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Community and Provider Acceptability of the COVID-19 Vaccine: A Systematic Review and Meta-analysis

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Abstract

Background:

The novel coronavirus disease (COVID-19) vaccines may help control the current pandemic but would require immunization levels that would achieve herd immunity. This study aimed to quantify current COVID-19 vaccine acceptance rates, as well as characterize the determinants, enablers and barriers to vaccine acceptability across the globe by synthesizing published evidence.

Methods:

A systematic review and meta-analysis of studies was performed on studies assessing the acceptability of a COVID-19 vaccine published between November 1st, 2019, and November 30th, 2020. PubMed, Embase and Cochrane central were searched for eligible studies. Data extracted from retained studies was analyzed using STATA statistical software. A quantitative and narrative synthesis was produced.

Results:

A total of 35 eligible articles (38 studies) involving a total of 70,997 participants across 7 regions and 35 countries were included. All studies were cross-sectional survey designs. The pooled vaccine acceptance rate across 32 studies was 71% (95% CI: 66 – 76%, p2= 99.4%, range: 29-97%). The pooled vaccine acceptance rate of parents for their children across 4 studies was 52% (95% CI: 37-67%, p2= 99.1%). Vaccine uptake was significantly higher among males (N=13 studies), older age groups (N=7), and healthcare providers (N=2). Enablers of vaccine uptake included perceived individual susceptibility to COVID-19 infection (N=11), prior influenza vaccination (N=7) and high vaccine effectiveness (N=6). The most common barriers to vaccine uptake were general negative attitudes towards vaccines/vaccine hesitancy (N=8), concerns over vaccine safety and efficacy (N=6), vaccine side effects (N=5), and misinformation or conspiracy beliefs around the experimental COVID-19 vaccines (N=2).

Conclusions:

There is a good acceptance of COVID-19 vaccines globally despite wide variations across countries. Public health campaigns may benefit from capitalising on identified enablers and dispelling important barriers with regards to vaccine safety.

Keywords

COVID-19, Vaccine, Acceptance

Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this paper

Introduction

Since the start of the coronavirus disease (COVID-19) pandemic in December 2019, there have been more than 70 million reported cases and more than a million and a half deaths due to infection with the SARS-CoV-2 virus.[1] Despite social distancing measures, self-isolation following exposure, and intermittent lockdowns[2,3], most countries are currently experiencing additional waves of infections[1]. Vaccination appears to be a viable option to help control the pandemic.[4] Significant progress has been made worldwide in the development of vaccines for COVID-19 with the recent rollout of mRNA vaccines by Pfizer & BioNTech (BNT162b2) and by Moderna (mRNA-1273), both with efficacies above 90%.[5–8]

Vaccines can only be effective to halt a pandemic if taken by enough of the population to produce herd immunity in order to stop its further spread.[9,10] Challenges to vaccination campaigns include affordability of the vaccine, willingness to pay for the vaccine[11], maintenance of the vaccine supply and cold chains, distribution of the vaccine worldwide to the most hard-to-reach areas, and very importantly, the acceptability of these vaccines by the general population. Acceptability is particularly challenging in the current era given rapidly circulating vaccine misinformation campaigns through social and media communication channels.[12] The World Health Organization cites "vaccine hesitancy" as one of the top ten threats to global health.[13] Levels of vaccine hesitancy vary across both geographical and socio-demographic population characteristics and are believed to be high enough to significantly affect acceptable levels of population immunity.[14–18] Failing to adequately prepare the general population and key stakeholders on the importance of these COVID-19 vaccines could therefore result in poor vaccine acceptability, as has been shown with other novel vaccines[19], and was seen in the recent H1N1 pandemic.[20] Exploring current vaccine acceptance rates, determinants of acceptability across populations and specific at-risk subgroups is essential in informing policy on the multi-faceted and targeted approaches required to ensure adequate vaccine acceptance and coverage to achieve herd immunity. This study aimed to synthesize published evidence on the determinants of COVID-19 vaccine acceptance worldwide, through a systematic review and meta-analysis. The study objectives were to: assess the current acceptance rates of a potential COVID-19 vaccine; determine socio-demographic and clinical characteristics in study populations that affect vaccine acceptance; and determine potential enablers and barriers to vaccine uptake.

Methods

This review was registered with the international prospective register of systematic reviews (PROSPERO registration number: CRD42020224096). The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) 2009 guidelines[21] were used to report this protocol (see Supplementary file 1 for more details).

Search strategy, screening process and selection criteria

This was a systematic review of studies that quantitatively assessed the COVID-19 vaccine acceptance rates and explored enablers and barriers to vaccine uptake. The search strategy used is presented in Supplementary file 2. The search strategy was developed by the authors with the assistance of an experienced medical librarian. The keywords COVID-19, Coronavirus, SARS-CoV-2 and their synonyms were combined with the keywords 'vaccine', 'vaccination', 'immunization', as well as the keywords 'acceptability', 'receptivity', 'enablers', 'barriers' and their respective synonyms using the Boolean operator 'AND' in the search strategy. The search

was run by the principal investigator (CAD). All searches were limited to articles in English. Databases searched included PubMed, Embase and Cochrane Central. Specialist searches for grey literature, public calls for literature, organizational websites or stakeholder contacts were not performed for this review.

Articles from the initial search were saved on Zotero Version 5.0.93 reference management software from which duplicates of articles were removed by the principal investigator (CAD). Two reviewers (CAD and BMK) then independently screened the titles and abstracts of the remaining articles to exclude articles outside of the scope of this review. Both reviewers then independently reviewed the full text of the retained articles according to the study selection criteria to identify eligible studies. There were no disagreements between both reviewers at each stage of the study selection process. The reference lists of eligible studies were also reviewed to identify more eligible studies.

The following studies were included:

1. Peer-reviewed studies published in English between November 1st, 2019, and November 30th, 2020;
2. Population: Studies on patients of all ages, both healthcare providers and non-healthcare providers;
3. Intervention: Studies on COVID-19 vaccine acceptance;
4. Outcomes: Studies reporting either COVID-19 vaccine acceptance rates, or determinants, enablers and barriers to vaccine uptake;
5. Study design: observational studies, including cross-sectional studies and surveys.

The following studies were excluded:

1. Population: Studies on participants who had been involved in COVID-19 vaccine trials;
2. Intervention: Studies focused on participants' willingness to participate in COVID-19 vaccine trials, rather than actual participant intent to receive the COVID-19 vaccine; studies reporting uptake to other vaccines similar to the COVID-19 vaccine such as the influenza vaccine;
3. Outcomes: Studies not reporting at least one of either vaccine acceptance rate, determinants, enablers or barriers; studies reporting exclusively on participants' willingness to pay for a COVID-19 vaccine rather than their intent to get vaccinated; studies reporting combined COVID-19 preventive health behavior including vaccination rather than vaccination as an individual preventive measure;
4. Other: Pre-prints, conference abstracts, editorials and letters not providing adequate information on the studies and outcomes of interest, bulletins, opinion papers, media reports.

Study validity assessment, data extraction and synthesis

Two independent reviewers assessed the quality and risk of bias of the eligible studies, comparing the reports to a hypothetical cross-sectional survey that mirrored the population demographics, wrote clear and unambiguous survey questions and collected all potential known confounding variables for vaccine uptake. The study quality were graded as poor, fair or good using the Study Quality Assessment Tools of the National Health Institute/National Heart, Lung and Blood Institute (NHI/NHLBI)[22] (see Supplementary file 3 for more details).

Metadata including the first author and publication year, and data on study methods and outcomes of interest were extracted from the selected studies unto a Microsoft Excel® extraction sheet. This data included study location (continent/region and country), study design, socio-demographic and clinical characteristics of study participants, study duration, vaccine acceptance rates, measures of effect/association (risk ratios, odds ratios, hazard ratios, relative risks, percentage change, and their respective confidence intervals) of the determinants/predictors of vaccine acceptance or hesitancy and reported enablers and barriers to vaccine acceptance. For studies not directly providing vaccine acceptance rates, the vaccine uptake rate was calculated as a proportion of the number of participants who mentioned they would accept a COVID-19 vaccine if available, to the total number of participants who answered that question. Vaccine acceptance was reported as 'yes' or 'no' to the question 'do you intend to take the COVID-19 vaccine?' For studies that only reported the number of participants who answered 'yes', we assumed the remaining participants to have responded with a 'no' to vaccination. Conversely, for studies reporting vaccine hesitancy as 'no' only, we assumed the remaining participants to have responded with a 'yes' to vaccination. For studies that reported vaccine acceptance as 'yes', 'no', and 'not sure', these answers were extracted and presented as such. For studies that reported the vaccine acceptance on a Likert scale such as 'definitely yes', 'likely/probably yes', 'definitely no', and 'likely/probably no', these were grouped into 'yes' and 'no' options only, with 'definitely yes' and 'likely/probably yes' answers grouped into the option 'yes' and the 'definitely no' and 'likely/probably no' answers grouped into the option 'no'. All extracted data was double-checked for errors by a second independent investigator. Data extracted was exported to STATA version 14.2 (STATA Corp, College Station, TX) for analysis.

Narrative synthesis of the study characteristics, as well as the socio-demographic and clinical characteristics of the participants in the various studies was done, complemented by tables with descriptive statistics. Random effects meta-analyses were performed after Freeman-Tukey Double Arcsine Transformation[23] to derive pooled estimates for the vaccine acceptance rate. Pooled estimates of the odds ratios for the effect of participants' sex on vaccine acceptance were also derived. Random effect models were used to account for between-study heterogeneity. Heterogeneity was assessed and presented using the Cochrane's Q test and the I^2 test statistic. These findings were presented on forest plots and summarized in tables. Publication bias through small-study effect assessment was determined both statistically (Egger's test) and graphically (funnel plot). For qualitative data on vaccine acceptance enablers and barriers extracted from the selected studies, a thematic content analysis approach was adopted for data analysis and synthesis. An initial coding framework was developed on Microsoft Excel® 2016 after identifying the main recurrent themes on enablers and barriers to vaccine uptake from the studies. This initial coding framework was then expanded to incorporate sub-themes that emerged as more studies were reviewed and analyzed in depth. Findings were also presented and summarised in tables.

Results

A PRISMA flow chart for the study selection process is presented on Figure 1 and a list of studies excluded following full text review is presented in Supplementary file 4.

Study characteristics

A total of 35 eligible articles all published in 2020[14–16,24–55], and involving 38 studies were included in the review. The study characteristics are summarized on Table 1. This involved a total of 70,997 participants across 7 regions (Africa, Asia, Europe, Middle East, North America, South

America, Oceania) in 35 countries. Four of the studies were multinational.[14,35,42,48] All studies were cross-sectional surveys and 34 were entirely online (Table 1). Seven studies were of good quality, 23 of fair quality and 6 of poor quality (see Supplementary file 3 for more details). The average male participation across the studies was 39%. Participants' ages ranged from 18 to 93 years (N=23), with age groups between 18 to 54 years being the most prevalent across studies (N=16) and age groups above 55 years being the most prevalent age group among participants in 4 studies.[30,33,38,47] Among the 11 studies that reported the ethnicity of the participants, the mean percentage of participants of Asian, Black, Hispanic, White and other ethnicities were 4%, 13%, 15%, 71%, and 5% respectively. An average of 82.4% of the participants resided in urban settings (N=8) and 71.2 % had an educational level beyond high school (N=21). Trust in the government and their handling of the current pandemic were reported in 2 studies at 75.4%[50] and 47.9%.[41]

Vaccine acceptance rate

The vaccine acceptance rate ranged from 28%[39] to 97%[50], with an overall combined acceptance rate of 71% (95% CI: 66 – 76%, p<0.001 across 32 studies with significant between-study heterogeneity; I^2= 99.4%, p<0.001) (Figure 2).
Conversely, combined vaccine hesitancy among participants who responded with a 'no' to the intent to vaccinate question across 33 studies was 15% (95% CI: 11 – 19%, p<0.001, I^2 = 99.4%, p<0.001, range: 2-72%) (Figure 3).

The combined proportion of participants who answered 'not sure' to if they would take the COVID-19 vaccine across 20 studies that reported this was 20% (95% CI: 16 – 23%, p<0.001) (Figure 4). There was both graphical evidence (Figure 5) and statistical evidence (Egger's test, p=0.003) of small-study effect.

The combined vaccine acceptance rate by parents for children in four studies was at 52% (95% CI: 37-67% p<0.001, I^2=99.1%, p<0.001) (Figure 6). Conversely, the combined vaccine hesitancy rate of parents for their children was 27% (95% CI: 9-49%, p<0.001, I^2 = 99.62%, p<0.001) (Figure 6). Lastly, the combined proportion of parents who answered 'not sure' to if they would give the vaccine to their children in two studies who offered this was 41% (95% CI: 38-43%, p<0.001) (Figure 6).

A single study reported a vaccine acceptance rate of 61% if vaccination was required by the participants' employers.[40]

On meta-regression, study sample size was categorized into studies with less than 1000 participants and those with 1000 or more participants; disease prevalence per region categorized into high (North America, South America, Europe) and low (Africa, Middle East, Asia, Oceania); and study quality categorized into good and fair or poor quality. There was no evidence that the between-study heterogeneity was due to any of these study characteristics (Supplementary file 5).

Socio-demographic determinants of vaccine uptake and hesitancy

The factors significantly associated with increased vaccine uptake included: male sex (N=14)[15,16,29,32,34,37,39,42,44,48,49,52,53,55], with a pooled adjusted OR of 1.60 (95% CI: 1.38 - 1.84, p<0.001, N=9, I^2 = 59.2%, p=0.012). Similarly, Reiter *et al*. reported female sex as a barrier to vaccine uptake.[16] Older age increased uptake (N=7), with the lowest uptake for the age group 30-49 years, and increasing uptake for ages above 45 and 55 years respectively.[15,25,29,34,42,48,51] Additional positive associations included higher educational attainment (N=5)[15,30,33,37,49], being married (N=2)[25,52], higher household income (N=2)[16,27], and healthcare providers compared to

non-healthcare providers (N=2).[29,38] The socio-demographic determinants of vaccine uptake and hesitancy are summarised on Table 2.

Enablers of vaccine uptake

COVID-19 infection-related factors that favoured vaccine acceptance included perceived individual susceptibility to COVID-19 infection (N=11)[16,29,32,34,36–38,49,51,52,55], fear of acquiring the infection (N=3)[25,29,34], perceived severity of the disease and general positive attitude towards the disease (N=4)[16,36,39,54], and desire to protect self and others (N=2).[27,54]
Vaccination-related factors that favoured vaccine uptake included current or prior influenza vaccination in the preceding year (N=7)[15,32–34,51–53], belief in the efficacy of the vaccine and high (>90%) vaccine effectiveness (N=6)[31,37,38,40,45,52], positive attitudes towards the vaccine (N=5)[36,43,51,55], lower vaccine side effects (N=4)[40,45,51,55] and longer duration of the protection offered by the vaccine (N=2).[31,50]

Trust-related factors included trust in the health care system or following a doctor's recommendation (N= 4)[16,25,27,52] and trust in scientific research (N=2).[43,48]

Other factors associated with vaccine uptake included health engagement, possession of health insurance, urban settings and more time spent on vaccine development. The enablers of vaccine across the included studies are summarised on Table 3.

Barriers to vaccine uptake

Vaccination-related factors reported as barriers to vaccine uptake included general negative attitudes towards vaccines or vaccine hesitancy (N=8)[29,33,34,37,42,50,52,55], safety and efficacy of the vaccine (N=6)[27,33,42,45,52,54], side effects of the vaccine (N=5)[31,33,37,42,45], rushed development of the vaccines (N=3)[27,33,37], cost of the vaccine (N=2)[31,55] and fear of injections or higher frequency of injections (N=2).[31,55]

Misinformation-related factors included general misinformation together with participants' susceptibility to misinformation/misconceptions (N=4)[30,33,48,54], conspiracy beliefs especially about an experimental vaccine (N=2)[42,47] and inadequate health literacy (N=1).[30]
Other reported factors significantly associated with vaccine hesitancy included having children (N=2)[32,49], FDA authorisation of the vaccine for emergency use, possible shortages of the vaccine, country of origin of the vaccine and content of the vaccine[27], specific populations subgroups such as people who already had the COVID-19 infection[27], pregnant women and people with allergies.[42]
The most frequently reported barriers to vaccine uptake across the studies included are summarized on Table 4.

Discussion

This review identified a good general acceptance of COVID vaccination worldwide, although a wide variability across countries was identified. It also summarizes enablers and barriers to vaccine uptake across 38 studies. This information is particularly relevant to policy makers across several countries currently planning on the rollout of the COVID-19 vaccines and prioritization of at-risk groups, as well as ensuring adequate vaccine coverage to ensure attainment of herd immunity. These findings also complement those of a recent systematic review on the receptivity of the COVID-19 vaccines which included syndicated surveys and peer-reviewed studies.[56]

Lower vaccine rates were noted in countries of the least affected inhabited continent, Africa, while high acceptance rates were noted in Europe (Supplementary file 6) which is one of

the most affected continents.[1] Nevertheless, a coordinated global response with regards to vaccine implementation is required, as disease transmission in a country with low vaccine acceptance/coverage could result in new outbreaks of the disease in the unvaccinated populations in countries with high vaccine coverage due to the easy transmissibility of the infection across borders. As reported in this review, a non-negligible proportion of the population is still undecided about their intent to get vaccinated. This should be an important subgroup of the population that governments and health systems and public health campaigns could capitalise on to edge closer to herd immunity. This would involve putting more emphasis on the identified enablers to vaccine uptake and minimising the impact of identified barriers to vaccine uptake on this population group.

The health belief model underpins the responses of individuals to health interventions, as individuals' responses to health interventions in such situations is largely based on their perceived risk of the disease and benefits of the proposed interventions.[57] The pandemic nature of COVID-19 infection has made it a global concern, directly or indirectly affecting individuals at all corners of the globe. This is reflected in the high vaccine acceptance rates in several countries and the perceived individual susceptibility to COVID-19 infection as one of the main determinants of vaccine acceptance.[16,29,32,34,36–38,49,51,52,55] Other important motivators to vaccine uptake are the development of vaccines of high enough effectiveness[31,40,55], with longer durations of protection.[31,50]

Concerns about vaccine safety and fear of the vaccine side effects together with the record-breaking vaccine development time underpin the hesitancy to accept the COVID-19 vaccine as noted in this review. These factors should be addressed by health authorities together with the scientific community through adequate communication[58] and health education campaigns among others to reduce the important vaccine hesitancy rate as noted in this study and enhance vaccine uptake. Likewise, dispelling misinformation and conspiracy beliefs around the COVID-19 vaccines are essential in order to observe greater vaccine uptake, especially in the context of inadequate health literacy, as these remain important barriers to vaccine uptake.[30,30,33,42,47,48,54] These misinformation and conspiracy beliefs are propagated by anti-vaccine movements mainly through online communication channels.[59] Involving these movements in discussions have also been proposed to improve vaccine uptake.[60]

Reinforcing known enablers of vaccine acceptance such as trust in the health system, health institutions, scientists and research altogether could turn out to be vital. This could be achieved with adequate community engagement. Inadequate community engagement is known to adversely affect the implementation of community-based interventions and clinical research[61], including the introduction of novel vaccines.[19] This could include appropriate stakeholder analysis and involvement to aid with engagement of population groups noted to be less likely to take the vaccine such as such as females[33], ethnic minorities[16,27,33], and non-healthcare providers among others.[29,38] Higher vaccine uptake rates were observed in healthcare providers probably due to a combination of their greater knowledge on the merits of vaccines and their increased exposure and susceptibility to infection.

Contrary to the belief that people with children are more likely to get vaccinated to reduce their risk of getting infected and transmitting the disease to their household, having children was found to be a barrier to vaccine uptake.[32,49] Also, a lower overall vaccine acceptance rate for children from their participating parents was observed, thought to be due to beliefs of lower disease transmission and disease severity among children.[27] This pooled vaccine acceptance estimate was from four studies only, as such more studies are required to make stronger conclusions on vaccine uptake for children.

It is worth taking into consideration that the observed vaccine acceptance rate in this review could be lower than in actual populations. This is because most studies in the review were conducted through online surveys with an overall younger participant population with a known lower disease severity who are less likely to take the vaccine compared to older individuals who are at higher risk of severe infection.[62,63]

The interpretation of the findings from this review should take into consideration a few limitations. The inclusion of studies exclusively published in English limits the generalizability of our findings to other settings, especially as COVID-19 disease is a pandemic affecting the entire globe at present. Also, important heterogeneity across the studies should be kept in mind while interpreting the pooled summary estimates from these studies with different study populations and methodological approaches, which implies that the variability between studies is due to study heterogeneity rather than chance. We therefore limited our meta-analysis to vaccine acceptance rate and proceeded with a narrative synthesis of the determinants of vaccine uptake given the expected between-study heterogeneity. Nonetheless, this review provides extensive evidence on the reception of COVID-19 vaccines across several countries and populations and could therefore be important in informing policy makers in several countries on important parameters to consider while establishing measures to optimize vaccine uptake in their respective settings. The fast-evolving nature of the COVID-19 pandemic means the findings of this study may not necessarily represent the actual vaccine acceptance rates and trends in the future. All included studies were published before the data on safety and efficacy of the current vaccines were known. Therefore, the responses of the participants to vaccine acceptance could not have taken this information into account. As this data becomes widespread and as internet misinformation spreads, public perceptions could change in either direction depending on the presence and seriousness of the side effects reported.

Conclusion

There is an overall good acceptance of COVID-19 vaccines globally despite the wide variations across countries. It is unclear, however, if the current acceptance rates will be sufficient to achieve herd immunity. Capitalising on identified enablers of vaccine uptake such as the high effectiveness of the vaccines and dispelling important barriers such as misinformation and conspiracy beliefs around vaccine safety and efficacy is essential in enhancing vaccine uptake in at-risk subpopulations with ‘unsure’ vaccination intents. Breaking the chain of disease transmission through vaccination to control the pandemic requires satisfactory vaccine uptake and coverage.

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List of Abbreviations

Covid-19	Coronavirus disease 2019
FDA	Food and Drug Administration
MeSH	The medical subject headings
NHI/NHLBI	National Health Institute/National Heart, Lung and Blood Institute
PRISMA	The Preferred Reporting Items for Systematic Reviews and Meta-Analysis

Data Availability

All data is available from the authors upon reasonable request

Conflicts of interest

The authors declare that there is no conflict of interest regarding the publication of this paper

Funding statement

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Author contributions

CAD conceived and designed the experiments, drafted the manuscript.
BMK contributed to the design, study selection and data check and edited the manuscript
HN contributed to the extracted data double-check and performed the quality analysis
AD contributed to the design, performed the quality analysis and edited the manuscript.
All authors reviewed the final manuscript

Supplementary Files

Supplementary file 1: Preferred Reporting Items for Systematic review and Meta-Analysis checklist
Supplementary file 2. Search Strategy for PubMed
Supplementary file 3: Quality Assessment of the included studies
Supplementary file 4: List of excluded studies following full text review
Supplementary file 5: Meta-regression analyses for between study heterogeneity
Supplementary file 6: Pooled Vaccine Acceptance rate according to region of study

Tables

Table 1: Socio-demographic characteristics of participants in the studies included

Author	Country	Study format	Sampling	Population studied	Participants (N=70997)	Males (%)
Abdelhafiz	Egypt	in-person & online	Convenience	general	559	37.7
Al-Mohaithef	Saudi Arabia	online	Snowball	general	992	NR
Barello	Italy	online	NR	students	934	20.4
Bell	England	online	NR	parents & guardians	1252	5.0
Bertin 1	France	online	NR	general	409	26.1
Bertin 2	France	online	NR	general		
Detoc	France	online	NR	general	3259	32.6
Dodd	Australia	online	NR	General	4362	NR
Dong	China	online	NR	general	1236	49.1
Dror	Israel	online	NR	general	1941	NR
Fisher	USA	online	Multistage	general	991	NR
Gagneux-Brunon	France	in-person & online	NR	HCW	2047	26
Goldman	Multinational	online	Convenience	parents & care givers	1541	50
Graffigna	Italy	online	Random	general	1004	NR
Guidry	USA	online	NR	general	788	49.1
Harapan	Indonesia	online	NR	general	1359	34.3
Kabamba	Congo	self-administered	NR	HCW	613	50.9
Lazarus	Multinational†	online	Random	general	13426	49.3
Kreps	USA	online	NR	general	1971	45.7
Malik	USA	online	Snowball	general	672	41.7
Muqattash	UAE	online	NR	general	1109	27.9
Neumann-Bohme	Multinational‡	online	Random	general	7664	NR
Palamenghi	Italy	online	Convenience	general	1004	NR
Papagiannis	Greece	online	NR	HCW	461	25.8
Pogue	USA	online	NR	general	316	50.3
Reiter	USA	online	Convenience	general	2006	43.3
Reuben	Nigeria	online	Snowball	general	589	59.6
Romer 1	USA	online	NR	general	1050	46.3
Romer 2	USA	online	NR	general	840	47.7
Roozenbeek	Multinational*	online	NR	general	5000	48.8
Salali 1	UK	online	NR	general	1088	29.6
Salali 2	Turkey	online	NR	general	3936	37.4
Sarasty	Ecuador	online	NR	general	972	61

Sherman	UK	online	NR	general	1500	48.6
Wang J	China	online	Stratified random	general	2058	12.5
Wang K	China	online	Stratified random	HCW	806	45.8
Williams	UK	online	NR	general	527	43.1
Wong	China	in-person & online	NR	general	1159	34

Multinational - USA, Canada, Israel, Japan, Spain, Switzerland; Multinational† - Brazil, Canada, China, Ecuador, France, Germany, India, Italy, Mexico, Nigeria, Poland, Russia, Singapore, South Africa, Spain, Sweden, UK, USA; Multinational‡ - Denmark, France, Germany, Italy, Portugal, Netherland, UK; Multinational* - USA, UK, Spain, Ireland, Mexico. HCW – health care workers, NR – not reported

Table 2: Socio-demographic and clinical determinants of vaccine uptake and hesitancy

Socio-demographics	Studies	Authors	Estimates, 95%CI
Vaccine acceptance (increase vaccine uptake)			
Sex			
Male	13	Detoc, Dror, Gagneux-Brunon, Guidry, Kabamba Malik, Neumann, Papagianis, Roozenbeek, Salali, Wang, Wang, Wong,	Summary estimate OR: 1.60, 95% CI: 1.38 – 1.84 N=9, I^2=59.2%, p=0.012
Age			
Older age compared to younger age	7	Al-Mohaithef, Detoc, Gagneux-Brunon, Malik, Neumann-Bohme, Roozenbeek, Sherman	NR
Ethnicity			
Asian compared to other ethnicities	1	Malik	NR
White and Hispanic compared to Black	1	Guidry	NR, (p=0.001 and p<0.001)
Marital status			
Married compared to being un-married	2	Al-Mohaithef Wang J	aOR: 1.79, 95%CI: 1.28-2.50 OR:1.70, 95% CI: 1.26–2.29
Education			
Higher educational attainment	2	Malik, Guidry	NR
Occupation			
Healthcare workers compared to non-healthcare providers	2	Detoc Harapan	OR: 1.53, 95% CI: 1.27 – 1.85 OR: 2.01; 95% CI: 1.01 – 4.00
Healthcare workers			
Doctors compared to nurses and other health care providers	2	Kabamba Papagianis	1.59, 95% CI: 1.03 - 2.44, and OR: 2.66, 95% CI: 1.77 - 4.03
Household Income			
Higher household income compared to a lower household income	2	Bell Reiter	aOR: 0.35, 95%CI: 0.17 - 0.73 aRR: 1.07, 95% CI: 1.01 - 1.14

			aRR: 1.09, 95% CI: 1.02 - 1.16
Vaccine hesitancy (decrease vaccine uptake)			
Sex			
Female	1	Reiter	aRR: 0.91, 95% CI: 0.87–0.96
Age			
Younger age compared to older age	1	Fisher	NR
Middle age compared to 18-34 year and >60 years age groups	1	Palamenghi	NR
Ethnicity			
Black, Asian, Chinese, Mixed or Other ethnicities compared to White British	1	Bell	aOR: 2.7, 95%CI: 1.27–5.87
Black ethnicity compared to other ethnicities	1	Fisher	OR: 6.4, 95% CI: 3.2 - 13
Non-Latinx black ethnicity	1	Reiter	aRR: 0.81, 95% CI: 0.74–0.90
Education			
Lower educational attainment	3	Dodd, Fisher, Salali	NR
Occupation			
Retired compared to civil servant	1	Harapan	NR

aOR – adjusted odds ratio, aRR – adjusted risk ratio, CI – confidence interval, NR – measure of effect not reported

Table 3: Enablers of Vaccine uptake

Enablers	Studies	Authors	Estimates, 95%CI
Covid-19 disease related factors			
Perceived individual risk of COVID-19 infection	11	Detoc Gagneux-Brunon Harapan Reiter Salali Wang J Wong Dror, Graffigna, Guidry, Sherman	aOR: 1.510, 95% CI: 1.269 - 1.851 aOR: 2.48, 95% CI: 1.93 - 3.2 aOR: 2.21, 95% CI: 1.07 - 4.59 aRR: 1.05, 95% CI: 1.01 - 1.09 aOR: 1.12, 95% CI: 1.04 - 1.2 aOR:1.46, 95% CI: 1.04 - 2.05 aOR: 1.36, 95% CI 1.04 - 1.79 NR
Fear of acquiring the infection	3	Al-Mohaithef Detoc Gagneux-Brunon	aOR: 2.13, 95% CI: 1.35 - 3.85 aOR: 2.445, 95% CI: 1.998 - 2.991 aOR: 4.69, 95% CI: 3.59-6.11
Perceived severity and attitude towards the disease	3	Kabamba Reiter Graffigna, Williams	aOR: 11.49, 95% CI: 5.88 - 22.46 aRR: 1.08, 95% CI: 1.04 - 1.11 NR
Protect self/others and health consequence to others			
Protect self/others and health consequence to others	2	Bell, Williams	NR
Vaccination-related factors			
Current or prior influenza vaccination	7	Fisher Gagneux-Brunon Wang J Wang K Dror, Malik, Sherman	RRR: 0.06, 95% CI: 0.03 - 0.11 aOR: 4.69, 95% CI: 3.59-6.11 OR:1.90, 95% CI: 1.43–2.51 OR: 2.03, 95%CI: 1.47–2.81 NR
Belief in vaccine efficacy/high effectiveness (>90%)	6	Kreps Guidry Wang J Dong, Harapan, Pogue,	coef: 0.16, 95% CI: 0.15 - 0.18 aRR: 1.46, 95% CI: 1.40 - 1.52 OR:1.56, 95% CI: 1.08–2.25) NR
Positive attitude towards/perceived benefits of vaccine	5	Palamenghi Wong Graffigna, Guidry, Sherman	$r = .618$; $p < .001$ OR = 2.51, 95% CI 1.19–5.26 NR

Lack or lower vaccine side effects	4	Kreps Wong Pogue, Sherman	coef: 0.07, 95% CI: 0.05 - 0.08 OR = 1.81, 95% CI 1.34–2.44 NR
Longer duration of protection by the vaccine	2	Dong, Sarasty	NR
Trust-related factors			
Trust in the health system/doctor's recommendation	4	Al-Mohaithef Reiter Wang J Bell	aOR: 1.533, 95% CI: 1.269 - 1.851 aRR: 1.73, 95% CI: 1.49 - 2.02 OR:2.32, 95% CI: 1.76–3.07 NR
Trust in scientific research/scientists	2	Palamenghi Roozenbeek	r = .373; p < .001 OR = 1.73, 95% CI: 1.57–1.91
Other factors			
Urban setting	1	Fisher	(RRR 0.33, 95% CI: 0.18 - 0.61)
Health engagement	1	Graffigna	NR
More time spent on vaccine testing	1	Pogue	NR
Having health insurance	2	Guidry, Reiter	NR

aOR – adjusted odds ratio, aRR – adjusted risk ratio, CI – confidence interval, NR – measure of effect not reported, RRR – relative risk ratio

Table 4: Barriers to vaccine uptake

Barriers	Studies	Authors	Estimates, 95%CI
Vaccination-related factors			
General vaccine hesitancy or negative attitude towards vaccines	8	Detoc Gagneux-Brunon Wong Sarasty, Neumann-Bohme, Fisher, Guidry, Wang J	aOR: 0.275, 95% CI: 0.23 - 0.329 aOR: 0.37, 95% CI: 0.29 - 0.48 NR, 52.5% NR
Vaccine safety/efficacy	6	Pogue Williams Wang Neumann Fisher Bell	NR, 45.45% NR NR, 76.43% NR, 15% NR, 2/83 NR, 49%
Vaccine side effects	5	Dong Guidry Pogue Neumann-Bohme Fisher	NR NR, p<0.001 NR, 63.47% NR, 55% NR, 14/83
Rushed development of the vaccine	3	Guidry Fisher Bell	NR, p<0.001 NR, 1/83 NR, 50%
Vaccine cost	2	Dong Wong	NR NR, 88.5%
Fear of or higher frequency of injections	2	Dong Guidry	NR NR, p-=0.026
Misinformation-related factors			
Susceptibility to misinformation/ misinformatio/ misconceptions	4	Roozenbeek Fisher Dodd Williams	OR = 0.77, 95% CI: 0.72 - 0.83 NR, 11/83 NR, 43.7%, 93/213 NR
Conspiracy beliefs/Experimental vaccine	2	Romer Neumann-Bohme	0.15, 99% CI: 0.25 - 0.06 NR
Inadequate health literacy	1	Dodd	OR: 0.58, 95% CI: 0.46 - 0.73
Other factors			
Having children	2	Dror Salali	NR, p=0.013 aOR: 0.82, 95% CI: 0.69 - 0.96
Perceived barriers	1	Guidry	NR
Possible vaccine shortage	1	Guidry	NR p=0.001
MMR Harm	1	Romer	0.033, 95% CI: 0.072 - 0.003

FDA emergency use authorisation	1	Kreps	coef: -0.03, 95% CI: -0.04 - 0.01
vaccine originating from a non-US country	1	Kreps Kreps	China: -0.13, 95% CI: -0.15 to -0.11 UK: −0.04, 95% CI: -0.06 to -0.02)

aOR – adjusted odds ratio, MMR – measles, mumps, rubella, CI – confidence interval, NR – measure of association not reported

Figure Legend

Figure 1: PRISMA Flow Chart for Study Selection

Figure 2: Forest plot showing the pooled and individual vaccine acceptance rates to the SARS-CoV-2 across 32 studies. *The dashed line on the Forest plot represents the overall pooled estimate. The grey squares and horizontal lines represent the vaccine acceptance rate of each study and their 95% confidence intervals. The size of the grey square represents the weight contributed by each study in the meta-analysis. The diamond represents the pooled vaccine acceptance rate and its 95% confidence intervals.*

Figure 3: Forest plot showing the pooled and individual vaccine hesitancy rates to the SARS-CoV-2 across 33 studies. *The dashed line on the Forest plot represents the overall pooled estimate. The grey squares and horizontal lines represent the vaccine acceptance rate of each study and their 95% confidence intervals. The size of the grey square represents the weight contributed by each study in the meta-analysis. The diamond represents the pooled vaccine acceptance rate and its 95% confidence intervals.*

Figure 4: Forest plot showing the pooled and individual rates of uncertainty to vaccination against the SARS-CoV-2 across 20 studies. *The dashed line on the Forest plot represents the overall pooled estimate. The grey squares and horizontal lines represent the vaccine acceptance rate of each study and their 95% confidence intervals. The size of the grey square represents the weight contributed by each study in the meta-analysis. The diamond represents the pooled vaccine acceptance rate and its 95% confidence intervals.*

Figure 5: Funnel Plot for studies on Covid-19 vaccine acceptance rate
The blue dots represent the studies, the solid vertical line represents the pooled estimate of the vaccine acceptance rate obtained from the meta-analysis, the dashed diagonal lines represent the 95% confidence limits around the pooled estimate.

Figure 6: Pooled Vaccine Acceptance rate among parents for their children
The dashed line on the Forest plot represents the overall pooled estimate. The grey squares and horizontal lines represent the vaccine acceptance rate of each study and their 95% confidence intervals. The size of the grey square represents the weight contributed by each study in the meta-analysis. The diamond represents the pooled vaccine acceptance rate and its 95% confidence intervals.

Figure 1: PRISMA Flow Chart for Study Selection

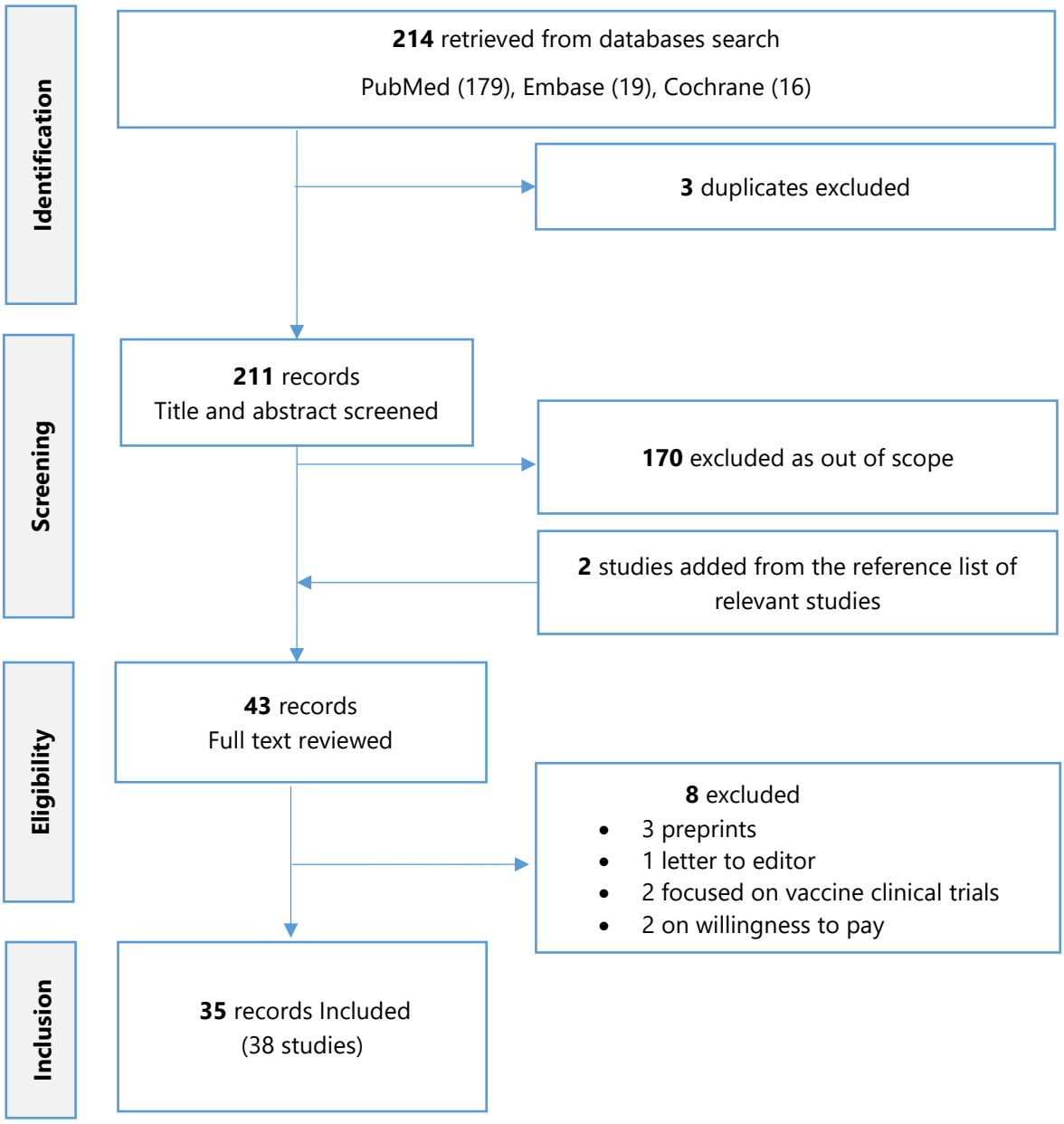


Figure 2: Forest plot showing the pooled and individual vaccine acceptance rates across 32 studies.

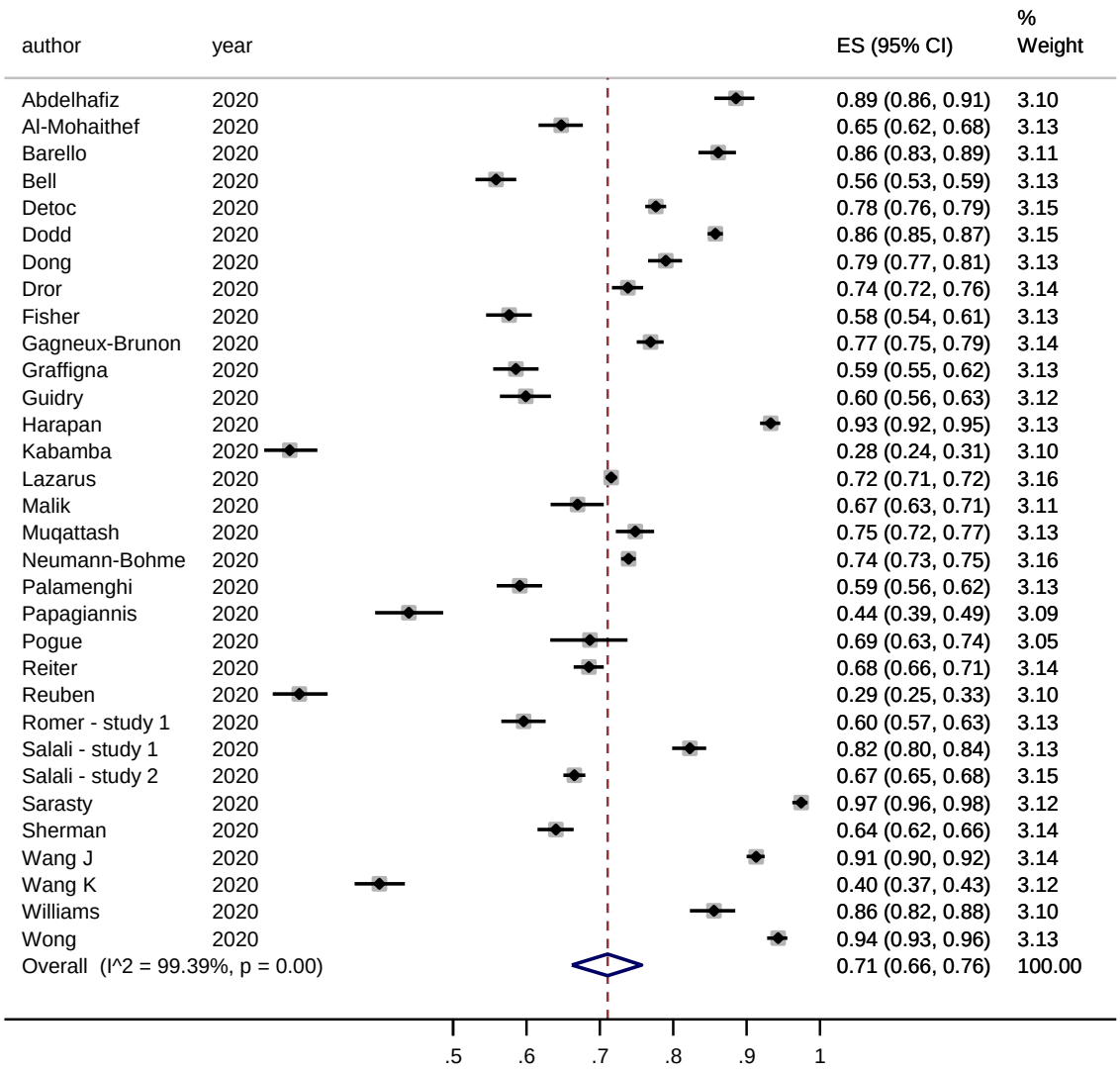


Figure 3: Forest plot showing the pooled and individual vaccine hesitancy rates to the SARS-CoV-2 across 33 studies.

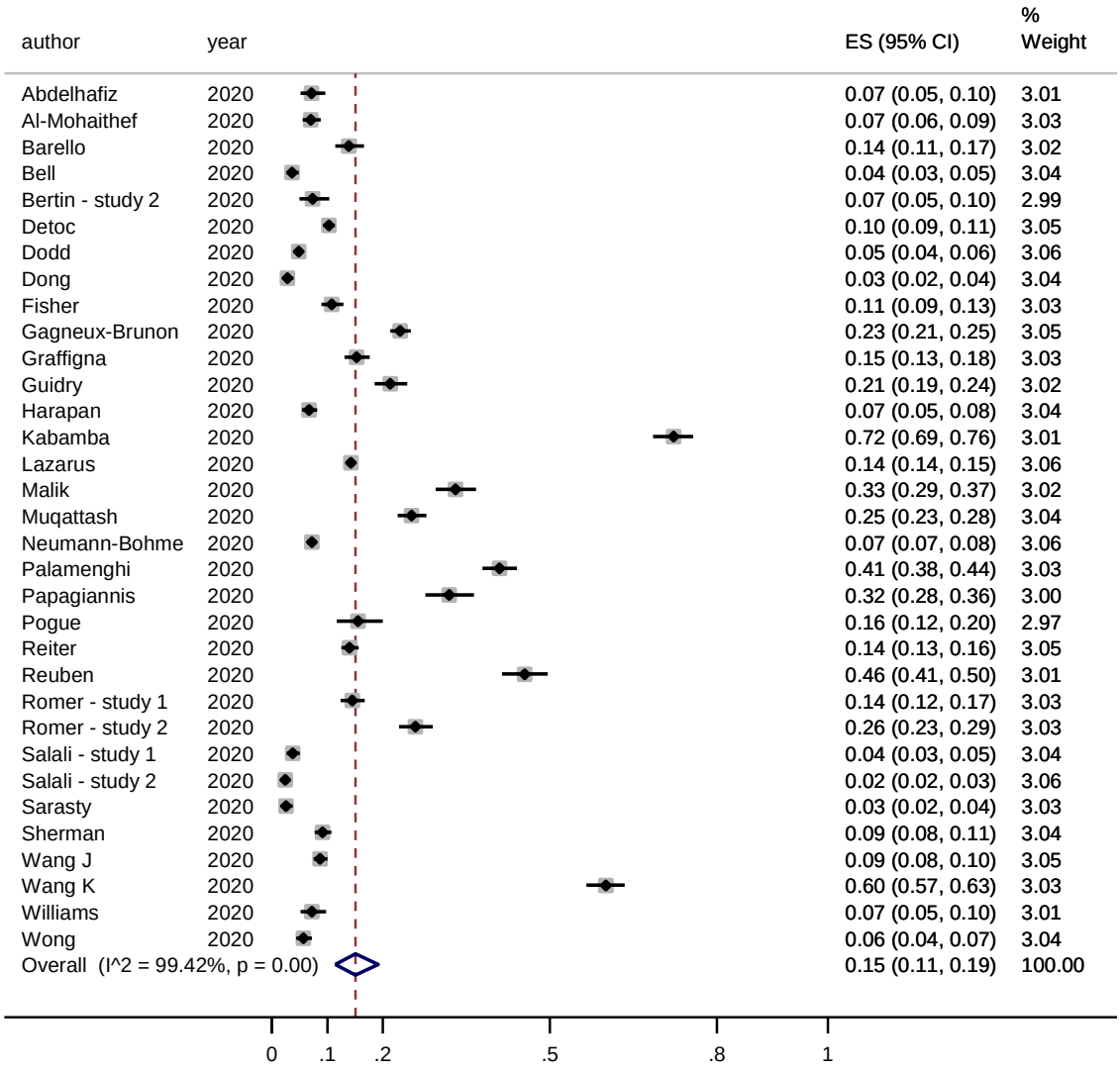


Figure 4: Forest plot showing the pooled and individual rates of uncertainty to vaccination against the SARS-CoV-2 across 20 studies.

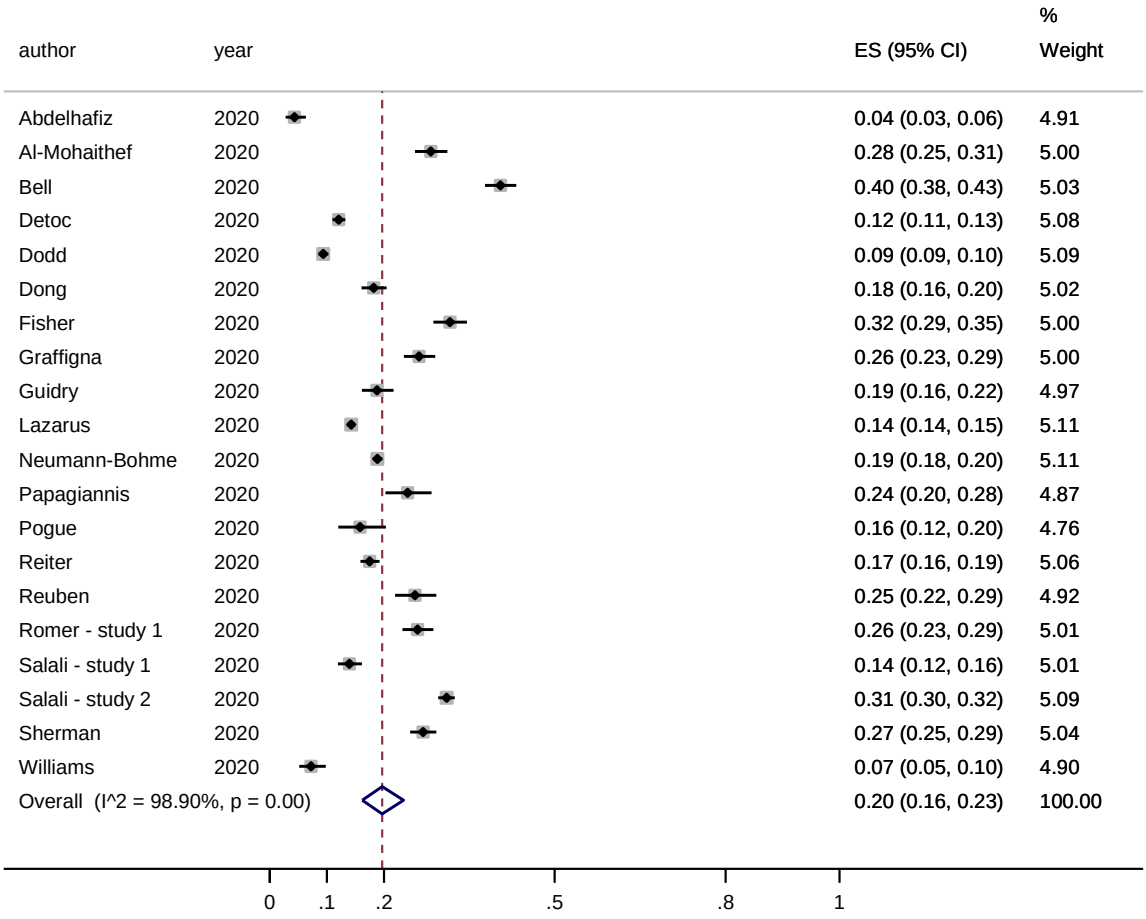


Figure 5: Funnel Plot for studies on Covid-19 vaccine acceptance rate

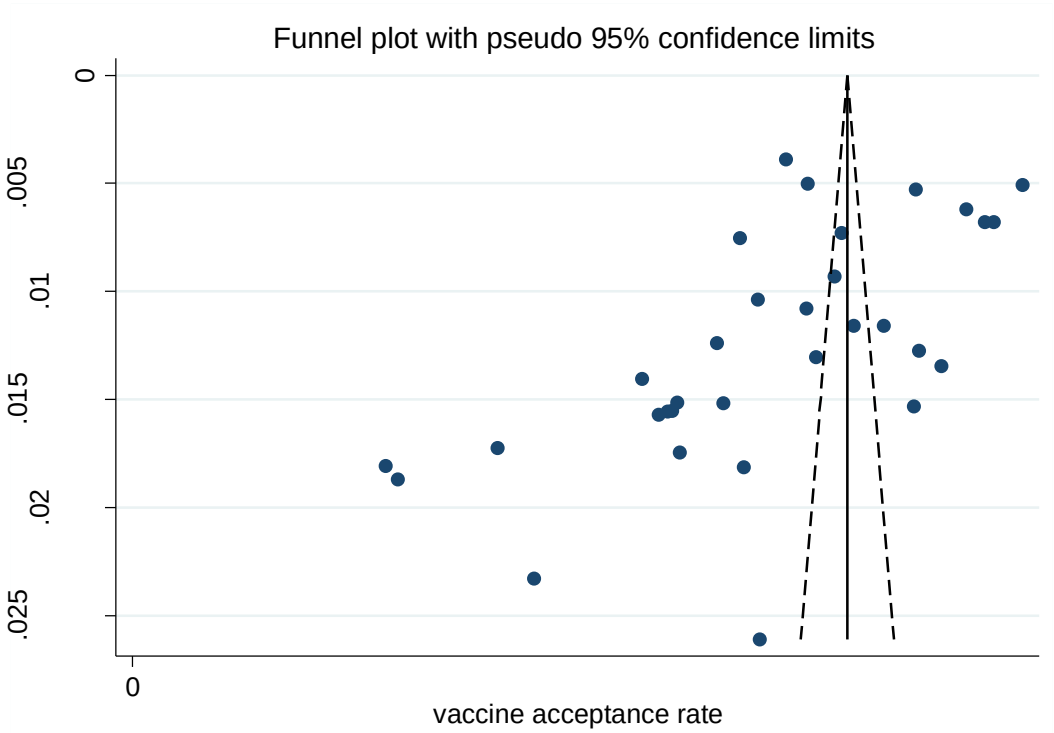
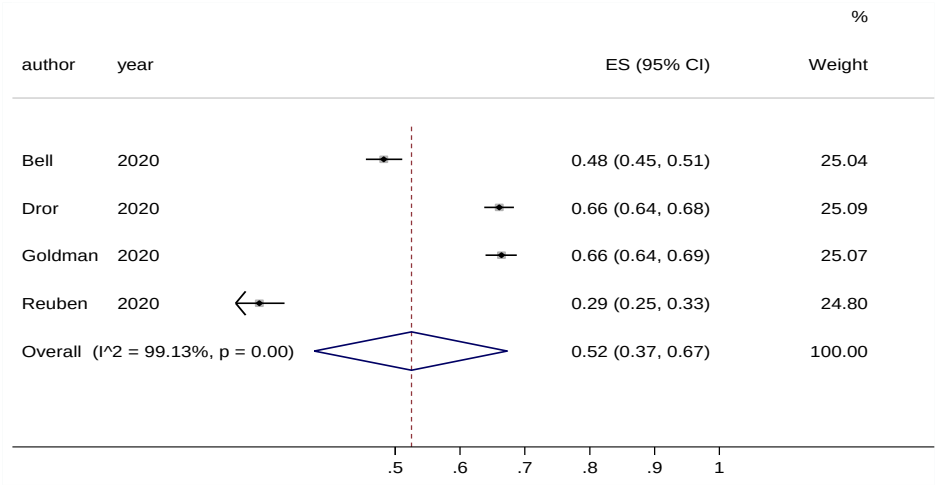
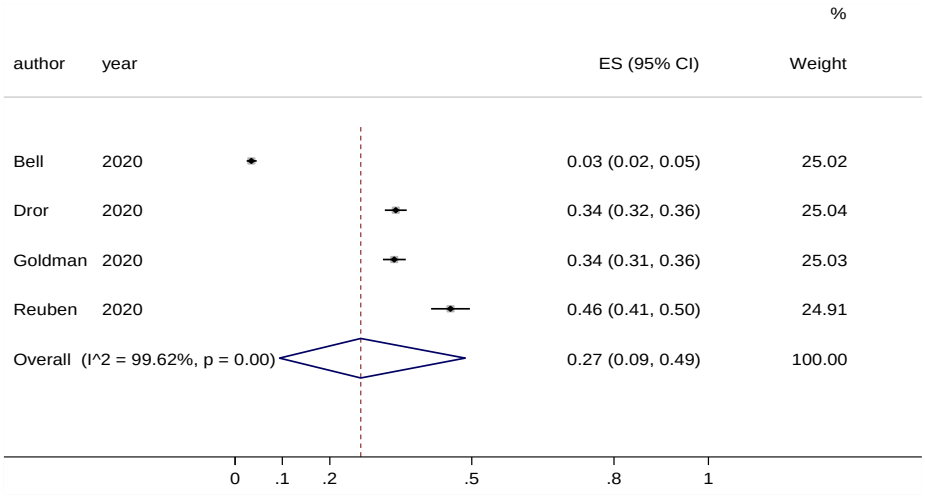


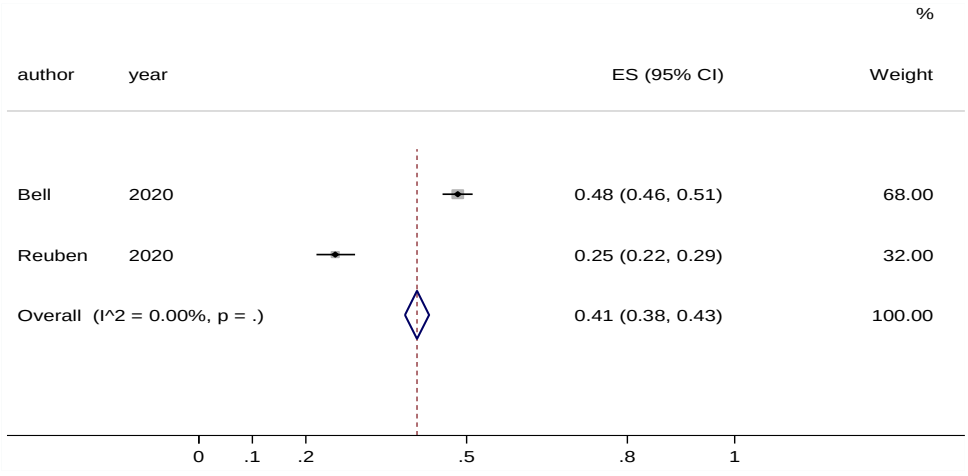
Figure 6: Pooled Vaccine Acceptance rate among parents for their children



'Yes' to vaccination of child



'No' to vaccination of child



'Not sure' to vaccination of child

Supplementary Files

Supplementary file 1. Preferred Reporting Items for Systematic review and Meta-Analysis (PRISMA-P) 2009 checklist

Section/topic	#	Checklist item	Page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	3
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	4
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4&5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	21
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4&5
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	5&6

Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	6
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	6&7
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7&18
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	7& Suppl. File 2
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	8
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	8
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	7
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			

Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	10-12
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	11&12
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	12
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	18

Supplementary file 2. Search Strategy for PubMed

Search #	Search words
1	"COVID-19" [Supplementary Concept] OR 2019-nCoV[tiab] OR 2019nCoV[tiab] OR COVID-19[tiab] OR SARS-CoV-2[tiab] OR “novel coronavirus”[tiab]
AND	
2	COVID-19 vaccine" [Supplementary Concept] OR vaccin*[tiab] OR immuniz*[tiab] OR BNT162[tiab] OR BNT162b2[tiab] OR mRNA-1273[tiab] OR “mRNA 1273”[tiab] OR ChAdOx1[tiab] OR Pfizer OR BioNTech OR Moderna OR AstraZeneca
AND	
3	Patient Acceptance of Health Care"[Mesh] OR accepta*[tiab] OR receptivity[tiab] OR "Attitude"[Mesh] OR attitude[tiab] OR willingness[tiab]

Supplementary file 3. Quality Assessment of the included studies

Criteria	Abdelhafiz	Al-Mohaithef	Barello	Bell	Bertin 1	Bertin 2	Detoc	Dodd	Dong
1. Was the research question or objective in this paper clearly stated?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
2. Was the study population clearly specified and defined?	Yes	Yes	Yes	Yes	No	Yes	No	No	Yes
3. Was the participation rate of eligible persons at least 50%?	NR	Yes	Yes	NR	NR	Yes	Yes	NR	NR
4. Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	Yes	Yes	NR	No	No	Yes	No	No	NR
5. Was a sample size justification, power description, or variance and effect estimates provided?	Yes	NR	No	No	Yes	Yes	No	No	No
6. For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?	Yes	Yes	Yes	Yes	CD	Yes	Yes	Yes	Yes
8. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?	NA	NA	NA	NA	NA	NA	NA	NA	NA
9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	NA	NA	NA	NA	NA	NA	NA	NA	NA
10. Was the exposure(s) assessed more than once over time?	NA	NA	NA	NA	NA	NA	NA	NA	NA

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11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	Yes	Yes	NR	Yes	Yes	Yes	Yes	Yes	CD
12. Were the outcome assessors blinded to the exposure status of participants?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
13. Was loss to follow-up after baseline 20% or less?	NA	NA	NA	NA	NA	NA	NA	NA	NA
14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?	No	Yes	No	Yes	No	No	Yes	NR	Yes
Quality rating	**Fair**	**Fair**	**Fair**	**Fair**	**Poor**	**Fair**	**Fair**	**Poor**	**Poor**

Supplementary file 3. Quality Assessment of the included studies continued…

Criteria	Fisher	Gagneux-Brunon	Graffigna	Guidry	Goldman	Harapan	Kabamba	Lazarus	Kreps
1. Was the research question or objective in this paper clearly stated?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
2. Was the study population clearly specified and defined?	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes
3. Was the participation rate of eligible persons at least 50%?	Yes	NR	NR	NR	NR	NR	NR	NR	Yes
4. Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes
5. Was a sample size justification, power description, or variance and effect estimates provided?	No	No	No	No	No	Yes	No	No	Yes
6. For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?	Yes	NA	NA	NA	NA	NA	NA	NA	NA
7. Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?	Yes	Yes	CD	Yes	Yes	Yes	Yes	Yes	Yes
8. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?	NA	NA	NA	NA	NA	NA	NA	NA	NA
9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	NA	NA	NA	NA	NA	NA	NA	NA	NA

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10. Was the exposure(s) assessed more than once over time?	NA	NA	NA	NA	NA	NA	NA	NA	NA
11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
12. Were the outcome assessors blinded to the exposure status of participants?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
13. Was loss to follow-up after baseline 20% or less?	NA	NA	NA	NA	NA	NA	NA	NA	NA
14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?	Yes	No	No	Yes	No	Yes	No	Yes	Yes
Quality rating	**Fair**	**Fair**	**Fair**	**Good**	**Fair**	**Fair**	**Fair**	**Poor**	**Good**

Supplementary file 3. Quality Assessment of the included studies continued…

Criteria	Malik	Muqattash	Neumann-Bohme	Palamenghi	Papagiannis	Pogue	Reiter	Reuben
1. Was the research question or objective in this paper clearly stated?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Was the study population clearly specified and defined?	Yes	No	NR	Yes	Yes	Yes	Yes	Yes
3. Was the participation rate of eligible persons at least 50%?	NR	NR	Yes	NR	Yes	NR	NR	NR
4. Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	Yes	No	NR	Yes	Yes	Yes	Yes	No
5. Was a sample size justification, power description, or variance and effect estimates provided?	Yes	No	Yes	No	No	No	No	No
6. For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?	NA	NA	NA	NA	NA	NA	NA	NA
7. Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
8. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?	NA	NA	NA	NA	NA	NA	NA	NA
9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	NA	NA	NA	NA	NA	NA	NA	NA

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10. Was the exposure(s) assessed more than once over time?	NA	NA	NA	NA	NA	NA	NA	NA
11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	Yes	No	CD	No	No	Yes	Yes	Yes
12. Were the outcome assessors blinded to the exposure status of participants?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
13. Was loss to follow-up after baseline 20% or less?	NA	NA	NA	NA	NA	NA	NA	NA
14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?	Yes	No	No	CD	No	Yes	Yes	Yes
Quality rating	**Good**	**Poor**	**Fair**	**Fair**	**Poor**	**Good**	**Good**	**Fair**

Supplementary file 3. Quality Assessment of the included studies continued…

Criteria	Romer	Roozenbeek	Salali	Sarasty	Sherman	Wang J	Wang K	Williams	Wong
1. Was the research question or objective in this paper clearly stated?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Was the study population clearly specified and defined?	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
3. Was the participation rate of eligible persons at least 50%?	Yes	NR	NR	Yes	Yes	Yes	Yes	NR	NR
4. Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
5. Was a sample size justification, power description, or variance and effect estimates provided?	Yes	No	No	No	No	No	No	No	No
6. For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
8. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?	NA	NA	NA	NA	NA	NA	NA	NA	NA
9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	NA	NA	NA	NA	NA	NA	NA	NA	NA

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10. Was the exposure(s) assessed more than once over time?	NA	NA	NA	NA	NA	NA	NA	NA	NA
11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	Yes	Yes	No	CD	Yes	No	No	Yes	Yes
12. Were the outcome assessors blinded to the exposure status of participants?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
13. Was loss to follow-up after baseline 20% or less?	NA	NA	NA	NA	NA	NA	NA	NA	NA
14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?	Yes	Yes	No	Yes	Yes	No	No	No	No
Quality rating	**Good**	**Fair**	**Fair**	**Fair**	**Good**	**Fair**	**Fair**	**Fair**	**Fair**

Supplementary file 4. List of excluded studies following full text review

#	Author (year)	Title	Reason for exclusion
1	Al-Hajri (2020)	Willingness of parents to vaccinate their children against influenza and the novel coronavirus disease-2019	The study did not provide enough data that could be extracted and analyzed as it was a letter to the editor, highlighting only their main findings
2	The Coconel group	A future vaccination campaign against COVID-19 at risk of vaccine hesitancy and politicisation	The study did not provide enough data that could be extracted and analyzed as it was a published comment, highlighting only their main findings
3	Daly (2020)	Willingness to vaccinate against COVID-19 in the US: Longitudinal evidence from a nationally representative sample of adults from April–October 2020	The study was a preprint and had not yet been peer-reviewed, so changes to their findings from this study once published could affect the overall results from our review
4	Goldmann (2020)	Factors associated with parents' willingness to enroll their children in trials for COVID-19 vaccination.	The study was focused on the willingness to enroll in clinical trials for covid-19 vaccination rather than if they wanted to get the vaccine once it becomes available
5	Harapan (2020)	Willingness-to-pay for a COVID-19 vaccine and its associated determinants in Indonesia	The study was focused on participants' willingness to pay for a vaccine at different vaccine costs but did not provide particular enablers or barriers to uptake
6	Qiao (2020)	Risk exposures, risk perceptions, negative attitudes toward general vaccination, and COVID-19 vaccine acceptance among college students in South Carolina	The study was a preprint and had not yet been peer-reviewed, so changes to heir findings from this study once published could affect the overall results from our review
7	Sun (2020)	Interest in COVID-19 vaccine trials participation among young adults in China: Willingness, reasons for hesitancy, and demographic and psychosocial determinants	The study was focused on the willingness to enroll in clinical trials for covid-19 vaccination rather than if they wanted to get the vaccine once it becomes available. The study is also a preprint
8	Thorneloe (2020)	Willingness to receive a COVID-19 vaccine among adults at high-risk of COVID-19: a UK-wide survey	The study was a preprint and had not yet been peer-reviewed, so changes to their findings from this study once published could affect the overall results from our review

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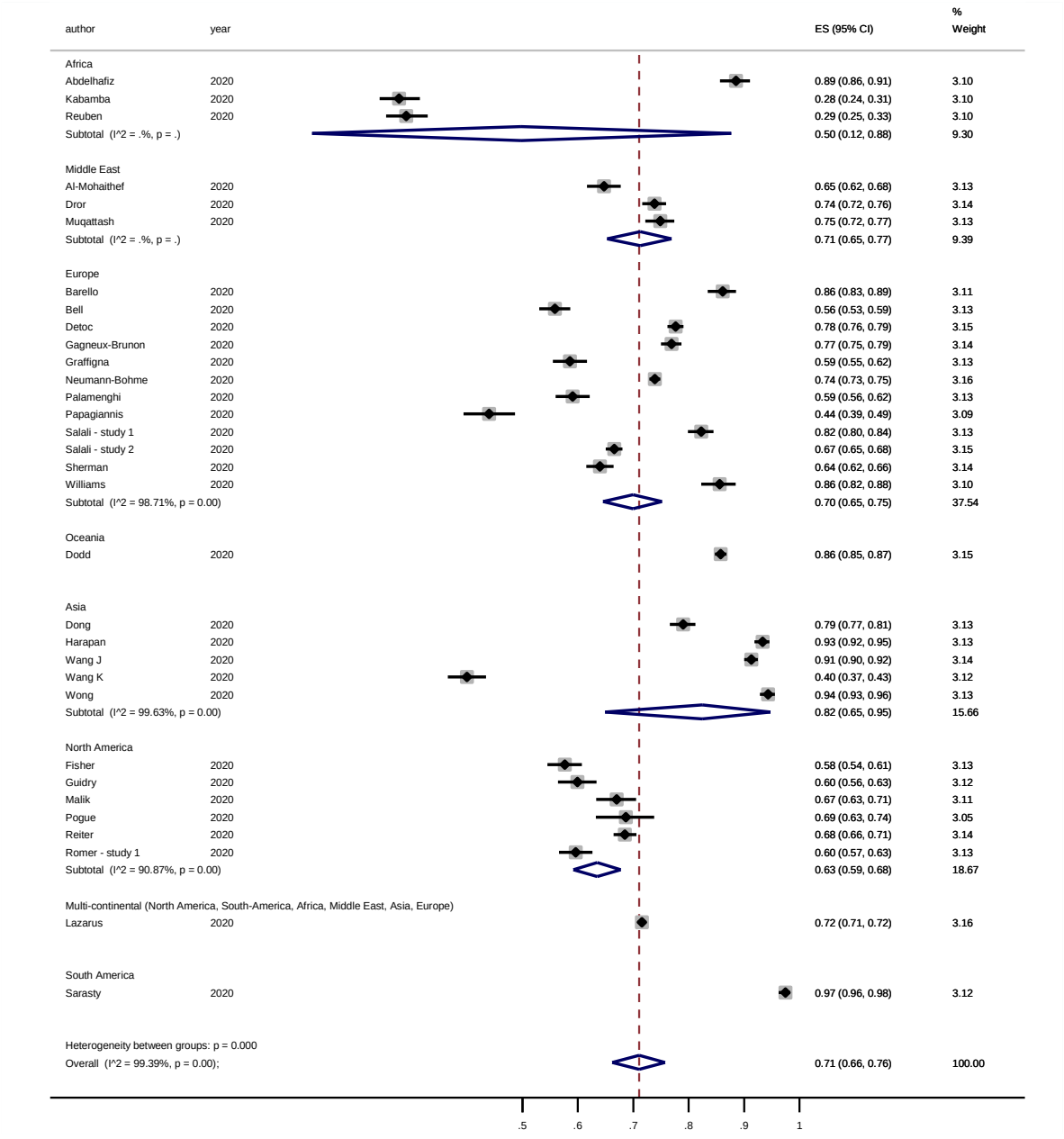
Supplementary file 5: Meta-regression analyses for between study heterogeneity

Study Characteristics	Strata	# of Studies	Vaccine acceptance Summary estimate (95% CI)	Within-stratum P value (I^2)	Between-Stratum P value
Sample size	≥1000	19	0.71 (0.66 – 0.76)	<0.001 (99.27%)	0.079
	<1000	13	0.65 (0.50 – 0.78)	<0.001 (99.49%)	
Disease prevalence	High	19	0.70 (0.65 – 0.75)	<0.001 (98.94%)	0.845
	Low	12	0.73 (0.60 – 0.83)	<0.001 (99.63%)	
Study Quality	Good	6	0.65 (0.61 – 0.68)	<0.001 (86.23%)	0.459
	Fair or poor	25	0.73 (0.67 – 0.78)	<0.001 (99.49%)	

Supplementary file 6. Pooled Vaccine Acceptance rate according to region of study



The dashed line on the Forest plot represents the overall pooled estimate. The grey squares and horizontal lines represent the odds ratios of each study and their 95% confidence intervals. The size of the grey square represents the weight contributed by each study in the meta-analysis. The diamond represents the pooled odds ratio and its 95% confidence intervals.

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