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Prevalence of hepatitis B and C infections among HIV-positive men who have sex with men: A systematic review and meta-analysis

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Abstract

Background: Human immunodeficiency virus (HIV) infection is highly prevalent and often coexists with other infectious diseases, especially Hepatitis B virus (HBV) and

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Hepatitis C virus (HCV). Men who have sex with men (MSM) represent a vulnerable population in terms of HIV infection. We aimed to determine the prevalence of HCV, HBV among HIV-infected MSM.

Methods: This systematic review and meta-analysis searched PubMed, Cochrane, Scopus, Web of Science, and ProQuest up-to 2023/04/22. All studies reporting the prevalence of HBV or HCV infection in MSM PLHIV were included. Meta-analysis used random effect model for synthesis and I^2 along with prediction interval for heterogeneity. Subgroup analysis based on continent and meta-regression for study size, average age and year of publication were used to explore heterogeneity. Modified Newcastle-Ottawa Scale was used to evaluate the quality of studies according to the protocol (PROSPERO: CRD42023428764).

Results: Fifty-six of 5948 studies are included. In 53 studies with 3,07,589 participants, a pooled prevalence of 7% (95% confidence interval [CI]: 5–10) was found for HCV among MSM PLHIV, while a 9% (95% CI: 4–18) prevalence was found for HBV infection from five studies which included 5641 MSM PLHIV. Asia reported the lowest pooled prevalence at 5.84% (95% CI: 2.98–11.13) for HCV while Europe reported the highest pooled prevalence at 7.76% (95% CI: 4.35–13.45). Baujat plot and influence diagnostic identified contributors to influence and between-study heterogeneity. Sensitivity analyses omitting these studies result in considerably more precise estimates. Another sensitivity analysis as leave-one-out meta-analysis did not change any pooled estimate significantly.

Conclusion: There is a significant burden of HCV and HBV among MSM PLHIV worldwide, with varying prevalence rates. Future studies should focus on these multimorbidity clusters and investigate factors influencing disease burden, long-term outcomes, optimal testing strategies, and tailored interventions.

KEYWORDS

Hepatitis B virus, Hepatitis C virus, human immunodeficiency virus (HIV), infectious diseases, men having sex with men (MSM), people living with HIV (PLHIV), prevalence, sexually transmitted infections (STIs), systematic review and meta analysis

1 | INTRODUCTION

The presence of three blood-borne viruses, namely human immunodeficiency virus (HIV), hepatitis C virus (HCV), and hepatitis B virus (HBV), can have a substantial impact on morbidity and pose significant challenges to global health. Due to the similar blood-borne transmission methods of these viruses, including sexual practices, vertical route, and use of shared needles, syringes, and other injection equipment, there is a substantial potential of concomitant infection in people.[1]

WHO estimated that in 2022, approximately 242,000 people died from hepatitis C, mostly from cirrhosis and hepatocellular carcinoma.[2] There were 13,800 estimated new HBV infections and 67,400 estimated HCV infections in 2022.[3] In 2019, the worldwide mortality attributable to HCV infections exceeded 290 thousand, while HBV infections were responsible for over 820 thousand deaths.[2] However, the undetected rate of HBV or HCV viruses is close to 80%[4] and 96% of deaths from viral hepatitis are caused by HBV or HCV.[2] Globally, 37.7 million individuals were predicted to be HIV-positive in 2020. In the year 2020, there were an estimated 1.5 million newly acquired HIV infections, and the global burden of HIV-related mortality reached approximately 680,000 deaths.[2] Out of the estimated global population of 36.7 million people living with HIV (PLHIV), approximately 2.3 million individuals show serological evidence of previous or current HCV infection, indicated by positive results for HCV antibodies (anti-HCV positive). Additionally, among the 36.7 million PLHIV, around 2.7 million individuals also have HBV infection. The worldwide prevalence of HBV infection in PLHIV is approximately 7.4%.[5–7]

Compared to those who have only one of these diseases, those with or HIV-HCV or HIV-HBV coinfection are more likely to

experience stigma and restricted access to healthcare facilities in some cases as well as rapid disease development, numerous liver-related ailments, and non-hepatic organ failure, all of which can lead to death. They might also be part of a population that is stigmatized as a result of using injectable drugs or engaging in certain sexual activities.[1,5] With shared health determinants, mechanisms of transmission, and high rates of coinfection, HIV and viral hepatitis together make up a cluster of interconnected communicable diseases. Within countries, certain demographic groups have different rates of HBV or HCV and HIV infection than others.[2,5] Men who have sex with men (MSM) are considered a high-risk group for both HIV and hepatitis infections. They account for 23% of those who contract HIV.[2] Specifically, higher risk of HBV infection is associated with MSM.[8] Reinfection has also been reported even among HIV-infected MSM who were successfully cured with treatment for hepatitis C.[9]

Previous observational studies, and systematic reviews have looked the prevalence of HBV and HCV among people living with HIV/AIDS as well as prevalence of HIV, HCV, and HBV among high-risk groups and at specific geographic regions.[10–16] Many recent studies are available which provide valuable insight[17–25] and are not included in the existing reviews.[12,26] This systematic review and meta-analysis investigated the total pooled prevalence of HBV and HCV among the HIV-infected MSM population including updated data with robust synthesis.

2 | METHODS

The systematic review adhered to the PRISMA guidelines, as detailed in Table S1. The review protocol for this particular study was officially registered in PROSPERO, an international database for systematic review protocols. It was assigned the unique registration number CRD42023428764. Ethical approval and informed consent were nor applicable for this study since it is based on published data.

2.1 | Inclusion and exclusion criteria

The aim of this systematic review was to assess the prevalence of HCV and HBV infections among MSM PLHIV. The review employed inclusive criteria, encompassing MSM PLHIV participants. All original studies reporting the prevalence of HBV or HCV infection in MSM PLHIV were included. The diagnostic criteria for HCV and HBV must be based on serum HCV-RNA positivity or anti-HCV IgG positivity. Narrative reviews, protocols, unpublished reports, editorials, clinical case reports, abstracts, and commentaries were excluded. Additionally, studies with a sample size of less than 100 were also excluded. This study included preprints and published articles that were available in English, without geographical or research environment restrictions. For further details on the eligibility criteria, please refer to Table S2.

2.2 | Searching and screening

A comprehensive literature search was conducted on April 22, 2023, across several databases, including PubMed, Cochrane, Web of Science, Scopus, and ProQuest. The search strategy employed a combination of keywords, synonyms, and truncated words related to HIV, Hepatitis, HCV, HBV, and MSM. English-language publications were specifically included, while there were no restrictions based on the publication year. The search strategy aimed to identify all relevant studies that mentioned on the number of HBV or HCV infections among MSM PLHIV. We have furnished a transparent reproducible search strategy across all databases in Table S3.

Upon obtaining the search results, duplicate entries were removed, and Mendeley was used for managing the references. The initial screening process was carried out by two researchers, A.Y. and M.S., utilizing Rayyan. They assessed the titles and abstracts of each study to exclude irrelevant articles. Subsequently, the full-text readings of the remaining studies were carefully evaluated to confirm their eligibility for inclusion in the review. The screening process was conducted independently by the two researchers to ensure accuracy and consistency. In cases of disagreements or discrepancies, a third senior researcher, Q.S.Z., was consulted to provide a binding independent assessment of the study's eligibility.

2.3 | Data extraction and quality assessment

Three investigators (A.Y., M.A., and M.N.K.) conducted data extraction from the included studies. The extracted data encompassed various aspects such as the first author's name, country of study, publication year, age, male percentage, type of population, total population of MSM PLHIV, and the number of HCV or HBV infections. To evaluate the quality of the included studies, a modified version of the Newcastle-Ottawa Scale was employed, with a scoring range from 0 to 6. This scale assessed the methodological rigor and potential bias of each study based on four criteria: representativeness (scored 0-2), sample size (scored 0-1), definition of infections (scored 0-2), and ascertainment of HCV or HBV infections (scored 0-1).[27,28] A higher score indicated a higher level of methodological quality and a lower risk of bias in the respective study.[29]

2.4 | Statistical analysis

A random-effect model was used to calculate the combined prevalence, taking into account the potential variation between studies. The prevalence from individual studies was logit-transformed. These were synthesized using random intercept logistic regression model. Heterogeneity, or the degree of variability between study results, was assessed using prediction interval, I^2 and tau-sqaured. I^2 values range from 0% to 100%, with higher values indicating greater heterogeneity.[30] 95% prediction interval is a more intuitive and appropriate way of representing heterogeneity.[31]

For future original studies answering the same research question, the individual study estimates are expected fall within this range 95% of the time. Tau-squared is computed using maximum likelihood estimator.[32] A $p \leq 0.05$ is considered to be significant. Then, subgroup analyses and meta-regression were performed to investigate potential factors contributing to the observed heterogeneity.[33]

For determining the risk of publication bias and small study effects, Doi plots with LFK index were utilized. Doi plots help assess publication bias in single-group studies as they don't rely on the concept of significance.[34] They plot the individual study estimates against a folded normal quantile. Study symmetry is assessed visually, and quantified using LFK index.[35] The statistical analyses, including the calculation of pooled prevalence, assessment of heterogeneity, other analyses, and generation of plots, were conducted using R version 4.3.[36]

3 | RESULTS

3.1 | Literature search

A total of 5948 records were obtained from multiple databases, out of which 1856 records were identified as duplicates. After removing these duplicates, the remaining 4092 records underwent primary screening based on reading title and abstract. A total of 114 records were deemed eligible for full-text reading. Sixty-seven studies were then excluded in which seven were with incorrect population, 11 were having wrong study design, 23 studies didn't mentioned prevalence among MSM, 25 were case reports, three were with duplicate data. Twelve records were identified from reference searching in which one study was excluded due to incorrect population, resulting in 11 studies. Overall, 56 studies met the eligibility criteria for inclusion in the systematic review and meta-analysis (Figure 1).

3.2 | Characteristics of included studies

Fifty-six studies fulfilled the inclusion criteria, as shown in Table 1, comprising a total of 309203 MSM PLHIV. Switzerland contributed five studies,[18,20,37–39] United States had 11 studies,[40–50] Spain had four studies,[51–54] Netherlands had four studies,[55–58] three studies were from France,[17,59,60] six studies were from Taiwan,[22,61–65] eight studies were from United Kingdom,[19,21,23,25,66–69] two studies were from Europe,[70,71] two studies from Japan,[24,72] two studies from Australia.[73,74] One study each were from Belgium,[75] Denmark,[76] Canada,[77] Italy,[78] Sri Lanka,[79] Germany,[80] South Korea,[81] China,[82] and Thailand.[83] Two studies reported both HCV and HBV data, and

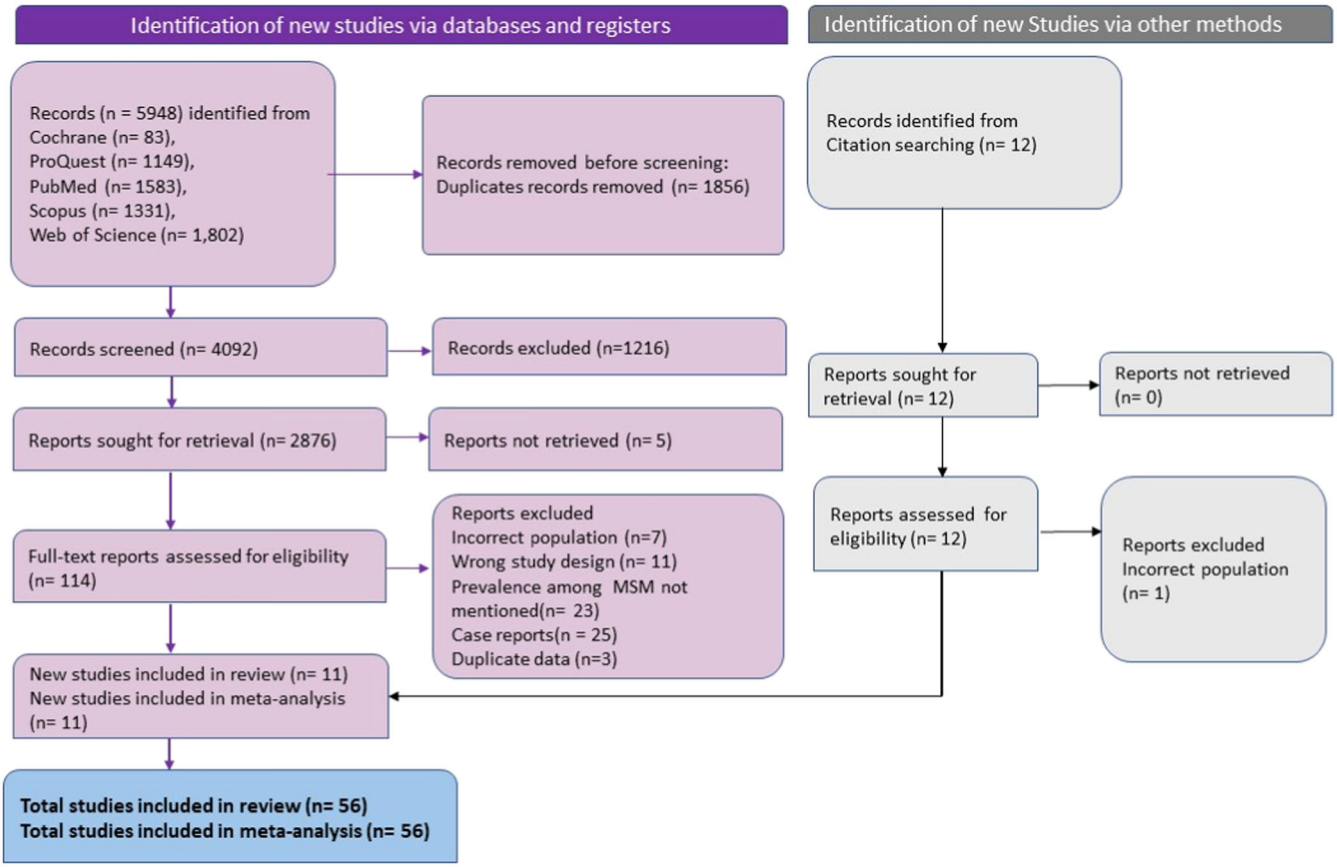

FIGURE 1 PRISMA flowchart depicting literature search and screening process.

TABLE 1 Characteristic of all included studies.

Author	Year	Country/region	Study Design	Age (mean/median)	HCV infections	HBV infections	Total MSM PLHIV
Chen	2019	USA	Retrospective cohort	N/A	371	N/A	1935
Vanhommerig	2017	Europe	Observational cohort	37.1	563	N/A	5038
Gamage	2011	Sri Lanka	Retrospective cohort	32	40	N/A	1445
Castry	2021	France	Prospective cohort	44	330	N/A	14,273
Rooijen	2016	Netherlands	Longitudinal	41	112	N/A	1742
Pradat	2018	France	Observational cohort	49	5557	N/A	40,714
Apers	2014	Belgium	Retrospective cohort	40.8	99	N/A	275
Marcellin	2015	France	Cross-sectional	N/A	93	N/A	1037
Dougan	2007	UK	Observational cohort	N/A	11	N/A	242
Barfod	2011	Denmark	Retrospective cohort	N/A	41	N/A	1846
Nwulia	2015	USA	Observational cohort	32	N/A	277	2375
Rauch	2005	Switzerland	Prospectivecohort	35	2638	N/A	7899
Huang	2019	Taiwan	Retrospective cohort	33.7	120	26	219
Nishijima	2014	Japan	Observational	35	21	N/A	1182
Helm	2011	Europe	Observational cohort	31.6	124	N/A	4724
Gabai	2020	USA	Observational	N/A	2762	N/A	54,077
Jongen	2020	Netherlands	Observational	N/A	16	N/A	1372
Cuomo	2018	Italy	Observational	51	40	N/A	421
Raymond	2011	USA	Cross-sectional	N/A	32	N/A	207
Breskin	2015	USA	Observational	34	2016	N/A	41,303
Kouyos	2014	USA	Observational	34	23	N/A	510
Medland	2017	Australia	Retrospective cohort	43.1	37	N/A	822
Santen	2021	USA	Observational cohort	35	361	N/A	9699
Chen	2016	USA	Retrospective cohort	38.4	42	N/A	1147
Sun	2014	Taiwan	Observational	28.5	N/A	37	767
Newsum	2019	Netherland	Observational	42.6	313	N/A	501
Kusejko	2022	Switzerland	Prospective cohort	N/A	28	N/A	4641
Garg	2013	USA	Retrospective cohort	38	64	N/A	1171
Salazar-Vizcaya	2015	Switzerland	Prospective cohort	N/A	314	N/A	1455
Turner	2006	UK	Cross sectional	34	11	N/A	308
Giraudon	2007	UK	Observational	N/A	389	N/A	42,985
Palacios	2015	Spain	Cross-sectional, open observational	42.9	61	N/A	725
Jin	2010	Australia	Observational cohort	N/A	23	N/A	245
Taylor	2011	USA	Prospective cohort	N/A	36	N/A	1830
Sun	2012	Taiwan	Nested case-control	44	28	N/A	731
Wandeler	2012	Switzerland	Prospective cohort	38	147	N/A	4629
Daskalopoulou	2014	UK	Cross-sectional	N/A	159	N/A	1195
Lin	2014	China	Observational	38	14	N/A	1311
Sobrino-Vegas	2014	Spain	Prospective cohort	N/A	1227	N/A	7977

(Continues)

TABLE 1 (Continued)

Author	Year	Country/region	Study Design	Age (mean/median)	HCV infections	HBV infections	Total MSM PLHIV
Burchell	2015	Canada	Observational cohort	41	51	N/A	1534
Jansen	2015	Germany	Prospective cohort	33	1784	468	1838
Lee	2016	South Korea	Retrospective cohort	44	41	N/A	790
Ho	2020	Taiwan	Retrospective cohort	28.7	277	N/A	3495
Santen	2017	Netherlands	Observational	N/A	703	N/A	10,061
Willekens	2021	Spain	Cross-sectional	N/A	4	N/A	301
Roche	2022	UK	Observational	N/A	56	N/A	1497
Serna	2020	Spain	Prospective cohort	44.1	21	N/A	242
Garvey	2021	UK	Retrospective cohort	43	378	N/A	9278
Braun	2021	Switzerland	Observational	N/A	177	N/A	4640
Huang	2021	Taiwan	Retrospective cohort	34.5	428	N/A	5156
Chen	2020	USA	Cross-sectional	40.9	472	N/A	1948
Lee	2021	Taiwan	Cross-sectional	36.6	110	N/A	844
Gouda	2023	UK	Cross-sectional	30	N/A	10	442
Wansom	2020	Thailand	Observational cohort	26	39	N/A	563
Nishikawa	2023	Japan	Retrospective cohort	N/A	45	N/A	1135
Monin	2022	UK	Observational cohort	41	55	N/A	464

Abbreviations; –HBV, Hepatitis B virus; HCV, Hepatitis C virus; HIV, Human immunodeficiency virus; MSM, men who have sex with men; N/A, not Available; PLHIV, People living with HIV.

eight studies were conducted across multiple centers. Among the study designs, eight were prospective cohort, 14 were observational, 13 were retrospective cohort, 10 were observational cohort, one was longitudinal, and nine were cross-sectional. Additionally, one study used a nested case-control design. Of the included studies, 53 reported HCV cases, while five reported HBV prevalence among MSM PLHIV. The studies included were of average quality, with seven studies scoring 6, 22 studies scoring 5, 17 studies scoring 4, six studies scoring 3, and four studies scoring 2 on the modified Newcastle-Ottawa scale. Further Details regarding the quality assessment of the studies can be found in Table S4.

3.3 | Prevalence of HCV and HBV among MSM PLHIV

Overall combined prevalence estimates were obtained by pooling number HCV cases from the 53 included studies. Meta-analysis of 3,07,589 participants revealed a global prevalence of HCV infection among MSM PLHIV to be 7% (95% confidence interval [CI]: 5–10) by using random effect model (Figure 2). A substantial degree of heterogeneity was observed among the included studies, as indicated by an I^2 value of 100%. The 95% prediction interval lies between 0% and 56%. Thus, an original study in the future is expected to give a prevalence between 0% and 56%.

Meta-analysis of 5641 participants from five studies revealed a global prevalence of HBV infection among MSM PLHIV to be 9% (95% CI: 4–18) by using random effect model (Figure 3). A substantial degree of heterogeneity was observed among the included studies, as indicated by an I^2 value of 98%. The 95% prediction interval falls in the range of 0%–69%.

3.4 | Heterogeneity and influence assessment

Both the pooled estimates for prevalence of HBV and HCV among MSM PLHIV are highly heterogenous with I^2 of 100% and 98% respectively. We further explored the heterogeneity graphically (Figure S1). The Baujat plot shows the contribution of individual studies to the heterogeneity and influence. The four studies in the upper or right portion contribute highly to both influence and heterogeneity (Figure S2).[37,59,67,80] Influence diagnostics have identified a study as an overly influential report (Figure S3).[61]

3.5 | Heterogeneity exploration

To explore the observed between-study heterogeneity, we performed subgroup analysis based on continent for the prevalence of HCV in MSM PLHIV. It failed to reduce heterogeneity ($p = 0.90$).

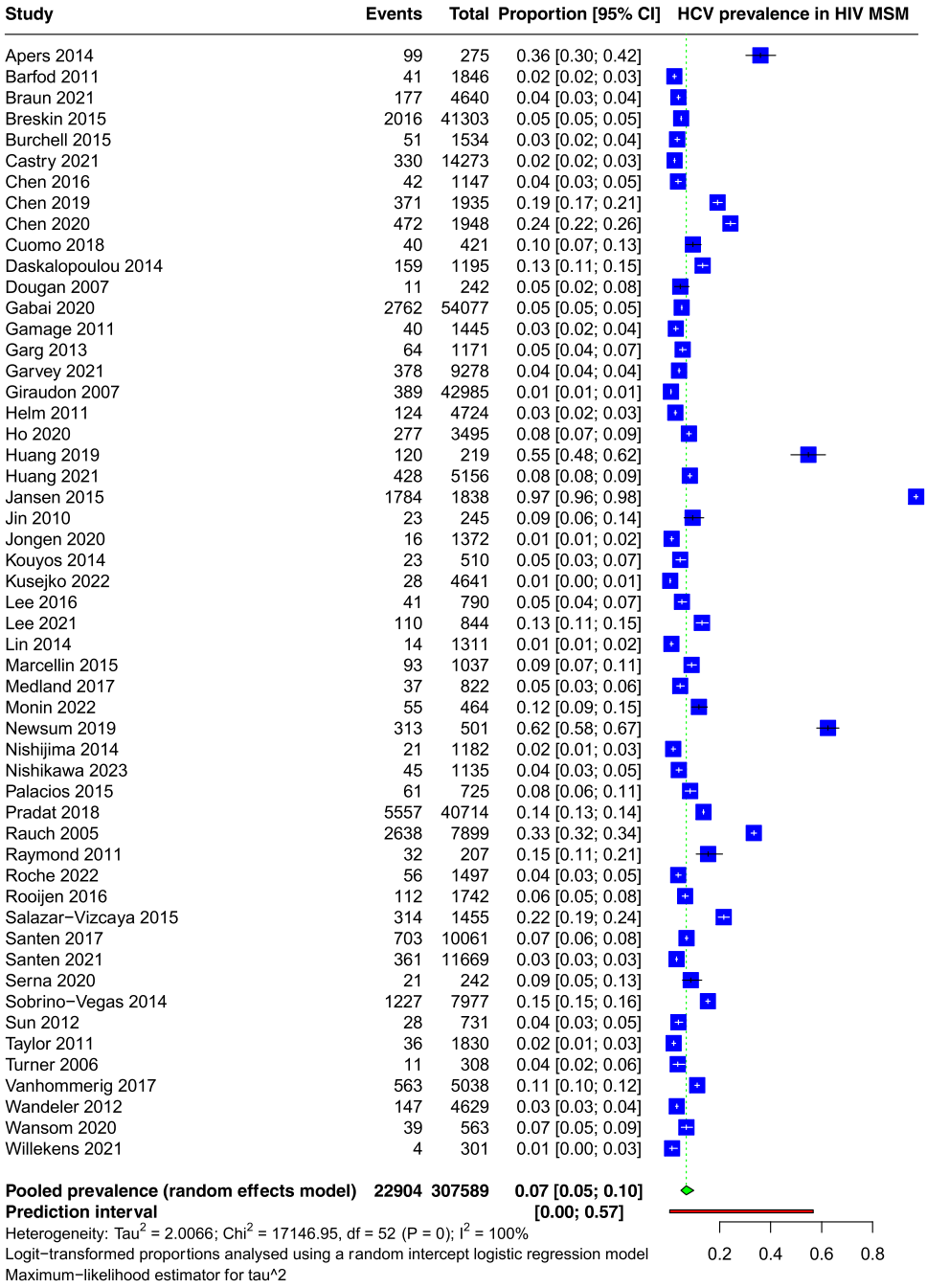

FIGURE 2 Forest plot showing the pooled prevalence of Hepatitis C virus among men having sex with men and people living with HIV.

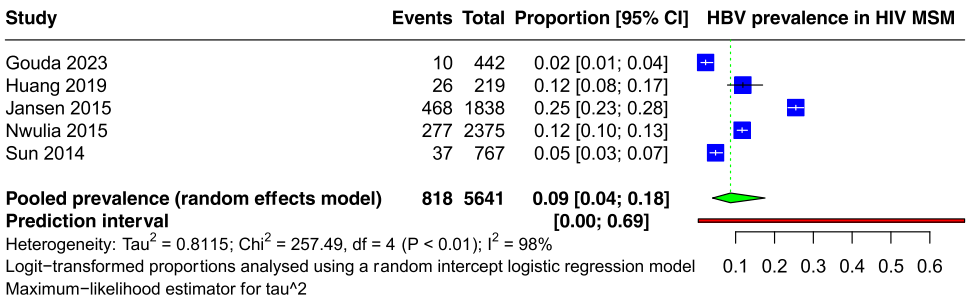

FIGURE 3 Forest plot showing the pooled prevalence of Hepatitis B virus among men having sex with men and people living with human immunodeficiency virus.

Asia reported the lowest pooled prevalence at 5.84% (95% CI: 2.98–11.13) while Europe reported the highest pooled prevalence at 7.76% (95% CI: 4.35–13.45) (Table 2). North America reported a prevalence of 6.09% (95% CI: 3.75–9.73) and Australia reported a prevalence of 6.28% (95% CI: 3.74–10.37) for HCV. Further, we performed meta-regression based upon sample size (Figure S4), year of study (Figure S5), and average age of participants (Figure S6).

3.6 | Sensitivity analysis

We performed several sensitivity analyses to assess the robustness of the pooled estimates. Omitting each study one-by-one in a leave-one-out meta-analysis did not reveal any significant difference in the pooled estimate (Figure S7). Another sensitivity analysis excluded the overly influential study. The pooled estimate changed from 7% (95% CI: 5–10) to 7% (95% CI: 7–8), thus becoming much more precise (Figure S8). Excluding the four studies contributing highly to influence and heterogeneity also increased the precision of the pooled estimate without a significant change 6% (95% CI: 6–6) (Figure S9).

3.7 | Publication bias

To determine publication bias in our meta-analysis, we employed Doi plot with LFK index. The Doi plots for prevalence of HCV and HBV in MSM PLHIV show gross visual asymmetry. This is corroborated by the accompanying LFK indices of −2.26, and −3.21 respectively (Figure 4). This finding could also be by chance. And in the absence of a prespecified expectation of lower prevalence studies being more likely to be published, this does not prove publication bias.

4 | DISCUSSION

The objective of this systematic review and meta-analysis was to assess the prevalence of HCV and HBV infections among MSM PLHIV. Our analysis revealed an overall prevalence of 7% for HCV at the global level, indicating a substantial burden of HCV infection among this population. However, when considering the prevalence of HCV among MSM PLHIV at the continents, there was some variation. Asia reported the lowest prevalence and Europe reported the highest prevalence. There is no relation with year of study, age of participants, and size of study. However, omitting the highly influential and heterogeneity-contributing studies made the pooled estimate considerably more precise. These studies collectively reported a pooled prevalence of 9% for HBV among MSM PLHIV. It is crucial to note the high heterogeneity observed among the included studies for both HCV and HBV, highlighting the need for cautious interpretation of the results. The sources of heterogeneity could not be identified despite conducting sensitivity analyses.

Comparing our results with a meta-analysis by Jin et al.,[12] which assessed pooled HCV prevalence in MSM, we found similar trends. Their study reported a global HCV prevalence of 3.4% among MSM, with higher rates in HIV-positive people compared to HIV-negative MSM. Our analysis, which included a larger number of studies specifically focusing on MSM PLHIV, obtained a higher prevalence of 9% for HCV. Similar trends of higher hepatitis incidence among MSM have also been reported in a meta-analysis focusing on the US population,[84] as well as among HIV-infected MSM and injectable drug users in another meta-analysis.[85]

The results of our meta-analysis have important implications for clinical practice and society. Healthcare providers should prioritize routine screening for HCV and HBV among MSM PLHIV, ensuring early detection and timely interventions. Access to effective treatment options is crucial, and ongoing monitoring and care are needed to address complications. Prevention strategies should focus on safe sex practices, harm reduction programs, and education to increase awareness. Policies that protect the rights of MSM PLHIV and address social stigmas are necessary.

Future research perspectives in this field hold great promise for advancing our understanding of HCV and HBV among MSM PLHIV. First, additional research are required to explore the factors contributing to the observed variations in prevalence among different countries and regions. This could include investigating the impact of sociocultural factors, healthcare disparities, and differences in prevention and treatment strategies. Second, more longitudinal studies are needed to examine the long-term outcomes of HBV and HCV infections among MSM PLHIV, including the progression of liver diseases and the effectiveness of interventions. Additionally, there is a need for research focused on the development and evaluation of tailored prevention and treatment interventions specifically targeting this population. This may involve exploring novel approaches such as community-based interventions, peer support programs, and the integration of HCV and HBV screening and

TABLE 2 Subgroup analysis for prevalence of HCV among MSM PLHIV based on geography (continents).

Subgrouping variable	Number of studies	Pooled estimate	95% Confidence interval	tau-squared	*p* Value
Continent					
Europe	29	7.76	4.35–13.45	2.82	$p = 0.90$
North America	11	6.09	3.75–9.73	0.73	
Asia	11	5.84	2.98–11.13	1.39	
Australia	2	6.28	3.74–10.37	0.11	

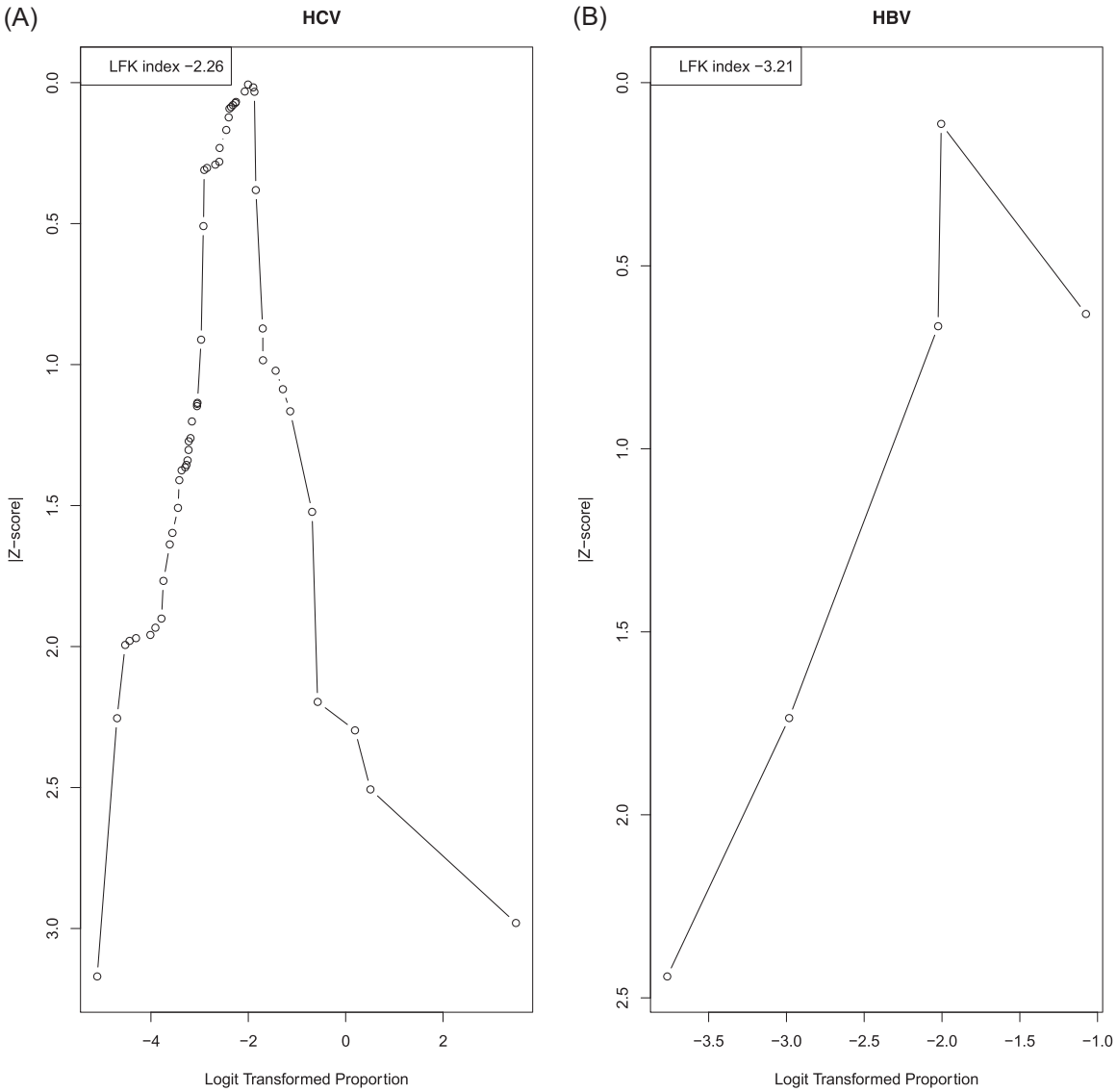

FIGURE 4 Doi plots and LFK indices for detecting publication bias. (A) Dot Plot of HCV. (B) Dot Plot of HBV.

management within existing HIV care frameworks. Furthermore, collaborative efforts between researchers, healthcare providers, and community organizations can facilitate the implementation and evaluation of these interventions in real-world settings. By addressing these research gaps, we can work towards improving the health outcomes and quality of life for MSM PLHIV affected by HCV and HBV infections.

Despite the valuable insights gained from our meta-analysis, several limitations should be acknowledged. First, our inclusion criteria were limited to studies published in the English language, potentially introducing language bias. Secondly, significant heterogeneity was observed among the included studies, which could not be fully resolved through sensitivity analyses. This heterogeneity might be attributed to variations in study design, population characteristics, and other factors. Additionally, publication bias was detected, suggesting the possibility of selective publication of studies with significant results and potentially influencing the overall findings. Lastly, the generalizability of our results is limited due to the uneven distribution of studies, with a lack of representation from Africa, South America, the Middle East, and the Indian subcontinent. Only 5 studies on HBV in HIV-positive MSM patients were available. The sample size was small, the clinical significance was also limited. In future studies, more studies should be available to summarize the prevalence of HBV in HIV-positive patients with MSM.

This meta-analysis highlights a substantial burden of HCV and HBV among PLHIV globally, with significant variation in prevalence rates. The high heterogeneity and wide prediction intervals emphasize the need for further research. Future studies should focus on understanding the factors contributing to variations in prevalence, exploring long-term outcomes, and developing tailored interventions. By addressing these research gaps, we can work towards reducing the prevalence and impact of HCV and HBV among vulnerable populations like MSM PLHIV and improving their health outcomes.

AUTHOR CONTRIBUTIONS

Muhammed Shabil: Conceptualization; investigation; writing—original draft; methodology; data curation. **Aarti Yadav**: Conceptualization; investigation; data curation; methodology; writing—original draft. **Muhammed A. Shamim**: Validation; visualization; methodology; data curation; formal analysis; investigation. **Mohammed Ahmed**: Conceptualization; software; resources. **Prakasini Satapathy**: Conceptualization; investigation; writing—review and editing; project administration; resources; software. **Ali A. Zaidan**: Conceptualization; writing—review and editing; project administration; supervision. **Mahalaqua N. Khatib**: Supervision; project administration; validation; resources; writing—review and editing. **Shilpa Gaidhane**: Writing—review and editing; resources; data curation; conceptualization. **Quazi S. Zahiruddin**: Conceptualization; methodology; writing—review and editing; project administration; supervision. **Ali A. Rabaan**: Conceptualization; formal analysis; visualization; supervision; writing—review and editing. **Nawal A. A. Kaabi**: Validation; supervision; resources; project administration; software. **Fadel A. M. Almosa**: Software; supervision; visualization; writing—review and editing. **Jehad AlSihati**: Writing—review and editing; visualization; project administration; supervision; resources. **Ranjit Sah**: Project administration; writing—review and editing; investigation; data curation; conceptualization; methodology.

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CONFLICTS OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request. All authors have read and approved the final version of the manuscript corresponding author had full access to all of the data in this study and takes complete responsibility for the integrity of the data and the accuracy of the data analysis.

TRANSPARENCY STATEMENT

The lead author Quazi Syed Zahiruddin, Ranjit Sah affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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