Review Article

Epidemiology of Hepatitis C Virus in Iranian Thalassemic, Hemodialysis and Hemophiliac Patients: A Meta-Analysis Study

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ABSTRACT

Introduction: Hepatitis C is one of the most serious viral infections that cause chronic liver disease. Objectives: The current study was conducted to estimate the pooled prevalence and geographical distribution of Hepatitis C Virus (HCV) in thalassemic, hemodialysis, and hemophiliac patients in Iran. Evidence Acquisition: Articles were identified through international searching databases including PubMed, Scopus, Elsevier, Google Scholar, and Web of Science and Iranian scientific information database (SID), Health.barakatkns, IranDoc, Civilica and MagIran. We reviewed systematically all studies reporting the prevalence of HCV in thalassemic, hemodialysis, and hemophiliac patients. All studies conducted ELISA tests for the evaluation of HCV antibodies. In this study meta-analysis method has been used to estimate the pooled prevalence. Results: 270 records were identified by the electronic search, of which 151 studies were identified as relevant papers that were meta-analysed for the pooled HCV prevalence. Overall, prevalence of HCV were 18.27% (15.99%-20.55%), 11.60% (9.98%-13.22%) and 45.16% (36.72%-53.60%) in thalassemic, hemodialysis and hemophiliac patients. Conclusion: Concerning the high prevalence of HCV among hemophiliac patients, ongoing preventive actions for this group are recommended.

Introduction

Infection with the Hepatitis C Virus (HCV) is a major concern for public health in developing and developed countries around the world (1). In the world, 71 million people are suffering from chronic HCV, according to reports from the World Health Organization (2) A previous study showed Hepatitis C virus infection led to 54,000 deaths and 955,000 disability-adjusted life years worldwide in 2013 (3) Also, there are 3-4 million new cases of HCV infection worldwide each year (3, 4). The area of the Middle East and North Africa (MENA) is the most affected by HCV infection estimated to affect over 3.5% of the population (3, 5, 6). One of the main means of transmission of HCV is through blood and blood transfusion (7). Patients with the
disease usually have multiple transfusions, such as those with thalassemia, or those with chronic renal failure who have been treated with hemodialysis machines (8, 9). Hepatitis C virus infection is a major cause of chronic hepatitis C and cirrhosis in hemophilia, thalassemia, and renal failure patients, as well as the most common indication of liver transplant in adults (10-12). Iran is a huge country with different ethnicities in different provinces in the Middle East. The prevalence and epidemiology of HCV vary across the country in different groups and regions. In Iran, hepatitis is mainly caused by problems such as increasing the injection population and the need to use common needles among them, to use a blood or its infected derivatives in surgery, or to prolong the survival of patients with thalassemia, hemophilia, and hemodialysis. On the other hand, the increase in the number of hemodialysis centers and blood transfusions for specific patients has unfortunately led to new sources of the virus in Iran (13, 14). Although repeated transfusions of blood and its derivatives may prolong the survival of patients with thalassemia, hemophilia, and dialysis, due to the lack of compliance with important health considerations in infection control in dialysis units (transmission of infection through dialysis and blood purifiers and other health service centers) These patients are at high risk of developing blood-borne viruses, especially hepatitis c viruses (15, 16). According to a recent meta-analysis published in 2018, patients with hemophilia, hemophilia, and thalassemia were at high risk for this virus in Iran and HCV prevalence among high-risk populations was reported at 32.1% (17). Morbidity and mortality associated with HCV put a burden on health care systems around the world (18).

In Iran, HCV is considered a public health problem, with various programs being implemented by the Ministry of Health to fight the disease (19). Data on the distribution of HCV prevalence in patients with thalassemia, hemodialysis, and hemophilia can contribute to effective policy and management decisions in public health. It has to be said that although many studies on HCV epidemiology have been published in various Iranian cities (17), there is still a lack of strong data on the epidemiology of HCV disease in three groups.

**Objectives**

Therefore, this systematic and meta-analysis study with the aim of estimating overall HCV pooled effect prevalence in different provinces in 3 high-risk subpopulations has been done.

**3. Evidence Acquisition**

**3.1. Search Strategy**

All studies used ELISA tests for assessing HCV antibodies. The literature on the HCV-Ab prevalence in Iran was acquired through international searching databases including PubMed, Scopus, Elsevier, Google Scholar and Web of Science and Iranian scientific information database (SID), IranDoc, Health.barakatkns, MagIran and Civilica. Our last search took place on 20 March 2019. To search and include related studies as many as possible, we used the following terms: “Hepatitis C”, “HCV”, “Prevalence”, “Thalassemic”, “Hemodialysis”, “Hemophilic”, “Iran” (or the names of its provinces), “Epidemiology”, as keywords for titles and/or abstracts in MeSH word search database.

**3.2. Selection of Studies and Data Extraction**

Published studies were regarded as qualified for the analysis if they met the
following criteria: (1) cross-sectional studies with the full text of the paper available in the Persian or English languages, (2) studies with a sample size of more than 30, and (3) studies reporting the prevalence of HCV antibodies by the ELISA test in Iran provinces. Conversely, the following studies were excluded: (1) non-English or non-Persian full-text reports, (2) studies not providing enough data to estimate the prevalence rate, (3) studies designed as letters to the editor, expert opinions, editorials, commentaries, case-reports, case-series, and reviews, and (4) Studies reporting overlapping data.

3.3. Data Extraction

All articles categorized as potentially relevant were reviewed separately by both of the authors (Alireza Molaei). They evaluated the relevance of each report and summarized the following data using Excel datasheets: First author’s name, year of publication, year of study, number of HCV patients, study sample size, name of the province, and mean age of responders. The analysis was conducted according to the preferred reporting items for systematic reviews and meta-analysis (PRISMA) (20). Publication bias was assessed, graphically and statistically, by funnel plot and Based on visual inspection of the funnel plot and on Egger’s test, evidence of publication bias was not found. In this study, “The Newcastle Ottawa Scale (NOS)” was used to assess the quality of the included studies. Extracted data were stratified by study populations’ risk of acquiring HCV infection as follows:

1- Thalassemic
2- Hemodialysis
3- Hemophilia

3.3. Statistical Analysis

The prevalence of HCV among thalassemic, hemodialysis and hemophilic patients from each province of Iran was computed by metaprop command. Statistical tests of heterogeneity among the studies were carried out using the Q test ($P < 0.10$ indicates statistically significant heterogeneity) and I-squared statistics. We also used a funnel plot to investigate publication bias. In this study, the results of the meta-analysis were adjusted with the HCV prevalence rates and the population size of each province of Iran (from the last census in 2016, based on the statistical center of Iran). For this purpose, the population size of each province was considered as a weight case in meta-analysis. we used "metafor" package in R software version 3.6. In each study, if the count of HCV was zero the prevalence estimation and confidence interval calculated using Jeffreys interval (25). In the current study maps indicating the geographical distribution of the prevalence prepared by https://paintmaps.com/map-charts/105/Iran-map-chart. finally, for clustering the Iran provinces the hierarchical cluster analysis was used.

4. Results

4.1. Search Results and Study Selection

The study selection process is depicted in Figure 1. A total of 270 studies were potentially associated with the prevalence of HCV in Iran provinces. After reviewing the abstracts and titles, 72 studies were eliminated based on the stated inclusion and exclusion criteria. Then 25 and 21 articles were excluded from the study due to not having the inclusion criteria and being duplicates respectively. After the full text screening and quality assessment, a total of 151 records were deemed as eligible studies published until 2019.
4.2. Prevalence of hepatitis C in Iran’s provinces

Data, including the prevalence of hepatitis C as well as other features like reference, province, first author’s name, year of publication, year of study, mean age and male percent, study sample size and prevalence of HCV also 95% confidence interval of each study were presented in Table 1 to Table 3 for Thalassemic, Hemodialysis, and Hemophiliac. Also, the pooled prevalence of hepatitis C according to the 31 provinces of Iran were presented in Table 4 (Figurs 2 and 3). As it can be seen, the average prevalence of HCV also 95% Confidence Interval (CI) in Thalassemic were 18.27% (95% CI: 15.99%-20.55%). The highest pooled prevalence for Thalassemic were in province Kerman (35%) , Gilan (35%) and Hamedan (28%) and the lowest were in Azerbaijan, West (3.745%), Khorasan, South (3.98%) and Lorestan (4.195%). The prevalence of HCV also 95% Confidence Interval (CI) in Hemodialysis was 18.27% (95% CI: 15.99%-20.55%). The highest pooled prevalence for Hemodialysis were in province Golestan.
The prevalence of HCV also 95% Confidence Interval (CI) in Hemophilic was 45.16%(95% CI: 36.72%-53.60%).

The highest pooled prevalence for Hemophilic were in province Gilan (71.28%) , Tehran (61.89%) and Isfahan (59.90%) and the lowest were Azerbaijan, West (11.76%). Fars (15.39%) and Khorasan, South (22.62%).

The Egger's Test for Hemodialysis (Z=-0.027 , P-Value=0.748), Hemophilic (Z=-1.48, P-Value=0.139) and Thalassemic (Z=-1.92, P-Value=0.054) in addition Begg's test for Hemodialysis (Z=-1.58 , P-Value=0.139), Hemophilic (Z=1.21, P-Value=0.235) and Thalassemic (Z=1.66, P-Value=0.102) showed any publication Bias.

**Table 1. Characteristics of the included published HCV articles in the field of Thalassemic in Iran**

| Province               | First Author       | Ref. | Year of Publish | Year of study | Mean Age | Male Percent | Number of HCV Cases (Study Sample Size) |
|------------------------|--------------------|------|-----------------|---------------|----------|--------------|----------------------------------------|
| Alborz                 | Kashan-cha        | [37] | 2011            | 2009          | 19.64    | 43.7         | 31(206)                               |
| Ardabil                | Manochehr barak   | [38] | 2003            | 2000          | 15       | 62           | 2(45)                                  |
| Azerbaijan, East       | Mashayekhi        | [39] | 2011            | 2008          | .        | .            | 3(100)                                 |
|                        | Torabi             | [40] | 2005            | 2003          | 21       | 59.5         | 6(84)                                  |
| Azerbaijan, West       | Valizadeh          | [41] | 2015            | 2014          | 11.41    | 56.25        | 18(103)                                |
| Chahtar Mahaal and     | Resi               | [42] | 2011            | 2004          | 13.2     | 45           | 23(103)                                |
| Bakhtiari              | Basirat nia        | [43] | 2002            | 1998          | 10       | 57.6         | 26(113)                                |
| Fars                   | Karimi             | [44] | 2001            | 1999          | 12.3     | 53           | 73(755)                                |
|                        | Hedayat            | [45] | 2009            | 2003          | .        | .            | 4(30)                                  |
|                        | Ansari             | [46] | 2007            | 2005          | 15.3     | 50.4         | 116(806)                               |
|                        | Karimi             | [47] | 2001            | 1999          | 11.7     | 52.1         | 73(666)                                |
|                        | Kashfi             | [48] | 2006            | 2008          | 16       | 51           | 24(111)                                |
|                        | Yaghobi            | [49] | 2012            | 2009          | 36       | 47.7         | 18(86)                                 |
| Gilan                  | Jafroodi           | [51] | 2015            | 2007          | 23.3     | 48.1         | 116(113)                               |
|                        | Ansar              | [52] | 2002            | 1997          | 14       | 52           | 46(105)                                |
|                        | Mansour-Ghanaei    | [53] | 2009            | .             | .        | 186(370)     |
| Hamedan                | Oshvandi           | [54] | 2009            | 2009          | 13       | 50           | 11(50)                                 |
|                        | Eghbalian          | [55] | 2002            | .             | .        | 18(53)       |
| Hormozgan              | Aminfar           | [56] | 2017            | 2014          | 31       | 47.7         | 60(587)                                |
| Isfahan                | Atei              | [57] | 2012            | 2003          | 17.48    | 58.3         | 37(466)                                |
|                        | Kalantari         | [58] | 2011            | 2008          | 27.1     | 83           | 50(545)                                |
|                        | Kassaian         | [59] | 2011            | 2010          | 18       | 6.9          | 60(570)                                |
|                        | Hariri            | [60] | 2006            | 2004          | 15.5     | 56           | 67(616)                                |
|                        | Naghavi          | [61] | 2007            | 2005          | 20.6     | 60           | 31(53)                                 |
|                        | Zahedi           | [62] | 2003            | 2002          | 11.5     | 45           | 14(100)                                |
|                        | Mirmomen         | [63] | 2000            | 1996          | 9.2      | 54.9         | 24(107)                                |
|                        | Khorshodmansorkhani | [62] | 2003          | 2002          | 11.5     | 45           | 31(100)                                |
|                        | Hassanshahi       | [64] | 2011            | 2007          | 51       | 61.2         | 81(181)                                |
|                        | Arababadi        | [65] | 2008            | 2006          | 12.1     | .            | 27(60)                                 |
|                        | Vahidi            | [66] | 2011            | 2008          | 14.72    | 51.76        | 228(340)                               |
| Kerman                 | Sayad            | [67] | 2017            | 2015          | 22.62    | 52           | 14(132)                                |
| Kermanshah             | Atzkar            | [68] | 2009            | 2007          | 54.1     | .            | 3(30)                                  |
| Khorasan, South        | Knooti            | [69] | 2017            | 2004          | 32.2     | 54.7         | 20(179)                                |
|                        | Company           | [70] | 2007            | 2005          | 14.9     | 50           | 40(195)                                |
|                        | Kompani          | [71] | 2008            | .             | .        | 46(219)      |
|                        | Ghafourian        | [72] | 2006            | 2002          | .        | 59.8         | 32(122)                                |
|                        | Ghafourian        | [73] | 2009            | 2006          | 16.4     | 47.1         | 58(206)                                |
| Kolghaieh and          | Sarkari          | [74] | 2012            | 2009          | 25.5     | 66.4         | 3(49)                                  |
| Boyer-Ahmad            | Mohammad         | [75] | 2017            | 2015          | 18       | 50.9         | 6(106)                                 |
| Lorestan               | Vasmehjani       | [76] | 2018            | 2015          | 25.5     | 74.1         | 6(143)                                 |
| Markazi                | Saminirad        | [77] | 2007            | 2004          | 13.1     | 51           | 5(98)                                  |
|                        | Mahdaviani        | [78] | 2008            | 2004          | 13.1     | 51.5         | 7(97)                                  |
| Mazandaran             | Karami           | [79] | 2010            | 2008          | 23       | 53           | 73(1010)                               |
|                        | Tamaddoni        | [80] | 2007            | 2005          | 21.66    | 43.36        | 12(113)                                |
|                        | Ghane            | [81] | 2012            | 2010          | 18.38    | 51           | 36(245)                                |
| Province | First Author | Ref. | Year of Publish | Year of study | Mean Age | Male Percent | Number of HCV Cases (Study Sample Size) |
|----------|--------------|------|-----------------|---------------|----------|--------------|---------------------------------------|
| Alborz   | Tajbaksh     | [105] | 2015            | 2010          | 54.89    | 56.2         | 11(185)                              |
| Ardabil  | Mamlaki      | [106] | 2011            | 2011          |          | 58.8         | 6(119)                               |
| Azerbaijan, East | Soni | [107] | 2008            | 2006          | 52.1     | 54.3         | 55(753)                              |
|           | Kheradpedzohou | [109] | 2007            | 2005          | 50.5     | 58           | 666(324)                             |
|           | Soni         | [110] | 2007            | 2006          | 52.7     | 55           | 133(462)                             |
| Azerbaijan, West | Khadem-Ansari | [111] | 2006            | 2005          | .        | .            | 11(50)                               |
| Fars     | Valizadeh    | [112] | 2013            | 2010          | 10.3     | 86           | 4(34)                                |
|           | Rais-jalali  | [113] | 2019            | 2012          | 37       | 100          | 9(182)                               |
|           | Jahromi      | [114] | 2007            | 2006          | 51.5     | 58.8         | 2(34)                                |
|           | Azerbaidjan  | [115] | 2011            | 2009          | 52.7     | 65.2         | 13(181)                              |
|           | Mohsenzadeh  | [116] | 2012            | 2011          | 51.46    | 67.7         | 12(62)                               |
|           | Joukar       | [117] | 2011            | 2009          | 54.8     | 55.66        | 61(514)                              |
|           | Dadgaran     | [118] | 2005            | 2004          | 53.57    | 58.5         | 70(393)                              |
|           | Amuri        | [119] | 2005            | 2001          | 52.2     | 52.3         | 73(298)                              |
|           | Mansour-Ghanaei | [120] | 2009            | 2007          | 45.5     | 66           | 47(163)                              |
| Golestan | Jabbari      | [121] | 2008            | 2005          | 47.37    | 54.8         | 269(93)                              |
| Hamedan  | Mohammad alizadeh | [122] | 2002            | 2002          |          |              | 11(96)                               |
| Hormozgan | Kheibabad    | [123] | 2016            | 2015          | 56.23    | 61.7         | 5(149)                               |
| Isfahan  | Kassaaan     | [59]  | 2011            | 2010          | 54       | 69           | 17(800)                              |
|           | Seyyedfani   | [124] | 2006            | 2005          | .        | .            | 16(556)                              |
|           | Kalantari    | [125] | 2014            | 2014          | 52.3     | 60.7         | 26(499)                              |
| Kerman   | Salehi       | [126] | 2014            | 2008          | 49       | 47           | 4(40)                                |
|           | Zahedi       | [127] | 2012            | 2010          | 51       | 59.6         | 16(228)                              |
|           | Hassanshahi  | [64]  | 2011            | 2007          | 51       | 61.2         | 64(203)                              |
|           | Azerbaidjan  | [128] | 2009            | 2009          | 60       | 42.2         | 30(54)                               |
|           | Sabour       | [129] | 2003            | 2000          | 45       | 68.6         | 38(140)                              |
| Khorasan, South | Azarkar | [68]  | 2009            | 2007          | .        | .            | 60.4(38)                             |
|           | Ziaee        | [130] | 2013            | 2010          | 54.93    | 68.3         | 1(41)                                |
| Khuzestan | Beladi Mousavi | [131] | 2012            | 2010          | 25       | 65           | 1(38)                                |
|           | Mousavi      | [132] | 2014            | 2012          | 55.27    | 57.4         | 2(47)                                |
|           | Samarbal-Zadeh | [133] | 2015            | 2014          | 23.68    | 55.23        | 39(430)                              |
|           | Asarehrazdegan | [134] | 2009            | 2005          | 37.3     | 63.1         | 34(214)                              |
|           | Mak          | [135] | 2001            |               |          |              | 27(86)                               |
| Kurdistan | Sohrabi      | [136] | 2018            | 2017          | 26.15    | 85           | 22(121)                              |
Table 3. Characteristics of the included published HCV articles in the field of Hemophilia in Iran

| Province                  | First Author               | Ref. | Year of Publish | Year of study | Mean Age | Male Percent | Number of HCV Cases (Study Sample Size) |
|---------------------------|---------------------------|------|----------------|---------------|----------|--------------|----------------------------------------|
| Azerbaijan, East          | Torabi [162]              | 2006 | 2004           | 18.5          | 89       | 63 (162)     |                                        |
| Azerbaijan, West          |                          |      |                |               |          |              |                                        |
| Bushehr                   | Khamisipour [163]         | 2000 | 1999           | 16            |          | 13 (31)      |                                        |
| Fars                      | Karimi [164]              | 2002 | 2002           | 17            | 90       | 47 (310)     |                                        |
|                          | Karimi [165]              |      |                |               |          |              |                                        |
| Gilan                     | MansourGhanaei [166]      | 2002 | 1999           | 19.7          | 99       | 72 (101)     |                                        |
| Hamedan                   |                           |      |                |               |          |              |                                        |
| Isfahan                   | Esfahani [167]            | 2014 | 2012           |               | 88.8     | 44 (89)      |                                        |
| Kerman                    | Zahedi [171]              | 2004 | 2001           | 21.8          | 87       | 43 (97)      |                                        |
| Khorasan, Razavi          | Ziaee [172]               | 2005 | 2004           | 20.1          | 97.7     | 44 (80)      |                                        |
| Khorasan, South           | Ziaee [173]               | 2015 | 2011           | 27.7          | 93.5     | 22 (108)     |                                        |
| Khuzeestan                |                           |      |                |               |          |              |                                        |
| Markazi                   | Ghafourian [175]          | 2013 | 2009           | 29            | 57.1     | 12 (56)      |                                        |
|                          | Assarehdezegan [176]      | 2012 | 2008           | 21.8          | 87.4     | 47 (87)      |                                        |
| Mazandaran                | Rafiei [84]               | 2011 | 2010           | 35.13         | 68.9     | 30 (132)     |                                        |
| Sistan and Baluchestan    | Sharifi-Mood [179]        | 2006 | 2005           | 13            | 84       | 23 (74)      |                                        |
|                           | Sharifi-Mood [180]        |      |                |               |          |              |                                        |
| Tehran                    | Lak [181]                 | 2000 | 1999           | 37            | 52       | 212 (385)    |                                        |
|                           | Alavian [182]             | 2001 | 2001           | 20.65         | 86       | 102 (176)    |                                        |
|                           | Toosi [183]               | 2008 | 2003           | 26.6          | 72.3     | 145 (236)    |                                        |
|                           | Mousavian [184]           | 2011 | 2004           | 27.5          | 98.3     | 792 (1095)   |                                        |
|                           | Javadzadeh [185]          | 2006 | 2003           | 22.5          | 93       | 35 (74)      |                                        |
|                           | Shahrshahani [104]        | 2005 | 2003           | 12.6          | 48.2     | 36 (74)      |                                        |
| Province                     | Thalassemic | Hemodialysis | Hemophiliac | Population Base 2016 survey | Weight in Meta Analysis | Cluster Analysis |
|------------------------------|-------------|--------------|-------------|-----------------------------|-------------------------|------------------|
| Alborz                       | %15.05      | %5.945       |             | 2,712,400                   | 3.39%                   | 1                |
| Ardabil                      | %7.215      | %5.04        |             | 1,270,420                   | 1.59%                   | 1                |
| Azerbaijan, East             | %5.118      | %15.982      | %38.89      | 3,909,652                   | 4.89%                   | 2                |
| Azerbaijan, West             | %3.745      | %16.703      | %11.76      | 3,265,219                   | 4.09%                   | 2                |
| Bushehr                      |             | %41.935      |             | 1,163,400                   | 1.46%                   | 2                |
| Chahar Mahaal and Bakhtiari  | %21.703     |              |             | 947,763                     | 1.19%                   | 3                |
| Fars                        | %16.274     | %15.178      | %15.394     | 4,851,274                   | 6.70%                   | 2                |
| Gilan                       | %34.705     | %27.905      | %71.285     | 2,530,696                   | 3.17%                   | 3                |
| Golestan                     | %27.658     | %11.46       | %53.841     | 1,738,234                   | 2.17%                   | 3                |
| Hormozgan                   | %10.22      | %3.355       |             | 1,776,415                   | 2.22%                   | 1                |
| Isfahan                      | %14.055     | %3.46        | %59.904     | 5,120,850                   | 6.41%                   | 1                |
| Kerman                      | %34.753     | %23.67       | %44.33      | 3,164,718                   | 3.96%                   | 3                |
| Kermanshah                  | %6.035      | %27.145      |             | 1,952,434                   | 2.44%                   | 2                |
| Khorasan, Razavi            |             | %55          |             | 6,434,501                   | 8.05%                   | 3                |
| Khorasan, South             | %3.98       | %4.72        | %22.624     | 768,898                     | 0.96%                   | 1                |
| Khuzestan                   | %21.135     | %12.901      | %37.75      | 4,710,509                   | 5.89%                   | 3                |
| Kohgiluyeh and Boyer-Ahmad  | %8.595      |              |             | 713,052                     | 0.89%                   | 2                |
| Kurdistan                   | %5.66       | %18.18       |             | 1,603,011                   | 2.01%                   | 2                |
| Lorestan                     | %4.195      |              |             | 1,760,649                   | 2.20%                   | 1                |
| Markazi                      | %5.982      | %4.9         | %43.485     | 1,429,475                   | 1.79%                   | 1                |
| Mazandaran                  | %14.986     | %13.103      | %22.73      | 3,283,582                   | 4.11%                   | 2                |
| Qazvin                       | %22.694     | %14.433      |             | 1,273,761                   | 1.59%                   | 3                |
| Qom                         | %13.38      | %16.121      |             | 1,292,283                   | 1.62%                   | 2                |
| Semnan                      | %18.52      | %6.25        |             | 702,360                     | 0.88%                   | 3                |
| Sistan and Baluchestan       | %9.274      | %30.315      |             | 2,775,014                   | 3.47%                   | 2                |
| Tehran                      | %21.414     | %7.118       | %61.895     | 13,267,637                  | 16.60%                  | 3                |
| Yazd                        | %9.41       | %4.375       | %48.443     | 1,138,533                   | 1.42%                   | 1                |
| Zanjan                      | %17.39      | %1.325       |             | 1,057,461                   | 1.32%                   | 1                |
| Overall                     | %18.269     | %11.601      | %45.158     | 79,926,270                  | 100%                    |                 |
Figure 2: The Forest plot of prevalence of hepatitis C among Thalassemic, Hemodialysis and Hemophiliac patients.
Figure 3: The GIS mapping of prevalence of hepatitis C among Thalassemic, Hemodialysis and Hemophiliac patients

Discussion

The result of this systematic review and meta-analysis study in three Thalassemic, Hemodialysis and Hemophiliac showed that the highest and the lowest HCV prevalence among these three subgroups were for Hemophiliac (45.16%) and Hemodialysis (11.60%) respectively. A previously published meta-analysis study reported HCV prevalence in the various subgroups of the Iranian population. Alavian et al (26), Mirminachi et al (27) and Mahmud et al (17) reported 0.16%, 0.6% and 0.3% HCV prevalence for general population respectively. Shamshirian et al (28) and Behzadifar et al (29) reported 17% and 19% HCV prevalence for thalassemia patients respectively. Such prevalence for hemodialysis patients was reported 12% (30), 7.61% (31) and 11% (32). For the Hemophiliac, Iran Hemophilia Center 77.5% (33), 76-82% (34, 35) were reported.
The result of this study also showed that 3 clusters (Low, Moderate and high) according to the HCV prevalence in 3 population sub sample (Thalassemic, Hemodialysis, Hemophiliac) according to the cluster analysis. There are several limitations to be noted in the present study. Firstly, The sample size in some provinces in Iran was insufficient and the amount of data varied between provinces. Secondly, different sample locations (public or private hospitals) were utilized in the sampling method, which may affect the obtained results of the current systematic review. Furthermore, nonexistent data and studies from certain provinces have not allowed us to include them in the final analysis. Also, there are some positive points in this analysis that should be considered. Use of Jeffreys interval and cluster analysis and reporting HCV prevalence in Thalassemic, Hemodialysis and Hemophiliac according to each province is another strong point of this study.

**Conclusion**

The result showed a high prevalence of HCV in Hemophiliac (45.16%). Therefore, ongoing preventive actions are highly recommended. Because there were not any published studies available for some provinces there are still gaps in our understanding of HCV epidemiology in Iran.

**Ethical Approval:**

Studies have been performed according to the Declaration of Helsinki and This article is based on the management plans approved by the educational meeting of Tarbiat Modares University with a code of ethics IR.MODARES.REC.1399.016 dated 2020 May 16.

**Conflict of interest**

The authors say they don't have any conflict of interest.

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