Prevalence of Hepatitis B and C in prisons worldwide: A meta-analysis during the years 2005-2015

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Abstract

Background: Viral hepatitis is still considered as a major cause of burden of disease in the world, and is the most common cause of cirrhosis and liver cancer. Prisoners are one of the groups most at risk for hepatitis. This study aimed to investigate the prevalence of hepatitis B and C in prisons worldwide during the years 2005-2015. Method: In order to find relevant articles published from 2005 to 2015, two members of the research team searched the databases of PubMed, Scopus, and Web of Science. The study was conducted using the random effects model and the fixed effects model. In order to examine heterogeneity, Cochran Q test was used at an error level of less than 10%; its quantity was estimated using the I² indicator. The publication bias was measured using Begg’s rank correlation test and Egger’s linear regression method. After extracting the required data, the meta-analysis was performed using the software Stata 12. Results: A total of 43 studies which met the inclusion criteria were analyzed. The results showed that the overall prevalence of hepatitis B in prisoners was 5.17% (95% CI: 2.19-9.30). The highest prevalence, that is, 13.14% (95% CI: 11.99-14.36), was observed in Africa. According to the World Health Organization (WHO) classification, the highest prevalence, that is, 5.04% (95% CI: 4.45-5.67), was observed in the Western Pacific region. The prevalence of hepatitis B in men and women were, respectively, 6.70% (95% CI: 6.52-6.88) and 4.34% (95% CI: 3.98-4.79). The results showed that the overall prevalence of hepatitis C in prisoners was 13.22% (95% CI: 8.95-8.16). The highest prevalence, that is, 26.4% (95% CI: 25.05-27.87), was observed in Australia. According to the WHO classification, the highest prevalence of hepatitis C, that is, 24.26% (95% CI: 21.6-27.02), was observed in the Southeast Asia region. The prevalence of hepatitis B in men and women were, respectively, 9.33% (95% CI: 1.56-1.98) and 6.25% (95% CI: 5.78-6.74). Conclusion: The prevalence of hepatitis B and C in prisoners was greater than that in the general population, and the prevalence in men was greater than that in women. Appropriate and effective interventions to reduce transmission of hepatitis B and C in the prisons worldwide is essential.
1. Introduction

Hepatitis, after tuberculosis and malaria, is the most common liver disease and the most common infectious disease in the world. Among the most important forms of hepatitis are hepatitis B and hepatitis C [1]. Hepatitis is a common cause of cirrhosis, liver failure and liver cancer, leading to approximately two million deaths annually [2]. More than 350 million people in the world have chronic hepatitis B, who constitutes 5% of the world population [3]. Each year, about 4 million people worldwide are infected with acute hepatitis B, and about 1 million people die due to chronic hepatitis infection [4]. Hepatitis B virus (HBV) exists in all the fluids and secretions of the body, and the transmission routes include sexual contact, intravenous drug injection, mother to fetus, needle stick, etc. [5]. The prevalence of hepatitis varies in different countries, ranging from 0.1% to 20%. The prevalence of hepatitis B ranges from 0.1% to 0.5% in Europe and North America, and from 5% to 20% in the Far East and tropical countries [6]. Vaccination is currently the most effective and cost-effective means of the prevention of hepatitis B [7].

Hepatitis C has a prevalence of approximately 3%, affecting more than 170 million chronic cases in the world. It is considered as one of the world’s current and significant problems, as it leads to severe complications such as liver cirrhosis, liver cancer, and early mortality [8]. The prevalence of hepatitis C in the general population varies from 2% to 18%. Currently, America and Europe are among the areas with lowest prevalence of hepatitis C, while Africa, the Eastern Mediterranean, the Southeast Asia and West Pacific have the highest prevalence. In fact, the lowest and the highest prevalence of the disease belong, respectively, to England, with 0.5%, and Egypt, with 12-15% [9].

One of the groups that is at highest risk for hepatitis are prisoners [10]. Studies have reported that the prevalence of hepatitis in prisoners is higher than that of the general population; it is also worth mentioning that the risk of individuals with hepatitis C being imprisoned is 9 times higher than that of the general population [11].

In prisons, prisoners are kept in a closed environment for a long time under conditions prone to overcrowding, poor nutrition, lack of medical care, and homosexuality. Thus, prisoners are susceptible to infectious diseases and, after release from prison, they might spread the disease in the community [9]. People referred to correctional centers often experience drug injection, needle sharing, and sexual risk behavior (often continued during their detention), which all contribute to a high risk of transmission of viruses such as human immunodeficiency virus (HIV), HBV, and hepatitis C virus (HCV) [9].

In a study conducted from 1993 to 2003 among prisoners, various risk factors were investigated for the transmission of diseases, including sexually transmitted diseases, hepatitis, HIV, and tuberculosis. Drug use and sexual risk behavior were reported to be the most important factors [12]. Since prisoners suffer from lack of proper health care, criminal systems can serve as a reservoir for HBV, HCV, and other viral diseases [11]. Indeed, the prevalence of chronic hepatitis B and chronic hepatitis C infection in prisoners have been found to be 2-6 fold and up to 10 fold greater, respectively, than that in the community [13].

A research study in the US among prisoners indicated that the prevalence of infection with hepatitis B was more than 20%, suggesting that prisons are a predominant source for infection and may facilitate transmission of infectious diseases in the society [14]. The prevalence of chronic hepatitis C infection among prisoners in the US ranged from 16-41%, which was 8-20 fold greater than that of the general population [15]. In a study carried out in Ghana in 2006, which included 281 prisoners, 17.4% of the prisoners were infected with hepatitis B [16]. It is estimated that, annually, approximately 2 million HCV infections occur through infected injections, which might account for up to 40% of all HCV infections in the world. The percentage of infection among the prisoners in different parts of the world is reported to be from 27% to more than 90% [17].

On the other hand, studies show that HIV infection and illnesses, such as sexually transmitted diseases and hepatitis, are increasing in prisons and the global need for a cohesive program is needed to reduce the risk of transmission of these diseases [12]. Greater knowledge of the
prevalence of infection in correctional centers could aid in proper prevention, management and planning of infectious diseases. Since one of the high-risk groups of individuals is prisoners and since viral hepatitis is one of the most important health issues for prisoners, the aim of this study was to obtain an estimate of the prevalence of viral hepatitis among prisoners in the world.

2. Materials and Methods

(a) Search Strategy

In this study, a meta-analysis was done for the prevalence of hepatitis B and C in prisons in the world during the years 2005-2015. In this study, two members of the research team extracted all the relevant articles published from 2005 to 2015 by searching the medical information databases of PubMed, Scopus, and Web of Science. Additionally, a search was conducted using the following keywords: (‘Hepatitis B’ [Mesh]) AND (‘prisons’ [Mesh: No exp]) AND (‘prevalence’ [Mesh]), (‘Hepatitis C’ [Mesh]) AND (‘prisons’ [Mesh: No exp]) AND (‘prevalence’ [Mesh]), as well as their derivatives. The reference entries used in all the articles found during the search were evaluated so that other possible sources could also be included in the study.

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Figure 1. Flow diagram of the literature search for studies included in meta-analysis.
(b) Study selection

The data extracted from the articles are shown in Figures 1 and 2. A final total of 43 articles were eligible and included in the study. All the articles (during the three stages) were evaluated by two independent researchers and, in case of any disagreement, a third examiner to arrive at the final analysis. With respect to the articles included in the data analysis phase, all information related to type of study, first author’s name, year of study, year of publication, participants’ gender, country of study, number of participants, and hepatitis type (B and C) by sex, were entered on the spreadsheet forms designed in the software Excel. The data, after the cleaning phase, were transferred from Excel to the Stata 12 software program.
Table 1: Characteristics of Studies on the Prevalence of HBV and HCV in Prisons

| Author, Year | Country     | Sample | HBV+(N) | HCV+(N) | Sex | Design      |
|-------------|-------------|--------|---------|---------|-----|-------------|
| Lai 2006 [18] | Taiwan      | 285    | 63      | 4       | Male | Cross-sectional |
| Reekie 2014  | Australia   | 1742   | 4       | 505     | Male | Cross-sectional |
| Bautista-Arredondo 2015 [19] | Mexico | 17084  | 26      | 548     | Both | Cross-sectional |
| Macalino 2009 [20] | Australia | 544    | 25      | 135     | Male | Cross-sectional |
| Daneshmand 2013 [21] | Iran     | 970    | 32      | —       | Male | Cross-sectional |
| Azbel 2013 [22]  | Ukraine    | 402    | 40      | 21      | Both | Cross-sectional |
| Azbel 2015 [23]  | Azerbaijan | 510    | 14      | 195     | Both | Cross-sectional |
| Butler 2006 [24]  | Australia  | 612    | 88      | 157     | Both | Cross-sectional |
| Adjei 2006 [25]   | Ghana      | 1366   | —       | 255     | Both | Cross-sectional |
| Babudieri 2005 [26]  | Italy     | 973    | 65      | 370     | Both | Cross-sectional |
| Adjei 2008 [27]   | Ghana      | 1366   | 349     | —       | Both | Cross-sectional |
| Barros 2013 [28]   | Brazil     | 148    | 28      | —       | Female | Cross-sectional |
| Azarkar 2010 [29]  | Iran       | 358    | 22      | 29      | Both | Cross-sectional |
| Amin-Esmaeili 2012 [30] | Iran | 895    | 22      | 31      | Both | Cross-sectional |
| Roux 2015 [31]    | France     | 5957   | —       | 308     | Both | Cross-sectional |
| Saiz de la Hoya 2011 [10] | Spain | 370    | 9       | 84      | Both | Cross-sectional |
| Kirwan 2011 [32]   | England    | 10723  | 107     | 2413    | Both | Cross-sectional |
| Falquetto 2013 [33] | Brazil    | 730    | 9       | 84      | Male | Cross-sectional |
| Kassaian 2011 [34] | Iran       | 943    | —       | 390     | Both | Cross-sectional |
| Fox 2005 [35]      | America    | 467    | —       | 160     | Both | Cross-sectional |
| Nelwan 2010 [36]   | Indonesia  | 679    | 37      | 118     | Both | Cross-sectional |
| Macalino 2005 [37] | America    | 297    | 86      | 119     | Male | Cross-sectional |
| Adoga 2009 [38]    | Nigeria    | 300    | 69      | 37      | Male | Cross-sectional |
| Maerrawi 2014 [39] | America    | 546    | 115     | 29      | Male | Cross-sectional |
| Taylor 2012 [40]   | Scotland   | 5076   | —       | 933     | Both | Cross-sectional |
| Miller 2009 [41]   | Australia  | 382    | —       | 240     | Both | Cross-sectional |

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| Study                  | Country      | Sample Size | Age | Gender | Study Design |
|-----------------------|--------------|-------------|-----|--------|--------------|
| Prasetyo 2013 [42]    | Indonesia    | 375         | 12  | Male   | Cross-sectional |
| Alvarez 2014 [43]     | America      | 2788        | —   | Both   | Cross-sectional |
| Lin 2010 [44]         | Taiwan       | 15007       | 3258| Both   | Cross-sectional |
| Brandolini 2013 [45]  | Italy        | 695         | 30  | Both   | Cross-sectional |
| Pompilio 2011 [46]    | Brazil       | 686         | —   | Both   | Cross-sectional |
| Salem 2013 [47]       | Taiwan       | 3000        | 122 | Male   | Cross-sectional |
| Nokhodian 2012 [48]   | Iran         | 163         | 2   | Female | Cross-sectional |
| Mahfoud 2010 [49]     | Lebanon      | 580         | 6   | Male   | Cross-sectional |
| Rosa 2012 [50]        | Brazil       | 195         | —   | Both   | Cross-sectional |
| Miller 2005 [51]      | Australia    | 1347        | —   | Male   | Cross-sectional |
| Kolaric 2010 [52]     | Croatia      | 601         | 5   | Male   | Cross-sectional |
| Kazi 2010 [53]        | Pakistan     | 365         | 21  | Male   | Cross-sectional |
| Adjei 2006 [54]       | Ghana        | 281         | 49  | Both   | Cross-sectional |
| Gilles 2008 [55]      | Australia    | 185         | 5   | Both   | Cross-sectional |
| Jovanovska 2014 [56]  | Macedonia    | 200         | 34  | Both   | Cross-sectional |
| Semaille 2013 [57]    | France       | 1876        | —   | Both   | Cross-sectional |
| Ziaee 2014 [58]       | Iran         | 881         | 61  | Both   | Cross-sectional |
(c) Statistical analysis

In this study, the pooled weighted average (derived from results of individual studies) were used in the evaluations. The weighted average for each study was calculated based on the sample size and variance. In this study, the random effects model (the DerSimonian and Laird method) and the fixed effects model (the Mantel-Haenszel method) were used; the indicator under study was "prevalence", which was calculated as the ratio of ($p$) with a 95% CI. In order to examine heterogeneity, Cochran’s Q test was used at an error level of less than 10%; its quantity was estimated using the $I^2$ indicator ($I^2$ is the percentage of total variation across studies due to heterogeneity rather than chance). A value of 0% indicates no heterogeneity among the studies. If $p < .01$ and $I^2 > 50\%$, the random effects model was used; otherwise, the fixed effects model was used.

The publication bias was measured using Begg’s rank correlation test and Egger’s linear regression method. After extracting the required data, the meta-analysis was performed using the software Stata 12.

3. Results

Of the 43 articles that were evaluated in our study, these were the following countries which were represented: Iran, Brazil, Azerbaijan, Indonesia, England, Scotland, Italy, France, Ghana, Spain, America, Croatia, Lebanon, Pakistan, Mexico, Nigeria, Ukraine, Australia, and Macedonia. The sample size in these studies varied from 200 to 17084 people Table 1.
Table 2: Prevalence of HBV Stratified by Different Factors

| Stratified factors | Country     | Prevalence rate | Lower limit | Upper limit | Heterogeneity I2 (%) | Model  |
|--------------------|-------------|-----------------|-------------|-------------|----------------------|--------|
|                    | Taiwan      | 6.42            | 4.97        | 8.15        | 99.8                 | Random |
|                    | Australia   | 4.70            | 4.07        | 5.40        | 99.6                 | Random |
|                    | Mexico      | 0.15            | 0.09        | 0.22        | 99.7                 | Random |
|                    | Indonesia   | 4.83            | 3.59        | 6.33        | 99.3                 | Random |
|                    | Azerbaijan  | 2.74            | 1.50        | 4.56        | 99.7                 | Random |
|                    | Brazil      | 4.12            | 3.62        | 4.66        | 99.8                 | Random |
|                    | England     | 1.13            | 0.93        | 1.37        | 99.2                 | Random |
|                    | Spain       | 2.43            | 1.11        | 4.56        | 99.5                 | Random |
|                    | France      | 0.89            | 0.68        | 1.14        | 99.45                | Random |
|                    | Ghana       | 12.13           | 10.97       | 13.37       | 99.60                | Random |
|                    | Italy       | 3.91            | 3.03        | 4.96        | 99.8                 | Random |
|                    | Croatia     | 5.75            | 3.59        | 8.66        | 98.9                 | Random |
|                    | Pakistan    | 2.71            | 2.17        | 3.33        | 99.8                 | Random |
|                    | Nigeria     | 23              | 18.35       | 28.18       | 99.6                 | Random |
|                    | Ukraine     | 9.95            | 7.20        | 13.30       | 98.9                 | Random |
|                    | America     | 21.20           | 20.56       | 21.84       | 98.8                 | Random |
|                    | Iran        | 2.62            | 2.27        | 3.00        | 99.4                 | Random |
|                    | Asia        | 3.05            | 2.76        | 3.35        | 99.9                 | Random |
|                    | Australia   | 4.70            | 4.07        | 5.40        | 99.7                 | Random |
|                    | America     | 9.34            | 9.05        | 9.63        | 98.9                 | Random |
|                    | Europe      | 1.16            | 1.03        | 1.30        | 99.6                 | Random |
|                    | Africa      | 13.14           | 11.99       | 14.36       | 99.8                 | Random |
|                    | Oceania     | 5.04            | 4.45        | 5.67        | 99.8                 | Random |
|                    | America     | 9.34            | 9.05        | 9.63        | 99.8                 | Random |

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| Region    | 2005 | 2006 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | Year |
|-----------|------|------|------|------|------|------|------|------|------|------|------|
| Europe    | 1.19 | 1.06 | 1.33 | 99.7 |      |      |      |      |      |      | Random |
| Africa    | 3.59 | 11.99| 14.36| 99.6 |      |      |      |      |      |      | Random |
| Asia      | 2.60 | 2.31 | 2.91 | 99.8 |      |      |      |      |      |      | Random |
| Year      |      |      |      |      |      |      |      |      |      |      |       |
| 2005      | 6.67 | 5.69 | 7.76 | 99.8 |      |      |      |      |      |      | Random |
| 2006      | 6.37 | 5.43 | 7.41 | 99.9 |      |      |      |      |      |      | Random |
| 2008      | 24.45| 22.34| 26.66| 99.7 |      |      |      |      |      |      | Random |
| 2009      | 7.67 | 6.25 | 9.31 | 99.8 |      |      |      |      |      |      | Random |
| 2010      | 5.09 | 4.26 | 6.02 | 99.9 |      |      |      |      |      |      | Random |
| 2011      | 1.65 | 1.47 | 1.86 | 99.5 |      |      |      |      |      |      | Random |
| 2012      | 1.01 | 0.81 | 1.24 | 99.8 |      |      |      |      |      |      | Random |
| 2013      | 3.72 | 3.30 | 4.19 | 99.7 |      |      |      |      |      |      | Random |
| 2014      | 17.80| 17.26| 18.35| 99.8 |      |      |      |      |      |      | Random |
| 2015      | 1.03 | 0.12 | 1.23 | 99.9 |      |      |      |      |      |      | Random |
| Year      |      |      |      |      |      |      |      |      |      |      |       |
| Gender    |      |      |      |      |      |      |      |      |      |      |       |
| Male      | 6.70 | 6.52 | 6.88 | 99.99|      |      |      |      |      |      | Fix   |
| Female    | 4.37 | 3.98 | 4.79 | 99.98|      |      |      |      |      |      | Fix   |
| Injection |      |      |      |      |      |      |      |      |      |      |       |
| Yes       | 12.68| 4.65 | 23.9 | 99.8 |      |      |      |      |      |      | Random |
| No        | 7.4  | 0.06 | 29.9 | 99.8 |      |      |      |      |      |      | Random |
| Total     | 5.17 | 2.19 | 9.30 | 99.8 |      |      |      |      |      |      | Random |
Figure 2. Forest plot of prevalence of HBV studies by country from 2005 to 2015.

(a) Prevalence of hepatitis B

From the 43 studies included in our analysis, 31 studies reported on the prevalence of hepatitis B in prisons during the years 2005-2015. For each study, the prevalence of hepatitis B according to country, continent, the WHO designated region, year of study, gender, and history of injection were obtained Table 2. Analysis of these studies showed that, overall, the prevalence of hepatitis B in prisoners around the world was 5.17% (95% CI: 2.19-9.30). The results also indicated that among the studies conducted in different countries, the highest prevalence of hepatitis B was in America, at 21.2% (9% CI: 20.6-21.84), and the lowest rate was in Mexico, at 0.15% (95% CI: 0.06-0.25) (Figure 1). The highest prevalence of hepatitis B, according to continent, was in Africa, at 13.14% (95% CI: 11.99-14.36), and the next lowest prevalence was in Europe, at 1.16% (95% CI: 1.03-1.30) Figure 3. When considering the prevalence of hepatitis B in prisons according to the WHO’s classification of regions, the results showed that the highest prevalence was observed in Oceania, with a rate of 5.04% (95% CI: 4.45-5.67), and the lowest prevalence was seen in Europe, with a rate of 1.19% (95% CI: 1.06-1.33). When the prevalence of hepatitis B in prisons was assessed according to the year of study, highest prevalence was in studies conducted in 2014, with a rate of 17.8% (95% CI: 17.26-18.35), and the lowest prevalence was seen in 2012, with a rate of 1.01% (95% CI: 0.81-1.24). Analysis related to gender revealed that the prevalence of hepatitis B in men and women was 6.70% (95% CI: 6.32-6.88) and 4.34% (95% CI: 3.98-4.79), respectively. The prevalence of hepatitis B among people with a history of injection was 12.68% (95% CI: 4.65-23.9), and the prevalence among those without a history of injection was 7.4% (95% CI: 0.06-29.9) Table 2.

(b) Prevalence of hepatitis C

Among the 43 studies included in our investigation, 38 studies reported on the prevalence of hepatitis C in prisons around the world during the years 2005-2015. For each, the prevalence of hepatitis C according to country, continent, the WHO classified region, year of study, gender, and
history of injection were obtained Table 3. Analysis of these studies indicated that, overall, the prevalence of hepatitis C in prisoners worldwide was 13.22% (95% CI: 8.95-18.16). The results also showed that according to countries, the highest prevalence of hepatitis C was related to Azerbaijan, with a rate of 38.23% (9% CI: 33.99-42.06), with the lowest rate in America, at 1.76% (95% CI: 20.56-21.84) Figure 2. The analyses related to gender showed that the prevalence of hepatitis C in men and women was 9.33% (95% CI: 1.56-1.98) and 6.25% (95% CI: 5.78-6.74), respectively. The highest prevalence of hepatitis C, according to continent, was in Australia, at 26.4% (95% CI: 25.05-27.87), and the lowest was in the Americas, at 3.68% (95% CI: 3.5-3.87). When the prevalence of hepatitis C in prisons was examined according to the WHO classification of regions, the results showed that the highest prevalence was in Southeast Asia, at 24.26% (95% CI: 21.6-27.02) and the lowest was in America, at 3.68% (95% CI: 3.5-3.87). When the prevalence of hepatitis C in prisons was examined according to the year of study, the highest prevalence was seen in the studies conducted in 2009, with a rate of 33.66% (95% CI: 31.01-36.38), and the lowest prevalence was seen in those carried out in 2008, with a rate of 2.55 (95% CI: 1.83-3.46). Regarding the prevalence of hepatitis C and the history of injection, the results showed that the prevalence for those with such a history was 19.32% (95% CI: 3.51-43.65), and the prevalence among those without a history of injection was 12.99% (95% CI: 1.03-35.24) Table 3.

4. Discussion

The population of prisoners consists of groups facing greater health problems influenced by unstable economy, history of drug abuse, and other instances of risk behavior. One of the main health-related concerns among prisoners is blood-borne infections, including hepatitis B and C [59].

This study aimed to investigate the prevalence of hepatitis B and C in prisons worldwide. In the present study, 43 studies were evaluated to examine the prevalence of hepatitis B and C in prisons around the world. In the final meta-analysis, 31 articles were included in the investigation.
Table 3. Prevalence of HCV Stratified by Different Factors

| Stratified factors | Prevalence rate | Lower limit | Upper limit | Heterogeneity I\(^2\) (%) | Model |
|--------------------|-----------------|-------------|-------------|---------------------------|-------|
| **Country**        |                 |             |             |                           |       |
| Taiwan             | 16.32           | 14.06       | 18.79       | 99.7                      | Random |
| Australia          | 26.40           | 25.05       | 27.78       | 99.8                      | Random |
| Mexico             | 3.20            | 2.94        | 3.48        | 99.7                      | Random |
| Indonesia          | 24.26           | 21.65       | 27.02       | 99.9                      | Random |
| Azerbaijan         | 38.23           | 33.99       | 42.06       | 99.5                      | Random |
| Brazil             | 10.34           | 9.57        | 11.15       | 99.8                      | Random |
| England            | 25.69           | 24.81       | 26.58       | 99.8                      | Random |
| Scotland           | 18.38           | 17.32       | 19.47       | 99.9                      | Random |
| Spain              | 22.70           | 18.53       | 23.71       | 99.7                      | Random |
| France             | 5.49            | 4.97        | 6.06        | 99.5                      | Random |
| Ghana              | 8.98            | 7.96        | 10.07       | 99.6                      | Random |
| Italy              | 24.29           | 22.24       | 26.42       | 99.7                      | Random |
| Croatia            | 15.06           | 11.55       | 19.15       | 99.5                      | Random |
| Pakistan           | 10.87           | 9.82        | 12.00       | 99.6                      | Random |
| Lebanon            | 9.74            | 5.96        | 14.79       | 99.7                      | Random |
| Nigeria            | 12.33           | 8.83        | 16.59       | 99.9                      | Random |
| Ukraine            | 5.22            | 3.26        | 7.87        | 99.8                      | Random |
| Macedonia          | 5.60            | 4.60        | 6.74        | 99.7                      | Random |
| America            | 1.76            | 1.56        | 1.98        | 99.7                      | Random |
| Iran               | 6.05            | 5.53        | 6.61        | 99.5                      | Random |
| **Continent**      |                 |             |             |                           |       |
| Asia               | 10.57           | 10.06       | 11.10       | 99.99                     | Random |
| Australia          | 26.40           | 25.05       | 27.78       | 99.7                      | Random |
| America            | 3.68            | 3.50        | 3.87        | 99.8                      | Random |
| Europe             | 16.9            | 16.44       | 17.36       | 99.5                      | Random |
| Africa             | 9.26            | 8.31        | 10.35       | 99.8                      | Random |
| **WHO**            |                 |             |             |                           |       |
| Oceania            | 24.4            | 23.27       | 25.66       | 99.9                      | Random |
| America            | 3.68            | 3.5         | 3.87        | 99.9                      | Random |
| Europe             | 17.31           | 16.85       | 17.77       | 99.8                      | Random |
| Africa             | 9.29            | 8.31        | 10.35       | 99.9                      | Random |
| Southeast Asia     | 24.26           | 21.65       | 27.02       | 99.8                      | Random |
| **Year**           |                 |             |             |                           |       |
| 2005               | 27.7            | 25.95       | 29.62       | 99.8                      | Random |
| 2006               | 17.27           | 15.80       | 18.83       | 99.9                      | Random |
| 2008               | 2.55            | 1.83        | 3.46        | 99.8                      | Random |
| 2009               | 33.66           | 31.01       | 36.38       | 99.8                      | Random |
| 2010               | 17.01           | 15.57       | 18.53       | 99.7                      | Random |
| 2011               | 19.13           | 18.53       | 19.73       | 99.9                      | Random |
| 2012               | 18.28           | 17.47       | 19.10       | 99.85                     | Random |
| 2013               | 2.62            | 2.27        | 3.02        | 99.9                      | Random |
| 2014               | 3.33            | 3.08        | 3.59        | 99.8                      | Random |
| 2015               | 4.46            | 4.20        | 4.73        | 99.7                      | Random |
| **Gender**         |                 |             |             |                           |       |
| Male               | 9.33            | 9.12        | 9.54        | 99.9                      | FiX   |
| Female             | 6.25            | 5.78        | 6.74        | 99.8                      | Fix   |
| **Injection**      |                 |             |             |                           |       |
| Yes                | 19.32           | 3.51        | 43.65       | 99.9                      | Random |
| No                 | 13.22           | 8.95        | 18.16       | 99.7                      | Random |
| **Total**          |                 |             |             |                           |       |
of the prevalence of hepatitis B, with the average sample size being 2014. The prevalence of hepatitis B was calculated. The heterogeneity of the prevalence rates was 99.5%, indicating high heterogeneity according to the related cut-off points (less than 25%: low heterogeneity, 25-75%: average heterogeneity, and more than 75%: high heterogeneity). The random effects model was, therefore, used for further examination. According to this model, it is assumed that the observed differences are due to different sampling as well as the differences in the measured parameters (prevalence of hepatitis B and C) in different studies.

The search results revealed that the 31 studies in our analysis had been conducted in different countries from 2005 to 2015 in order to investigate the prevalence of hepatitis B. Overall, the prevalence of hepatitis B in the prisons worldwide was 5.17% (95% CI: 2.19-9.30). The highest prevalence of hepatitis B was related to the studies conducted by Macalino et al. in 2005, with a sample size of 297 and a prevalence of 28.95% (95% CI: 23.86-34.47) [20]. Moreover, hepatitis B was associated with a study conducted in Mexico by Bautista-Arredondo et al. in 2015, with a sample of 17,000 and a prevalence of 0.15% (95% CI: 0.09-0.22) [19].

The search results also showed that 38 studies had been carried out in different countries from 2005 to 2015 in order to investigate the prevalence of hepatitis C. The sample size of these studies varied from 200 to 17,000. The smallest and largest sample sizes (i.e., 200 and 17000) were associated with Macedonia and Mexico, respectively. The highest estimated prevalence of hepatitis C was observed in a study by Miller et al., conducted in Australia in 2009 and with a prevalence of 62.82% (95% CI: 57.76-67.68) [60]. Overall, the prevalence of hepatitis C in prisons around the world was estimated to be 13.22% (95% CI: 8.95-18.16). The highest prevalence of hepatitis B, according to continent, was seen in Africa, at 13.14% (95% CI: 11.99-14.36), and the lowest was in Europe, at 1.16% (95% CI: 1.03-1.30). However, the highest prevalence of hepatitis C in prisons, according to the WHO's classification of regions, was in Australia, at 26.4% (95% CI: 25.05-27.87), and the lowest was seen in the Americas, at 3.68% (95% CI: 3.5-3.87). Health organizations should, therefore, seek to modify the existing patterns and halt the growing trend of hepatitis infection by implementing proper vaccination programs and/or preventative education to lower risk and prevalence.

The results showed that the overall prevalence of hepatitis B in men was 6.7% (95%: 6.52-6.88). The highest prevalence of hepatitis B in men in Italy, at 35.19% (95% CI: 32.58-37.87), and the lowest was in Mexico, at 0.13% (95% CI: 0.08-0.2). The results showed that the overall prevalence of hepatitis B in female prisoners was 4.34% (95% CI: 3.98-4.79). The highest prevalence of hepatitis B in women was in Spain, at 29.03% (95% CI: 14.22-48.03), and the lowest was in Mexico, at 0.28% (95% CI: 0.09-0.67).

According to the results, it could be argued that the prevalence of hepatitis among male prisoners is greater when compared with that among female prisoners. Given the higher prevalence of risk behavior and drug injection among men, these findings affirm the greater need for training in this group. Drug use is currently a global problem; indeed, nearly 5% of the world’s population (200 million people) use drugs [61]. Injection is one of the most harmful ways of drug use. It is estimated that there are 13 million injection drug users in the world, 75% of which live in developing countries [59]. Drug injection and needle sharing in closed environments, such as prisons, could exacerbate the transmission of blood-borne diseases. The results of the present study showed that the prevalence of hepatitis B among the people with a history of injection was 12.68% (95% CI: 4.65-23.9), and the prevalence among those without a history of injection was 7.4% (95% CI: 0.06-29.9). With respect to the prevalence of hepatitis C and the history of injection, the results showed that the prevalence for those with such a history was 19.32% (95% CI: 3.51-43.65), and the prevalence among those without a history of injection was 12.99% (95% CI: 1.03-35.24).

5. Conclusion
The results suggest that the prevalence of hepatitis B and C, in general, and that of hepatitis C, in prisons, are of particular concern. The prevalence of hepatitis is higher among men than women
in prisons (due to men’s higher rate of risky sexual behavior) as well as among those with a history of injection. Therefore, adequate training should be given to prisoners in health planning and prevention in order to prevent further spread of the disease in prisons and the community.

6. Open Access
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7. List of abbreviations
CI: Confidence Interval, WHO: World Health Organization

8. Ethics approval and consent to participate
Not be applied

9. Competing interests
The authors declare that no competing interests exist.

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11. Authors’ contributions
All authors contributed to the design of the research. ZKH, EG, and GM collected the data. ZKH, and EG conducted analysis and interpretation of data. All authors drafted the first version. ZKH, EG and GM edited the first draft. All authors reviewed, commented and approved the final draft.

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