Original Article

Coronavirus Disease 2019 Vaccine Hesitancy and Acceptance among the Indian Population: A Systematic Review and Meta-analysis

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Abstract

Introduction: The disastrous impact of the coronavirus disease 2019 (COVID-19) pandemic worldwide necessitated the prompt development of vaccines to combat the situation; however, vaccination drives have been challenged by vaccine hesitancy among several communities across geographies. Understanding vaccine hesitancy and acceptance can help design appropriate vaccination strategies. With this background, a systematic review and meta-analysis were conducted to estimate the prevalence and assess the factors associated with vaccine hesitancy and acceptance among the Indian population. **Methods:** This systematic review is reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. The data were extracted from May 1, 2024, to May 30, 2024, using PubMed, Scopus, and DOAJ search engines. The keywords used in the search string are "COVID-19," "vaccine hesitancy," "vaccine acceptance," and "India." Finally, 26 articles were selected, and the included articles underwent a quality assessment with the help of the JBI-Checklist for cross-sectional studies. The pooled vaccine hesitancy and acceptance prevalence was estimated at a 95% confidence interval (CI) using a random effect model assuming potential heterogeneity. Analysis used Stata Now 18 SE (Stata Corp., College Station, TX, USA). **Results:** Of the 26 studies, 14 studies were conducted among healthcare workers, seven studies among the general population, two studies among pregnant women and one each among school children, parents, and socioeconomically disadvantaged people. The reported highest vaccine acceptance was 92.74% and 86.3%, and hesitancy was 60.8% and 50% among healthcare workers and the general population, respectively. Between the general population and healthcare workers, the estimated pooled prevalence of vaccine acceptance is 66.1% (95% CI: 53%–78%) and 65.9% (95% CI: 57%–74%), respectively. The estimated pooled prevalence of vaccine hesitancy is 33% (95% CI: 20%–46%) among the general population and 24% (95% CI: 11%–40%) among healthcare workers. With the random effect model, high heterogeneity was observed in both acceptance (I^2 >99%) and hesitancy (I^2 >98%). **Conclusion:** A significant variation in the acceptability of the COVID-19 vaccine has been reported across different regions of India. Hence, future research is needed to enable comparability and generalizability, as the variations may also reflect differences in study designs, demographics, and time frames.

Keywords: Acceptance, confidence, eagerness, hesitancy, resistance, willingness

Introduction

Coronavirus Disease 2019 (COVID-19) caused by the Severe Acute Respiratory Syndrome Corona Virus-2 has remained a global concern since its emergence in late 2019.[1] It was declared a pandemic by the World Health Organization on March 11, 2020. As of April 13, 2024, there were 704,753,890 cases and 7,010,681 deaths worldwide.[2] The pandemic was able to create a strong ripple in the socioeconomic front around the globe and the consequences are still evident in society.[3] The high contagiousness and the predicted mortality rate which

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was significantly higher than that of the regular seasonal flu, caused significant disruption in day-to-day living. The condition was accentuated as a result of restrictive measures such as lockdowns, restricted movements, and school closures that were brought into action to minimize the spread of the disease.[4,5] To combat such a situation, around the globe, efforts were made to develop vaccines by various institutions in different sectors.[6] As of May 10, 2024, each day some 3189 new vaccine doses are being administered globally resulting in 70.6% of the global population receiving at least one dose of COVID-19 vaccination with 13.57 billion doses.[7] In India, the vaccination drive began on January 16, 2021, initially with the frontline healthcare workers that consisted of the healthcare personnel, sanitation workers, law enforcement officers, volunteers, and emergency medical technicians among others who supported the pandemic.[8] Approximately 120 million people received only one dose of the vaccine up until the end of 2021, compared to 1.1% of the population who received two doses.[9] To attain herd immunity, the WHO predicted that 1.45 billion doses of the vaccine are supposed to be administered in India by the end of May 2022. Initially, it was difficult to reach the target, but as people's understanding and awareness of the importance and efficacy of the COVID-19 vaccine grew, India was able to successfully immunize around 2 billion people by the beginning of 2023.[10] As of May 1, 2024, as per the CoWIN Dashboard, more than 2.2 billion doses were given to the Indian population including around 1.03 billion 1st doses, more than 952 million 2nd doses and more than 227 million precaution doses.[11]

Despite the progress made by both the Government agencies and other supporting civil society organizations to achieve the desired immunization coverage, one major obstacle could be the fear of COVID-19 vaccination, which is both authorized and anticipated[12,13] with its initial vaccination wastage standing at 6.5%.[14] Vaccine ambivalence is as widespread in India as it is worldwide, and is described by the WHO as a delay in acceptance, a reluctance to accept, or a refusal of vaccines in the face of easily accessible immunization facilities.[15] Several studies carried out in India and other parts of the world found that vaccine safety, rumors and controversy about the negative effects of vaccinations, a lack of knowledge about the benefits of immunizations, cost, and traditional belief systems were the main reasons for vaccine reluctance.[15-17] The rate of acceptance of COVID-19 vaccination was deemed satisfactory overall. Given the urgency of the situation and the seriousness of the spread of the disease, the majority of medical professionals agreed to receive the COVID-19 vaccine. Few people in general thought that getting the COVID-19 vaccine was necessary to protect oneself against the fatal disease.[18]

As per the information shared in the COWIN portal (https://www.cowin.gov.in/) of the Ministry of Health and Family Welfare, Government of India, the following COVID-19 vaccines are available for the citizens of India [Table 1].

Given the background, a systematic review and meta-analysis was carried out to understand the COVID-19 vaccine hesitancy and acceptance and the prevalence of the same among different population groups in India.

Objective

The main objectives of this systematic review and meta-analysis were as follows;

1. To estimate the prevalence of COVID-19 vaccine hesitancy and acceptance across different population groups in India
2. To enumerate the factors associated with COVID-19 vaccine hesitancy and acceptance among different population groups
3. To assess whether any difference exists among different population groups about vaccine hesitancy and acceptance in India.

Methods

This systematic review is being reported based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [Appendix 1].[19] This section describes the information about sources and the search strategies that were used to obtain the selected studies, including the study selection process and the inclusion–exclusion criteria. For deduplication, Zotero 7.0.7 (corporation for digital scholarship) was used.[20]

Information sources and search strategy

The pertinent studies were identified through electronic searches in PubMed, Scopus, and DOAJ databases. Articles were screened from May 1, 2024, to May 30, 2024. The following keywords: "COVID-19," "vaccine hesitancy," "vaccine acceptance," and "India" were used to search the articles in these databases. The Boolean operators "AND" and "OR were used to search the articles with the mentioned keywords. The search strings used were;

- ((("vaccine acceptance") OR ("vaccine hesitancy")) AND (India)) AND ("COVID-19")).

Study selection

The articles were first screened by three authors (JS, PKR, and NL) with the titles and abstracts to remove the duplicates. The remaining articles were then independently reviewed, which involved reading article titles, abstracts and methods. PCVI, abbreviated for P-Peer reviewed, C-Cross-sectional studies, V-Vaccine hesitancy/acceptance, and I-India, was used as inclusion criteria for this review. All authors met to compare the article selections, resolve disagreements and finalize the article selection. Finally, the authors independently reviewed the full text of each of the articles.

Eligibility criteria

Table 2 depicts the inclusion and exclusion criteria for the study selection.

Quality assessment of included studies

After the screening, the full-text articles were evaluated individually using the Joanna Briggs Institute Critical

Table 1: Available coronavirus disease 2019 vaccines in India

Type of beneficiary	Age group	Birth year	Eligibility for vaccines	Availability at COVID-19 vaccination centers
Adults	Age group: 18 years and above	Year 2005 or earlier	COVISHIELD	Public and private
			COVAXIN	Public and private
			SPUTNIKV	Private
			CORBEVAX	Private
			COVOVAX	Private
			GEMCOVAC	Private
			iNCOVACC	Private
			GEMCOVAC®-OM	Private
Children	Age group: 15–17 years	Years 2006, 2007, 2008	COVAXIN	Public and private
			CORBEVAX	Private
			COVOVAX	Private
			ZyCOV-D	Private
	Age group: 12–14 years	Years 2009, 2010, 2011	CORBEVAX	Public and private
			COVOVAX	Private
			ZyCOV-D	Private

COVID-19: Coronavirus disease 2019

Table 2: Inclusion and exclusion criteria of sources of evidence

Parameters	Inclusion criteria	Exclusion criteria
Year	2020–2024	Before 2020
Language	English language	Other than English
Country	India	Other than India
Study design	Cross-sectional studies	Studies with different methodologies
Publication status	Peer reviewed and indexed published articles	Articles under press/ peer review
Study focus	Vaccine acceptance and hesitancy	Other studies

Appraisal Tools Checklist for cross-sectional studies[21] to ascertain the superiority of these studies, as depicted in Table 3. The checklist has eight items:

1. Were the criteria for inclusion in the sample clearly defined?
2. Were the study subjects and the setting described in detail?
3. Was the exposure measured in a valid and reliable way?
4. Were objective, standard criteria used for measurement of the condition?
5. Were confounding factors identified?
6. Were strategies to deal with confounding factors stated?
7. Were the outcomes measured in a valid and reliable way?
8. Was appropriate statistical analysis used?

Answers such as yes, no, unclear, or not applicable were assigned to each item and were abbreviated as "Y" for Yes, "N" for no, "UC" for unclear and "NA" for not applicable. The score was calculated and the quality of these studies was categorized based on the scores; <50% - Poor quality, 50%–75% - Moderate quality, >75% - Good quality.

Data extraction

The extracted data were captured into a separate MS Excel sheet and the following data were gathered in the sheet from the included studies.

- Basic details of the published article such as the author's name, title, and study setting/Indian state where the study was conducted
- The survey year, type of population studied/participated and the sample size
- Furthermore, the prevalence of vaccine hesitancy and vaccine acceptance, and the factors associated with that vaccine behavior were also recorded.

Quality of included studies

Statistical analysis

The pooled prevalences of vaccine hesitancy and acceptance were estimated at a 95% confidence interval using a random effect model assuming potential heterogeneity. For the subgroup analysis, two groups were considered; healthcare workers and the general population. The general population includes all other small groups except the healthcare workers in the reported studies. Forest plots and funnel plots were used to graphically display the heterogeneity and bias, respectively, within the included studies. Statistical significance was set at $P < 0.05$. Analysis used Stata Now 18 SE (Stata Corp., College Station, TX, USA).

Results

Study selection

Of the 1247 articles identified 325 articles were removed as duplicates and 920 articles were screened of which 882 were excluded. 38 articles were sought for retrieval, two studies could not be retrieved and 10 studies were excluded for not meeting the eligibility criteria leading to the inclusion of 26 articles for the review. Figure 1 shows the PRISMA flow chart depicting the stages of identification, screening, and final inclusion of the articles.

Study characteristics

Of the 26 studies, 77% (n = 20) of the studies reported the surveys being carried out in 2021, and 69.23% (n = 18) of

Table 3: The Joanna Briggs Institute Critical Appraisal tools, checklist for cross-sectional studies

Authors	Journal	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Score (%)	Quality of studies
Jose S *et al*.	*J Prev Med Hyg*	Yes	Yes	Yes	Yes	No	No	Yes	Yes	75	Moderate
Vaghela G *et al*.	*Health Sci. Rep.*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100	Good
Rath TS *et al*.	*Al-Rafidain J Med Sci.*	Yes	Yes	No	Yes	No	No	No	Yes	50	Moderate
Akhtar N *et al*.	*J Infect Dev Ctries*	Yes	Yes	No	Yes	No	No	No	Yes	50	Moderate
Tiwari N *et al*.	*Indian J. of Com. Health.*	Yes	Yes	No	Yes	No	No	No	Yes	50	Moderate
Kumar V *et al*.	*J Edu Health Promot*	Yes	Yes	No	Yes	No	No	No	Yes	50	Moderate
Srivastava U *et al*.	*Front Public Health*	Yes	Yes	No	Yes	No	No	No	Yes	50	Moderate
K. Goel *et al*.	*Clinical Epidemiology and Global Health*	Yes	Yes	No	Yes	No	No	No	Yes	50	Moderate
Kusuma YS *et al*.	*Vaccine X*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100	Good
Padhi BK *et al*.	*Front Public Health*	Yes	Yes	Yes	Yes	No	No	Yes	Yes	75	Moderate
Sarkar P *et al*.	*Vaccine*	Yes	Yes	Yes	Yes	No	No	Yes	Yes	75	Moderate
Saxena M *et al*.	*J Indian Acad Oral Med Radiol*	Yes	Yes	No	Yes	No	No	No	Yes	50	Moderate
Achrekar GC *et al*.	*Vaccines*	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	87.5	Good
Padhi BK *et al*.	*Front. Med.*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	100	Good
Srivastava A *et al*.	*Int J Acad Med*	Yes	Yes	No	Yes	No	No	No	Yes	50	Moderate
Samanta S *et al*.	*Vacunas*	Yes	Yes	Yes	Yes	Yes	Yes	UC	Yes	87.5	Good
Arora M *et al*.	*Tzu Chi Medical Journal*	Yes	Yes	UC	Yes	No	No	UC	Yes	50	Moderate
Mundackal R *et al*.	*Indian J Med Res*	Yes	Yes	UC	Yes	No	No	UC	Yes	50	Moderate
Parthasarathi A *et al*.	*Vaccines*	Yes	Yes	Yes	Yes	No	No	Yes	Yes	75	Moderate
Mehta V *et al*.	*J. Med. P'ceutical Allied.Sci.*	Yes	Yes	No	Yes	No	No	No	Yes	50	Moderate
Shah NN *et al*.	*J Edu Health Promot*	Yes	Yes	UC	Yes	No	No	UC	Yes	50	Moderate
Dkhar SA *et al*.	*J Edu Health Promot*	Yes	Yes	UC	Yes	No	No	UC	Yes	50	Moderate
Sucharitha S T *et al*.	*Infectious Diseases: News, Opinions, Training*	Yes	Yes	No	Yes	No	No	No	Yes	50	Moderate
Dwivedi D *et al*.	*J South Asian Feder Obst Gynae*	Yes	Yes	No	Yes	No	No	No	Yes	50	Moderate
Kamboj S *et al*.	*Journal of Experimental Biology and Agricultural Sciences*	Yes	Yes	No	Yes	No	No	No	Yes	50	Moderate
Sharun K *et al*.	*Journal of Experimental Biology and Agricultural Sciences*	Yes	Yes	No	Yes	No	No	No	Yes	50	Moderate

UC: Unclear, NA: Not applicable, <50%: Poor quality, 50%–75%: Moderate quality, >75%: Good quality

the articles were published in 2022. Most (92.30%, n = 24) of the articles were published from 2021 to 2023, with one article each on either side of this year's range [Figure 2]. Of the total studies, 50% (n = 13) of the studies were conducted on a pan-India basis and the rest across different Indian states [Figure 3]. Healthcare workers were used maximum times (53.84%, n = 14) as the study participants, followed by the general population (26.92%, n = 7), as depicted in Figure 4. Similarly, 61% (n = 16) of the studies reported vaccine acceptance in the reviewed studies [Figure 5].

Result of individual studies

The following Table 4 delineates the results of individual studies.

Result synthesis

Of the 26 studies, 14 studies reported vaccine behavior among healthcare workers in India. Out of these, five (35.71%) studies focused on vaccine hesitancy and the rest 64.29% of the studies focused on vaccine acceptance. The studies having the highest hesitancy (60.8%) were reported in Tamil Nadu and the lowest (7%) in Chandigarh among the healthcare workers. Similarly, the highest (92.74%) vaccine acceptance is reported in Gujrat and the lowest (40%) in a pan-India study among healthcare workers. Seven studies reported vaccine behavior among the general population, of which three (42.85%) studies reported vaccine acceptance and the rest reported vaccine hesitancy. Of these seven studies, the highest (50%) vaccine hesitancy is reported in a pan-India study for booster doses and the lowest (15%) is reported in Uttar Pradesh. Similarly, the highest (86.3%) vaccine acceptance in reported in a pan-India study and the lowest (44.33%) was reported from West Bengal among the general population. Two studies each in Odisha and Maharashtra and one each in nine other states were conducted, two studies were conducted among pregnant women and one study each was found to be conducted among school children, parents, and socio-economically disadvantaged groups in India.

The overall pooled prevalence of COVID-19 vaccine acceptance of included 17 studies was 66% (95% confidence interval [CI]: 59%–73%). On subgroup analysis, the pooled prevalence was 66.1% (95% CI: 53%–78%) among the general population and the pooled prevalence was 65.9% (95% CI: 57%–74%) among healthcare workers [Figure 6]. There was high heterogeneity (I^2 > 99%) by the random effect model, which did not reduce much subgroup differences.

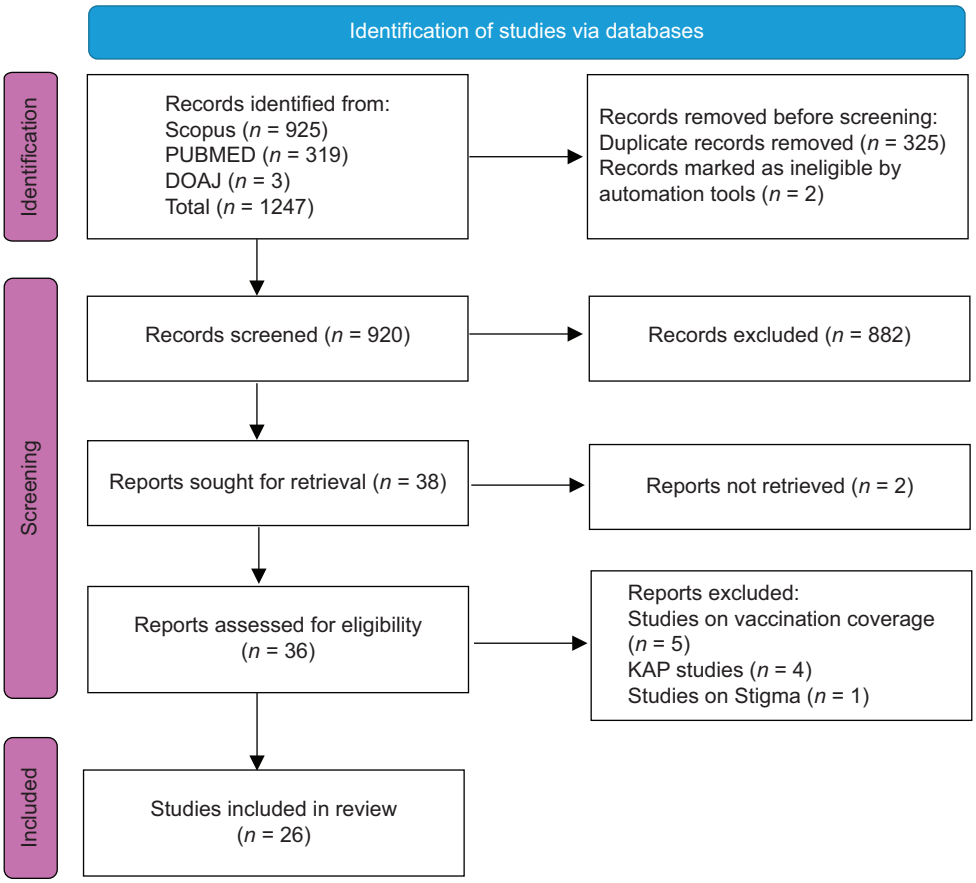

Figure 1: Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow-chart

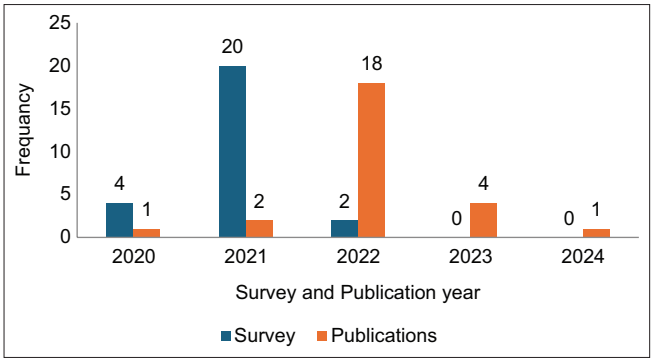

Figure 2: Year-wise surveys and publication of reviewed articles

The Egger test reported the potential presence of a small study effect which is not statically significant with a $P = 0.2201$, thus is not strong enough to conclude that there is an asymmetry in the funnel plot [Figure 7].

The prevalence of COVID-19 vaccine hesitancy in the included ten studies was 28% (95% CI: 19%–38%). On subgroup analysis, the pooled prevalence was 33% (95% CI: 20%–46%) among the general population and 24% (95% CI: 11%–40%) among healthcare workers [Figure 8]. There was high heterogeneity ($I^2 > 98\%$) by the random effect model, which did not reduce subgroup differences.

The Egger test reported the absence of a small study effect, which is not statistically significant, with a $P = 0.3871$, suggesting no strong evidence of an absence of a small study effect [Figure 9].

Several factors were identified that affected the decision to accept or reject the COVID-19 vaccine across the reviewed studies in India. All the factors were grouped into 12 different categories and are presented in Table 5.

Discussion

The pandemic of COVID-19 created the strongest ripple around the world. This is one of its kind of public health disaster that affected both the supply and demand side of the health system. Nations had to struggle a lot to bring in control measures, manage the cases and the administration of vaccines. The administration of COVID-19 vaccines across different communities has been a major challenge for the authorities despite the successfully run Immunization Programs owing to several of the peculiarities associated with the COVID-19 vaccine and its vaccination. One of the major problems of COVID-19 vaccination was the vaccine hesitancy associated with it owing to several of the individual, community, and contextual level issues. With enormous efforts, countries around the globe were able to manufacture vaccines and supported other nations as well, who were in dire need of urgent

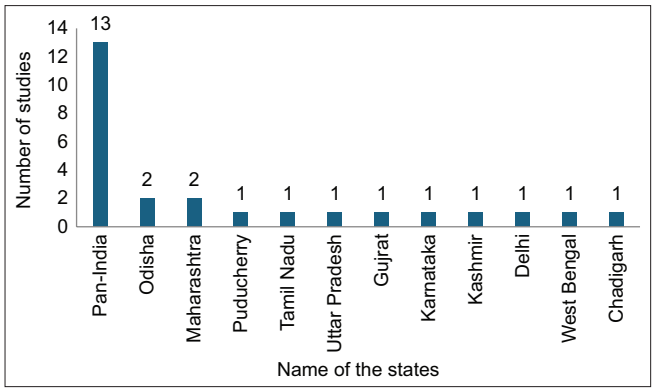

Figure 3: Representation of states that the included articles covered for the study of vaccine behaviour

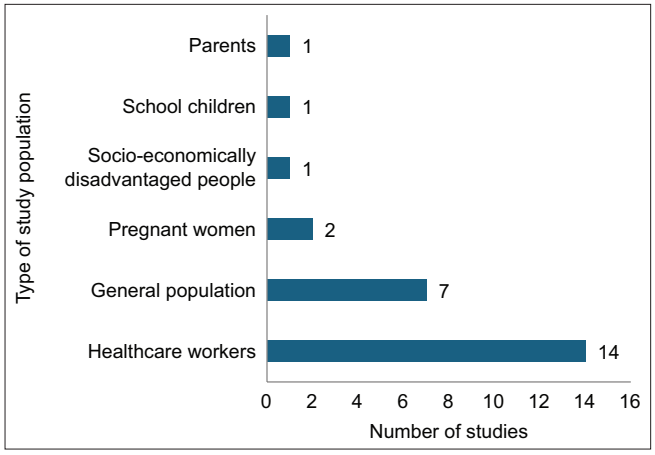

Figure 4: Frequency distribution of population groups as studied in reviewed articles (n = 26)

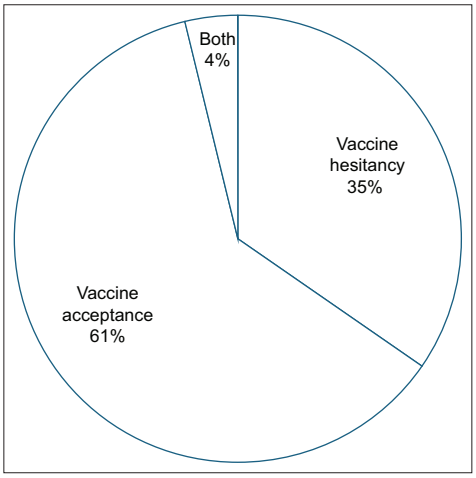

Figure 5: Proportion of studies on vaccine behaviour

vaccination for their citizens.[48] Around mid-2021, many of the vaccine candidates had received emergency use approval signifying the urgency of the fight against the pandemic. On the other hand, the realization of the potential of these vaccines was significantly affected by the willingness and acceptance to get vaccinated.[49,50]

This review focused on the vaccine behavior among different population groups in India and studied both vaccine hesitancy and acceptance. The study found that the pooled prevalence of vaccine hesitancy is 27.2% among the general population. A pan-India study conducted in early 2021 estimated the prevalence of vaccine hesitancy among the general population in India exactly at 27. 2%.[51] Another study among the general population in a developing country estimated the prevalence of vaccine hesitancy at 29.8%.[52] Similarly, the common factors of vaccine hesitancy found through this review include the fear of side effects, concerns of safety and efficacy, not knowing anyone who died of COVID-19, never tested for COVID-19 in the past, lack of clarity about the vaccine, concern with the efficacy of new COVID-19 vaccines and are like other studies in India. A study in Odisha reported that the participants had the perception that the vaccines contain dangerous ingredients, COVID-19 infection provides better immunity than the vaccine and concerns about the safety of the vaccine.[53] A West Bengal study reported vaccine hesitancy owing to a lack of medical information and a lack of understanding of the COVID-19 pandemic and its associated vaccination campaigns.[37] A Delhi-based study reported a lack of knowledge about COVID-19 immunizations and concerns about vaccine efficacy and long-term efficacy were the major factors of vaccine hesitancy among the studied population.[54]

The review found heterogeneity of vaccine hesitancy and acceptance among different population groups, which signifies the diverse and complex landscape of vaccine perception globally, consistent with other studies around the world.[55] The review found that the prevalence of vaccine hesitancy among healthcare workers and the general population is negligible, which might be due to widespread awareness about the benefits of vaccination among both categories. Moreover, the reduction in vaccine hesitancy among healthcare workers is most likely linked to their better understanding of the risks of the disease and the benefits of the vaccine.[56,57] Nonetheless, the observed heterogeneity signifies differing viewpoints and potentially different ways of information dissemination within these groups. Variations in vaccination acceptance and hesitancy among populations are representative of the complex web of perceptions, beliefs, and information access that makes up the world's population. Issues regarding vaccine safety in these vulnerable groups, for example, are probably a factor in the lower acceptance rates seen among pregnant women and parents giving their approval for their children, as reported in one of the included studies among the health worker parents in Puducherry. This highlights the need for focused communication strategies that address these issues.[58]

The review found the pooled acceptance at 66.1% among the general population. A study among the general population in Delhi found 56.2% of vaccine acceptance for two doses of vaccine.[55] One of the systematic reviews on vaccine acceptance has reported a vaccine acceptance rate of 65.7% in January–February 2021, which increased to 92.8% in May–August 2021 among the Indian population.[59] The disparities in vaccine

Table 4: Result of individual studies included in the review

Authors	Journal	YOP	Survey year	Survey duration	State(s) covered	Sample size	Study design	Population and age group	Vaccine behaviour studied	Prevalence of the behaviour (%)
Jose *et al.*[22]	*J Prev Med Hyg*	2022	2021	January 2nd–25th, 2021	Chandigarh	403	Cross-sectional study (online survey)	Healthcare workers (20–>43 years)	Vaccine hesitancy	7
Vaghela *et al.*[23]	*Health Sci. Rep.*	2024	2022	January and October 2022	Gujrat	441	Cross-sectional study	Healthcare workers parents (21–52 years)	Vaccine acceptance	92.74
Rath *et al.*[24]	*Al-Rafidain J Med Sci.*	2023	2021	August 1, 2021–January 31, 2022	Odisha	317	Cross-sectional study	Pregnant women (26–30 years)	Vaccine acceptance	70.66
Akhtar *et al.*[25]	*J Infect Dev Ctries*	2023	2022	February 23, 2022 and March 10, 2022	Odisha	343	Cross-sectional study	School children (12–14 years)	Vaccine acceptance	79
Tiwari *et al.*[26]	*Indian J. of Com. Health.*	2023	2021	January 15, 2021–March 30, 2021	Pan-India	450	Cross-sectional study	Healthcare workers (18 years or older)	Vaccine acceptance	60
Kumar *et al.*[27]	*J Edu Health Promot*	2023	2021	February–May 2021	Maharashtra	919 (585 - pregnant mothers + 334 - LMs)	Cross-sectional study	PM and LM (19 and 50 years)	Vaccine acceptance and vaccine hesitancy	VA - 58 VH - 49
Srivastava *et al.*[28]	*Front Public Health*	2022	2021	Not available	UP	603	Cross-sectional study	General population (18–40 years)	Vaccine hesitancy	15
Goel *et al.*[29]	*Clinical Epidemiology and Global Health*	2022	2020	November–December 2020	Pan-India	377	Cross-sectional study	Healthcare workers (community health workers) (18–49 years)	Vaccine acceptance	40
Kusuma and Kant[30]	*Vaccine X*	2022	2020	September 2020–January 2021	Delhi	1539	Cross-sectional study	Socioeconomically disadvantaged communities (18–>60 years)	Vaccine acceptance	64.90
Padhi *et al.*[31]	*Front Public Health*	2022	2021	Three time points; (1) October 2020, (2) January 2021, (3) May 2021	Pan-India	3095	Cross-sectional study	Healthcare workers (18–>50 years)	Vaccine acceptance	59.03
Sarkar *et al.*[32]	*Vaccine*	2022	2021	Not available	Puducherry	269	Cross-sectional study	Healthcare worker-parents (18 years or older)	Vaccine hesitancy	12.69
Saxena *et al.*[33]	*J Indian Acad Oral Med Radiol*	2022	2021	May 30 and June 30, 2021	Pan-India	1271	Cross-sectional study	Healthcare workers (dental professionals) (18–>60 years)	Vaccine hesitancy	19.5
Achrekar *et al.*[34]	*Vaccines*	2022	2021	December 13, 2021–February 10, 2022	Pan-India	687	Cross-sectional study	General population (18 years or older)	Vaccine hesitancy for booster dose	50
Padhi *et al.*[35]	*Front. Med.*	2022	2021	November 2020 and January 2021	Pan-India	770	Cross-sectional study	Parents (18–>50 years)	Vaccine acceptance	33.5
Srivastava *et al.*[36]	*Int J Acad Med*	2022	2021	January 5–January 14, 2021	Pan-India	496	Cross-sectional study	Healthcare workers (18 years or older)	Vaccine acceptance	63.51

Contd...

Table 4: Contd...

Authors	Journal	YOP	Survey year	Survey duration	State(s) covered	Sample size	Study design	Population and age group	Vaccine behaviour studied	Prevalence of the behaviour (%)
Samanta *et al.*[37]	*Vacunas*	2022	2021	February 22, 2021–March 22, 2021	West Bengal	803	Cross-sectional study	General population (18 years or older)	Vaccine acceptance	44.33
Arora *et al.*[38]	*Tzu Chi Medical Journal*	2022	2020	November–December 2020	Pan-India	250	Cross-sectional study	Healthcare workers (18–>55 years)	Vaccine acceptance	60.4
Mundackal *et al.*[39]	*Indian J Med Res*	2022	2021	July–August 2021	Karnataka	297	Cross-sectional study	General population (18 years or older)	Vaccine hesitancy	21.90
Parthasarathi *et al.*[40]	*Vaccines*	2022	2021	Mid-February–March, 2021	Pan-India	1582	Cross-sectional study	General population (18 years or older)	Vaccine hesitancy	30.8
Mehta and Patel[41]	*J. Med. P'ceutical Allied. Sci.*	2022	2021	Not available	Maharashtra	824	Cross-sectional study	Healthcare workers (18–72 years)	Vaccine hesitancy	29
Shah *et al.*[42]	*J Edu Health Promot*	2022	2021	January–February, 2021	Jammu and Kashmir	511	Cross-sectional study	Healthcare workers (≤30–>50 years)	Vaccine acceptance	67.7
Dkhar *et al.*[43]	*J Edu Health Promot*	2022	2021	Over a period of 7 days	Pan-India	511	Cross-sectional study	Healthcare workers (doctors) (18–>60 years)	Vaccine acceptance	66.53
Sucharitha Sree *et al.*[44]	*Infectious Diseases: News, Opinions, Training*	2022	2021	Not available	Tamil Nadu	393	Cross-sectional study	Healthcare workers (<25–>40 years)	Vaccine hesitancy	60.8
Dwivedi *et al.*[45]	*J South Asian Feder Obst Gynae*	2021	2021	December 26, 2020–January 23, 2021	Pan-India	314	Cross-sectional study	Healthcare workers (<25–>65 years)	Vaccine acceptance	75.1
Kamboj *et al.*[46]	*Journal of Experimental Biology and Agricultural Sciences*	2021	2021	May 16, 2021–May 28, 2021	Pan-India	711	Cross-sectional study	General population (18–>65 years)	Vaccine acceptance	84.4
Sharun *et al.*[47]	*Journal of Experimental Biology and Agricultural Sciences*	2020	2020	October 2020	Pan-India	351	Cross-sectional study	General population (18–>60 years)	Vaccine acceptance	86.3

LMs: Lactating mothers, PM: Pregnant women, VA-Vaccine acceptance, VH-Vaccine hesitancy

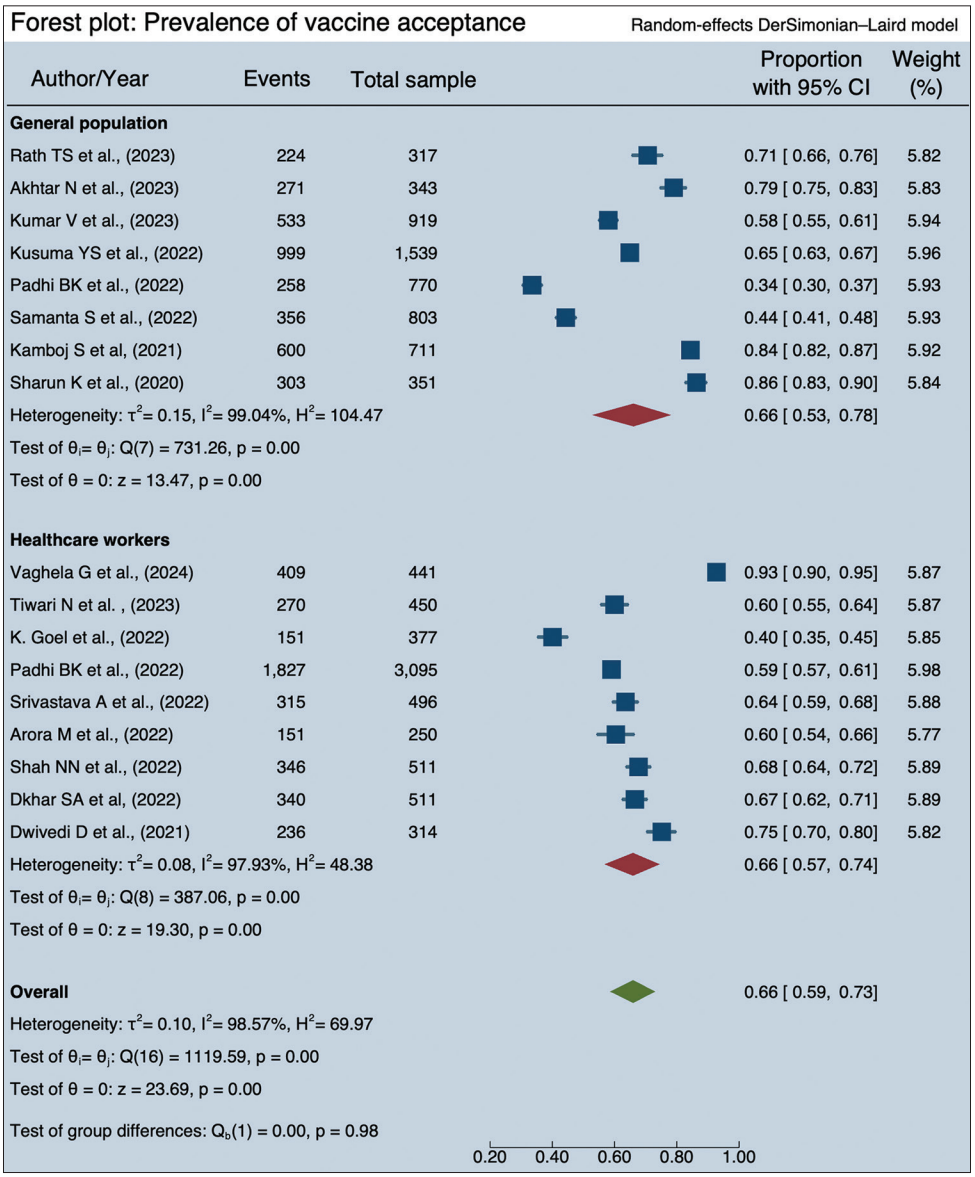

Figure 6: Forest plot for pooled prevalence for vaccine acceptance and heterogeneity among studies

acceptance among different population groups need focused and tailored population-level interventions.[60] The concept of a "one shoe fits all" approach may not help the masses, given the diverse geographic, cultural, socio-economic, individual and contextual differences in a country like India. Each group exhibit unique concerns, misconceptions and information needs. The pregnant mother in Maharashtra, for instance, has shown higher resistance most likely due to concerns regarding the impact of the vaccine on pregnancy and the growing fetus.[27,61,62] In such population groups, vaccine acceptability can be improved by addressing specific concerns through counseling and focused awareness campaigns. Analogously, programs that address parental concerns, as found out in one of the studies in Puducherry among healthcare parents, regarding the safety and effectiveness of vaccines for children are required due to the decreased acceptance rates of parental assent.[63] It is important to emphasize the need for standardization in future research to enable comparability and generalizability, as the variations may also reflect differences in study designs, demographics, and time frames.[64] The fact that vaccine hesitancy has become a global phenomenon, independent of a nation's economic standing, highlights the significant influence that public perception and information distribution have in influencing vaccination-related behaviors.[65]

Combating misinformation associated with vaccine hesitancy needs a multipronged approach that includes social media strategy, healthcare professionals, and community leaders working together. Misinformation can be repelled by disseminating factual, understandable, and open information about the development, effectiveness, and safety of vaccines. With the highest 92.74% acceptance rate, healthcare professionals are vital in influencing public attitudes and vaccination practices.[23,66] Healthcare professionals can

effectively address the concerns, dispel myths and promote the advantages of vaccines as a reliable source of information.[67,68] Their interactions with patients and the community can have a big impact on whether or not vaccines are accepted, particularly in groups such as parents and pregnant women who have high levels of hesitancy. Effective strategies to improve vaccine acceptance in various cultural contexts can be developed by leveraging community influences and understanding sociocultural dynamics.[69]

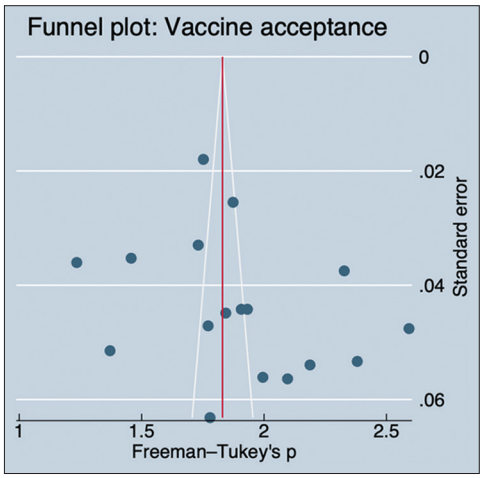

Figure 7: Funnel plot for representing publication bias

The review was carried out using research studies that used cross-sectional study designs only, and other studies could have also been included. The inclusion of qualitative studies could have ushered more light on the individual, cultural and contextual factors on both vaccine hesitancy and acceptance. Furthermore, two groups have been created, the general population and healthcare workers, which have internal variations as the general population includes pregnant mothers, parents, children, and socioeconomically disadvantaged populations, and the healthcare workers include healthcare worker parents, dental professionals and community professionals which could have been separated for sub-group analysis for better results.

Implications of the study

The review comes up with the following implications.

Tailored communication strategies

The varying degrees of acceptance and resistance among different population groups suggest that there is a need to tailor the communication strategies considering regional cultural beliefs, historical distrust, and educational backgrounds.

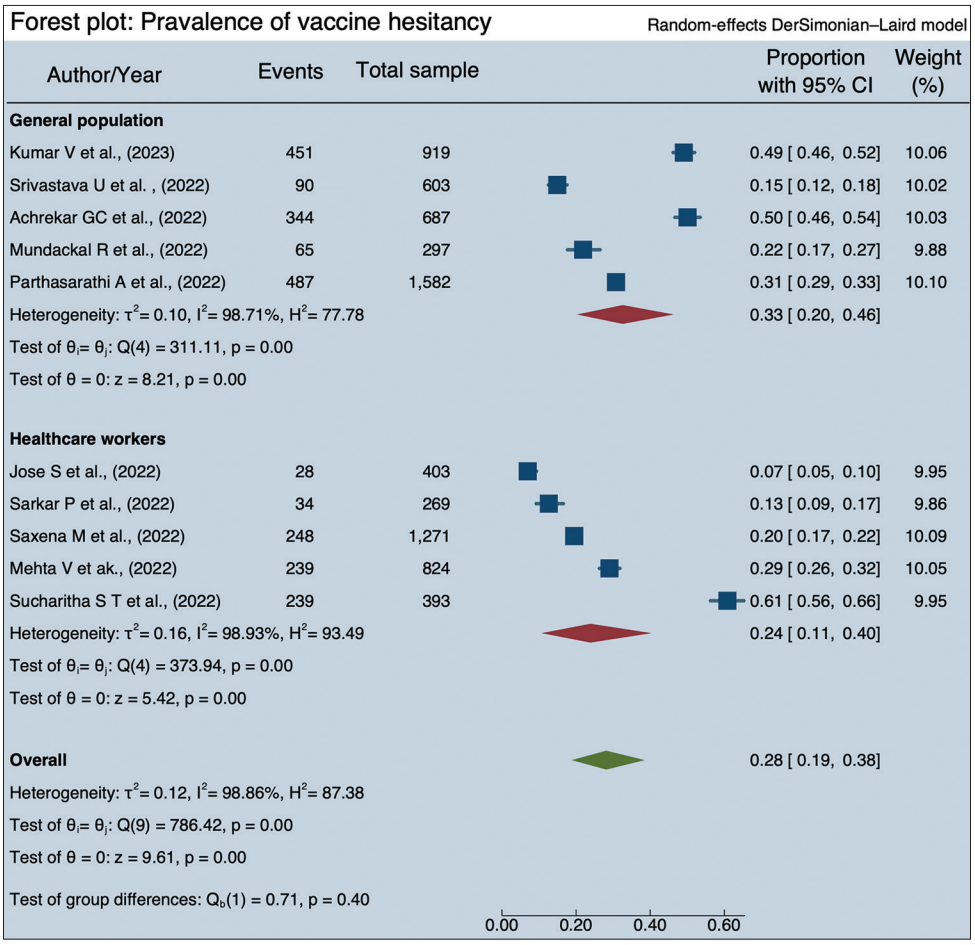

Figure 8: Forest plot for pooled prevalence for vaccine hesitancy and heterogeneity among studies

Table 5: Factors associated with vaccine behaviour as depicted in the reviewed studies

Specific factors	As depicted in studies	Vaccine behaviour linked
Fear specific	Fear, concerned with safety, fear of side effects	Vaccine hesitancy
Age specific	Younger age group	Vaccine acceptance
Gender specific	Men as gender	Vaccine acceptance
Education specific	Educated, educated up to school level	Vaccine acceptance
Vaccine specific	AEFI, lack of clarity about vaccine, side effects and efficacy of COVID vaccine, concerns regarding vaccine cleared by HCPs, doubt on vaccine safety, lack awareness on COVID-19 vaccine eligibility, disagreement of vaccine being unsafe during pregnancy, perceived threats about the vaccine, concerned with efficacy of new COVID-19 vaccines	Vaccine hesitancy
	Vaccine acceptance by others and social acceptance, agreement on vaccine benefiting the baby, government's vaccine communication strategy	Vaccine acceptance
Trust specific	Lack of trust, rumour on social media, unvaccinated with the initial doses, people's attitude towards the health system, distrusted source on vaccine information	Vaccine hesitancy
	Trust in health authorities, trust in the healthcare sector, trust in the healthcare system and trust in domestic vaccine	Vaccine acceptance
COVID disease specific	Not knowing anyone who died of COVID, never tested for COVID-19 in the past	Vaccine hesitancy
	Perceive the pandemic as severe (HCP)	Vaccine acceptance
Preexisting health specific	Existing co-morbidities, disease worsening (autoimmune disease)	Vaccine hesitancy
Socioeconomic specific	Lower income, rural areas, not living with vulnerable individuals, family/friends not tested positive, wage loss owing to possible side effects, economic status	Vaccine hesitancy
	Higher pro-social mindset, belonging to the upper socioeconomic class	Vaccine acceptance
Stigma specific	Advised against the vaccine	Vaccine hesitancy
	Less stigmatization regarding the vaccine	Vaccine acceptance
Awareness specific	Short time to decide, illness not severe in children, negative attitude toward vaccination	Vaccine hesitancy
	Excellent knowledge among HCWs, knowledge, and awareness	Vaccine acceptance
Family specific	To protect the family members	Vaccine acceptance

COVID-19: Coronavirus disease 2019, HCWs: Healthcare workers, HCP: Healthcare provider, AEFI: Adverse event following immunization

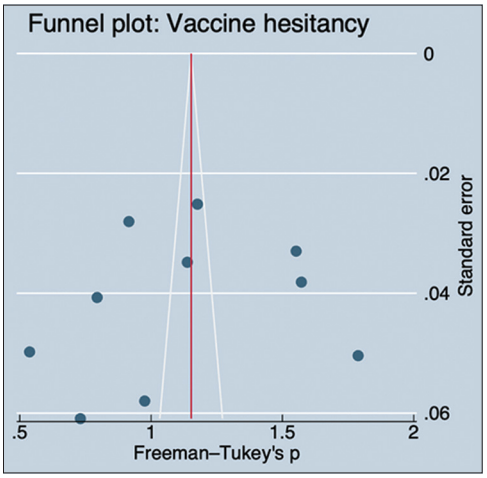

Figure 9: Funnel plot for representing publication bias

Specific focus on hesitant groups

The review found that the gap of resistance among both the general population and healthcare professionals is very negligible, and both groups need specific strategies to overcome the hesitancy. Moreover, healthcare workers need more focused attention as they are the primary sources of information for patients, and play a critical role in promoting vaccine uptake.

Fixing the parallel infodemic

The study shows a great degree of heterogeneity in hesitancy rates, which may be caused by societal or regional factors. It emphasizes how critical it is to address misinformation/disinformation and local myths that could influence people's perceptions. Local influencers might be partnered with public health campaigns to dispel vaccine myths and foster more confidence.

Policy implications

The critical findings from this review can help in policy matters such as vaccine distribution, community-based health education programs and outreach programs by underscoring the areas and populations of low vaccine acceptance rates.

Conclusion

There has been significant variation in the acceptability of the COVID-19 vaccine as reported by different studies in India. The review found several factors of vaccine hesitancy and acceptance reiterating the fundamental principle that health service delivery, in this case vaccination services, must take the individual, community and contextual factors into account. Parents, children, and socioeconomically disadvantaged populations were the subject of only one study each, which suggests that more research must be done to evaluate their awareness, perspective, and acceptance of the COVID-19 vaccination. Moreover, the decision-makers must recognize the country's widespread vaccine hesitancy. Building community trust in healthcare institutions and immunization programs is crucial to ensuring that everyone receives vaccinations

successfully free from cumbersome approaches. There must be more public awareness campaigns, especially in developing and rural areas where there is a general misperception regarding illness and immunization. Moreover, it is a given fact that COVID-19 vaccination is currently not in vogue as rigorously as it used to be in 2021 and 2022; however, the learnings can be applied to other adult vaccinations as well.

Research quality and ethics statement

The study did not involve human subjects and is based on published literature. Hence, ethical approval was not sought. The authors followed applicable EQUATOR network-guidelines during the conduct of research project.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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Appendix

Appendix 1: PRISMA checklist for all care cascade gaps

Supplement to:

COVID-19 Vaccine hesitancy and acceptance among the Indian population: A systematic review and Meta-analysis

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PRISMA 2020 Abstract Checklist

Section and Topic	Item #	Checklist item	Reported (Yes/No)
		TITLE	
Title	1	Identify the report as a systematic review.	Yes
		BACKGROUND	
Objectives	2	Provide an explicit statement of the main objective (s) or question (s) the review addresses.	Yes, last sentence of the "introduction" section
		METHODS	
Eligibility criteria	3	Specify the inclusion and exclusion criteria for the review.	Yes, in "Materials and Methods" section
Information sources	4	Specify the information sources (e.g. databases, registers) used to identify studies and the date when each was last searched.	Yes, in "Materials and Methods" section
Risk of bias	5	Specify the methods used to assess risk of bias in the included studies.	Yes, in "Materials and Methods" section
Synthesis of results	6	Specify the methods used to present and synthesise results.	Yes, in "Materials and Methods" section
		RESULTS	
Included studies	7	Give the total number of included studies and participants and summarise relevant characteristics of studies.	Yes, in "result" section
Synthesis of results	8	Present results for main outcomes, preferably indicating the number of included studies and participants for each. If meta-analysis was done, report the summary estimate and confidence/credible interval. If comparing groups, indicate the direction of the effect (i.e., which group is favoured).	Yes, in "result" section
		DISCUSSION	
Limitations of evidence	9	Provide a brief summary of the limitations of the evidence included in the review (e.g. study risk of bias, inconsistency and imprecision).	Yes, in "Methods section", third sentence
Interpretation	10	Provide a general interpretation of the results and important implications	Yes, in "result" section
		OTHER	
Funding	11	Specify the primary source of funding for the review.	No but mentioned elsewhere
Registration	12	Provide the register name and registration number.	No

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ 2021;372:n71

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Section and Topic	Item #	Checklist item	Location where item is reported
		TITLE	
Title	1	Identify the report as a systematic review.	Title page
		ABSTRACT	
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Abstract page: see the separate PRISMA abstract checklist included on the previous two pages of this document
		INTRODUCTION	
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Introduction, 2nd paragraph
Objectives	4	Provide an explicit statement of the objective (s) or question (s) the review addresses.	"Objective" section
		METHODS	
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Materials and Methods section, subsection on eligibility criteria and are reported in a matrix (Table no-2)
Information sources	6	Specify all databases, registers, websites, organisations, reference lists, and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Materials and Methods section, subsection on "Information Sources and Search Strategy"
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Materials and Methods section, subsection on "Information Sources and Search Strategy"
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Materials and Methods section, subsection on "Study selection"
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Materials and Methods section, subsection on "Study selection"
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g., for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Materials and Methods section, subsection on "Study selection"
	10b	List and define all other variables for which data were sought (e.g., participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Materials and Methods section, subsection on "Study selection"
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool (s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Materials and Methods section, subsection on "Study selection" Methods section, subsection on 'Quality assessment of included studies'
Effect measures	12	Specify for each outcome the effect measure (s) (e.g., risk ratio, mean difference) used in the synthesis or presentation of results.	No, review used cross-sectional studies
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g., tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Methods section, subsection on 'Data extraction'
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Methods section, subsection on 'Data extraction'
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Methods section, subsection on 'Data extraction'
	13d	Describe any methods used to synthesize results and provide a rationale for the choice (s). If meta-analysis was performed, describe the model (s), method (s) to identify the presence and extent of statistical heterogeneity, and software package (s) used.	Methods section, subsection on 'statistical analysis'
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g., subgroup analysis, meta- regression).	Methods section, subsection on 'statistical analysis'

Contd...

Section and Topic	Item #	Checklist item	Location where item is reported
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	NA
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Methods section, subsection on 'statistical analysis'
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Methods section, subsection on 'Quality assessment of included studies'
		RESULTS	
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Results section, sub-section "study section"
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Results section, sub-section "study section"
Study characteristics	17	Cite each included study and present its characteristics.	Results section, sub-section "study characteristics"
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Results section, sub-section "result synthesis"
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Results section, sub-section "result of individual studies"
Results of syntheses	20a	For each synthesis, briefly summarize the characteristics and risk of bias among contributing studies.	Results section, sub-section "result synthesis"
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g., confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Results section, sub-section "result synthesis"
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Results section, sub-section "result synthesis"
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	No
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Results section, sub-section "result synthesis"
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	No
		DISCUSSION	
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Discussion section
	23b	Discuss any limitations of the evidence included in the review.	Discussion section
	23c	Discuss any limitations of the review processes used.	Discussion section
	23d	Discuss implications of the results for practice, policy, and future research.	Discussion section
		OTHER INFORMATION	
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	NA
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	NA
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Funding section
Competing interests	26	Declare any competing interests of review authors.	Competing interests section
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Not publicly available however can be provided with reasonable request

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, *et al.* The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ 2021;372:n71