Prevalence of COVID-19 Vaccine Hesitancy in South Asia: A Systematic Review and Meta-Analysis

Mohammad Mainul Islam[1]*, Md. Yeasir Yunus[2], Muhammad Saifullah Akib[1], Md. Rakibul Iqbal[3], and Mohona Khan[1]

[1] Department of Population Sciences, University of Dhaka, Bangladesh
[2] Department of Human Trafficking, Modern Slavery, Migration and Organised Crime, St Mary's University, London, UK
[3] Department of Health Promotion and Public Health, Ulster University, Belfast, Northern Ireland, UK
* Mohammad Mainul Islam, corresponding author. Email: mainul@du.ac.bd
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Abstract

Vaccine uptake and coverage in susceptible populations are needed through effective vaccination campaigns to address the COVID-19 pandemic in South Asian countries. We aimed to measure the pooled proportion of COVID-19 vaccine hesitancy in this regard. Research articles published between January 1, 2020, to December 31, 2021, were searched through Medline, PubMed, Cochrane, Google Scholar, and the WHO COVID-19 database. The Joanna Briggs Institute (2014) tool for prevalence studies was used to assess data quality. We performed a meta-regression test and a sensitive analysis among the studies and used the DerSimonian and Laird random-effects model to measure the pooled effect estimates. Subgroup analyses were performed concerning vaccine hesitancy, countries, study population, study level, and the time since the first outbreak of the pandemic. A total of 43 studies out of 598 published articles across the eight countries in South Asia were included. The pooled proportion of COVID-19 vaccine hesitancy was 26.5% (95% CI [22, 31], $I^2 = 99.59\%$). Vaccine hesitancy was higher in Afghanistan (37%), Pakistan (33%), and Bangladesh (28.9%); among the general population (29%); at community levels (27.9%); and the duration of time of 1–12 months since the first outbreak in each country (27.5%). Vaccine hesitancy exists in South Asia with different rates among countries, population sub-groups, communities, study-levels, duration of time since the first outbreak, and study population. Therefore, enhancing public awareness of vaccination and vaccine hesitancy is required to prevent future pandemics.

Keywords

COVID-19 vaccine hesitancy; Meta-analysis; South Asia; systematic review

Introduction

Vaccination is often considered the most cost-effective public health intervention to save lives, improve health and ensure long-term prosperity. Globally, vaccination prevents 2 to 3 million deaths each year, with another 1.5 million potential lives could be saved if universal vaccination coverage improved (World Health Organization, 2019). However, recent literature indicates rising negative attitudes toward COVID-19 vaccines in many countries (Afolabi & Ilesanmi, 2021; Coustasse et al., 2021; Paul et al., 2021; Sallam, 2021). The general population has shown a degree of COVID-19 'vaccine hesitancy' resulting from mistrust towards the vaccine, unseen effects, natural preference for immunity, etc. (Coustasse et al., 2021; Paul et al., 2021).

The World Health Organization defined vaccine hesitancy as a delay in accepting or refusing vaccines despite available vaccination services (Marti et al., 2017), leading to the reluctance of people to receive safe and recommended available vaccines. This outlook has become a growing concern before the COVID-19 pandemic (MacDonald, 2015). In a pandemic, people should be more motivated to take vaccines (Scherr et al., 2016). However, some factors influence vaccine uptake and may lead to vaccine hesitancy, where people may refuse to uptake the vaccine or may influence other people to take the vaccine (Yaqub et al., 2014). One study on the impact of the Health Belief Model (HBM) constructs on COVID-19 vaccination hesitancy by doing a thorough analysis found that the prevalence rate of such hesitancy was found in one-third of the population (Limbu et al., 2022). The most prevalent Health Belief Model (HBM) constructs substantially linked with vaccine hesitancy were perceived barriers and perceived benefits. A recent systematic review and meta-analysis among low and lower-middle-income countries reported vaccine hesitancy at 38.2% (Patwary et al., 2022). They suggested that promoting global vaccination coverage should be a top priority to raise vaccine acceptance rates in the developing world.

Similarly, a study on vaccine acceptance reported dominant vaccination hesitancy among the general adult population and healthcare workers, with reports of low acceptance rates for the COVID-19 vaccine in the Middle East, Russia, Africa, and various European countries (Sallam, 2021). The hesitancy regarding the COVID-19 vaccine is evident worldwide; South Asia is no exception. The main factors for COVID-19 vaccine hesitancy are still complex, critical, and unexplored, especially in South Asia, which is the home of one-fourth of the world's population (World Bank, 2022). South Asian countries (e.g., Bangladesh, India, Pakistan, Afghanistan, Nepal, Maldives, Sri Lanka, and Bhutan) have socioeconomic and cultural similarities and distinctiveness from the other parts of Asia; therefore, vaccine hesitancy could increase the vulnerability of the countries in this region with constrained healthcare delivery systems, high population density, limited resources, persisting inequalities, and the prevalence of low uptake of pandemic prevention behaviors (Kusuma et al.,2021). Few countries in South Asia have successful evidence of taking the vaccine to prevent disease because of its safety and effectiveness (de Figueiredo et al., 2020); the shortage of synthesized evidence of vaccine hesitancy is noticeable in the South Asian region. Furthermore, although few review studies on COVID-19 vaccine hesitancy are available in the different areas (Aw et al., 2021; Sallam, 2021; Salomoni et al., 2021), studies focusing only on South Asian countries to estimate the prevalence of vaccine hesitancy toward COVID-19 is rare.

Research conducted in South Asian countries reported that two third of the respondents were willing to take the COVID-19 vaccine in four South Asian countries (Hawlader et al., 2022). It

was also discovered that vaccine availability and acceptance varied across nations depending on age, sex, marital status, education, comorbidities, worry about contracting an infection, perceived COVID-19 impact, belief regarding vaccine efficacy, and positive attitude toward mandatory measures. The limitation of this study included convenience sampling instead of getting structured and focusing on only four South Asian countries from the eight countries. Another narrative review on global COVID-19 vaccine acceptancy reported the vaccine acceptance rate of five South Asian countries but did not report any pooled prevalence for the region (Sallam et al., 2022). However, creating more valid and generalized evidence based on all countries of this region remains missing.

Insights into vaccination-hesitant populations and their characteristics through sub-group analysis could help identify gaps, potentially strengthening vaccination campaigns to increase awareness and vaccination coverage. Likewise, determining the pooled estimated proportion of COVID-19 vaccination hesitancy can guide policymakers to prepare for an effective vaccination program among South Asian countries to address the COVID-19 pandemic successfully. Thus, this study aimed to conduct a systematic review and meta-analysis calculating the pooled prevalence of vaccine hesitancy of COVID-19 among South Asian countries and gain insight into vaccination hesitancy. Promoting the uptake of vaccines in South Asia will require more understanding of whether people are willing to be vaccinated, why they are ready or unwilling to do so, and the most trusted sources of information in their decision-making.

Methods

A systematic review and meta-analysis were conducted to determine the prevalence and determinants of COVID-19 vaccine hesitancy among South Asian countries. The study was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement (Aw et al., 2021) and Cochrane Handbook (Higgins et al., 2019).

Search strategy

This review paper accessed the database, registers, and other search platforms, including Medline, PubMed, Cochrane, and Google Scholar. Although we did not have direct institutional access to Scopus and Web of Science, we searched the WHO COVID-19 database (World Health Organization, 2022) for access to relevant studies and reports. Nevertheless, we had proxy access to Scopus and Web of Science databases by exploring the WHO COVID-19 database (World Health Organization, 2022). The search was conducted from January 1, 2022, to January 5, 2022, and updated on January 30, 2022. The search timeframe for this study was set from January 1, 2020, to December 31, 2021, as the review focused on the COVID-19 pandemic and the hesitancy toward COVID-19 vaccines. The general search strategy used in this study is displayed in Table 1.

The final search query with the Boolean operators was:

((Coronavirus) OR (COVID-19) OR (SARS-CoV-2) OR (2019-nCoV)) AND (Vaccine hesitancy) AND (Prevalence) AND ((Afghanistan) OR (Bangladesh) OR (Bhutan) OR (India) OR (Maldives) OR (Nepal) OR (Pakistan) OR (Sri Lanka)) NOT (Global))

Table 1: General Search Strategy Used in this Study

Query	Search topic	Keywords (titles, abstracts) with Boolean operators
A	Exposure/Context	"Coronavirus" OR "COVID-19" OR "SARS-CoV-2" OR "2019-nCoV"
B	Outcome of interest	"Vaccine hesitancy"
C	Epidemiological phenomenon	"Prevalence"
D	Location	"Afghanistan" OR "Bangladesh" OR "Bhutan" OR "India" OR "Maldives" OR "Nepal" OR "Pakistan" OR "Sri Lanka"
E	Year Range	"2020 OR 2021"
F	Final search query	**((A)** AND (**B)** AND **(C)** AND **(D** NOT Global**)** AND **(E))**

Data inclusion criteria

The following inclusion criteria were applied: studies with participants at least 18 years old, cross-sectional study design, COVID-19 hesitancy data reported, and peer-reviewed journal articles in English. Five authors independently searched the studies and reports on different databases and registers. Two authors independently assessed the titles and abstracts of the retrieved articles based on the inclusion and exclusion criteria. After that, the final list of articles was examined by one author. The disagreements were solved through logical discussions about the study objective between all authors.

Data items

The participants were divided into general populations, healthcare workers, and students. Participants from the community or national survey referred to the general population. The healthcare workers included those providing healthcare services (e.g., medical doctors, nurses, staff, etc.). Students were included from colleges and universities above 18 years old. We divided the studies into two primary levels: community and institutional. Studies conducted in a community (e.g., village, district, or national survey) were referred to as community level. The institutional level study was defined by the studies conducted in an institutional setup (e.g., hospitals, healthcare centers, etc.). The data collection period since the first outbreak was calculated by the time spent from the first day of COVID-19-positive cases in the individual country to the last day of data collection of the individual study. The first reported COVID-19-positive cases in Afghanistan were on February 24, 2020 (Sediqi & Karimi, 2020), March 8, 2020, in Bangladesh (Islam et al., 2020), March 6, 2020, in Bhutan (AFP, 2020), January 27, 2020, in India (Andrews et al., 2020), March 7, 2020, in the Maldives (Reuters, 2020), January 23, 2020, in Nepal (Shrestha et al., 2020), February 26, 2020, in Pakistan (Abid et al., 2020), and January 27, 2020, in Sri Lanka (Arambepola et al., 2021).

Quality assessment of the included studies

The Joanna Briggs Institute (2014) critical appraisal checklist for studies reporting prevalence data was used to assess the quality of the articles. The checklist is used to scrutinize the methodological quality and determine the extent to which a study has addressed the possibility of bias in its design, conduct, and analysis. The checklist was maintained against the questions addressing the appropriate sampling frame to address the targeted population, the recruitment of study participants, the adequate sample size, study subjects and setting

description in detail, proper data analysis, measurement or classification bias, considerable judgment for outcome measure, and response rate. Five authors independently marked the comprehensive appraisal for the selected studies, and one author cross-checked the final critical appraisal checklist.

Statistical analysis

We used OpenMetaAnalyst, Comprehensive Meta-Analysis, and StatsDirect software to perform the meta-analysis. We used the DerSimonian and Laird random-effects model to calculate the pooled effect estimates with 95% confidence intervals (Higgins et al., 2019). When there is heterogeneity among studies, such as systematic differences between the results of minor and more extensive studies, one of the most appropriate models is the random effects model, as it gives small sample size studies a greater weight to compare (Dettori et al., 2022). The DerSimonian and Laird random-effects model is a popular method for comparing the effect sizes for different studies with smaller and larger sample sizes (Higgins et al., 2019).

The pooled prevalence rate was estimated by individual studies' proportions of vaccine hesitancy. The size of the squares of the forest plots showed the weight of each study. It is common practice to explore heterogeneity in systematic reviews using the I-squared statistic (I^2) (Migliavaca et al., 2022). The I^2 statistic calculated the presence of heterogeneity among the studies. An I^2 value of 0–25% indicates low heterogeneity, 25–75% moderate heterogeneity, and high 75–100%. Cochrane's Q-test was used for measuring heterogeneity with a significance level of $p < .10$ (Higgins et al., 2019).

Meta-regression was conducted to identify the sources of heterogeneity among studies with study covariates and pooled prevalence estimates. We used the study country, population, type, and data collection period from the first outbreak as the covariates to perform the meta-regression.

Subgroup analysis was performed by country, sex (male, female), study population (general population, healthcare worker, and students), study level (community level, institutional level), and period of data collection since the first outbreak (0–12 months, 12–18 months). An I^2 statistic is also calculated for subgroup differences to determine the variability in effect estimates from the different subgroups (Higgins et al., 2019).

Sensitivity analyses were performed in this meta-analysis to assess the influence of individual studies on the pooled prevalence estimates or heterogeneity (Higgins et al., 2003). We used the "leave one out" process that excluded each survey and estimated the pooled estimates for the rest of the studies.

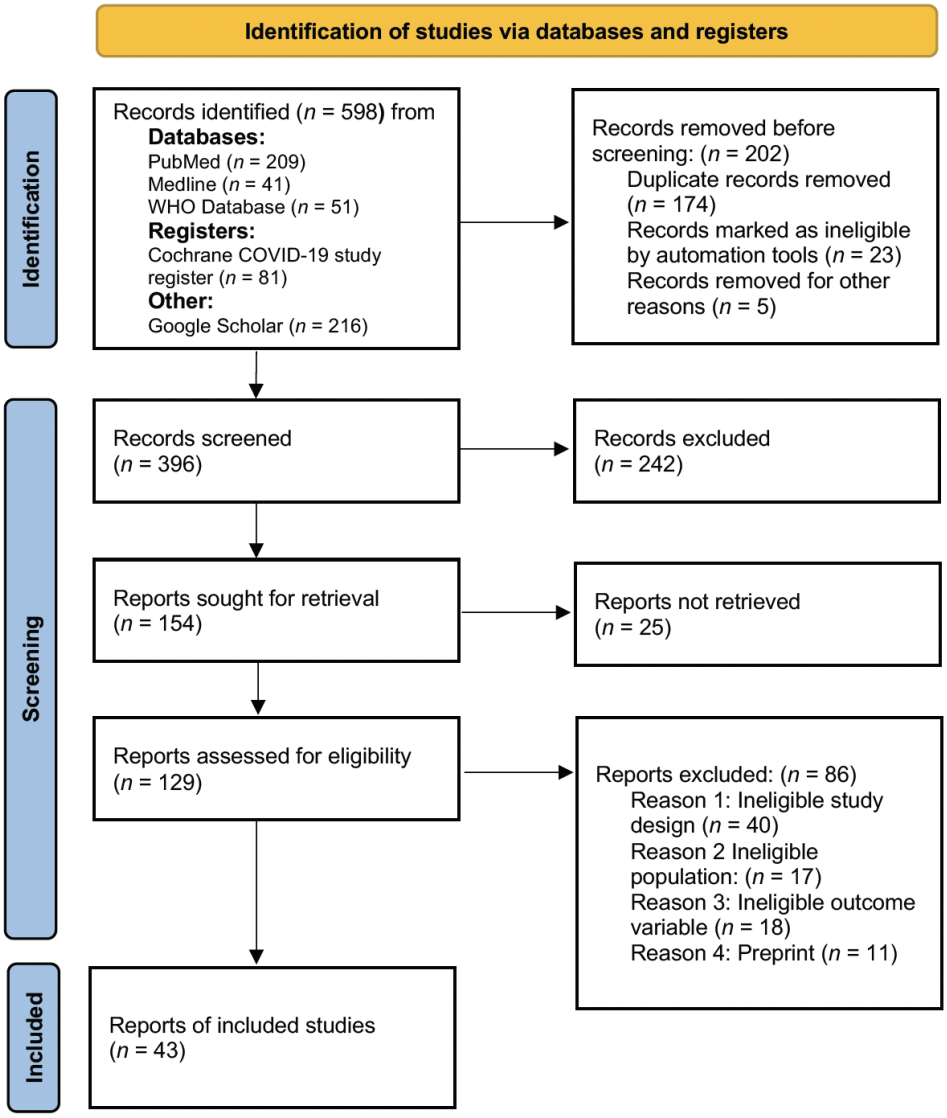
Publication bias was assessed by inspecting funnel plots and Egger's tests. In a meta-analysis, Egger's test is commonly used to determine the possibility of publication bias based on the asymmetry of funnel plots. A triangle on the funnel plot signifies a lower publication bias if the triangle covers the studies. During Egger's test, publication bias is considered to exist if the p value was less than 0.1.

Results

This meta-analysis yielded 43 published studies on vaccine hesitancy of COVID-19 among eight South Asian countries. A total of 598 records were found from the initial search through different electronic databases and registers. After excluding 202 studies (duplicate records/ ineligible by automation process), we screened 396 records. From the title and abstract screening, we retrieved 154 records though 25 could not be retrieved due to lack of access and lack of full texts. Exactly 86 papers were excluded based on the ineligibility criteria of the framework. Unfortunately, we could not find relevant articles from Bhutan that addressed the outcome variable.

A PRISMA flowchart describing the selection of the studies is illustrated in Figure 1.

Figure 1: PRISMA 2020 Flow Diagram of the Included Studies for the Systematic Review and Meta-Analysis of the Prevalence and Determinants of Vaccine Hesitancy in South Asian Countries



Characteristics of the included studies

The summary characteristics of the included studies are provided in Table 2. Overall, the study had a total of 60,852 participants. Among them, 31,978 (53%) were male, and 28,874 (47%) were female. Exact 33 (77%) of all studies were conducted among the general population, six (14%) studies focused only on healthcare workers, and four (9%) studies focused only on students who were more than 18 years old. Also, 36 (83%) of the studies were at the community level, and 7 (16%) were conducted at different institutional levels in South Asia.

The pooled prevalence of vaccine hesitancy ranged from 2% to 54%. The forest plot shows the individual studies for the weighted prevalence of COVID-19 vaccine hesitancy among the included studies (Figure 2). Overall, the pooled prevalence of vaccines in South Asia was 26.5% (95% CI [22, 31]) among the 43 studies. Significant heterogeneity in the meta-analysis was observed, $I^2 = 99.59\%$, $p < .001$.

Table 2: Summary Characteristics of Studies Included in the Systematic Review and Meta-Analysis of the Prevalence and Determinants of Vaccine Hesitancy in South Asian Countries

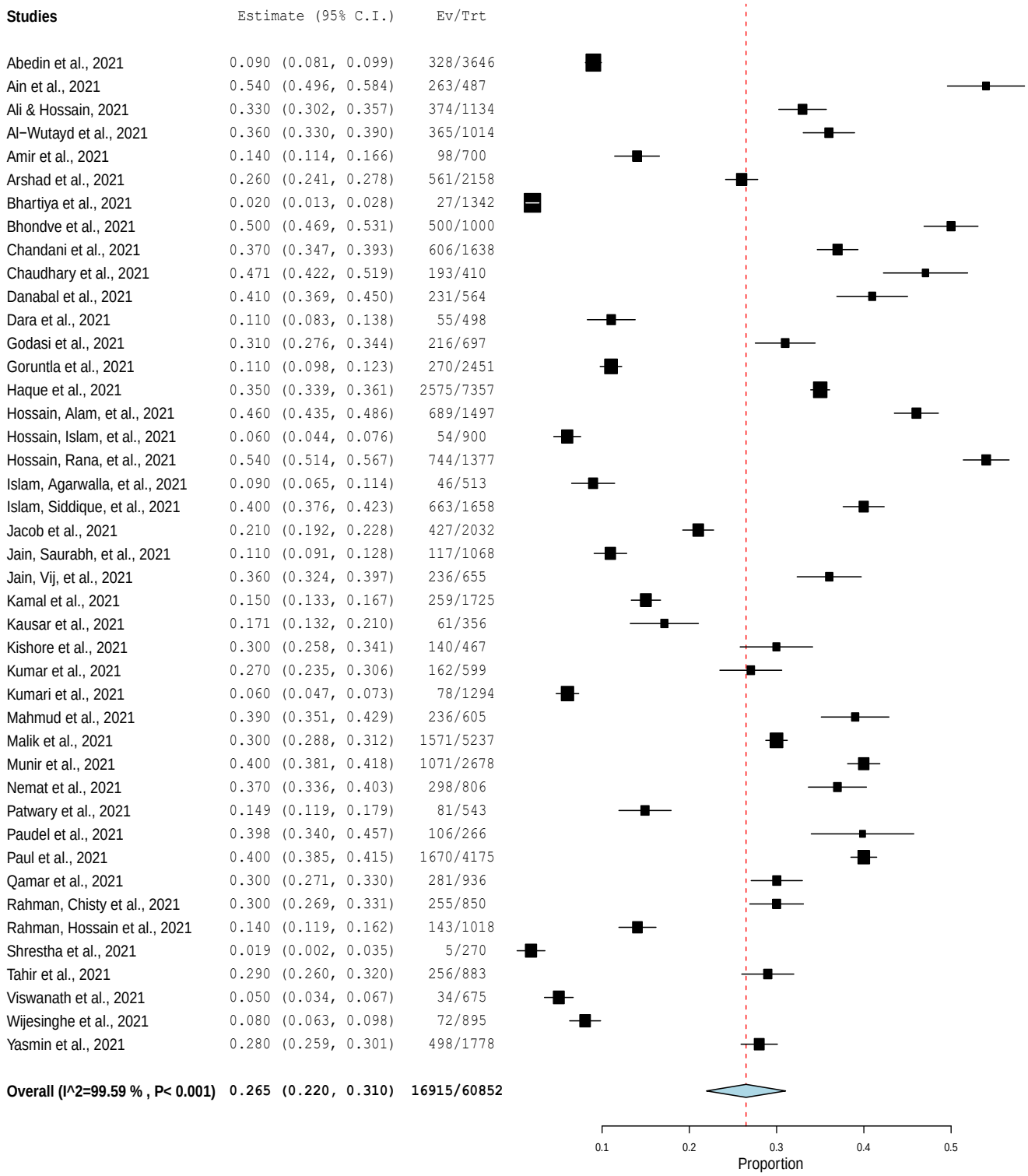
Authors & year	Study Country	Study Design and Type	Sampling Design	Study Population	Period of data collection since the first outbreak (In month)	Age range of participants	Total participants (N)	Female, (n)	Vaccination hesitancy, (%)
Abedin et al., 2021	Bangladesh	Cross-sectional, community-based	Systematic sampling	General population	1–12	18–60 ≤	3,646	2,212	9%
Ain et al., 2021	India	Cross-sectional, community-based	Convenience sampling	General population	1–12	18–31 ≤	487	269	54%
Ali & Hossain, 2021	Bangladesh	Cross-sectional, community-based	Two-stage cluster sampling technique	General population	1–12	18–61 ≤	1,134	449	33%
Al-Wutayd et al., 2021	Pakistan	Cross-sectional, community-based	Convenience sampling	General population	12–18	18–60 ≤	1,014	478	36%
Amir et al., 2021	Maldives	Cross-sectional, community-based	Stratified random sampling	General population	12–18	18–65 ≤	700	445	14%
Arshad et al., 2021	Pakistan	Cross-sectional, community-based	Convenient sampling	General population	1–12	18–50 ≤	2,158	966	26%
Bhartiya et al., 2021	India	Cross-sectional, community-based	NR	General population	1–12	18–60 ≤	1,342	710	2%
Bhondve et al., 2021	India	Cross-sectional, community-based	Convenience sampling	General population	NR	32[a]	1,000	466	50%
Chandani et al., 2021	India	Cross-sectional, community-based	Convenience sampling	General population	1–12	18–51 ≤	1,638	732	37%
Chaudhary et al., 2021	Pakistan	Cross-sectional, institution-based	Convenience sampling	General population	12–18	18–51 ≤	410	234	47%
Danabal et al., 2021	India	Cross-sectional, community-based	Multistage systematic random sampling	General population	1–12	18–84	564	355	41%
Dara et al., 2021	India	Cross-sectional, institution-based	Convenience sampling	Healthcare Worker	1–12	18–25 ≤	498	144	11%
Godasi et al., 2021	India	Cross-sectional, community-based	Snowball sampling	General population	12–18	20–65 ≤	697	358	31%

Authors & year	Study Country	Study Design and Type	Sampling Design	Study Population	Period of data collection since the first outbreak (In month)	Age range of participants	Total participants (N)	Female, (n)	Vaccination hesitancy, (%)
Goruntla et al., 2021	India	Cross-sectional, community-based	Snowball sampling	General population	1–12	20–60 ≤	2,451	978	11%
Haque et al., 2021	Bangladesh	Cross-sectional, community-based	Convenience sampling	General population	1–12	18–50 ≤	7,357	2,528	35%
Hossain, Alam, et al., 2021	Bangladesh	Cross-sectional, community-based	Quota sampling	General population	1–12	18–50 ≤	1,497	692	46%
Hossain, Islam, et al., 2021	Bangladesh	Cross-sectional, institution-based	Convenient sampling	Students	12–18	23.95[b]	900	398	6%
Hossain, Rana, et al., 2021	Bangladesh	Cross-sectional, community-based	Convenience sampling	General population	1–12	18–51 ≤	1,377	598	54%
Islam, Agarwalla, et al., 2021	India	Cross-sectional, community-based	Simple random sampling	General population	1–12	18–55 ≤	513	248	9%
Islam, Siddique, et al., 2021	Bangladesh	Cross-sectional, community-based	Snowball sampling	General population	1–12	18–25 ≤	1,658	736	40%
Jacob et al., 2021	India	Cross-sectional, community-based	Snowball sampling	General population	1–12	18–55 ≤	2,032	1,270	21%
Jain, Saurabh, et al., 2021	India	Cross-sectional, institution-based	Snowball sampling	Students	1–12	NR	1,068	519	11%
Jain, Vij, et al., 2021	India	Cross-sectional, community-based	Snowball sampling	Students	1–12	18–65 ≤	655	406	36%
Kamal et al., 2021	Bangladesh	Cross-sectional, community-based	Convenience and snowball sampling	General population	1–12	18–56 ≤	1,725	714	15%
Kausar et al., 2021	India	Cross-sectional, institution-based	Convenience sampling	Students	12–18	18–23 ≤	356	213	17%
Kishore et al., 2021	India	Cross-sectional, community-based	Convenience sampling	General population	1–12	18–60 ≤	467	190	30%
Kumar et al., 2021	India	Cross-sectional, community-based	NR	Healthcare Worker	12–18	18–30 ≤	599	306	27%
Kumari et al., 2021	India	Cross-sectional, community-based	Purposive and snowball sampling	General population	12–18	18–60 ≤	1,294	539	6%

Authors & year	Study Country	Study Design and Type	Sampling Design	Study Population	Period of data collection since the first outbreak (In month)	Age range of participants	Total participants (N)	Female, (n)	Vaccination hesitancy, (%)
Mahmud et al., 2021	Bangladesh	Cross-sectional, community-based	NR	General population	1–12	18–100	605	229	39%
Malik et al., 2021	Pakistan	Cross-sectional, community-based	Snowball sampling	Healthcare Worker	1–12	18–60 ≤	5,237	3,315	30%
Munir et al., 2021	Pakistan	Cross-sectional, community-based	NR	General population	1–12	18–45 ≤	2,678	1,522	40%
Nemat et al., 2021	Afghanistan	Cross-sectional, community-based	Convenient sampling	General population	1–12	18–40 ≤	806	220	37%
Patwary et al., 2021	Bangladesh	Cross-sectional, community-based	Convenience sampling	General population	12–18	24.3[b]	543	333	15%
Paudel et al., 2021	Nepal	Cross-sectional, institution-based	Stratified random sampling	Healthcare Worker	1–12	20–30	266	190	40%
Paul et al., 2021	Bangladesh	Cross-sectional, community-based	Convenience sampling	General population	1–12	18–60 ≤	4,175	1,452	40%
Qamar et al., 2021	Pakistan	Cross-sectional, community-based	Convenience sampling	General population	1–12	18–60 ≤	936	558	30%
Rahman, Chisty, et al., 2021	Bangladesh	Cross-sectional, community-based	Convenient sampling	General population	12–18	18–55 ≤	850	404	30%
Rahman, Hossain, et al., 2021	Bangladesh	Cross-sectional, community-based	Snowball sampling	General population	1–12	18–26 ≤	1,018	346	14%
Shrestha et al., 2021	Nepal	Cross-sectional, community-based	Convenience sampling	Healthcare Worker	1–12	31.47[b]	270	129	2%
Tahir et al., 2021	Pakistan	Cross-sectional, community-based	Convenience sampling	General population	1–12	18–51 ≤	883	392	29%
Viswanath et al., 2021	India	Cross-sectional, institution-based	NR	Healthcare Worker	1–12	18–45 ≤	675	71	5%
Wijesinghe et al., 2021	Sri Lanka	Cross-sectional, community-based	Purposive sampling	General population	12–18	18–65 ≤	895	407	8%
Yasmin et al., 2021	Pakistan	Cross-sectional, community-based	NR	General population	1–12	18–60	1,778	1,153	28%

Note: NR= Not Reported, [a] = median age, [b] = mean age

Figure 2: Forest Plot of the Pooled Prevalence of Vaccine Hesitancy in South Asian Countries



Subgroup analysis

As seen in Table 3, among the South Asian countries reporting the pooled prevalence of COVID-19 vaccine hesitancy, Afghanistan had the highest rate (37%, 95% CI [33.6, 40.3], I^2 = N/A) followed by Pakistan (33%, 95% CI [29.1, 37.0], I^2 = 96.18%), Bangladesh (28.9%, 95% CI [20.2, 37.6], I^2 = 99.67%), India (23.4%, 95% CI [17.0, 29.8], I^2 = 99.45%), Nepal (20.7%, 95% CI [-16.5, 58.0], I^2 = 96.18%), Maldives (14%, 95% CI [11.4, 16.6], I^2 = N/A), and Sri Lanka (8.0%, 95% CI [6.3, 9.8], I^2 = N/A).

A higher prevalence was reported among the general population (29%, 95% CI [23.6, 34.4], I^2 = 99.63%) compared to healthcare workers (19%, 95% CI [6.8, 31.2], I^2 = 99.53%), and students (17.4%, 95% CI [7.0, 27.8], I^2 = 98.68%). Additionally, the meta-analysis showed that studies conducted at any community level had a higher prevalence rate (27.9%) than those conducted at an institutional level, and the studies which were conducted in the first year since the first outbreak had a higher level of hesitancy reporting (27.5%) than studies which were conducted in a later period.

Furthermore, an independent sub-group analysis was run to differentiate the prevalence among males and females for each study. However, there was no statistically significant difference in vaccine hesitancy among males and females.

Table 3: Subgroup Analysis of the Prevalence of COVID-19 Vaccine Hesitancy in South Asia

Subgroup	Number of studies	Total Sample	Prevalence [95% CI]	Heterogeneity	
				I^2	*p* value
Overall	43	60,852	26.5% [22, 31]	99.59%	.00
By Country					
Afghanistan	1	806	37% [33.6, 40.3]	NA	NA
Bangladesh	13	26,485	28.9% [20.2, 37.6]	99.67%	.00
India	17	16,336	23.4% [17, 29.8]	99.45%	.00
Maldives	1	700	14% [11.4, 16.6]	NA	NA
Nepal	2	536	20.7% [-16.5, 58]	99.33%	.00
Pakistan	8	15,094	33% [29.1, 37]	96.18%	.00
Sri Lanka	1	895	8% [6.3, 9.8]	NA	NA
By Study Population					
General Population	33	50,328	29% [23.6, 34.4]	99.63%	.00
Healthcare Worker	6	7,545	19% [6.8, 31.2]	99.53%	.00
Students	4	2,979	17.4% [7, 27.8]	98.68%	.00
By Study Level					
Community Level	36	56,679	27.9% [22.8, 32.9]	99.62%	.00
Institutional Level	7	4,173	19.2% [11.7, 26.7]	98.5%	.00
By Period of Data Collection Since First Outbreak					
1–12 Months	31	51,594	27.5% [22, 33]	99.65%	.00
12–18 Months	11	8,258	21.4% [14.5, 28.4]	98.93%	.00
Not Reported	1	1,000	50% [46.9, 53.1]	NA	NA

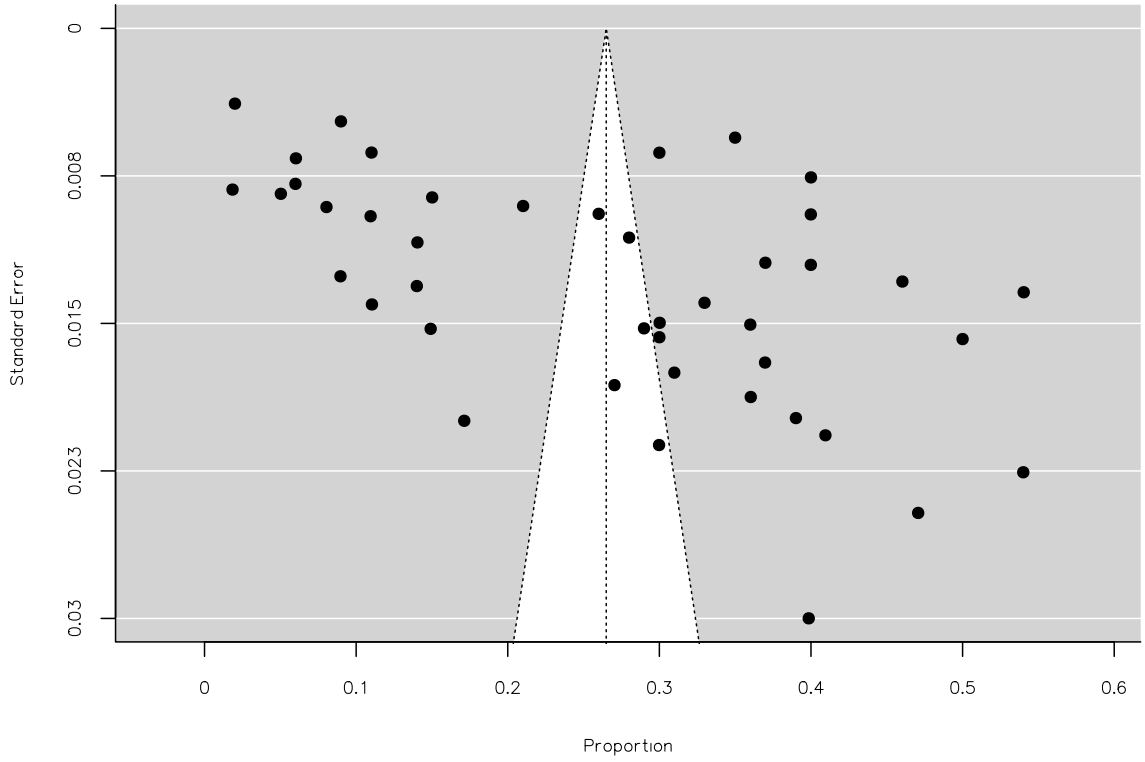
Note: NA = Not Applicable

Meta-regression and publication bias

A meta-regression analysis was performed as there was data collection period heterogeneity; the p value of the I^2 test was less than .05. The analysis aimed to distinguish the source of heterogeneity. However, the meta-regression analysis found no significant covariate to describe the heterogeneity. In addition, there was no statistically significant study level covariate: study country, study population, study type, and data collection period since the first outbreak.

Egger's regression asymmetry test confirmed a significant level of publication bias, with p value < .001. From the Rank Correlation test, the Begg-Mazumdar Kendall's value was 0.24, p = .02. The visual assessment of the funnel plot also reported a high publication bias (Figure 3).

Figure 3: Funnel Plot of Publication Bias for the Selected Studies



Quality assessment score of the articles

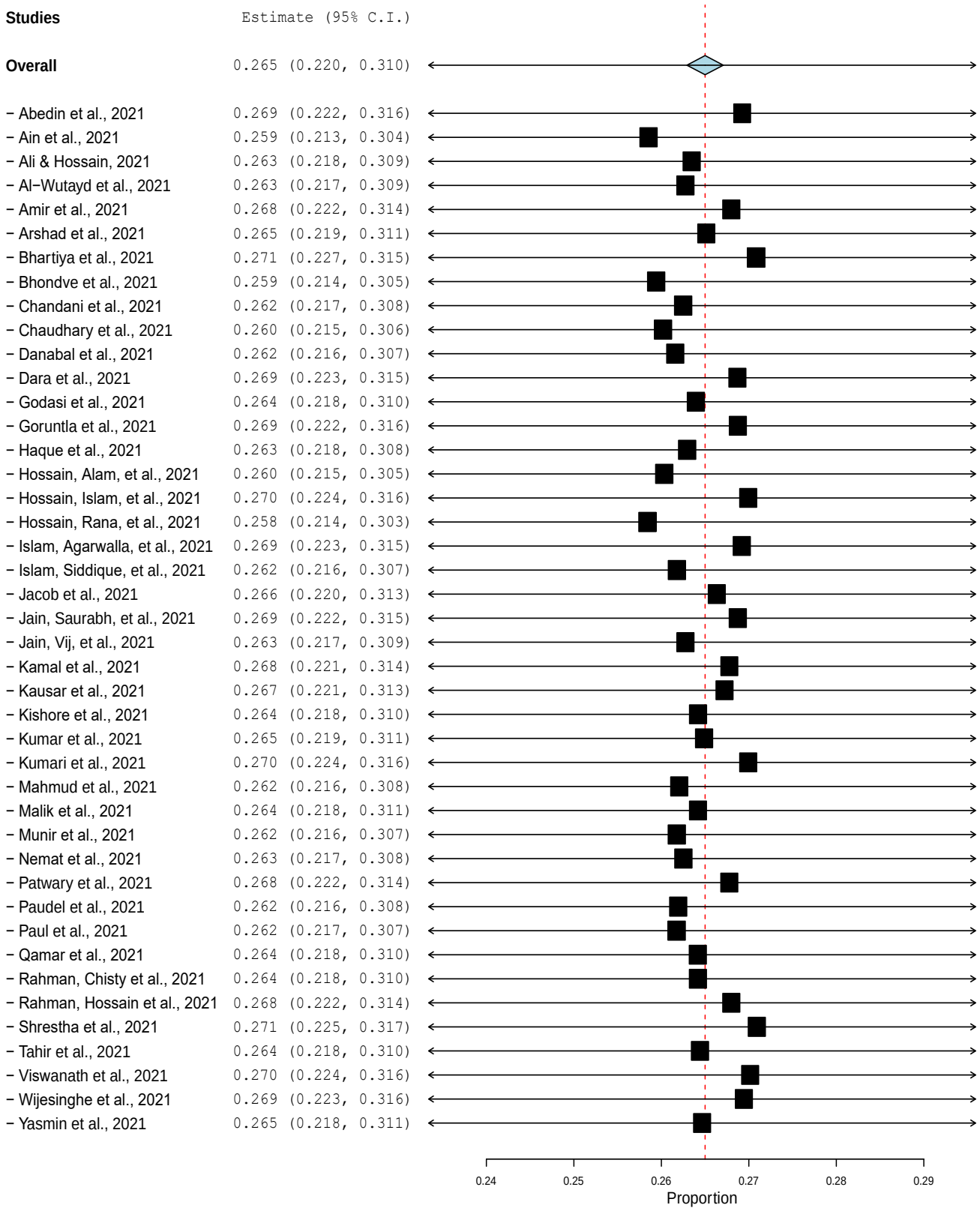
The mean quality score of the selected articles (n = 43) was calculated as 7.9 out of 9.00 according to the Joanna Briggs Institute (2014) critical appraisal checklist for studies reporting prevalence data, while the lowest score had the value of 4.00, and the highest score had the value of 9.00. The individual scores of the articles are shown in the annex (Table 1).

Sensitivity analysis

To better understand the prevalence rate, we further conducted a sensitivity analysis. First, we ran a 'leave one out' test to perform the sensitivity analysis (Figure 4). After excluding each

study and calculating the overall estimation, the pooled prevalence rate was unchanged (26.5%, 95% CI [22, 31]).

Figure 4: Sensitivity Analysis (Leave One Out) for Studies for Vaccine Hesitancy



Discussion

Vaccine hesitancy is considered a risk factor for hindering the success of vaccination programs aiming to control the COVID-19 pandemic (Bono et al., 2021; Leng et al., 2021). This review was conducted to estimate the prevalence of COVID-19 vaccine hesitancy in the South Asian region. From the South Asian countries, we systematically selected 43 articles based on the inclusion criteria and PRISMA statement, which led us to 60,852 participants. The overall prevalence was 26.5% in this study. This finding is much lower compared to the Southeast Asian countries (49.3%) (Marzo et al., 2022), the United Kingdom (36.5%) (Paul et al., 2021), the United States (32%) (Norhayati et al., 2022), and the African region (47%) (Norhayati et al., 2022), but similar to the estimate of 25% COVID-19 vaccine hesitancy rate found globally (Fajar et al., 2022). The prevalence rate varied among general people, healthcare workers, students, community and institutional studies, and the selected seven countries.

This study also compared the prevalence by the time studies were conducted since the beginning of the COVID-19 outbreak. We chose this covariate as people's knowledge, attitude, and practice may change or develop over time within the pandemic as new information about COVID-19 and vaccines is coming to people very quickly. Our finding suggests that vaccine hesitancy was high in the first year of the COVID-19 outbreak in each country, and then it declined over time. Possible causes are increasing levels of awareness, proper knowledge, media campaign, and government emergency action (Barello et al., 2020; Norhayati et al., 2022; Paul et al., 2021). Also, the findings from the meta-analysis indicated that the students have the least rate of hesitancy compared to the general adult population and healthcare workers. Most of the studies showed that the intention to vaccinate was much lower among people with lower education (Abedin et al., 2021; Bhartiya et al., 2021; Chandani et al., 2021; Godasi et al., 2021; Haque et al., 2021; Hossain, Rana, et al., 2021). These findings are similar to studies conducted in Southeast Asia, low and middle-income countries, France, the middle east, and the United States of America (Bono et al., 2021; Marzo et al., 2022; Qunaibi et al., 2021; Schwarzinger et al., 2021; Szilagyi et al., 2021). We also reviewed studies in South Asia that discussed the medical students' high acceptance level (Kausar et al., 2021). This finding was similar to studies conducted among medical and tertiary level students outside this region as well (Barello et al., 2020; Mant et al., 2021; Mascarenhas et al., 2021; Riad, Abdulqader, et al., 2021; Riad, Pokorná, et al., 2021; Saied et al., 2021; Tavolacci et al., 2021).

Based on this systematic review, people diagnosed with COVID-19 earlier were more willing to accept the vaccine (Ain et al., 2021; Chandani et al., 2021). Physicians' recommendation also affects the vaccine hesitancy of an individual (Yasmin et al., 2021). People with a negative attitude and inadequate knowledge of the vaccine were more likely to refuse or equivocate a COVID-19 vaccine (Rahman, Chisty, et al., 2021). Opposition affiliation with political views often showed more hesitancy (Ali & Hossain, 2021). Some studies from Africa and Sub-Saharan African countries depicted that a lack of government willingness was also responsible for the vaccine hesitancy (Afolabi & Ilesanmi, 2021; Kanyanda et al., 2021). In our reviewed article in Pakistan, belief in COVID-19-related myths or conspiracy theories was responsible for vaccine hesitancy (Al-Wutayd et al., 2021; Arshad et al., 2021; Chaudhary et al., 2021; Malik et al., 2021; Munir et al., 2021; Qamar et al., 2021; Tahir et al., 2021; Yasmin et al., 2021). The Middle East and the United States of America studies reported a similar factor (Romer & Jamieson, 2020; Sallam et al., 2021).

Our review has some limitations to address. Firstly, we could not include Bhutan in our review as no relevant study based on our criteria was found in the selected database or registered until the last day of our search process. Secondly, we excluded some studies conducted in multiple time frames, as it was very complex to pick the hesitancy rate from one period of time from many. Thirdly, we did not include the keywords vaccine acceptance, resistance, and rejection in our search strategy; therefore, some studies could not be included. The main reason for this exclusion was the inconsistency of the academic and clinical definitions of these terms. For example, vaccine resistance has a different clinical definition related to pathogens (Kennedy & Read, 2018). We excluded those keywords from the searches to avoid this confusion and make the analysis more relevant only to hesitancy. Finally, this review expressed a significant level of publication bias. A possible reason can be the exclusion of preprints, grey literature, and studies conducted in different languages rather than English.

Conclusion and policy suggestions

Vaccination is essential to curb COVID-19 to achieve herd immunity in the population. In South Asia, the effectiveness of this approach depends on vaccination acceptance in the population. However, one in every four people in South Asia has hesitancy toward the COVID-19 vaccine. The varied difference in vaccine hesitancy rate was found among countries, even within countries in the general population group, community level, and period of 1–12 months since the first outbreak in every country and among the male population. Although hesitancy was lower among healthcare workers than the general people, it was not nonexistent among healthcare workers.

Based on the analysis and findings of this study, there are a few policy suggestions. Firstly, future interventions to increase vaccine acceptance in this region should target the general population. Therefore, a mass communication program is needed. Secondly, intervention programs should be designed to spread the message among the community through the vaccinated people to give the belief about its safety and effectiveness. Friends and family members can play a significant role in motivating others. Thirdly, although hesitancy was lower among the healthcare workers than the general people, it was reported among them significantly. Thus, targeted interventions are required for them to address and eradicate any misinformation. Fourthly, to increase vaccine literacy and debunk misinformation shortly and future pandemics, governments and non-governmental organizations (NGOs) can play a vital role in broadening the population for the successful commencement of vaccination campaigns. Fifthly, advocacy programs on vaccination can be encouraged through religious leaders in the community. In the South Asian region, religious leaders have access to motivate the mass population quickly by clearing their misconceptions. Finally, future research should focus on misconceptions about the motivational factors in parallel with the social determinants so that government and relevant stakeholders can introduce the immunization program on health promotion, focusing on and using these factors to increase the acceptance rate and reduce the vaccine hesitancy among South Asian countries and beyond.

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Annex

Table 1: JBI Critical Appraisal Checklist and Overall Score of the selected articles

Authors & year	1. Was the sample frame appropriate to address the target population?	2. Were study participants sampled in an appropriate way?	3. Was the sample size adequate?	4. Were the study subjects and the setting described in detail?	5. Was the data analysis conducted with sufficient coverage of the identified sample?	6. Were valid methods used for the identification of the condition?	7. Was the condition measured in a standard, reliable way for all participants?	8. Was there appropriate statistical analysis?	9. Was the response rate adequate, and if not, was the low response rate managed appropriately?	Overall Score
Abedin et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00
Ain et al., 2021	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8.00
Ali & Hossain, 2021	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Unclear	6.00
Al-Wutayd et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00
Amir et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00
Arshad et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00
Bhartiya et al., 2021	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8.00
Bhondve et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00
Chandani et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00
Chaudhary et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00
Danabal et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00
Dara et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00
Godasi et al., 2021	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	7.00
Goruntla et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00
Haque et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00
Hossain, Alam, et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00

Authors & year	1. Was the sample frame appropriate to address the target population?	2. Were study participants sampled in an appropriate way?	3. Was the sample size adequate?	4. Were the study subjects and the setting described in detail?	5. Was the data analysis conducted with sufficient coverage of the identified sample?	6. Were valid methods used for the identification of the condition?	7. Was the condition measured in a standard, reliable way for all participants?	8. Was there appropriate statistical analysis?	9. Was the response rate adequate, and if not, was the low response rate managed appropriately?	Overall Score
Hossain, Islam, et al., 2021	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	8.00
Hossain, Rana, et al., 2021	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	7.00
Islam, Agarwalla, et al., 2021	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	7.00
Islam, Siddique, et al., 2021	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	7.00
Jacob et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00
Jain, Saurabh, et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00
Jain, Vij, et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00
Kamal et al., 2021	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	7.00
Kausar et al., 2021	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	8.00
Kishore et al., 2021	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	Unclear	Yes	7.00
Kumar et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00
Kumari et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00
Mahmud et al., 2021	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	6.00
Malik et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00
Munir et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00
Nemat et al., 2021	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	4.00
Patwary et al., 2021	Unclear	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	7.00
Paudel et. al. 2021	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	7.00

Authors & year	1. Was the sample frame appropriate to address the target population?	2. Were study participants sampled in an appropriate way?	3. Was the sample size adequate?	4. Were the study subjects and the setting described in detail?	5. Was the data analysis conducted with sufficient coverage of the identified sample?	6. Were valid methods used for the identification of the condition?	7. Was the condition measured in a standard, reliable way for all participants?	8. Was there appropriate statistical analysis?	9. Was the response rate adequate, and if not, was the low response rate managed appropriately?	Overall Score
Paul et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00
Qamar et al., 2021	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	7.00
Rahman, Chisty, et al., 2021	Unclear	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Yes	7.00
Rahman, Hossain, et al., 2021	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	7.00
Shrestha et al., 2021	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Unclear	4.00
Tahir et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00
Viswanath et al., 2021	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	7.00
Wijesinghe et al., 2021	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	5.00
Yasmin et al., 2021	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	9.00
					Overall Mean Score					**7.9**

Note: Yes = 1, No= -1, Unclear = 0