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Acceptance and reluctance of COVID-19 vaccination among the general population: a systematic review and meta-analysis of cross-sectional studies

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ABSTRACT

The objective of this study was to systematically review the selected literature and identify the rate and reasons for acceptance and hesitancy among the common public toward coronavirus disease 2019 (COVID-19) vaccination in various countries. The systematic review was conducted in compliance with the "Preferred Reporting Project for Systematic Evaluation and Meta-Analysis" recommendations using search words in search engines (PubMed, Scopus, Google Scholar), and the cross-sectional studies were screened based on inclusion and exclusion standards. Institute of Joanna Briggs. A critical analytical checklist was used to evaluate publication bias in the included studies. The analysis was performed using the 4.0.5 version of R. Of the 84 articles screened, 18 were included. Ten articles that assessed the acceptance of COVID-19 vaccination in 22,212 participants reported an overall 59.6% acceptance rate with highest in Malaysia (94.3%) and the lowest in Hong Kong (42.2%). The proportion of the vaccination acceptance rate published in 16 studies with weighted mean difference (WMD) was 63.79% (95% CI: 54.19%–73.39 %; I^2 = 100 %; $p < 0.00001$), and the proportion of hesitancy rate in 8 studies with WMD was 25.13% (95% CI: 17.21%–33.06%; I^2 = 100 %; $p < 0.00001$). Hesitancy to get vaccinations was due to concerns about adverse consequences, lack of reliability, belief as a biological weapon, newness, issues regarding effectiveness and safety, and not wanting to be the first to receive the vaccination. COVID-19 vaccine acceptability rates overall were around 64%, and concerns about vaccine safety had led to hampered vaccination promotion among the public.

INTRODUCTION

Coronavirus disease 2019 (COVID-19) in 2019 that emerged from Wuhan, China caused a devastating impact on the socioeconomic crisis globally, distressing the day-to-day life, business, and mental health of the citizens [1]. SARS-CoV is the cause of severe acute respiratory syndrome, which has resulted in a massive surge in mortality and morbidity rates across the globe [2–5]. To reduce the pandemic, governments of various countries took measures like initiating curfews, ushering in quarantine of suspected individuals and augmented centres for testing and treatment of patients [6]. As COVID-19 spread across the globe, governments turned to research and vaccine production to combat the disease [7]. Therefore, COVID-19 vaccines were in need of the hour as they were

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considered the main source to halt the robust negative impact of the pandemic on education, the economy, healthcare, and countless other activities of a functioning society [8].

As estimated by the World Health Organization, vaccines are believed to have prevented at least 10 million fatalities globally between 2010 and 2015 [5]. Despite the growing evidence that vaccines are safe [9,10], vaccine skepticism also exists [11,12]. Ironically, vaccine hesitancy is also a result of their effectiveness, as some people are less worried about contracting the infection, which contributes to increased vaccine hesitancy [13]. High vaccination coverage in South East Asia was essential to reduce the spread of the COVID-19 global health crisis COVID-19. However, there was uncertainty about the effectiveness and safety of these vaccines for individuals because of the momentum of vaccine development and approval in less than a year or the insufficient testing data [14–16]. The public's doubt about vaccines has become an increasingly important global issue, and this attitude of vaccine hesitancy can impede herd immunity. The rate of acceptance and hesitancy toward vaccines has become vital for defining public health policies and attaining herd immunity. Outbreaks may persist if a large portion of the population refuses or delay vaccination, preventing herd immunity [17]. Obstacles in vaccinating the entire global population arise because of varied vaccine demand in people with low and intermediate incomes compared to those with high income countries with diverse educational backgrounds. It is now imperative that governments ascertain the degree of demand and acceptability of COVID-19 vaccination to guarantee community preparedness [18,19]. Effective communication, tailored interventions, and data-driven decision-making are essential components of a comprehensive strategy to combat vaccine hesitancy and protect public health [20]. Studies focusing on the perception and acceptance of COVID-19 vaccination by the common public were in greater need to identify the reasons for hesitancy toward vaccination and implement strategies to overcome it. This systematic review and meta-analysis assessed the rates of acceptance and hesitancy, the determinants of vaccine acceptance, and hesitancy among the common public toward COVID-19 vaccination.

MATERIALS AND METHODS

This analysis was conducted from April 2020 to December 2021 based on the "Preferred Reporting Project for Systematic Evaluation and Meta-Analysis" guidelines (PRISMA) [21]. The present meta-analysis was registered in PROSPERO [Registered Number CRD42024 550407].

Selection criteria and research questions

The research questions identified for this review are: what are the rates and determinants of COVID-19 vaccine reluctance and hesitancy in the general population and can the acceptance and hesitancy be assessed by cross-sectional studies using validated questionnaires or surveys. Studies that satisfied the following PICOS criteria were deemed acceptable for consideration in the population (P): studies conducted in the general population; the intervention (I): studies that investigated COVID-19 vaccination acceptance/reluctance assessed via a questionnaire or survey; the comparator (C): studies that used tools for measurement with validation to assess the acceptance and hesitancy views; and the outcome (O): studies that identified the rates and determinants of vaccine acceptance and hesitancy. The study design (S) is the cross-sectional research part of this meta-analysis. The studies were selected by three investigators (T.G., B.P., and V.R.N.), and the first screening of the identified titles and abstracts was performed. The second screening for peer-reviewed full-text articles was also completed following the first screening. Studies such as case reports, basic research, medical news, popular science pieces, nonmedical papers, letters, comments, and conference abstracts were not included.

Statistical analysis

The R software version 4.0.5 was used to build the forest plots and conduct statistical analysis. The single proportions were examined using a random-effects meta-analysis to calculate the combined percentage of vaccine acceptance and reluctance. The chi-square test [95% confidence interval] was used to estimate the within-study variation, whereas the maximum likelihood estimator for tau2 was employed to assess the between-study variation. Heterogeneity was evaluated using the higgins's and Thompsons' I^2 measures. The I^2 values, which range from 0% to 100%, correspond to low, moderate, and high levels of heterogeneity, respectively, with values of 25%, 50%, and 75%. Significant heterogeneity was denoted by 50% of the I^2 value.

RESULTS

Our search strategy identifies 758 studies, of which 84 articles were meet the eligibility and 18 articles satisfied the PICO criteria (Fig. 1), with a total population of 74409 (Table 1. A forest plot was drawn for the pooled proportion of vaccine acceptance (16 studies) [22–36,37] and vaccine hesitancy (8 studies) [23,24,25–27,31,38,39]. Out of the 18 studies, 16 studies had reported vaccine acceptance, and six studies reported vaccine acceptance and hesitancy [22,24–28]. Overall, only two studies had reported vaccine hesitancy only [40,41]. The pooled estimates of COVID-19 vaccine acceptance rate reported in the 16 studies consisted of 40106 individuals, providing a pooled estimate of 63.79% (95% CI: 54.19%–73.39 %) with considerable heterogeneity ($\chi^2 = 8265.4$, $p < 0.00001$; $I^2 = 100$ %) (Fig. 2). Furthermore, the pooled estimates of COVID-19 vaccine hesitancy reported in the 8 studies, consists of 45629 individuals, providing a pooled estimate of 25.13% (95% CI: 17.21%–33.06 %) with considerable heterogeneity ($\chi^2 = 8265.4$, $p < 0.00001$; $I^2 = 100$ %) (Fig. 3).

Studies on the rates and determinants of vaccine acceptance

There were 10 studies reported on the acceptance rate of COVID-19 vaccination [19,23,25,28–30,32,35,36,37]. Subgroup analysis of the population studied in the articles on acceptance rates of COVID-19 immunization as stratified by country (Supplementary Material Table 1). A total of 22,212 people were involved in all 10 studies, and all were cross-sectional and conducted online. With a study population ranging in age from 18 to 79 years old, female engagement was higher (59.97%), and most of the analysed population were

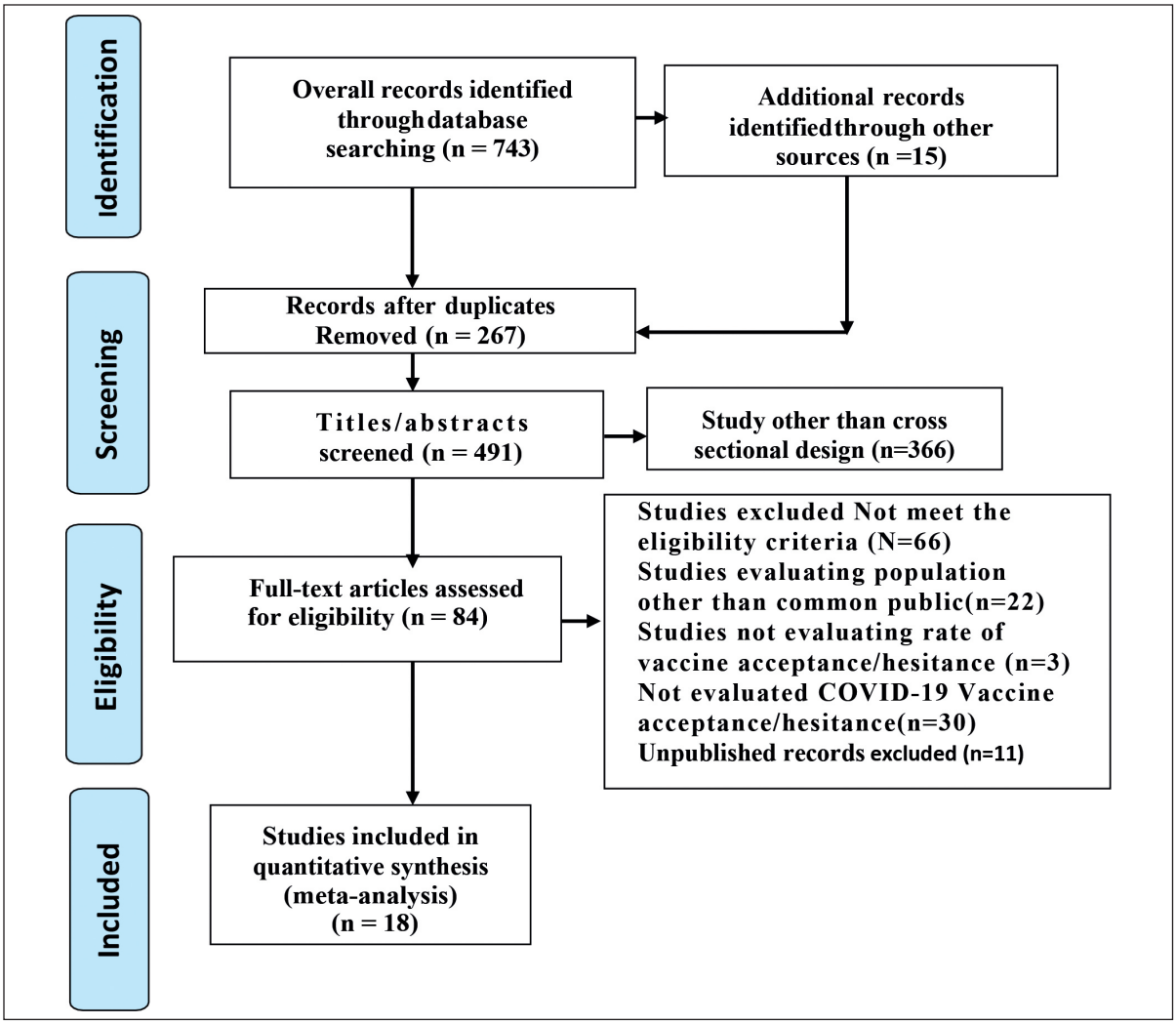

Figure 1. PRISMA flow chart outlining literature search.

employed; most of the participants resided in the urban region. Evaluation of the studies' quality concerning bias risk was part of the review. The acceptance rate was found to be 59.6%, with the highest in Malaysia (94.30%) [33] and the lowest in Hong Kong (42.20%) [34]. The main factors influencing the acceptance of vaccination were older age, having received an influenza vaccination the previous winter, feeling that one was more likely to contract COVID-19, having more positive general beliefs and attitudes about COVID-19 vaccination, having fewer beliefs that the shot would be unsafe or cause side effects, feeling that there was enough information to make an informed decision about COVID-19 vaccination, and having less support for the idea that only those at risk of serious illness should receive the vaccination [37]. Overall, earning more and having higher education levels enhanced vaccine acceptance. In addition, the other determinants of acceptance of vaccines involved government trust [25], the conviction that vaccination reduces fear of contracting COVID-19, the readiness to vaccinate to protect others, and the importance of following medical advice [29].

Studies on the rates and determinants of vaccine hesitancy

There were two publications on vaccination hesitancy [38,39], conducted by online survey in the United Kingdom (UK) and France, with 32361 and 1942 participants, respectively (Supplementary Material Table 2). The participants ranged in age from 18 to 65 years. Female engagement (63%) was higher, and the majority of the population was employed. The majority of participants (76.05 %) lived in metropolitan areas [38,39]. The reasons behind immunization reluctance among the population were that France had the highest level of apprehension and refusal and an overall hesitance rate of 72.0%. Negative attitudes toward vaccination in France were stabilized by mistrust in the efficacy and safety of the new COVID-19 vaccines, lower vaccination compliance in the past, unwillingness to pay for vaccination, and reduced perceived severity of the illness [39]. The UK study had a hesitancy rate of 37 %, and the strong determinants of hesitancy included high mistrust of vaccine safety, strong worries about unexpected consequences, worries about profiteering in the business sector, and a strong preference for natural immunity [38].

Table 1. Demographic characteristics of the population in studies on the acceptance and hesitancy of COVID-19 vaccination.

S. No	Author, year	Place and sample size (*N*)	Age (years)	Gender (%)	Occupational status of the study population	Educational status of the study population	Study setting (rural/urban etc,)
1	Akarsu *et al* [22]	Turkey (*N* = 759)	18 and above	F: 62.8% M: 37.2%	Not working: 12.6; Student: 13.7%; Health care professional: 40.6%. Others: 33.1%	Literate: 0.3%; Literate: 0.4%; Primary School: 2.8%; High School: 10.9%. UG: 63.6%; PG/PhD: 22%	Not mentioned
2	Al Mohaithef *et al.* [23]	Arabia Saudi (*N* = 992)	18 to 65 years of age and above	F: 65.83 % M:34.1%	Government: 43.15%; private sector: 15.22%; Self-employed: 1.92%; Unemployed: 39.72%	PG: 20.06%; UG: 50.10%; Diploma: 15.42%; high school: 14.42%	Not mentioned
3	Bendau *et al.* [24]	Germany (*N* = 1779)	18–84	F:77.5% M:21.8% O: 5.62 %	Not mentioned	Intermediate or lower secondary school degree: 14.7%; Higher education entrance qualification: 25.2%. University degree: 59.8%	Not mentioned
4.	Faasse and Newby *et al.* [25]	Australia (*N* = 2174)	Not clearly specified.	F: 75.2% M: 23.1% O:1.7%	Not mentioned	High school only: completed (Year 12) or not completed (Year 11 or below): 24.6%. Grade certificate, diploma, or advanced diploma: 24.3%; UG: 25.9%; PG/Graduate diploma: 25.0%; Not stated: 0.3%	Not mentioned
5.	Fisher *et al.* [26]	USA (*N* = 991)	18–93	F:51.5% M: 48.5%	49.3% of respondents were working as paid employees; 8.3% were working as independent contractors; 1.2% were unemployed; 6.7% were unemployed but seeking employment; 19.5% were unemployed but disabled; 9.9% were unemployed; and 5.2% were unemployed but employed.	9.7% of people did not have a high school diploma; 28.2% have one; 27.6% have some college education; and 34.5% had completed college or more.	Household Population
6.	Kessel *et al.* [27]	Belgium (*N* = 2698)	18-80	F: 51%, M: 49%	Working; 51%; Homemaker: 4%; Student: 8%; Unemployed: 7%; Disabled: 6%; Retired: 24%	Primary education: 3%; secondary education at the first degree: 10%; secondary education at the second degree:13%; secondary education at the third degree:35%; and higher education (not including universities): 24%; UG/PG: 14%, PhD: 21.1%.	Dutch: 57% French: 43%
7.	Kreps *et al.* [28]	USA (*N* = 1971)	30-58	F: 51% M: 49%	Not mentioned	Less than two years of education: 2%; high school/ GED: 21%; some college: 30%; four years of college degree: 24%; and graduate school: 24%	Not mentioned
8.	Lazarus *et al.* [29]	USA (*N* = 7423)	18–65 years	F: 53.5% M: 45.8%	Not mentioned	Below the high school level: 28.6% Senior high school or college: 35.0%; bachelor's degree: 27.6%; postgraduate degree: 8.8%	Not mentioned
9	Machida *et al.* [30]	Japan (*N* = 2956)	20-79	F: 50.6% M: 49.3%	Employed:60.48%.Unemployed: 39.51%	UG or above: 52.6%. Below UG level; 47.3%	Tokyo Metropolitan
10.	Abu-Farha *et al.* [31]	Middle east (*N* = 2925)	18 and above	F: 62.4% M: 37.6 %	Holding medical-related degreeNo: 4.2%; Yes: 45.8%	UG: 60.3%; PG/PhD: 20.6%; school level or below: 7.2%; diploma: 11.9%;	Not mentioned
11	Wirawan *et al.* [32]	Indonesia (*N* = 779)	20–26	F: 61.1% M: 38.9%	Unemployed: 5.4%; Student: 9.8%;Part-time employment: 16.7%Full-time employment: 38.1%	Without higher education: 36.2%; With higher education: 63.8%	Not mentioned

Continued

S. No	Author, year	Place and sample size (*N*)	Age (years)	Gender (%)	Occupational status of the study population	Educational status of the study population	Study setting (rural/urban etc,)
12	Wang *et al.* [33]	China (*N* = 2058)	18 and above	F:54.2%, M: 55.8%	Employed:80.2%.Unemployed:19.8%	Middle school and below: 6.7%; High school: 33.2%; Associate or bachelor: 55.4%; Master and above: 6.4%	Urban: 79.6%; rural: 20.4%
13	Wong *et al.*[34]	Hong Kong (*N* = 1200)	More than 55	F:71.3% M: 28.7%	Student: 4.3%; Unemployed: 3.0%;Retired: 35.7 %; Housewife: 34.6%;Medical or healthcare: 0.8 %;Restaurant: 0.7 %; Public transport driver: 0.9%; Others: 17.3 %; Refused to answer but employed: 2.6 %; Refused to answer unemployed: 0.3%	Primary or below: 36.8 %. Secondary: 39.5%; Tertiary or higher: 22.9%; Refused to answer: 0.8%	Not mentioned
14	Wong *et al.* [35]	Malaysia (*N* = 1159)	Not clearly specified	F: 66% M: 34%	Professional and managerial: 55.5%; General worker: 20.4%; Students: 8.5%; Housewife, retired, unemployed, and others: 15.6%	Secondary and below: 10%. Tertiary: 90%	Urban
15	Cho *et al.* [36]	China (*N* = 8742)	18–60	F: 63.3 % M:36.7%	Not mentioned	High school: 14.6 %; UG: 63.5%; PG: 22.0%	Urban: 78.9 % Rural: 21.1%
16	Paul *et al.* [38]	United Kingdom (*N* = 32361)	18-65	F: 74.9% M:25.1%	Employed: 58.2%Unemployed 41.8%	PG: 26.6%; UG: 41.8% Vocational or A-level: 17.4% 11.4% for GCSE 11.4% 2.8% without qualifications	Urban:74.4% Rural 25.6%
17	Schwarzinger *et al.* [39]	France (*N* = 1942)	18–64	F: 51·1% M: 48·9%	Employed in private sector: 42·7%Employed in public sector: 21%–2%Unemployed: 36·1%	Higher education: 44·0%21.6% of graduates from high school; 34.4% of undergraduates	Rural: 70.1% Urban: 29·9%
18	Sherman *et al.* [37]	UK (*N* = 1500)	18–87	F: 51% M: 49%	45.2% were full-time; 17.1% were part-time; 37.1% were unemployed; 0.1% were unsure; and 0.5% preferred not to answer.	UG/PG: 52.6%, Other or no qualification: 46.9%, Prefer not to say: 0.5%	Not mentioned

F: Female; M: Male; O: others/third gender; UG: Undergraduate; PG: Post-graduate; Ph. D: Doctor of philosophy; GED: General education development test; GCSE: General certificate of secondary education.

Studies on both acceptance and hesitancy

Six publications from China, the United States, Belgium, Germany, Turkey, and Middle Eastern countries assessed both acceptance and hesitancy rates [22,24,26,27,31,36]. A total of 8,927 people participated in these studies, ranging in age from 18 to 80 years, with a higher female participation (52.91%) majority being employed (Supplementary Material Table 3). Belgium has a higher acceptance rate of 73.0% [27]. The determinants of acceptance included: the necessity of vaccination to safeguard family [22]; anxiety and health-related worries [24], people's faith in the government, delivery system, and vaccine [36]; knowing someone who has been hospitalized for COVID-19, belonging to a medically vulnerable group, educational status [27], being single, earning more than $1,000 a month, being a doctor, and being extremely afraid of COVID-19. The total vaccine hesitance rate was 40.6%, with the highest hesitance rates of 75.1 % in the Middle East (Jordan, Saudi Arabia, Lebanon, and Iraq) [31]. Vaccination hesitancy was due to fear of side effects, lack of vaccine reliability, perception of COVID-19 as a biological weapon, concerns on the safety, efficacy, and newness of the vaccine, and not wanting to be the first to receive the vaccination. Other determinants of hesitancy included: fear of the rigor with which tests were conducted, fear of the vaccine content, need for more information; fear of compatibility with one's health issues (e.g., allergies, comorbid conditions), religious convictions, lack of belief in vaccine efficacy and safety, and previous terrible vaccine experiences.

Quality assessment of the included studies

The studies with methodological quality were eventually incorporated into the systematic review, and the Joanna Briggs Institute Critical Appraisal Checklist for Cross-Sectional Studies was used to evaluate how well the studies addressed the potential for bias in their design, conduct, and analysis [42]. The nine evaluation criteria/ parameters of the checklist included: (i) a sample frame that addresses the specific audience; (ii) appropriate selection methods; (iii) sufficient sample sizes; (iv) study participants and setting characterizations; (v) enough statistical investigations; (vi) uses appropriate techniques for the aforementioned parameters; (vii) uses valid measurements for all the study subjects; (viii) the use of appropriate statistical analysis; and (ix) an adequate response rate. Answers such as yes, no, unclear, or not applicable are assigned to each item. (Supplementary Material Tables 4 and 5; Supplementary Material Figs. 1 and 2**)**. The quality assessment of the included studies was conducted by the authors (PBS, VRN, and RKP). A high-quality (80% and above), moderate-quality (60%–80% score), and low-quality (60% and below) classification was made based on the

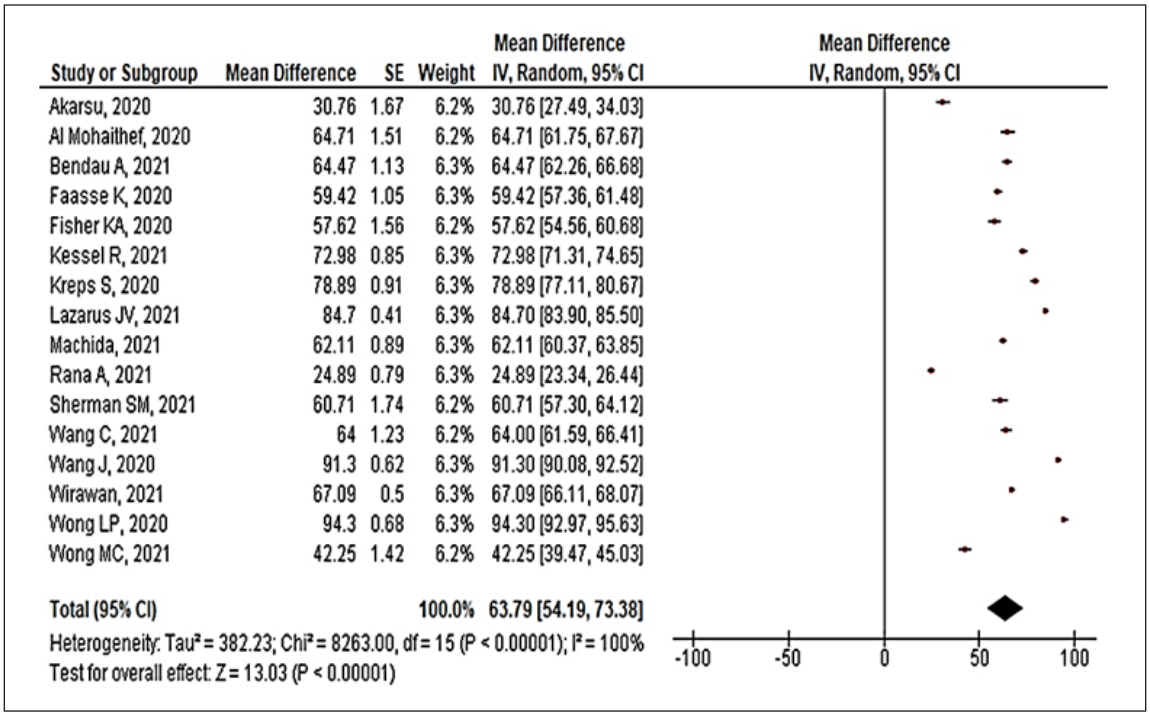

Figure 2. The combined fraction of vaccine acceptability is represented by a forest plot.

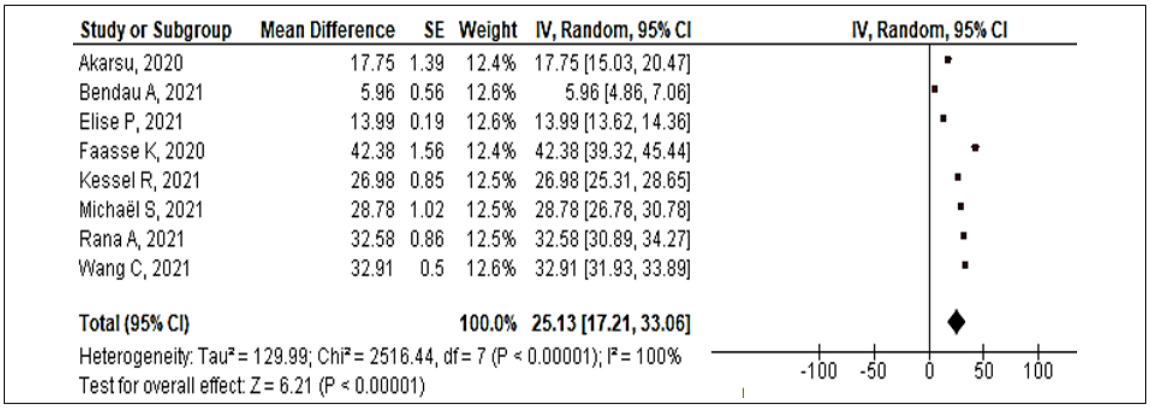

Figure 3. A forest plot representing the combined percentage of vaccine reluctance.

items in the assessment instrument mentioned above. included studies were 90% high, 4% moderate, and 6% low quality based on brigg's criteria. To estimate the publication bias, we plotted the funnel plot along with Begg's test, in which a *p*-value of < 0.05 was considered significant. In the present study, the *p*-value was approximately 0.271.

DISCUSSION

This review explored attitudes toward hesitancy and acceptance toward COVID-19 vaccination among diverse populations from varied geographical and cultural backgrounds. This review identified the highest hesitance rate of 75.1 % in the public of Middle East countries [31], followed by 55% in Turkey [22]. Studies in the UK have reported varied responses toward COVID-19 vaccination, with an acceptance rate of 64% Sherman *et al.* [37] and a hesitancy rate of 14% [37]. France recorded a hesitancy rate of 72.8 % [39], and the most compelling reasons identified in these studies included distrust of the safety and effectiveness of the vaccine and the lower perceived severity of the COVID-19 pandemic. More than half (56.6%) of the people who explained that they did not want to get vaccinated also had anti-vaccination attitudes, beliefs, or emotions [27,31,34]. This review also identified participants' willingness (5.8 %) to obtain a vaccine if it is available for free of cost [39]. Economic considerations are also important, and our research supports this. Furthermore, vaccination uptake was predicted to be lower in younger individuals, those with reduced risk of severe COVID-19, women, less educated individuals, and persons with lower levels of faith in the government. This hesitant segment, however, may play a crucial role in

determining whether the population can develop herd immunity against coronavirus.

The vaccination acceptance rates were 94% in Malaysia [35] , 91% in China [36], and 72% in the USA [28]. Apart from common reasons like higher educational status, higher income, and trust in the health system, approximately 49 % of the participants expressed willingness toward COVID-19 immunization as it was crucial for their own safety as well as for the protection of their family [22,30]. Around 28% of the population was found to be in Favor of vaccination in general but apprehensive about COVID-19 vaccination because of its shortest development time and concerns about commercial profiteering [37]. This research also identified that communication and educational initiatives should target the group identified as pro-vaccine but dubious of COVID-19 vaccination, rather than concentrating on vaccine skeptics or anti-vaxxers, who will find it more difficult to convince that COVID-19 vaccination is required [28,34,37]. Approximately 65% of the participants reported that their primary sources of information about COVID-19 and its vaccination were television and social networking sites. Disseminating false, inaccurate, and distorted information, however, can be done by unaffiliated sources that could be detrimental to the public's mental health by causing worry, despair, and fear [36]. This anxiety could therefore make people less likely to accept a potentially safe and effective COVID-19 vaccination, which could stop the pandemic. It was found that having a degree in medicine, having previously received the influenza vaccine, fearing infection from COVID-19, and having a higher fear score were additional factors that significantly and favourably influenced willingness to receive the vaccine. Conversely, a history of COVID-19 infection increased the likelihood of refusing vaccination [26,38]. Public health campaigns that aim to increase the uptake of COVID-19 vaccination should therefore concentrate on educating and building trust among those who are reluctant or unsure about getting vaccinated about the safety, effectiveness, and side effect profile of the vaccine, the significance of adhering to social distancing guidelines, and the availability of clear information about the virus and disease itself.

This strategy is critical for reaching out to the public who have low educational attainment. According to a Reuters poll, almost 75% of Americans said they would consent to receiving COVID-19 vaccination if they were assured of its safety [25]. It was discovered that 50% of American adults in the population intended to get vaccinated as soon as possible. A small percentage of the population (10%) has already decided not to be vaccinated. While some 'Unlikely' may decide to get vaccinated in the future, they are unlikely to have their opinions changed due to their experiences, attitudes, and beliefs. Public health initiatives should therefore be directed toward addressing the requirements of the "Intenders" and "Wait and Learn" groups rather than the "Unlikely," who have already made up their minds and are unlikely to alter them even if new information regarding COVID-19 vaccinations becomes available [24,36–39,43].

Since the beginning of the vaccine drive in India in January 2021, very few studies have assessed the acceptance of COVID-19 vaccination by the public. A community-based cross-sectional investigation done by Suresh *et al* [43]. assessed the awareness of the public in India concerning COVID-19 vaccinations and immunization acceptability. Of the 358 participants in the study, 66% thought that the COVID-19 vaccines were secure, 30% exhibited an attitude of fear was exhibited by 30% and a neutral attitude was expressed by 22% of participants. The major determinants of hesitancy towards vaccination were stated by 44% as the possibility of adverse effects and the absence of adequate clinical trial data regarding its safety and efficacy. One of the main concerns was the cost of vaccination. The study also reported a varied association between knowledge and acceptance of vaccination in different states of India.

This review is advantageous in identifying the correlation among sociodemographic factors such as age, gender, educational attainment, place of residence, economic status, and acceptance/hesitancy outcomes. This review also identified factors like trust in their government and willingness to protect the family by getting themselves vaccinated and valuing their physician's recommendations as significant contributors to vaccine acceptance. Likewise, inadequate information about vaccination and mistrust and apprehension toward the effectiveness of vaccines and safety, fear of side effects, and non-availability of the vaccine free of cost were the major contributors to vaccine hesitancy. To date, few studies have reviewed the evidence in the literature on this topic of interest [21,40]. As time rolled out, with the full-fledged efforts of various countries toward vaccination, there were studies reported to have an enhanced positive intention in public toward COVID-19 vaccination. Recently, a review has been published on the percentage of low- and middle-income nations that accept vaccines [44]. Another review conducted in 2022 reported a drop in the median hesitancy rate (37%–54%) among Gulf Cooperation countries from an initial 70%. This wide variation can be attributed to varied factors like different time of study and the efforts taken by the respective governments to improve vaccine acceptance [45]. Although a distinct rate of COVID-19 vaccination has been achieved in many countries, there is still vaccine apprehension among the public, even in developed countries. A study conducted in low- and middle-income countries identified high levels of COVID-19 vaccine acceptance compared with the lower rates in Russia and the United States. The authors suggested that translating the expressed positive intentions to be vaccinated for COVID-19 into behavior might result in an increase in the current herd immunity threshold for COVID 19 in these countries [46]. An Indian study conducted recently reported vaccine hesitancy in 31% (1669 of 5411 participants), and the reasons included were fear of adverse effects, long-term side effects, and death, lack of trust in Indian vaccines, suspicions of profiteering by pharmaceutical industries, lack of awareness on eligibility for vaccination, and administrative issues like difficulty in getting access to vaccines [47]. With the second and third waves and prevailing uncertainty, still there exists a dire need to identify the determinants of vaccination hesitance in many countries and measures to overcome them to increase the public acceptance of second-dose and booster-dose vaccinations. In addition, the incessant emergence of new variants of the coronavirus instigated many countries to

initiate COVID-19 vaccination for children and adolescents aged below 18 years from August 2021. The parental attitude toward their children being vaccinated has become a major concern. A recent study in the United States identified 28 % of parental hesitancy toward COVID-19 vaccination of their children. The reasons reported for parental hesitancy were poor vaccine knowledge, conspiracy beliefs, lowest annual income, and a lower perceived threat of COVID-19 to their children. Women and mothers had more doubts about vaccinating their children than men and fathers [48]. A similar survey in Japan identified 57.1% of cases of parental vaccine hesitancy (PVh) [49]. A study conducted in Thailand reported 58% PVh toward COVID-19 among the 480 parents who participated in the study, and the parents with negative beliefs, refusing to vaccinate themselves or refusing any other vaccinations for their children, exhibited the highest hesitancy level [50]. An online survey of parents in Taiwan reported 64.1% of vaccine hesitancy, and the reasons were identified to be the same as those of the aforementioned studies [44]. In general population, attitudes, acceptance, and hesitancy towards vaccination was reviewed by Cascini *et al.* [51], they noticed that, the Key factors driving vaccine hesitancy included concerns about efficacy, safety, convenience, cost, and disparities among socio-demographic groups. A recent study in Brazil on vaccine acceptance and hesitancy among general population and health care workers reported lack of understanding about the disease, disbelief about the vaccine's efficacy, and a fear of adverse reactions and serious complications, short time for vaccine development as the major reasons for unwillingness by the people and the health care workers to vaccinate during the pandemic [52]. A cross-sectional study in the Nepalese population reported that only 7.2% of the non-vaccinated participants were hesitant towards COVID vaccination and the reasons being the fear of adverse effects of the COVID-19 vaccine and lack of enough information regarding COVID-19 vaccine [53]. A study in Indian population identified a higher proportion COVID-19 vaccine acceptance among females and low vaccine literacy, family or social media influence, and fear of vaccine side effects as most commonly influencing factors for vaccination hesitancy [54]. A systematic review and meta-analysis done by Dey *et al.* [55] in 2022 on COVID vaccination acceptance and hesitancy in Indian population reported a decrease in vaccine hesitancy rate from 37% to 12% from December 2020 to November 2021, with a 31% estimated pooled COVID-19 vaccine hesitancy and fear of the vaccine's safety and efficacy, side effects as prime barriers to vaccine acceptance [55].

Overall, the findings of this review recommend educating the public on the nature of COVID-19 vaccination, combating misinformation about vaccine development and safety, emphasizing the safety of approved COVID-19 vaccines, ensuring the affordability of vaccines, and communicating the availability of vaccines and vaccination sites for easy accessibility, especially for the elderly, as key interventions for attaining comprehensive vaccination. Educational interventions focusing on the threats and consequences of COVID-19, highlighting the risk-benefit ratio of vaccination, enhance positive intention of the public toward COVID-19 vaccination and significantly build parental confidence in vaccinating their children. Additionally, since the public and the parents view their and their child's physicians as a trusted source of information, it is crucial for healthcare providers to engage in discussions with the public and the parents about COVID-19 vaccines.

Implications

Apart from socioeconomic and cultural issues, the most common factors contributing to vaccination apprehension in most countries were inadequate information about vaccination, mistrust of the effectiveness and safety of new COVID-19 vaccines, and higher faith in the health system. The same factors are also the reasons for reluctance toward vaccination in many countries. As public perception evolves, it is imperative for governments and health advisories in various countries to focus on identifying and addressing population-specific factors associated with vaccine hesitancy to increase vaccination rates. This would provide a basis for the government and the health sector to implement strategies to make more people earnestly come forward to vaccinate themselves. With changes in public perception over time and the approval of COVID-19 vaccination for those aged less than 18 years, education and understanding of the importance of recommended doses of vaccination and its benefits can help increase vaccine coverage and protection against COVID-related complications in the future. Policies ensuring the accessibility and affordability of vaccines for people of all strata; a vaccine mandate policy are key measures to enhance acceptance rates of self-vaccination and parental consent for COVID-19 vaccination of their wards against COVID-19.

CONCLUSION

The results of this systematic review revealed a varied proportion of vaccine acceptance and hesitancy rates, with an overall acceptance rate of 59.6%, with the highest rate observed in Malaysia and a hesitancy rate of 40.6%, the highest reported in the Middle East. Higher faith in health systems, a conviction that vaccination reduces the risk of COVID-19 infection and protecting others and family against COVID-19 infection were the determinants of acceptance and distrust in the efficacy and safety of new COVID-19 vaccines were the main determinants of vaccine apprehension. Differences in rates were observed in the same geographical locations at different time periods due to inconsistencies in public perception. The findings may be taken into consideration by relevant parties, such as researchers, politicians, decision-makers, and planners of health programs, to take suitable action that can support vaccination acceptance, guarantee sufficient vaccination coverage, and advance health. We also urge additional research, especially on the variables or elements that contribute to reluctance.

LIMITATIONS

Despite its strengths, this review has limitations. This method relies on cross-sectional studies, making causal assessment difficult. Various sampling techniques can explain differences in vaccination acceptance rates; thus, the results should be interpreted cautiously. Data were collected through self-reported surveys, introducing biases like recall, response,

volunteer, and social desirability bias, but was the most appropriate method at the time. The review period was limited, with studies from few higher, middle, low, and very low-income countries failing to capture global data. Consequently, the findings may vary with time and country. Moreover, the studies did not represent diverse populations from heterogeneous nations like the USA. Future research should focus on the determinants of vaccine hesitancy/acceptance rates based on cultural, economic, and administrative factors influencing diverse populations in larger countries.

AUTHOR CONTRIBUTIONS

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work. All the authors are eligible to be an author as per the International Committee of Medical Journal Editors (ICMJE) requirements/guidelines.

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This study does not involve experiments on animals or human subjects.

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DATA AVAILABILITY

All data generated and analyzed are included in this research article.

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USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declares that they have not used artificial intelligence (AI) -tools for writing and editing of the manuscript, and no images were manipulated using AI.

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