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REVIEW

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Prevalence of Mpox vaccine acceptance and hesitancy among people living with HIV: a comprehensive systematic review and meta-analysis

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Abstract

Background Vaccine acceptance among People Living with HIV (PLWH) is crucial for managing and mitigating the spread of infectious diseases, including Mpox. This systematic review and meta-analysis assess the rate of vaccine acceptance for Mpox among PLWH and identify factors influencing these rates.

Methods We searched major databases including PubMed, Embase, and Web of Science up to 30 August 2024 for observational studies involving PLWH that reported on mpox vaccine acceptance rates. A random-effects model was employed for the meta-analysis, utilizing R software version 4.4. Heterogeneity among the studies was quantified using the I^2 statistic, and the methodological quality of each study was assessed using a modified version of the Newcastle-Ottawa Scale.

Results Out of 1,123 articles identified, 17 studies met the inclusion criteria and included 7,248 participants. The pooled estimate of the Mpox vaccine acceptance rate was 61.1% (95% CI: 44.2-75.7%), with high heterogeneity (I^2 = 99%). Additionally, a pooled vaccine hesitancy prevalence was 13.2%, (95% CI: 2.4-48.6%), reflecting substantial variability and had high heterogeneity (I^2 = 98%).

Conclusion This systematic review and meta-analysis reveal moderate Mpox vaccine acceptance and considerable hesitancy among PLWH. To further increase vaccine uptake and address any remaining hesitancy in this at-risk

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population, targeted public health strategies and ongoing research are necessary. Strengthening vaccine acceptance is critical to safeguarding PLWH against emerging infectious diseases such as Mpox.

Clinical Trial Number Not applicable.

Introduction

The Mpox virus, part of the Orthopoxvirus genus in the Poxviridae family, typically causes symptoms less severe than those of smallpox [1]. The infection initiates when the virus binds to cellular receptors and enters cells via macropinocytosis or plasma membrane fusion [2, 3]. Once inside, it replicates its genetic material and produces viral proteins, leading to the formation of "Guarnieri bodies," which are detectable under a microscope [4]. The disease progresses from a symptom-free incubation period of 7 to 14 days to a prodromal phase marked by fever, headaches, lymphadenopathy, and myalgia, followed by a rash that starts on the face and spreads, evolving from macules to crusts [5, 6]. People living with HIV (PLWH) are at a heightened risk of severe and prolonged symptoms due to their compromised immune systems, increasing their likelihood of complications such as secondary infections and pneumonia [7, 8]. This vulnerability highlights the urgent need for accessible and effective Mpox vaccines for these high-risk groups to prevent severe health outcomes [9].

Vaccine acceptance among PLWH is influenced by factors including personal beliefs, social stigma, and perceptions of vaccine safety and efficacy [10]. The challenges of managing HIV can interfere with their access to preventive health services [11]. Moreover, vaccine hesitancy among this group is often compounded by broader social and healthcare issues [12], such as stigma surrounding HIV and other infectious diseases, which can lead to increased distrust or reluctance to engage with healthcare interventions [13]. Additionally, systemic issues like access to healthcare, the quality of interactions with healthcare providers, and supportive health policies play critical roles in influencing vaccine uptake [14]. Despite the clear need for vaccinations, data on vaccine acceptance among PLWH remains sparse and fragmented, complicating efforts by health authorities to implement effective protective measures for this high-risk group.

This systematic review and meta-analysis compile and analyzes current research on Mpox vaccine acceptance among PLWH. The study aims to provide essential information to assist one of the most at-risk groups during ongoing global health challenges. This information is crucial for developing targeted health messages and strategies to ensure that PLWH are well-protected against emerging threats like Mpox.

Methods

This systematic review and meta-analysis followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [15] (Table S1), and the review protocol was registered in the data base of International Prospective Register of Systematic Reviews (PROSPERO) with CRD42024582724. The data review was conducted using Nested Knowledge software.

Eligibility criteria

Studies included in this analysis met the following criteria: they involved PLWH, reported data on Mpox vaccine acceptance rates or hesitancy, and were observational in design, such as cohort, case-control, or cross-sectional studies. Commentaries, editorials, case reports, clinical trials, and studies that did not specifically address Mpox vaccine acceptance among PLWH were excluded (Table S2).

Search strategy

A comprehensive search was conducted across multiple electronic databases including PubMed, Embase, and Web of Science through August 30, 2024. The strategy involved using a combination of search terms, specifically ("smallpox vaccine" OR "Monkeypox" OR mpox OR "mpox vaccine" AND ("hiv" OR "human immunodeficiency viru*" OR "acquired immune deficiency syndrome virus" OR "human t cell lymphotropic virus type III" OR "human t cell leukemia virus type iii") AND (acceptance OR uptake OR willingness OR Readiness OR Hesitency), to meticulously identify studies relevant to Mpox vaccine acceptance among PLWH. To ensure the inclusion of all pertinent literature, an extensive citation search was also conducted (Table S3).

Screening

The screening process was conducted in two stages using Nested Knowledge software. First, titles and abstracts were reviewed by two independent reviewers (A.Y and G.B) to identify potentially eligible studies. Any disagreements were resolved through consultation with a third reviewer (R.S). In the second stage, the same two reviewers conducted a thorough assessment of the full texts of the potentially eligible studies. Studies that met the eligibility criteria were included in the review, with any discrepancies again resolved through discussion with the third reviewer.

Data extraction

Data were independently extracted by two reviewers (A.Y. M.N.K) using Nested Knowledge software. The extracted information included study characteristics (author, year of publication, country), participant demographics (age, sex, HIV status), study design, sample size, and reported vaccine acceptance rates. Any discrepancies were resolved through discussion and consensus, or by consulting a third reviewer (A.K.B).

Quality assessment

The methodological quality of the studies was evaluated using a modified version of the Newcastle-Ottawa Scale (NOS), with a scoring range from 0 to 6, tailored for prevalence studies [16]. Studies scoring 4 to 6 were categorized as low risk of bias, indicating high methodological quality. Those scoring 2 to 3 were considered moderate risk, and scores of 0 to 1 were classified as high risk, suggesting lower methodological quality (Table S4).

Statistical analysis

Meta-analyses were carried out using the statistical software R [17]. A random-effects model was employed to determine pooled estimates of the 'Vaccine Acceptance Rate for Mpox among PLWH' along with 95% confidence intervals (CIs). The I^2 statistic was used to assess heterogeneity among the studies, with I^2 values of 25%, 50%, and 75% indicating low, moderate, and high heterogeneity, respectively [18]. Leave-one-out sensitivity analyses were conducted to assess how individual studies influenced the findings [19]. Publication bias was assessed through visual inspection of Doi plots [20].

Results

A total of 1,123 records were identified from database searches. After removing 234 duplicates, 889 records were screened. Of these, 832 irrelevant records were excluded during the title and abstract screening, leaving 57 full-text articles for further review. During this full-text screening, 49 articles were excluded for the following reasons: 33 had no relevant outcomes, 1 was a review, and 15 were not relevant to the study. Additionally, 9 studies were identified through citation searching. Ultimately, 17 studies met the inclusion criteria and were included in the meta-analysis. The PRISMA flow diagram (Fig. 1) illustrates the results of the literature search and screening process.

Summary characteristics of included studies

A total of included 17 studies with a total of 7,248 participants. Sample sizes of PLWH ranged from 15 to 1,920 across these studies. Fourteen studies focused on vaccine acceptance, three addressed both vaccine acceptance and hesitancy, and one solely investigated vaccine hesitancy. All participants were aged 16 years or older. The study designs varied, including one retrospective observational study, one observational longitudinal study, another general observational study, and 14 cross-sectional studies.

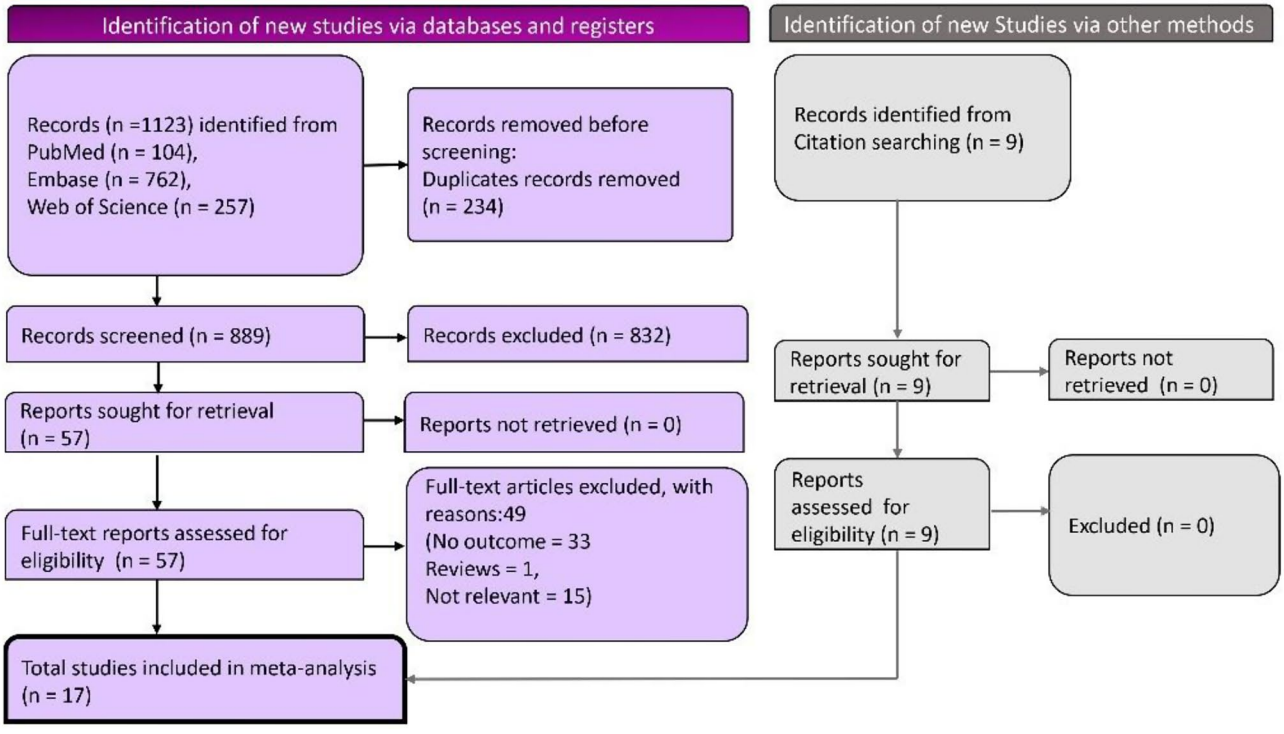

Fig. 1 PRISMA Flow Diagram

These studies were conducted in multiple countries, with three from China [21–23], Four from the USA [24–27], two from Australia [28, 29], two from Turkey [30, 31], and one from United Kingdom [32], the Netherlands [33], Denmark [34], and France [35], Israel [36] (Table 1).

Meta-analysis

Vaccine acceptance

Meta-analysis reveals significant variability in vaccine acceptance rates, with findings ranging from 24 to 84.1% among larger samples. The overall pooled prevalence is 61.1%, with a wide 95% confidence interval of 44.2–75.7%, and with considerable heterogeneity (I^2 = 99%). The prediction interval extended from 0.86 to 96% (Fig. 2). Leave-one-out sensitivity analyses show variations in pooled estimates: omitting MacGibbon 2023 or Zheng 2022 results in a reduced pooled vaccine acceptance rate to 58% (95% CI: 41–74%) with an I^2 of 99%, whereas excluding Amanda D 2022 increases the rate to 65% with the same level of heterogeneity (Fig. 4).

Region wise subgroup analysis

A significant variation in Mpox vaccine acceptance across different countries (Fig. 2). Vaccine acceptance is highest in China (92, 95% CI: 89–94) and the Netherlands (86, 95% CI: 81–90), while lower acceptance is observed in Israel (27, 95% CI: 23–31) and France (24, 95% CI: 19–30). Other countries like the USA, Turkey, Australia, and the United Kingdom show varying acceptance rates, with considerable heterogeneity within each subgroup. The test for subgroup differences indicates significant variation in vaccine acceptance ($=p<0.01$).

Vaccine hesitancy

The pooled vaccine hesitancy prevalence was 13.2%, with a 95% confidence interval of 2.4-48.6%, reflecting substantial variability and had high heterogeneity (I^2 = 98%). The prediction interval ranged from 0.1 to 97% (Fig. 3). Leave-one-out sensitivity analyses demonstrate changes in the hesitancy rates: omitting Zheng 2023 shifts the pooled prevalence to 19% with an I^2 of 87%, while excluding Borcak 2024 or D. Filardo 2023 changes it to 10% with an I^2 of 91% (Fig. 5).

Publication bias

The Doi plot analysis for publication bias shows significant asymmetry, with an LFK index of -0.76, suggesting potential bias due to underrepresentation of smaller, less significant studies. Another Doi plot for a study on vaccine hesitancy displays even greater asymmetry, with an LFK index of 3.5, strongly indicating publication bias. (Fig. 6).

Discussion

This systematic review and meta-analysis on the vaccine acceptance rate and hesitancy for Mpox among PLWH provides critical insights into the dynamics of vaccine acceptance within this vulnerable group. The findings reveal a wide variability in vaccine acceptance, with rates ranging from 26.6 to 84.1% and a pooled prevalence of 61.1% (95% CI: 44.2–75.7%). This high variability, underscored by a heterogeneity index (I^2) of 99%, indicates that factors such as socioeconomic status, healthcare accessibility, and regional health policies significantly influence vaccine uptake. These results resonate with previous

Table 1 Summary characteristics of included studies

Author	Country	Study design	Male numbers	Age (years)	Self-reported or health record data	Sample size	NOS score
Abara 2023 [25]	USA	Cross-sectional study	NA	≥ 15	Self-reported data	78	4
Amanda D 2022 [26]	USA	Cross-sectional study	58	≥ 18	Self-reported data	229	5
Borcak 2024 [30]	Turkey	Cross-sectional study	176	18–29 years	Self-reported data	203	5
Chow 2023 [28]	Australia	Cross-sectional study	491	> 18	Self-reported data	44	4
D. Filardo 2023 [27]	USA	Cross-sectional study.	87	46 (Median)	Self-reported data	15	5
Dukers-Muijrers 2022 [33]	Netherlands	Cross-sectional study	NA	42 (Median)	Self-reported data	225	4
Fu 2023 [21]	China	Cross-sectional study	299	< 25 to ≥ 40	Self-reported data	577	5
Karapinar 2023 [31]	Turkiye	Cross-sectional study	NA	38 (mean)	Self-reported data	155	5
M. Araoz-Salinas 2023 [24]	USA	Cross-sectional study	285	31 (mean)	Self-reported data	131	5
MacGibbon 2023 [29]	Australia	Cross-sectional study	NA	> 16 years	Self-reported data	1733	4
P. F. Chow 2023 [46]	Australia	Retrospective observational study	NA	> 16 years	Self-reported data	84	5
Reyes-Uruena 2022 [32]	United Kingdom	Cross-sectional survey	NA	> 18 years	Self-reported data	123	5
Svartstein 2023 [34]	Denmark	Observational, longitudinal study	727	55.7 (Median)	Self-reported data	246	4
Wolff Sagy 2023 [36]	Israel	Cross-sectional study	2,054	18–42	Health-reported data	511	4
Zheng 2022 [22]	China	Observational study	618	< 25 to > 45	Self-reported data	1920	6
Zheng 2023 [23]	China	Cross-sectional study	7163	≥ 16	Self-reported data	722	5
Zucman 2022 [35]	France	Cross-sectional study	252	30 to 59	Self-reported data	252	4

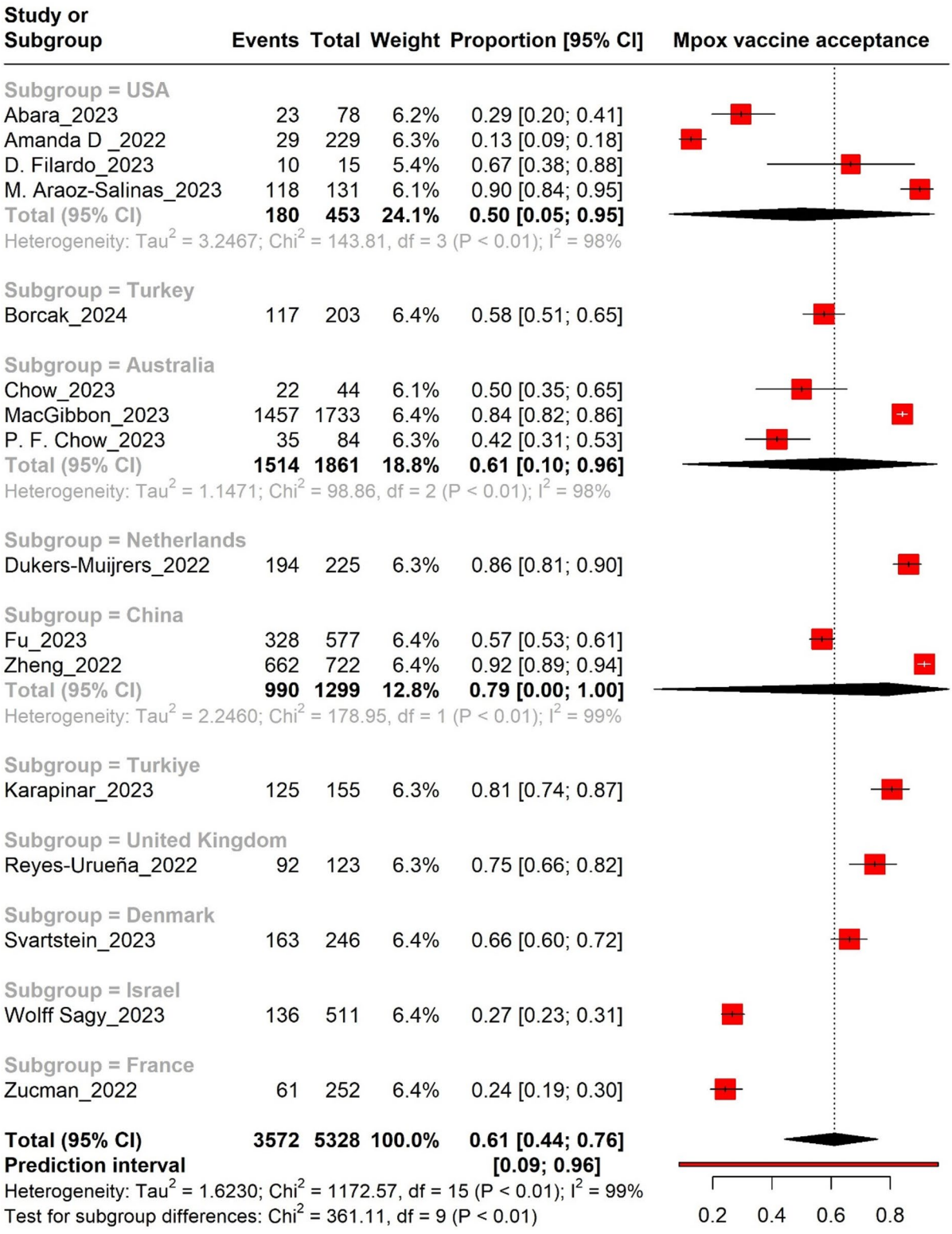

Fig. 2 A forest plot illustrating the acceptance rates of the Mpox vaccine

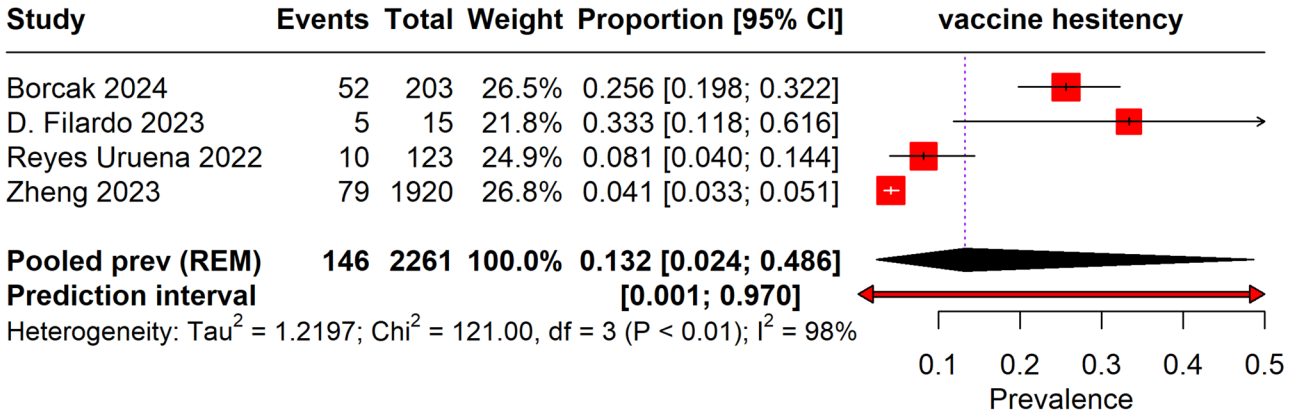

Fig. 3 Forest plot depicting the pooled estimate of Mpox vaccine hesitancy

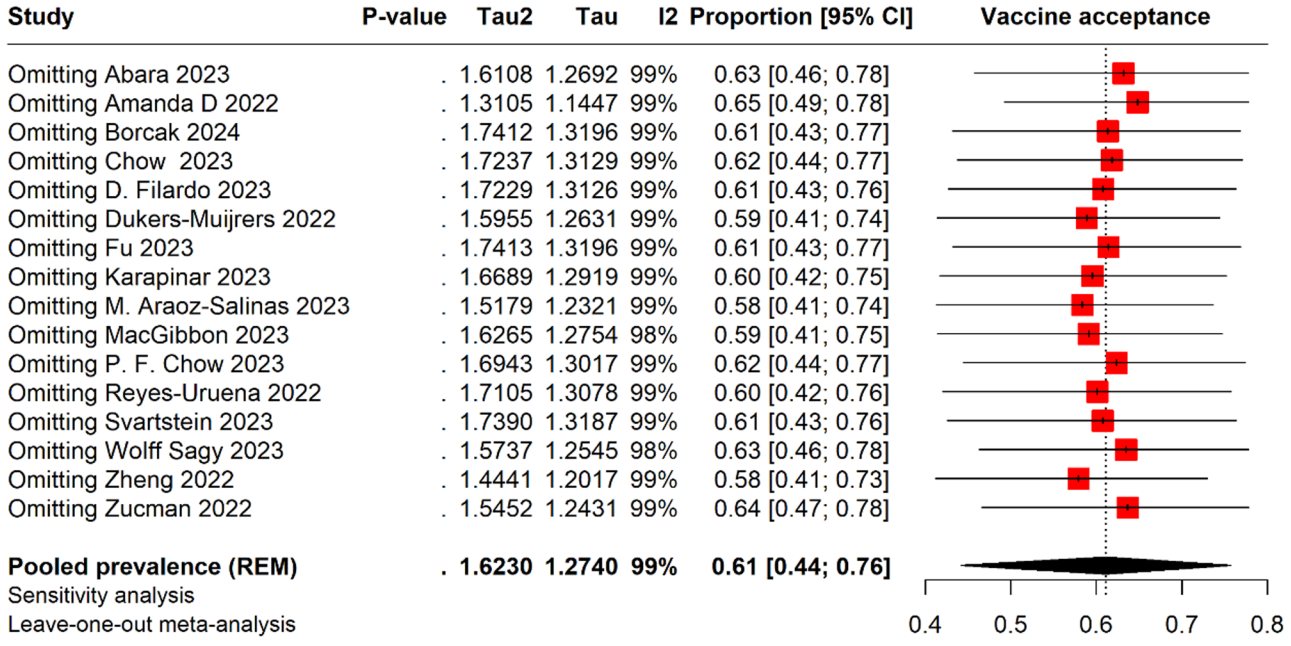

Fig. 4 Leave-one-out analysis of the vaccine acceptance for Mpox

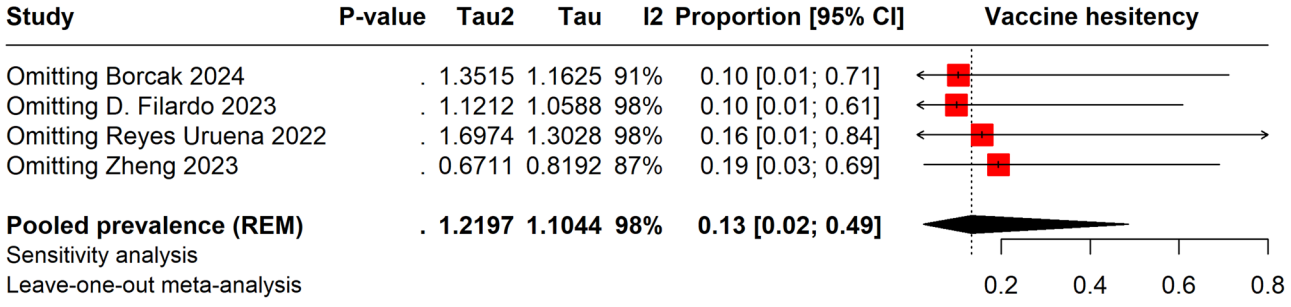

Fig. 5 Leave-one-out analysis of the vaccine hesitancy for Mpox

studies on vaccine uptake in other immunocompromised populations, which identified barriers including misinformation, access to healthcare, and socio-economic challenges. The analysis highlights substantial regional disparities in vaccine uptake, with some areas achieving high acceptance likely due to effective public health campaigns, active community engagement, and strong trust in medical interventions. Conversely, regions with

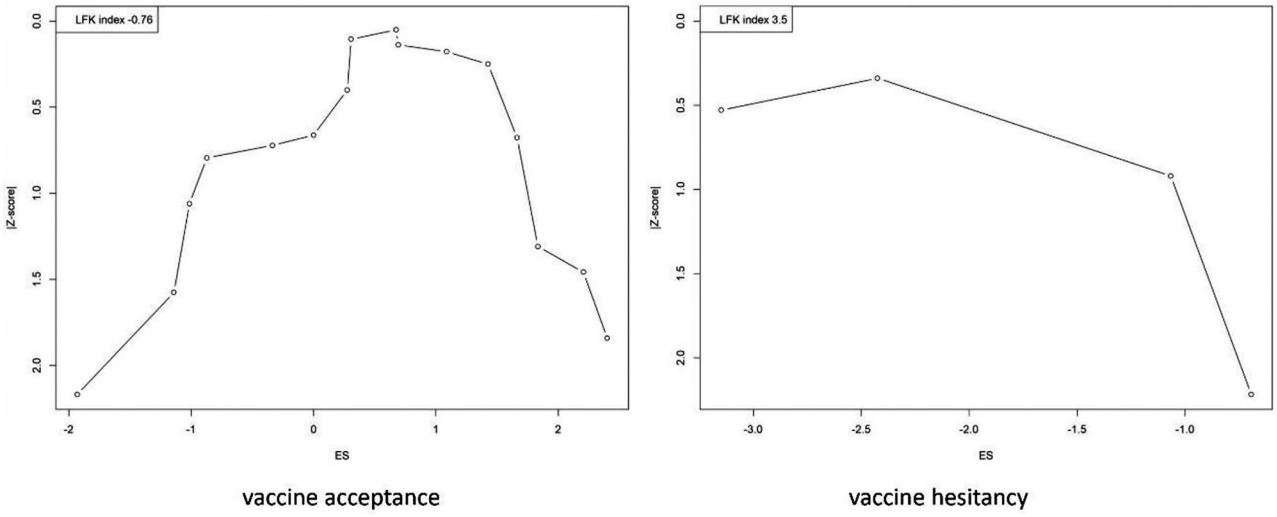

Fig. 6 Doi plot illustrating publication bias

lower acceptance rates may struggle due to inadequate public health strategies or diminished trust in healthcare systems.

Sensitivity analysis performed during this study underscores the robustness of our findings, consistently showing similar results across various studies. However, an LFK index of -0.76 signals potential publication bias, pointing to an underrepresentation of smaller, possibly less significant studies. Additionally, vaccine hesitancy was examined, showing a pooled prevalence of 13.2% (95% CI: 2.4–48.6%), marked by almost uniform high heterogeneity (I^2 = 98%). The sensitivity analysis reaffirms the reliability of this estimate, although a Doi plot with an LFK index of 3.5 indicates strong publication bias, suggesting that smaller studies may be contributing disproportionately to the observed higher hesitancy rates.

Our analysis aligns with recent literature indicating regional variations in vaccine acceptance rates among populations at high risk, such as men who have sex with men (MSM) and healthcare workers [37]. The vaccine uptake among health care workers was high, with a willingness rate of 77.3% [38]. These variations highlight the impact of sociocultural and health system factors on vaccine acceptance and suggest that localized public health interventions could enhance uptake [39].

Furthermore, our review identifies a notable gap in vaccination coverage among PLWH, similar to trends observed in broader population studies on infectious diseases like COVID-19 [39]. In addition to the Mpox vaccine, vaccine uptake among PLWH has been studied for other infectious diseases. For instance, the uptake of the HPV vaccine among PLWH remains suboptimal, despite recommendations for its use in this high-risk group due to their increased susceptibility to HPV-related cancers [40]. Similarly, influenza vaccination rates are lower in PLWH compared to the general population, often due to concerns about, competing healthcare priorities, and access to care [41]. Hepatitis A vaccination is also recommended for PLWH, but its uptake is frequently hindered by factors such as lack of awareness, healthcare access, and cost barriers [42]. This gap points to potential barriers such as vaccine hesitancy, accessibility issues, and a lack of targeted education and outreach efforts tailored to the concerns of PLWH [43, 44]. Addressing these barriers is crucial for improving vaccine uptake, as the severity of potential Mpox complications in PLWH necessitates higher coverage rates. Moreover, the global perspective provided in the literature suggests that improving vaccine acceptance among PLWH may require addressing both global and local challenges. These include enhancing trust in vaccine safety and efficacy, combating stigma, and providing clear, accurate information about the benefits of vaccination against Mpox [45].

The strengths of the study include comprehensive data collection from multiple databases, robust analysis using a random-effects model to accommodate high heterogeneity (I^2 = 99%), and detailed sensitivity analyses. The study addresses crucial gaps in research by focusing on a vulnerable population.

One major limitation of the evidence included in this review is the potential for publication bias, as indicated by an LFK index of -0.76. This suggests that studies with non-significant or unfavorable results might be underrepresented in the literature, potentially skewing the overall findings towards more positive outcomes. Additionally, the reliance on self-reported data could introduce bias, as such data may not accurately reflect actual vaccination behaviors.

Another concern is the significant heterogeneity among studies, which complicates the synthesis of data

and interpretation of the pooled results. This heterogeneity could stem from differences in study design, measurement of vaccine acceptance, and demographic variables across studies, which challenges the drawing of universal conclusions about vaccine acceptance rates among PLWH. We acknowledge the critique regarding the handling of clinical heterogeneity in our analysis. While statistical methods like random-effects models and subgroup analyses help in assessing heterogeneity, they do not uncover the underlying causes or specific differences between subgroups. This limitation underscores the importance of a more detailed exploration into the characteristics and variations among study participants, as well as the definitions and measurements of outcomes across studies. Recognizing these challenges, it is imperative to adopt a more nuanced approach to analyze these differences to enhance the precision of pooled outcomes. In instances where a precise measure remains elusive, a thorough description of these variations can be immensely beneficial. Such detailed reporting can provide critical insights for stakeholders and policymakers involved in developing vaccination strategies, ensuring that public health decisions are informed by a comprehensive understanding of the data's complexity.

The review process itself also presents certain limitations. Despite rigorous methodology, the variability in study designs included in the meta-analysis could impact the robustness of the findings. Furthermore, most studies included are from high-income countries, which might limit the applicability of the findings to low- and middle-income countries where different socioeconomic conditions and health system challenges prevail.

Additionally, the rapid evolution of public health policies and vaccine technologies, especially during pandemics like that of Mpox, may mean that some of the included studies were already outdated at the time of their publication, thus affecting the relevance of the findings to current policy-making.

The results of this review have important implications for clinical practice, policy-making, and future research. Clinically, there is a need for healthcare providers to understand the specific barriers to vaccine uptake among PLWH and to address these through tailored communication and intervention strategies.

From a policy perspective, the findings suggest the need for targeted public health interventions that address the identified barriers to vaccine acceptance. Policies should aim to enhance accessibility, increase educational outreach, and build trust within the community. Additionally, public health messages need to be adapted to local cultural and social contexts to improve their effectiveness.

For future research, there is a critical need for longitudinal studies that can provide more definitive evidence on the factors influencing vaccine behavior over time among HIV-positive individuals. Such studies should strive to include diverse populations from different geographical and economic backgrounds to enhance the generalizability of the findings. Furthermore, more research is needed to explore the impact of newly developed vaccine technologies and changing public health policies on vaccine acceptance among PLWH.

Conclusion

This systematic review and meta-analysis reveal moderate Mpox vaccine acceptance and considerable hesitancy among PLWH. To further increase vaccine uptake and address any remaining hesitancy in this at-risk population, targeted public health strategies and ongoing research are necessary. Strengthening vaccine acceptance is critical to safeguarding PLWH against emerging infectious diseases such as Mpox.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12981-025-00726-8.

Supplementary Material 1

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Data availability
All data generated or analyzed during this study are included in this published article (and its Supplementary information files).

Declarations

Ethics approval and consent to participate
Not applicable, as there were no human participants involved in this study.

Human Ethics and Consent to Participate Declarations
Not applicable. This study did not involve human subjects, so Human Ethics and Consent to Participate declarations are not required.

Consent for Publication
Not applicable, as this study does not involve any individual person's data in any form.

Competing interests
The authors declare no competing interests.

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