DOI: 10.34172/mejdd.2021.231

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

Leila Kasraian [1], Mohammad Hossein Imanieh [2,*], Reza Tabrizi [3,4], Reza Shahriarirad [5], Amirhossein Erfani [5], Sahar Hosseini [5]

1. Department of Fars Blood Transfusion Research Center, Shiraz University of Medical Sciences, Shiraz, Iran
2. Gastroenterohepatology Research Center, Shiraz University of Medical Sciences, Shiraz, Iran
3. Non-Communicable Diseases Research Center, Fasa University of Medical Sciences, Fasa, Iran
4. Health Policy Research Center, Institute of Health, Shiraz University of Medical Sciences, Shiraz, Iran
5. 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: imaniehmh@sums.ac.ir

Received: 16 Dec. 2020
Accepted: 22 May 2021

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

Please cite this paper as:
Kasraian L, Imanieh MH, Tabrizi R, Shahriarirad R, Erfani A, Hosseini S. Prevalence of HBV and HCV Infections in Iranian Blood Donors; An Updated Systematic Review and Meta-Analysis. *Middle East J Dig Dis* 2021;**13**:237-252. doi: 10.34172/mejdd.2021.231.

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 adaption 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 441 [43] 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,

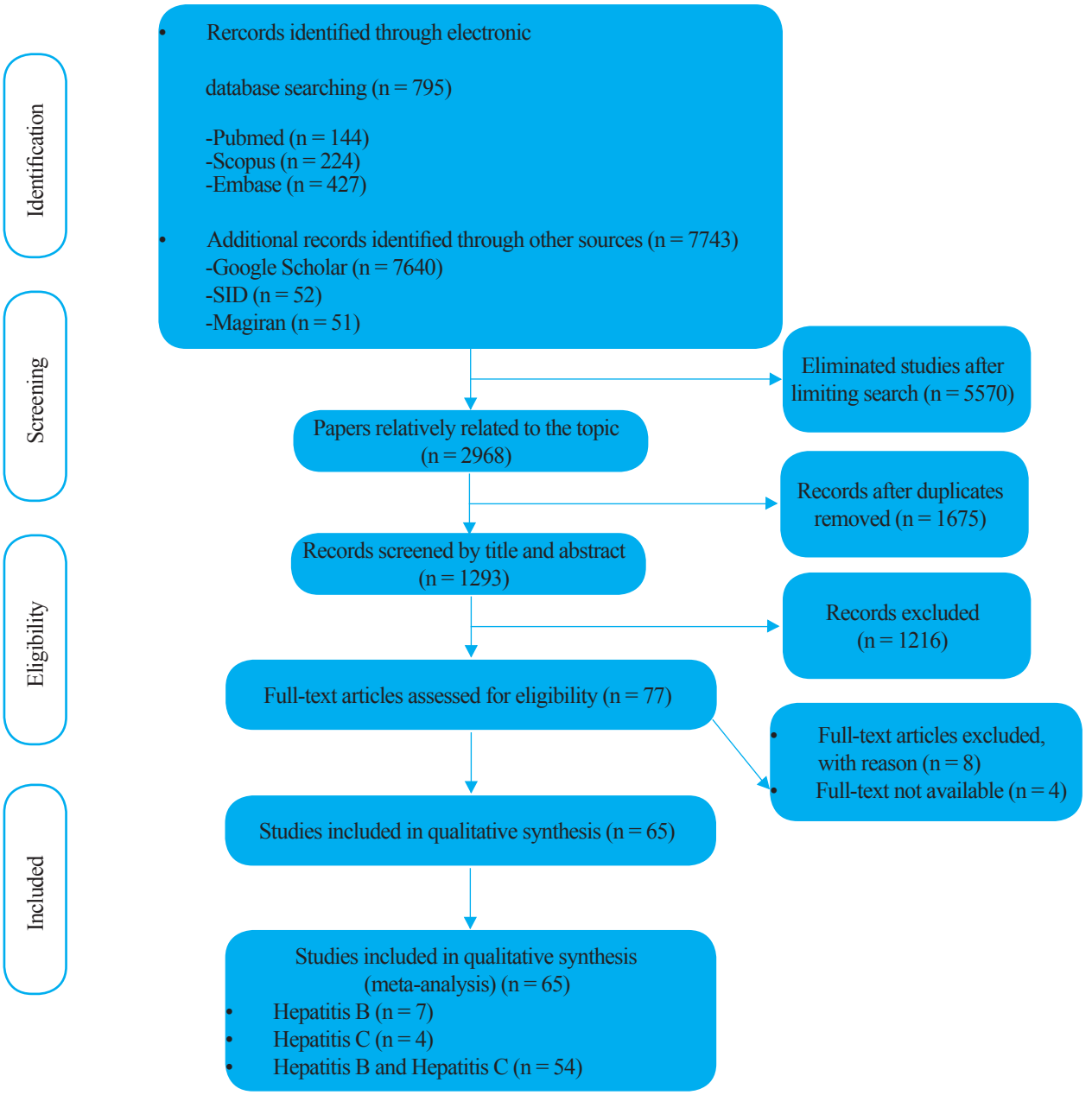

Fig.1: The flowchart of the identification of the studies and selection process

$p < 0.001$) were associated with HBV prevalence (figure 3A), but there was no significant impact on the total sample size ($\beta = 0.00$, $p = 0.671$).

Based on the sensitivity analysis, we found that the highest pooled prevalence of HBV was 0.58% (95% CI: 0.48- 0.68) after excluding the study by Etminan and colleagues,38 and the lowest pooled prevalence of HBV was 0.54% (95% CI: 0.44 – 0.64) after excluding the article by Sanei Moghaddam and co-workers.[73] The pooled prevalence of HBV based on blood donors' conditions, sex, and quality status is shown in table 2.

Hepatitis C

The total sample size included in the meta-analysis was 12,686,297 ranging from 441 [43] to 2,413,275. [23] 14 [23, 25, 26, 29, 37, 38, 58, 65, 68, 71-73, 77, 82], 12 [23, 25, 26, 29, 37,38,54,58,71-73,77], and 9 [23,26,29, 37, 38,58,71,72,77] studies had reported the prevalence of HCV among the first time (1,852,977 donors ranging from

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
Esmaeili et al [36]	2007	Bushehr	72	19699	47	19627
Esmaieli 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 Azarbayejan	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
Mahdaviani 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 Khorasan	3636	314154	311	310518
Yazhan et al [81]	2016	Razavi Khorasan	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 (β=-0.02, $p < 0.001$) was associated with HCV prevalence (figure 3 B), but the total sample size did not show a significant impact

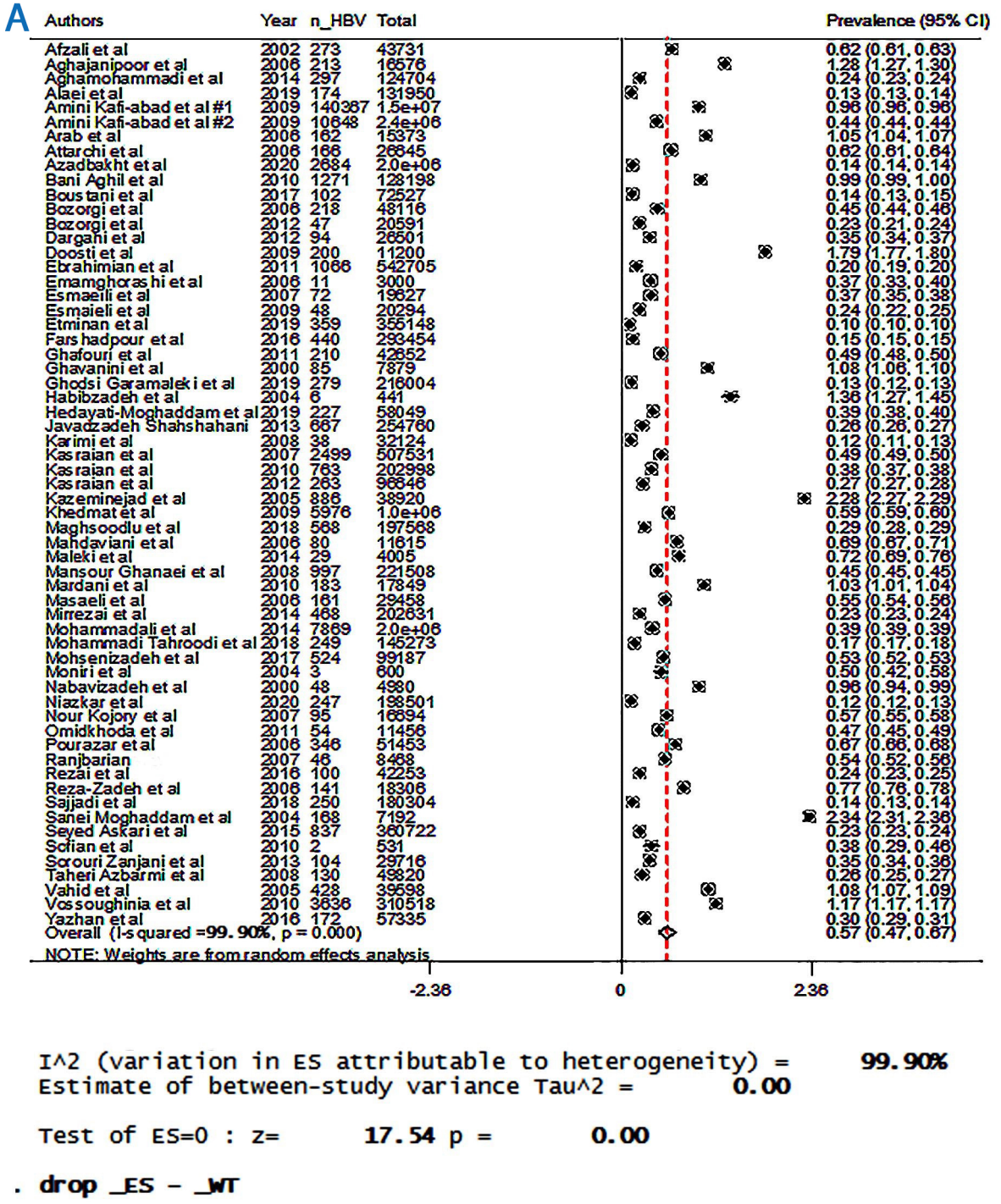

Fig.2 A: The forest plot of pooled HBV

(β = -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 excluding 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

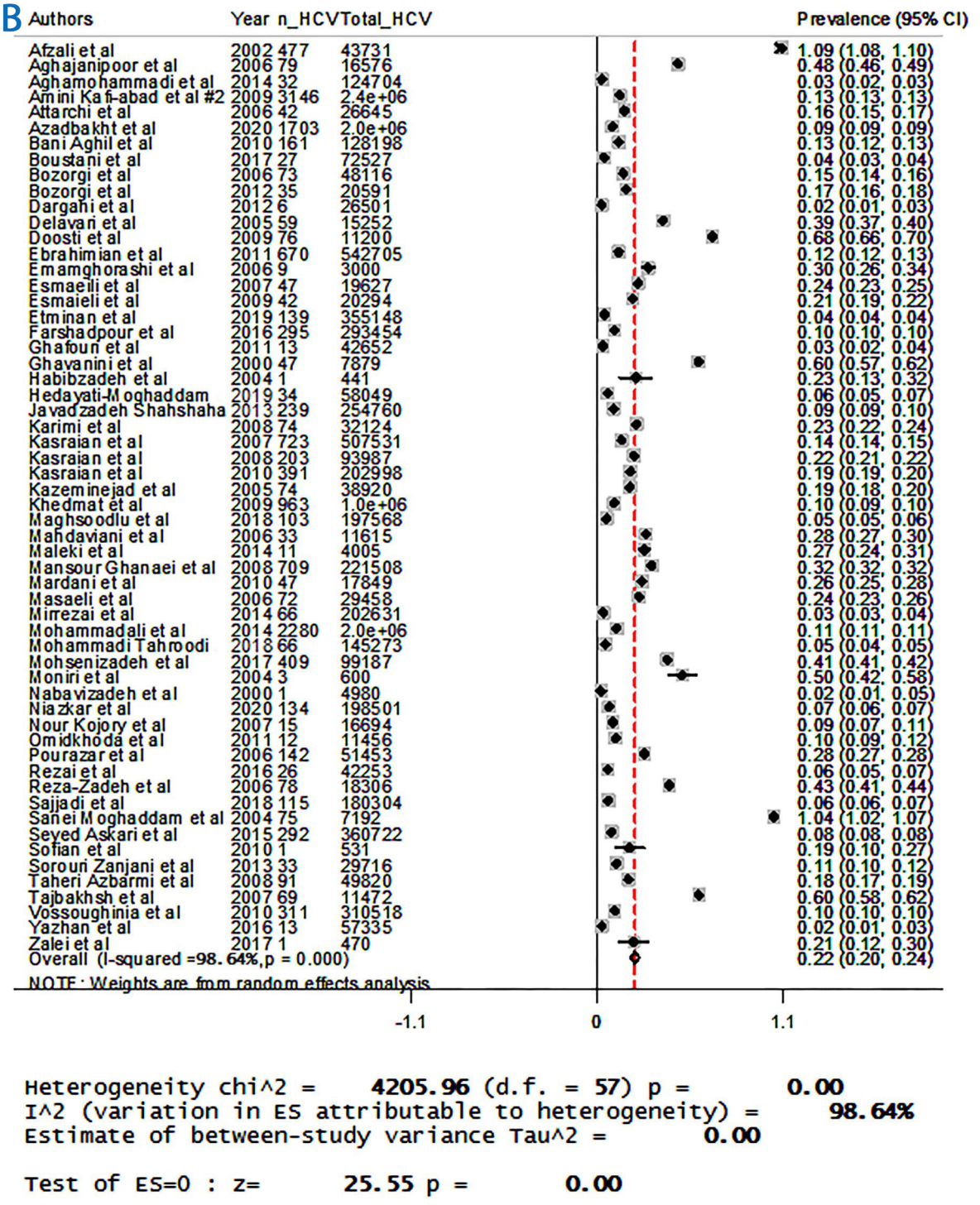

Fig.2 B: The forest plot of pooled HCV prevalence

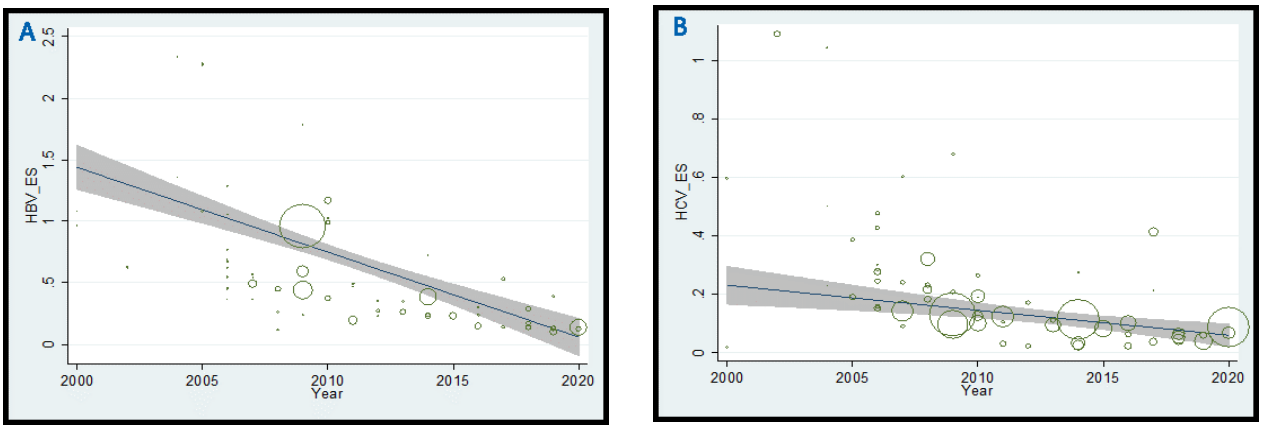

Fig. 3 A-B: **Line graph of fitted values plotted using meta-regression against year for HBV (A) and HCV (B) prevalence**

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	Esmaeili et al (19)	2007	*	*	*			*	*	*		6	Low
20	Esmaieli 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	Ghodsi 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	Masaeli et al (41)	2006	*	*	*			*	*	*	*	7	High
42	Mirrezai 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.

ACKNOWLEDGMENTS

The authors want to thank Dr. Soheil Ashkani Esfahani, Medipress™, and SIMR Co. for providing the required data and assisting in preparing the draft of the present paper and scientific editing of the paper. The authors would also like to thank the Center for Development of Clinical Research of Nemazee Hospital and Dr. Nasrin Shokrpour for editorial assistance. The authors also thank Dr. Mohammad Salehi Marzijarani for his cooperation in analyzing the data.

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.

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