donors in Kurdistan Province of Iran. *Int J Med Lab* 2018;**5**:58-65.
 54. Mahdaviani F, Maghsoudlu M, Pourfathollah AA. Prevalence of blood transmitted viral infections in regular and non-regular donors of Arak Blood Center. *Sci J Iran Blood Trans Organ* 2006;**2**:343-51.
 55. Maleki F, Hemati S, Mahdavi Z, Azizian M, Amraei M. Prevalence of viral infection of blood donors in Ilam blood transfusion center. *J Basic Res Med Sci* 2014;**1**:51-5.
 56. Mansour-Ghanaei F, Fallah MS, Jafarshad R, Joukar F, Salari A, Tavafzadeh R, et al. Prevalence of hepatitis B and hepatitis C, and their risk factors among Guilan blood donors. *Sci J Iran Blood Transfus Organ* 2008;**4**:331-6.
 57. Mardani A, Ghanbari S, Shahsavarani M, Sahami Zibafar M, Mardani H. Demographic Characteristics of Blood Transmitted Viral Infections in Qom Blood Donors after Bam Earthquake. *Iran J Infect Dis Trop Med* 2010;**15**:31-6.
 58. Masaeli Z, Jaber MR, Magsudlu M. A comparison of seroprevalence of blood-borne infections among regular, sporadic, and first-time blood donors in Isfahan. *Sci J Iran Blood Transfus Organ* 2006;**2**:301-7.
 59. Mirrezaie SM, Saber HR, Hajibeigi B, Salekmoghaddam E, Abbasian A, Alavian SM. Impact of HBV vaccination on prevalence of hepatitis B virus infection among volunteer blood donors in Tehran-Iran. *Shiraz E Med J* 2014;**15**:e18066. doi: 10.17795/semj18066.
 60. Mohammadali F, Pourfathollah AA. Changes in Frequency of HBV, HCV, HIV and Syphilis Infections among Blood Donors in Tehran Province 2005 - 2011. *Arch Iran Med* 2014;**17**:613-20.
 61. Mohammadi Tahroodi F, Abdyazdani N, Shakeri F, Rahmani M, Afrazian MS, Abbasi M, et al. The Prevalence of Hep-

- atitis B, Hepatitis C and AIDS in Blood Donors in Ilam Province: A Retrospective Study. *Iran J Virol* 2018;**12**:32-9.
62. Mohsenizadeh M, Mollaei HR, Ghaziizadeh M. Seroepidemiological study of hepatitis B, C and HIV among blood donors in Kerman. *Asian Pac J Cancer Prev* 2017;**18**:3267-72. doi: 10.22034/APJCP.2017.18.12.3267.
 63. Moniri R, Mosayebii Z, Mossavi GA. Seroprevalence of cytomegalovirus, hepatitis B, hepatitis C and human immunodeficiency virus antibodies among volunteer blood donors. *Iran J Public Health* 2004;**33**:38-42.
 64. Nabavizadeh S, Haghbin S. Prevalence of blood transmitted infection in donors of Yasuj blood transfusion organization. *J Guilan Uni Med Sci* 2000;**9**:64-7.
 65. Niazkar HR, Dorgalaleh A, Rad F. First-time Blood Donors Are Double-edged Swords for Blood Transfusion Centers: A Retrospective Study in Southwest Iran. *Turk J Haematol* 2020;**37**:30-5. doi: 10.4274/tjh.galenos.2019.2019.0166.
 66. Nour Kojory S, Alaoddowleie H, Seddighian F. Efficacy of confidential self-exclusion and failed systems on blood donation safety in Sari and Behshahr blood donors. *Sci J Iran Blood Transfu Organ* 2007;**4**:153-8.
 67. OmidKhoda A, Gharehbaghian A, Jamali M, AhmadBeigi N, Hashemi SM, Rahimi A, et al. Comparison of the prevalence of major transfusion-transmitted infections among Iranian blood donors using confidential unit exclusion in an Iranian population: Transfusion-transmitted infections among Iranian blood donors. *Hepat Mon* 2011;**11**:11-3.
 68. Pourazar A, Akbari N, Hariri M, Yavari F, Akbari S. Evaluation of demographic profiles and prevalence of major viral markers in first time vs repeat blood donors in Esfahan. *Sci J Iran Blood Transfu Organ* 2006;**2**:323-9.
 69. Ranjbarian P. Comparison of positive HBsAg prevalence in first-time, repeat, and regular blood donors for the purpose of selecting donors in Hamedan Blood Transfusion Center. *Sci J Iran Blood Transfu Organ* 2008;**4**:359-63.
 70. Rezaie M, Khaleghian A. Prevalence of hepatitis B, hepatitis C and HIV in blood donors in Semnan Province (Iran) from 2011 to 2015. *Faslnameh Kumish* 2016;**17**:501-8.
 71. Reza-Zadeh M, Mani Kashani KH, Mohammadi A, Zandvakili H, Lotfi A, Bahrami H, et al. Prevalence of human immunodeficiency, hepatitis B and hepatitis C viruses in the first time, repeat and regular donors in blood transfusion center, Hamadan, 2004-2005. *Iran J Infect Dis Trop Med* 2006;**11**:55-60.
 72. Sajjadi SM, Pourfathollah AA, Mohammadi S, Nouri B, Hassanzadeh R, Rad F. The prevalence and trends of hepatitis B, hepatitis C, and HIV among voluntary blood donors in kohgiluyeh and boyer-ahmad transfusion center, South-western Iran. *Iran J Public Health* 2018;**47**:944-51.
 73. Sanei Moghaddam E, Khosravi S, Gharibi T. Prevalence of HBsAg and Anti-HCV reactivity in donors embarking on direct blood donation and among first-time blood donors in Zahedan Blood Transfusion Center. *Sci J Iran Blood Transfu Organ* 2005;**1**:19-25.
 74. Seyed Askari SM, Beigzadeh A, Mohammadpoor Ravari M. The prevalence of transfusion transmitted infections among blood donors in Kerman, Iran. *J Kerman Uni Med Sci* 2015;**22**:669-76.
 75. Sofian M, Aghakhani A, Izadi N, Banifazl M, Kalantar E, Eslamifar A, et al. Lack of occult hepatitis B virus infection among blood donors with isolated hepatitis B core antibody living in an HBV low prevalence region of Iran. *Int J Infect Dis* 2010;**14**:e308-10. doi: 10.1016/j.ijid.2009.05.011.
 76. Sorouri Zanjani R, Mazloomzadeh S, Koochehi A, Noori M. Prevalence of Hepatitis B, C and HIV Infection in Blood Donors in Zanjan, 2005-2006. *Prev Care Nurs Mid J* 2013;**3**:56-63.
 77. Taheri Azbarmi z, Nouri S, Joukar F, Jafarshad R, Haajikarimian K, Alinejad s, et al. Transfusion transmitted diseases in Rasht blood donors. *Sci J Iran Blood Transfu Organ* 2008;**4**:337-43.
 78. Tajbakhsh E, Yaghobi R, Vahedi A. A serological survey on hepatitis C virus Antibody in blood donors with an ELISA method. *Tehran Uni Med J* 2007;**65**:69-73.
 79. Vahid T, Alavian SM, Kabir A, Kafae J, Yektaparast B. Hepatitis B prevalence and risk factors in blood donors in Ghazvin, IR. Iran. *Hepat Mon* 2005;**5**:117-22.
 80. Vossoughinia H, Taghi Shakeri M, Mokhtari Amirmajdi E, Abedini S. Risk Factors for Hepatitis B and C in 400 Blood Donor Volunteers in Mashhad During 2003-2007: A Case-control Study. *Horizon Med Sci* 2010;**15**:68-75.
 81. Yazhan S, Sohrabi E, Jamili P, Saffari S, Mojaddadi MS. Frequency of HBV, HCV and HIV infections among Sabzevar blood donors based on demographic characteristics during 2009-2013. *Sci J Iran Blood Transfu Organ* 2016;**13**:197-206.
 82. Zalei B, Pourmand D, Rahmani Y, Bilvaye S. Investigating the prevalence of HTLV and HCV infection in blood donors (for the first time) in blood transfusion organization of Kermanshah, Iran. *J Clin Anal Med* 2017;**8**:509-12. doi: 10.4328/JCAM.5540.
 83. Hauri AM, Armstrong GL, Hutin YJ. The global burden of disease attributable to contaminated injections given in health care settings. *Int J STD AIDS* 2004;**15**:7-16. doi: 10.1258/095646204322637182.
 84. Jimenez AP, Mohamed MK, Sharaf Eldin N, Abou Seif H, El Aidi S, Sultan Y, et al. Injection drug use is a risk factor for HCV infection in urban Egypt. *PLoS One* 2009;**4**:e7193. doi: 10.1371/journal.pone.0007193.
 85. Candotti D, Laperche S. Hepatitis B Virus Blood Screening: Need for Reappraisal of Blood Safety Measures? *Front Med* 2018;**5**:29. doi: 10.3389/fmed.2018.00029.
 86. Alavian SM. Hepatitis B virus infection in Iran; Changing the epidemiology. *Iran J Clin Infect Dis* 2010;**5**:51-61.
 87. Kabir A, Alavian SM, Ahanchi N, Malekzadeh R. Combined passive and active immunoprophylaxis for preventing perinatal transmission of the hepatitis B virus in infants born to HBsAg positive mothers in comparison with vaccine alone. *Hepatol Res* 2006;**36**:265-71. doi: 10.1016/j.hepres.2006.08.001.

88. Mohammadi Z, Keshtkar A, Eghtesad S, Jeddian A, Pour-fatholah AA, Maghsudlu M, et al. Epidemiological profile of hepatitis B virus infection in Iran in the past 25 years; a systematic review and meta-analysis of general population studies. *Middle East J Dig Dis* 2016;**8**:5-18. doi: 10.15171/mejdd.2016.01.
89. Schweitzer A, Horn J, Mikolajczyk RT, Krause G, Ott JJ. Estimations of worldwide prevalence of chronic hepatitis B virus infection: a systematic review of data published between 1965 and 2013. *Lancet* 2015;**386**:1546-55. doi: 10.1016/S0140-6736(15)61412-X.
90. Gower E, Estes C, Blach S, Razavi-Shearer K, Razavi H. Global epidemiology and genotype distribution of the hepatitis C virus infection. *J Hepatol* 2014;**61**:S45-S57. doi: 10.1016/j.jhep.2014.07.027.
91. Merat S, Rezvan H, Nouraie M, Jafari E, Abolghasemi H, Radmard AR, et al. Seroprevalence of hepatitis C virus: the first population-based study from Iran. *Int J Infect Dis* 2010;**14**:113-6. doi: 10.1016/j.ijid.2009.11.032.
92. Alavian SM. Hepatitis C infection in Iran; A review article. *Iran J Clin Infect Dis* 2009;**4**:47-59.
93. Nematollahi S, Ayubi E, Almasi-Hashiani A, Mansori K, Moradi Y, Veisani Y, et al. Prevalence of hepatitis C virus infection among high-risk groups in Iran: a systematic review and meta-analysis. *Public Health* 2018;**161**:90-8.
94. Almasi-Hashiani A, Ayubi E, Mansori K, Salehi-Vaziri M, Moradi Y, Gholamaliei B, et al. Prevalence of hepatitis B virus infection among Iranian high risk groups: a systematic review and meta-analysis. *Gastroenterol Hepatol Bed Bench* 2018;**11**:91-100.