COVID-19 vaccine hesitancy: an umbrella review of systematic reviews and meta-analysis

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Table of Contents

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Abstract

Background: The unprecedented emergence of the COVID-19 pandemic has necessitated the development and global distribution of vaccines, making the understanding of global vaccine acceptance and hesitancy crucial to overcoming barriers to vaccination and achieving widespread immunization.

Objective: This umbrella review synthesizes findings from systematic reviews and meta-analyses to provide insights into global perceptions on COVID-19 vaccine acceptance and hesitancy across diverse populations and regions.

Methods: We conducted a literature search across major databases to identify systematic reviews and meta-analysis which

reported COVID-19 vaccine acceptance and hesitancy. AMSTAR-2 criteria was used to assess the methodological quality of included systematic reviews. Meta-analysis was performed by STATA 17 using a random effect model. The data synthesis was presented in tables format and narrative way.

Results: Seventy-eight meta-analyses, published between 2021 and 2023, met our inclusion criteria. Our analysis revealed a moderate vaccine acceptance rate of 63% (95% CI: 0.60-0.67) in the general population, with significant heterogeneity (I2 = 97.59%). Higher acceptance rates were observed among healthcare workers and chronic disease patients, at 64% (95% CI :0.57-0.71) and 69% (95% CI: 0.61-0.76), respectively. However, lower acceptance was noted among pregnant women at 48% (95% CI: 0.42-0.53) and parents consenting for their children at 61.29% (95%CI: 0.56-0.67). Pooled vaccine hesitancy rate was 32% (95% CI: 0.25-0.39) in the general population. The quality assessment revealed 19 high-quality, 38 moderate-quality, 15 low-quality, and 6 critically low-quality meta-analyses.

Conclusions: The review reveals the presence of vaccine hesitancy globally, emphasizing the necessity for population-specific, culturally sensitive interventions, and clear, credible information dissemination to foster vaccine acceptance. The observed disparities accentuate the need for continuous research to understand evolving vaccine perceptions and to address the unique concerns and needs of diverse populations, thereby aiding in the formulation of effective and inclusive vaccination strategies.

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This umbrella review synthesizes findings from systematic reviews and meta-analyses to provide insights into global perceptions on COVID-19 vaccine acceptance and hesitancy across diverse populations and regions.

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We conducted a literature search across major databases to identify systematic reviews and meta-analysis which reported COVID-19 vaccine acceptance and hesitancy. AMSTAR-2 criteria was used to assess the methodological quality of included systematic reviews. Meta-analysis was performed by STATA 17 using a random effect model. The data synthesis was presented in tables format and narrative way.

Results

Seventy-eight meta-analyses, published between 2021 and 2023, met our inclusion criteria. Our analysis revealed a moderate vaccine acceptance rate of 63% (95% CI: 0.60-0.67) in the general population, with significant heterogeneity (I^2 = 97.59%). Higher acceptance rates were observed among healthcare workers and chronic disease patients, at 64% (95% CI :0.57-0.71) and 69% (95% CI: 0.61-0.76), respectively. However, lower acceptance was noted among pregnant women at 48% (95% CI: 0.42-0.53) and parents consenting for their children at 61.29% (95%CI: 0.56-0.67). Pooled vaccine hesitancy rate was 32% (95% CI: 0.25-0.39) in the general population. The quality

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Keywords: COVID-19, Vaccine Acceptance, Vaccine Hesitancy, Umbrella Review, Systematic Review, Meta-analysis

Introduction

The global health landscape has been profoundly altered by the emergence of the coronavirus disease 2019 (COVID-19), triggered by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). First identified in Wuhan, China, in December 2019, this virulent pathogen swiftly traversed continents, leading the World Health Organization (WHO) to categorize the situation as both a pandemic and a public health emergency of international concern. The repercussions of this pandemic have been multifaceted, with a staggering death toll and a profound impact on socio-economic structures worldwide [1]. In the face of this unprecedented challenge, the global community recognized the pressing need for effective countermeasures. While therapeutic interventions were explored, the primary focus shifted to preventive strategies, with vaccines against COVID-19 emerging as the most promising solution [2]. The efficacy of this approach, however, is contingent not just on the scientific success of vaccine development but equally on the global populace's acceptance of these vaccines [3].

By the midpoint of 2022, the scientific community had successfully developed, trialed, and secured emergency use authorization for several vaccines [4]. However, the distribution of these vaccines unveiled pronounced disparities [5]. Developed nations, with their robust healthcare infrastructures and financial resources, rapidly initiated vaccination drives. In stark contrast, many developing countries faced challenges, ranging from limited vaccine access to infrastructural constraints [6]. A more insidious challenge that emerged globally, irrespective of a country's economic status, was vaccine hesitancy. Rooted in a complex interplay of factors, including safety apprehensions, distrust towards health advisories, cultural nuances, and the deluge of misinformation, vaccine hesitancy has been observed across diverse geographies, from Africa and Europe to North America [3].

Empirical studies conducted across various regions have painted a mixed picture of vaccine acceptance [3,7]. While certain demographics exhibited a commendable eagerness to embrace vaccination, others displayed pronounced skepticism [3,8]. These disparities in vaccine acceptance, if

unchecked, have the potential to impede global strides towards achieving herd immunity, a critical milestone in the fight against the pandemic. Recognizing the pivotal role of vaccine acceptance in the trajectory of the pandemic, it becomes imperative to understand the nuances of global vaccine perceptions. Numerous systematic reviews and meta-analyses have been published, shedding light on factors that are driving vaccine hesitancy and acceptance [8-17].

In this context, our umbrella review seeks to collate and synthesize findings from these diverse studies, aiming to present a holistic understanding of global COVID-19 vaccine acceptance rates and hesitance rates. This approach offers a comprehensive overview of existing evidence, highlighting consistencies and discrepancies across studies. By assessing the quality and breadth of current research, umbrella reviews identify knowledge gaps and inform evidence-based decision-making. They serve as a valuable tool for policymakers, clinicians, and researchers, providing a holistic understanding of a topic without the need for sifting through numerous individual studies. Through this study, we aspire to provide valuable insights that can steer future vaccination strategies, ensuring they are both effective and inclusive. Our umbrella review aims to collate and synthesize findings from these diverse studies to present a comprehensive understanding of global COVID-19 vaccine acceptance and hesitancy rates.

Methods

The method for conducting this umbrella review is based on the framework set forth by the Joanna Briggs Institute (JBI) [18]. This study adhered to the PRISMA guideline [19] (**Table S1**). This study has been registered in PROSPERO.

Inclusion criteria

We specifically targeted meta-analyses of epidemiological studies that investigated either the acceptance/willingness or hesitancy towards the COVID-19 vaccine. Our scope was global, encompassing studies from all geographical locations without any specific focus on a particular

population. This inclusivity ensured that our review captured a diverse range of perspectives and settings. However, to maintain the rigor and specificity of our review, we excluded certain types of publications. Specifically, narrative or systematic reviews that did not include a meta-analysis, conference abstracts, and letters to the editors were not considered. In essence, our inclusion criteria were centered on meta-analyses of either prospective, retrospective or cross-sectional studies that evaluated rates of vaccine acceptance or hesitancy (**Table S2**).

Literature Search

We conducted a comprehensive literature search across four major databases: PubMed, Scopus, Embase, and the Cochrane Database of Systematic Reviews. The search spanned from the inception of each database until 20th August 2023. To ensure a thorough retrieval of relevant articles, "keyword search" and "textword search" were used, and different search phrases were combined using Boolean and proximity operators. Specifically, we used the terms (“meta-analysis” OR “systematic review”) AND (Acceptance OR willingness OR hesitancy OR intention OR unwillingness) AND (“COVID-19” OR "Sars-cov-2" OR "corona*"). To further enhance the robustness of our search, we also manually screened the reference lists of the identified articles. This step ensured that we did not overlook any pertinent studies that might not have been captured through the database search. For transparency and replicability, the complete search strategy, including all terms and combinations used, is documented in **Table S3**. Importantly, we did not impose any filters or restrictions during our search. This means that articles of any type, published in any year, and in any language, were considered, ensuring a broad and inclusive search scope.

Screening

The screening process for this systematic review was conducted by two independent authors,

structured into two sequential steps to ensure unbiased selection and comprehensive coverage of relevant studies. The first step, primary screening, involved scrutinizing the titles and abstracts of identified articles to shortlist those potentially relevant to topic. Subsequently, in the second step, articles that passed the primary screening were subjected to a thorough full-text review. During this stage, the authors carefully evaluated the complete content of each article, focusing on the removal of duplicates and a more detailed assessment of each study's relevance and alignment with the review's scope and objectives. To enhance the precision and efficiency of our screening process, we employed the specialized software 'Nested Knowledge' with its 'AutoLit' function, instrumental in streamlining our workflow and improving the accuracy of article selection. In cases of disagreement or uncertainty between the two reviewers, a third reviewer with senior expertise was engaged to mediate and provide decisive judgment, ensuring a consensus-based approach to the final selection of studies.

Data Extraction

During the data extraction process, two independent authors systematically reviewed each study that met our inclusion criteria. From each eligible meta-analysis, they gathered a comprehensive set of details. This included the first author's name, the year of publication, type of study design, total number of participants, type of population and the date when the database search was conducted. Additionally, they extracted the pooled acceptance rate for each subgroup, specific number of participants within these subgroups, accompanied by their 95% confidence intervals (CIs). Furthermore, they documented the p-values for pooled effects, the results from Egger’s or Beggs test (which measures publication bias), and the I^2 statistics, which offer insights into the heterogeneity of the studies. Any associated p-value for significance was also recorded. Given the complexity of the data and the importance of accuracy, any discrepancies or disagreements that arose between the two primary authors were diligently addressed. They consulted a third, senior reviewer to ensure consistency and precision in the data extraction process.

Assessment of Methodological Quality

To ensure the rigor and reliability of our review, the methodological quality of each included meta-analysis was meticulously evaluated. This assessment was jointly undertaken by two authors using the well-established AMSTAR 2 tool [20] , which is recognized for its robustness in appraising systematic reviews. Based on the criteria set by AMSTAR 2, studies were categorized into one of four methodological quality grades: high, moderate, low, or critically low. A study was deemed to be of 'high' quality if it exhibited no flaws or only a single minor defect. In contrast, a 'moderate' quality designation was given to studies that presented multiple minor defects. The distinction between minor and major defects was made based on the guidelines provided by the AMSTAR 2 tool. Any disagreements or uncertainties regarding the quality grading were discussed and resolved collaboratively between the two authors to ensure a consistent and objective assessment.

Data Analysis

Data analysis was conducted using STATA version 17. Proportion, along with their 95% confidence intervals, were pooled from all included eligible meta-analyses for each outcome and based on the population [21]. We employed a random-effects model to compute the combined effect sizes, recognizing the inherent variability among the studies and providing a more conservative estimate of the overall effect. The degree of variability or heterogeneity in outcomes across studies was quantified using the I^2 metrics. Values for I^2 can range from 0% to 100%, with higher values indicating greater heterogeneity. We predetermined specific thresholds to assess the statistical significance of the observed heterogeneity. The 95% prediction interval provides a more comprehensive understanding of the range in which the true effect size lies, considering the observed heterogeneity. A p-value < 0.05 is considered statistically significant.

Results

Search result

A total of 662 articles were identified through the primary search, of which 263 duplicates were eliminated, leaving 399 for title and abstract screening. In the primary screening (title and abstract), 214 articles were excluded, leaving 185 articles for full-text screening. One hundred eight articles were excluded for various reasons, including only systematic reviews without meta-analysis, incorrect population, outcomes, and study design. As a result, 77 articles fulfilled the eligibility criteria. Additionally, we conducted a citation search to maintain the rigor of the review and found four relevant articles, of which one was included. This umbrella review ultimately identified 78 meta-analyses that met the inclusion criteria.

Characteristics of meta-analyses and quality assessment

Table S4 presents an overview of all included meta-analyses published between 2021 and 2023. These studies looked at different groups, such as the general population, healthcare workers, parents, pregnant women, migrant workers, Black/African communities, Chinese communities, and people with specific health conditions like cancer, HIV, diabetes, inflammatory bowel disease, and epilepsy. The focus of these meta-analyses was on outcomes like rate of vaccine acceptance, hesitance, willingness, uncertainty, unwillingness, and intention to receive vaccines. Most of the meta-analyses included articles from around the world, while some concentrated on specific countries.

The quality of these meta-analyses was evaluated using the AMSTAR 2 criteria. Among the meta-analyses examined, 19 meta-analyses were rated as having high quality, 38 meta-analyses received a moderate quality rating, 15 meta-analyses received a low-quality rating, which points to potential limitations in their methodology, and 6 meta-analyses were classified as critically low quality, implying significant concerns about their methods and the reliability of their findings (**Table S5**).

Vaccine acceptance and hesitancy among populations

Table 1 provides a summary of vaccine acceptance and hesitancy rates among different populations. Fifty-eight systematic reviews and meta-analyses were conducted to study acceptance rates, and 1^2 distinct reviews reported on hesitancy rates.

Table 1. Summary of vaccine acceptance rates across different populations.

Population	Studies	Rate (95%CI)	Heterogeneity (I^2)	Overall rate (95% CI)
	Wang et al., 2021[22]	0.74 (0.71-0.77)		
	Alimohamadi et al., 2021[10]	0.67 (0.62-0.74)		
	Abdelmoneim et al., 2022[23]	0.81 (0.75-0.85)		
	Nehal et al., 2021 [15]	0.66 (0.6-0.7)		
	Khabour et al., 2021[24]	0.39 (0.33-0.46)		
	Sahile et al., 2021[25]	0.57 (0.47-0.67)		
	Norhayati et al., 2021[12]	0.61 (0.59-0.64)		
	Wake et al., 2021[26]	0.48 (0.39-0.58)		
	Alarcón-Braga et al., 2021[27]	0.78 (0.74-0.82)		
	Mekonnen et al., 2022 [28]	0.56 (0.47-0.64)		
	Mengistu et al., 2022 [29]	0.64 (0.6-0.69)		
	Gudayu et al., 2021[30]	0.68 (0.67-0.68)		
	Kumar et al., 2021[16]	0.62 (0.55-0.69)		
	Alemayehu et al., 202 [31]	0.60 (0.52-0.67)		
	Kawuki et al., 2023 [32]	0.58 (0.49-0.67)		
	Wang et al., 2021[22]	0.67 (0.67-0.68)		
	Belay et al., 2021[33]	0.51 (0.43-0.58)		
	Robinson et al., 2021[34]	0.72 (0.66-0.78)		
General Population	Mahmud et al., 2021[35]	0.62 (0.58-0.66)	97.59%	0.63 (0.60-0.67)

	Azanaw et al., 2021[36]	0.55 (0.47-0.62)		
	Terry et al., 2021[37]	0.73 (0.64-0.81)		
	Yenew et al., 2021[38]	0.67 (0.60-0.74)		
	Kukreti et al., 2021[39]	0.60 (0.51-0.68)		
	Nnaemeka et al., 2021[40]	0.52 (0.46-0.57)		
	Akem Dimala et al., 2021 [41]	0.71 (0.66-0.76)		
	Renzi et al., 2021 [42]	0.66 (0.61-0.71)		
	Kazeminia et al., 2021 [43]	0.63 (0.59-0.68)		
	Mose et al., 2021 [44]	0.51 (0.43-0.59)		
	Yanto et al., 2021 [9]	0.71 (0.69-0.74)		
Chronic disease	Wang et al., 2021 [22]	0.85 (0.82-0.88)		
	Yazdani et al., 2022 [45]	0.76 (0.67-0.85)		
	Zhao et al., 2023 [46]	0.65 (0.59-0.72)		
	Lin et al., 2022 [47]	0.58 (0.45-0.75)		
	Meybodi et al., 2022 [48]	0.59 (0.39-0.79)		
	Ejamo et al., 2023 [49]	0.62 (0.56-0.69)		
	Ekpor et al., 2023 [50]	0.76 (0.66-0.83)		
	Prabani et al., 2022 [51]	0.59 (0.52-0.67)	87.50%	0.69 (0.61-0.76)
Healthcare workers	Wang et al., 2021 [22]	0.65 (0.55-0.75)		
	Luo et al., 2021 [11]	0.51 (0.41-0.62)		
	Alimohamadi et al., 2022 [10]	0.55 (0.47-0.64)		
	Shui et al., 2022 [52]	0.78 (0.73-0.83)		
	Lin et al., 2022 [47]	0.81 (0.72-0.89)		
	Ackah et al., 2022 [53]	0.46 (0.37-0.54)		
	Moltot et al., 2023 [54]	0.54 (0.42-0.66)		
	Ulbrichtova et al.,	0.71 (0.67-0.75)	91.72%	0.64 (0.57-0.71)

	2022 [55]			
	Politis et al., 2023 [56]	0.64 (0.55-0.72)		
	Wang et al., 2022 [13]	0.66 (0.61-0.67)		
Pregnant woman	Sarantaki et al., 2022 [57]	0.53 (0.44-0.61)	74.20%	0.48 (0.42-0.53)
	Nikpour et al., 2022 [58]	0.54 (0.45-0.62)		
	Nassr et al., 2022 [59]	0.47 (0.38-0.57)		
	Halemani et al., 2022 [60]	0.54 (0.46-0.61)		
	Shamshirsaz et al., 2022 [61]	0.47 (0.38-0.57)		
	Galanis et al., 2022 [62]	0.27 (0.18-0.37)		
	Bhattacharya et al., 2022 [63]	0.49 (0.42-0.56)		
	Worede et al., 2023 [14]	0.42 (0.28-0.56)		
	Azami et al., 2022 [64]	0.53 (0.47-0.59)		
Parents for children	Wang et al., 2022 [65]	0.58 (0.28-0.98)	50.29%	0.61 (0.56-0.67)
	Galanis et al., 2022 [66]	0.6 (0.517-0.68)		
	Chen et al., 2022 [67]	0.61 (0.53-0.68)		
	Ma et al., 2022 [68]	0.7 (0.62-0.78)		
	Alimoradi et al., 2023 [69]	0.57 (0.52-0.62)		
Migrants and refugees	Alimoradi et al., 2023 [70]	0.7 (0.62-0.77)	74.04%	0.69 (0.56-0.82)
	Hajissa et al., 2023 [71]	0.56 (0.449-0.685)		
Chinese community residents	Xu et al., 2022 [72]	0.8 (0.71-0.87)	NA	0.80(0.72-0.88)

Table 2. Summary of vaccine hesitancy rates across different populations.

Population	**Studies**	**Rate (95%CI)**	**Heterogeneity (I^2)**	**Overall rate (95% CI)**
General population	Patwary et al., 2022 [73]	0.382 (0.272-0.497)	73.90%	0.32 (0.25-0.39)
	Islam et al., 2023 [17]	0.265 (0.22-0.31)		
	Kawuki et al., 2023	0.29 (0.18-0.43)		

	[32]			
	Fajar et al., 2022 [74]	0.25 (0.19-0.32)		
	Cénat et al., 2022 [75]	0.423 (0.337-0.51)		
Older adults	Veronese et al., 2021 [76]	0.27 (0.15-0.38)	NA	0.27 (0.16-0.39)
Black/African American	Ripon et al., 2022 [77]	0.35 (0.26-0.45)	NA	0.35 (0.25-0.44)
Diabetics	Bianchi et al., 2023 [78]	0.27 (0.156-0.419)	NA	0.27 (0.14-0.40)
Healthcare students	Patwary et al., 2022 [79]	0.258 (0.185-0.338)	NA	0.26 (0.18-0.33)
Pregnant and breastfeeding women	Bianchi et al., 2022 [80]	0.484 (0.434-0.534)	NA	0.48 (0.43-0.53)
Parents for their children	Bianchi et al., 2023 [81]	0.55 (0.43-0.66)	95.79%	0..39 (0.07-0.70)
	Galanis et al., 2022 [66]	0.229 (0.173-0.29)		
Migrants	Hajissa et al., 2023 [71]	0.31 (0.215-0.42)	NA	0.31 (0.21-0.41)
Healthcare workers	Bianchi et al., 2022 [78]	0.13 (0.069-0.209)	97.30%	0.29 (0.18-0.33)
	Kigongo et al., 2023 [82]	0.46 (0.38-0.54)		

Vaccine acceptance

We synthesized findings from twenty-nine systematic reviews to assess vaccine acceptance rate in the general population. The pooled acceptance rates ranged from 51% to 81%. Our meta-analysis revealed a consolidated vaccine acceptance rate of 63% (95% CI: 0.60-0.67). Notably, a high level of heterogeneity was observed, with an I^2 of 97.59% (Figure 2). Eight systematic reviews focused on chronic disease patients, reporting a pooled acceptance rate of 69% (95% CI: 0.61-0.76) and an I^2 of 87.5% (Figure S1**)**. Ten systematic reviews and meta-analyses examined healthcare workers, indicating a 64% acceptance rate (95% CI: 0.57-0.71) and a heterogeneity I^2 of 91.72% (Figure S2**)**. Vaccine acceptance was comparatively lower among pregnant women, as depicted by nine systematic reviews, showing a rate of 48% (95% CI: 0.42-0.53) and an I^2 of 74.2% **(**Figure S3**).** Similarly, five systematic reviews presented a 61.29% acceptance rate (95% CI: 0.56-0.67) with 50%

heterogeneity for parents consenting for their children (Figure S4**)**. Two reviews investigated vaccine acceptance among migrants and refugees, showing a prevalence of 69% (95% CI: 0.56-0.82) with an I^2 of 74%, and one review focused on the Chinese community resident unveiled an 80% acceptance rate (95% CI: 0.72-0.88) **(**Figure S5).

Vaccine Hesitancy

Figure 3 shows the forest plot of COVID-19 vaccine hesitancy for different populations. Vaccine hesitancy has been reported in the general population by five systematic reviews, with the observed hesitancy varying between 25% and 42%. Our meta-analysis has shown a pooled vaccine hesitancy rate of 32% (95% CI: 0.25-0.39), with a high level of heterogeneity (I^2 = 73.90%). In older adults, one review reported a hesitancy rate of 27% (95% CI: 0.15-0.38). For Black/African Americans, vaccine hesitancy was found to be 35% (95% CI: 0.26-0.45) in another review. Pregnant or breastfeeding women exhibited a higher hesitancy rate of 48.4% (95% CI: 0.43-0.53) as reported by another systematic review. Two reviews provided results on the hesitancy rates among parents considering vaccinating their children, revealing a pooled hesitancy rate of 39% (95% CI: 0.07-0.70), accompanied by a high level of heterogeneity (I^2 = 95.7%). Migrant workers exhibited a hesitancy rate of 31% (95% CI: 0.21-0.41) according to one study. Lastly, healthcare workers showed a rate of 29% (95% CI: 0.18-0.33) as concluded from two systematic reviews.

Discussion

Our umbrella review synthesized findings from numerous systematic reviews and meta-analyses, providing insights into global vaccine acceptance and hesitancy rates across diverse populations and geographies. The consolidated acceptance rate of 63% in the general population indicates a moderate level of willingness to receive the vaccine.

The emergence of the COVID-19 pandemic necessitated the prompt development and distribution of

vaccines to curb the spread of the virus and mitigate its adverse impacts on global health, economies, and societies [83]. As of the midpoint of 2021, several vaccines have received emergency use authorization, signifying a milestone in the fight against the pandemic. However, the realization of the potential of these vaccines is significantly influenced by the global population's acceptance and willingness to get vaccinated [84,85]. However, the significant heterogeneity observed in this and other populations studied underscores the diverse and complex landscape of vaccine perceptions globally [53]. The vaccine acceptance rates among healthcare workers and patients with chronic diseases were relatively higher, possibly reflecting a better understanding of the disease's risk and the vaccine's benefits in these populations [86,87]. However, the observed heterogeneity suggests diverse opinions and possibly varied information dissemination within these groups. The disparities in vaccine acceptance and hesitancy across populations are emblematic of the intricate tapestry of perceptions, beliefs, and information access that characterize the global populace. For instance, the lower acceptance rates observed among pregnant women and parents consenting for their children are likely influenced by concerns about vaccine safety in these vulnerable groups, emphasizing the need for targeted communication strategies addressing these concerns [88].

The pronounced disparities in vaccine acceptance across different populations highlight the urgent need for tailored, population-specific intervention strategies [89]. A one-size-fits-all approach may not address the unique concerns, misconceptions, and information needs of different demographic groups. For example, pregnant women exhibited lower acceptance and higher hesitancy rates, possibly due to concerns regarding the vaccine's impact on pregnancy and the fetus [90,91]. Addressing such specific concerns through targeted awareness campaigns and counseling can enhance vaccine acceptance in this group. Similarly, the lower acceptance rates in parents consenting for their children necessitate interventions addressing parental concerns about vaccine safety and efficacy in children [92]. Engaging pediatricians and child healthcare providers in vaccine advocacy can potentially alleviate parental apprehensions and foster trust. The high heterogeneity observed

across studies denotes the existence of multiple influencing factors, including cultural, socio-economic, educational, and individual beliefs, which vary extensively within and across populations [93,94]. The variations may also reflect the differences in study designs, populations, and timeframes, emphasizing the need for standardization in future research to facilitate comparability and generalizability [95].

The emergence of vaccine hesitancy as a global phenomenon irrespective of a country's economic status underscores the influential role of information dissemination and public perception in shaping vaccine-related behaviors [96,97]. Misinformation and distrust in health advisories have been pivotal in fostering hesitancy, indicating the need for credible, clear, and consistent communication from health authorities and governments [98-102]. Addressing misinformation necessitates a multifaceted approach involving the collaboration of healthcare providers, public health officials, social media platforms, and community leaders. The propagation of accurate, comprehensible, and transparent information regarding vaccine development, efficacy, and safety can contribute to counteracting misinformation. Healthcare workers, with an acceptance rate of 64%, play a crucial role in shaping public perceptions and behaviors regarding vaccination [103]. As trusted sources of health information, healthcare providers can effectively address concerns, clarify misconceptions, and advocate for the benefits of vaccination [63,68]. Their interactions with patients and communities can significantly influence vaccine acceptance, especially in populations with high hesitancy levels, such as pregnant women and parents. However, the hesitancy rate of 29% among healthcare workers is concerning, as it can potentially impact their vaccine advocacy efforts. Addressing the concerns and information needs of healthcare workers is imperative to fostering confidence in vaccines and enhancing their role as vaccine advocates.

The acceptance and hesitancy rates in specific communities, such as Black/African Americans and Chinese communities, underscore the impact of cultural and community nuances on vaccine perceptions [104,105]. Culturally sensitive approaches, community engagement, and addressing

systemic barriers are essential to enhancing vaccine acceptance in such communities [106,107]. The 80% acceptance rate in Chinese communities may be indicative of the influence of community norms, government policies, and public health campaigns in shaping vaccine perceptions. Understanding the socio-cultural dynamics and leveraging community influences can be instrumental in developing effective strategies to enhance vaccine acceptance in different cultural contexts.

This umbrella review, while offering insights into global vaccine acceptance and hesitancy, does possess limitations inherent to the studies included. The substantial heterogeneity across these studies hinders the ability to draw definitive conclusions and underscores the necessity for a cautious interpretation of the findings. Variations in study designs, targeted populations, timeframes, and geographic locations highlight the need for standardization in future research to improve comparability and generalizability. Our review only included articles published in English. The overlap of the same primary studies is inevitable; different systematic reviews might have included the same primary studies.

Future research should focus on exploring the underlying factors influencing vaccine acceptance and hesitancy in diverse populations and contexts. Qualitative studies can provide in-depth insights into individual beliefs, perceptions, and information needs, enabling the development of targeted interventions. Longitudinal studies can assess the temporal variations in vaccine perceptions and the impact of evolving information landscapes on vaccine-related behaviours.

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Conception or design of the study by BKP, and PS. Data Acquisition by PS and RM, Data Analysis and Interpretation: Manuscript Drafting: BKP, PS, RM. Critical revision of the manuscript: BKP, MNK. Final approval for submission: BKP, PS, MNK. All authors attest they meet the ICMJE criteria for authorship.

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Figures and Table legends

Figure 1. PRISMA flow diagram illustrating the screening and selection process

Figure 2. Forest plot depicting pooled acceptance rates of COVID-19 vaccine in general population

Figure 3 Forest plot showing COVID-19 vaccine hesitancy rates for different population

Table 1. Summary of vaccine acceptance rates across different populations.
Table 2. Summary of vaccine hesitancy rates across different populations.

Figure S1. Forest plot illustrating pooled vaccine acceptance rate in chronic disease patients.

Figure S2. Forest plot depicting vaccine acceptance rate among health care workers

Figure S3. Forest plot depicting vaccine acceptance rate among pregnant women

Figure S4. Pooled vaccine acceptance rate of parents consenting for their children

Figure S5. Vaccine acceptance rate in Chinese community residents, migrants and refuges.

Table S1. PRISMA Checklist

Table S2. Inclusion and Exclusion criteria

Table S3. The adjusted search terms as per searched electronic databases [as of 15.09.2023]

Table S4: Overview of Included Meta-Analyses (2021-2023)

Table S5. Summary of quality assessment of included systematic reviews using AMSTAR

All authors attest they meet the ICMJE criteria for authorship

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Figures and tables

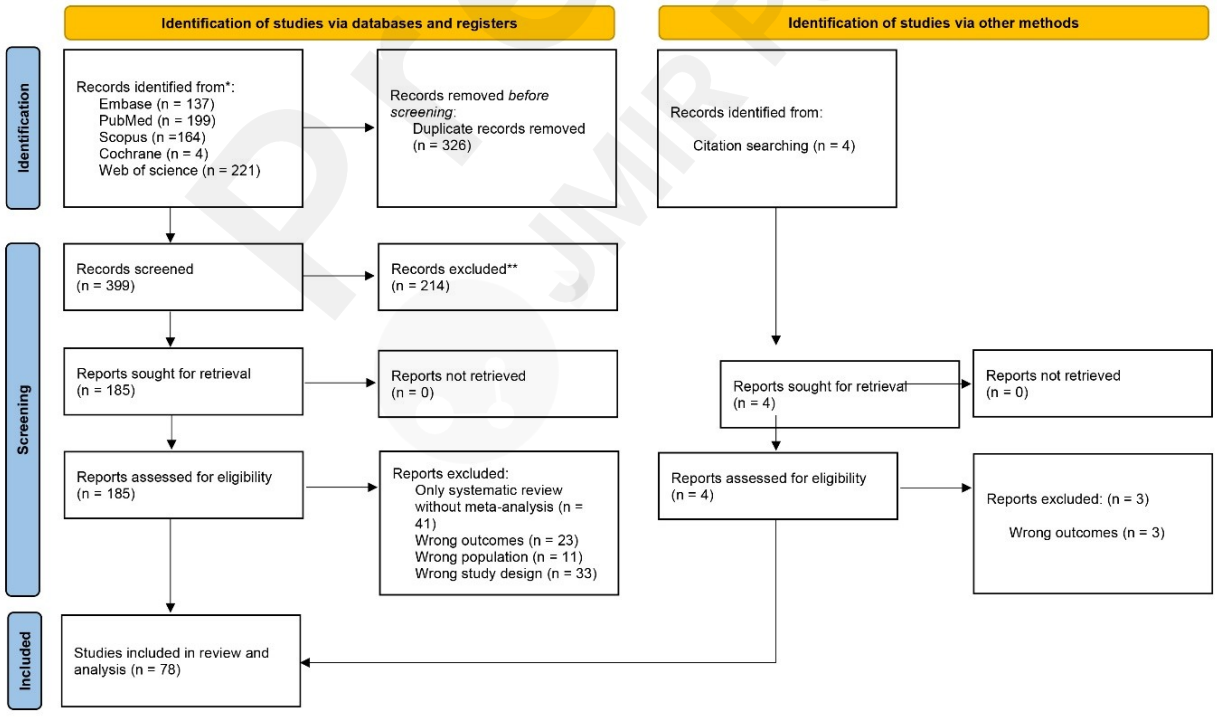

Figure 1. PRISMA flow diagram illustrating the screening and selection process

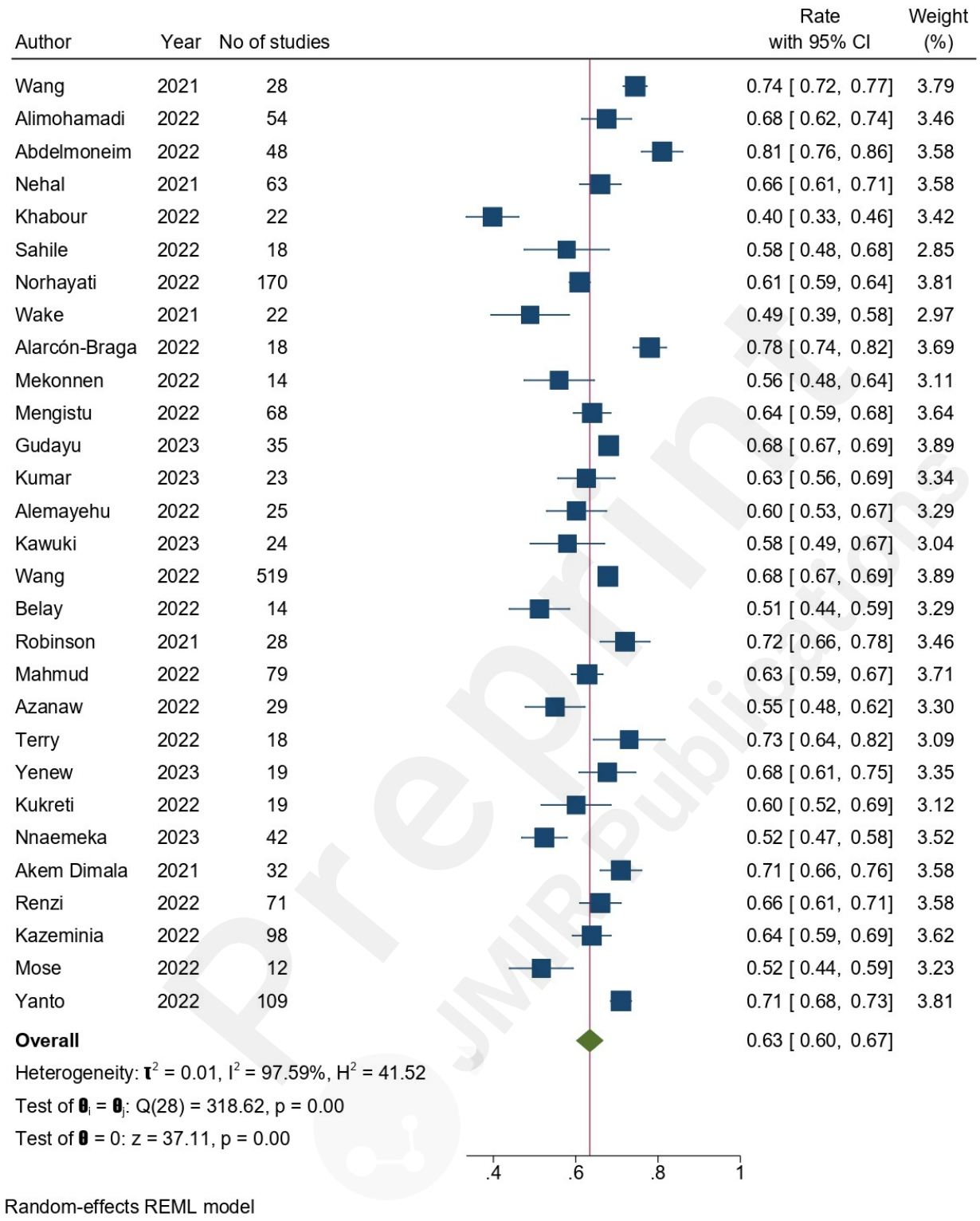

Figure 2. Forest plot depicting pooled acceptance rates of COVID-19 vaccine in general population

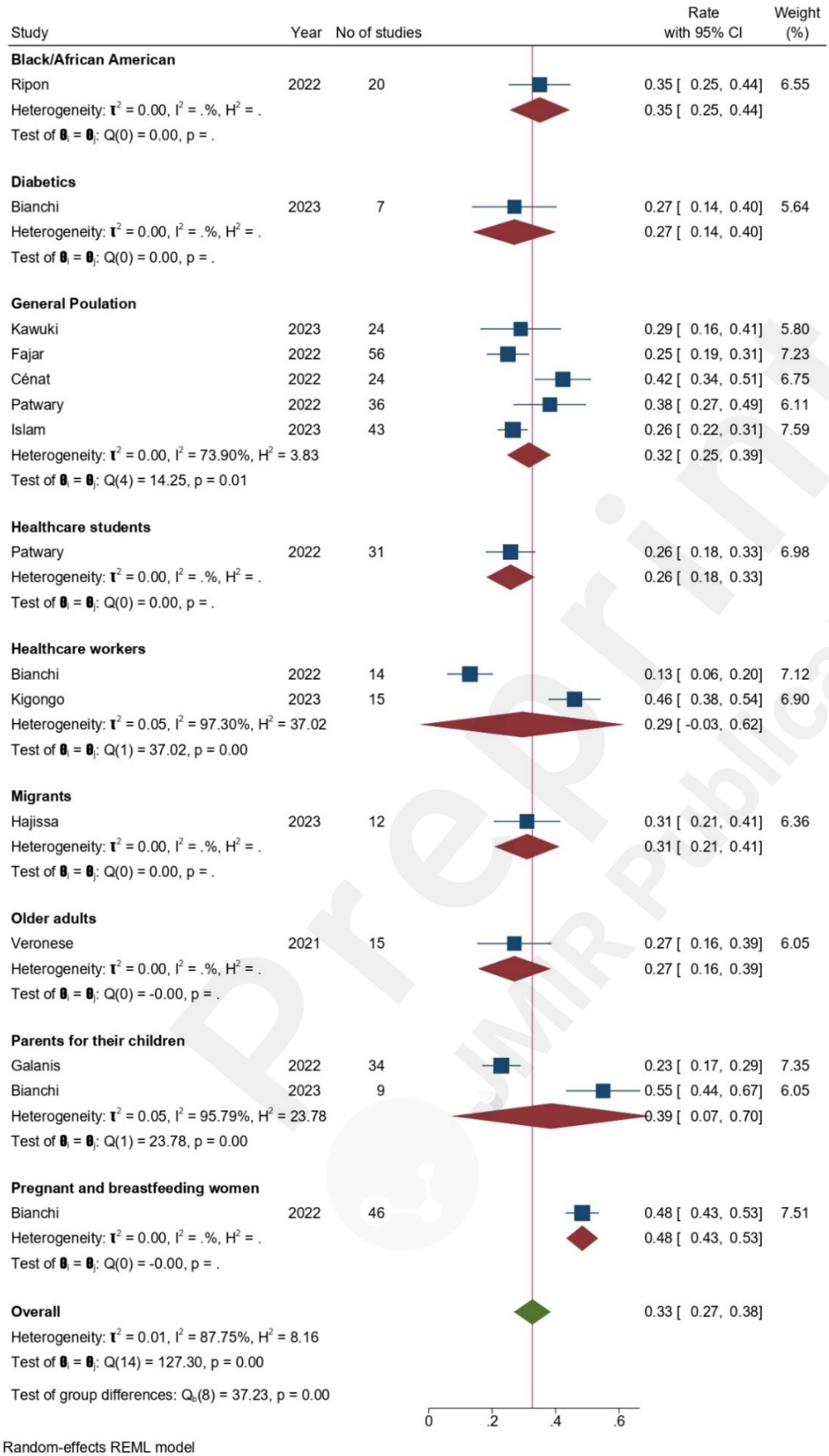

Figure 3 Forest plot showing COVID-19 vaccine hesitancy rates for different populations

Supplementary Files

Untitled.
URL: http://asset.jmir.pub/assets/908e323560963ecc52d33a288348139b.docx

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CONSORT (or other) checklists

PRISMA Checklist.
URL: http://asset.jmir.pub/assets/72ab8d322e77ffde280bcfdbfef6e0cc.pdf

Related publication(s) - for reviewers eyes onlies

Supplementary Files.
URL: http://asset.jmir.pub/assets/f9ad2d58d7af40552afa7efc0e8fb33e.pdf