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REVIEW ARTICLE

Global COVID-19 vaccine acceptance rate: a systematic review and meta-analysis

Yousef Alimohamadi[1] · Hadiseh Hosamirudsari[2] · Elahe Hesari[3] · Mojtaba Sepandi[1]

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Abstract

Aim Achieving high COVID-19 vaccination coverage rates is essential as soon as a vaccine is available to deal with and end this pandemic. Due to the different amounts of COVID-19 vaccine acceptance rates in different regions, the pooled estimation of this rate is essential. Therefore, we conducted a systematic review and meta-analysis to investigate worldwide COVID-19 vaccine acceptance rates.

Subject and methods International databases (including, Web of sciences, PubMed, and Scopus) were searched to identify related studies. The heterogeneity among studies was assessed using the I^2 index, the Cochran Q test, and T^2. A random-effects model was used to pool estimate vaccine acceptance rates.

Results The overall pooled estimate of COVID-19 vaccine acceptance rate was 65.1 (95% CI 60.1–70.1; $P < 0.001$, $I^2 = 99.8$). The vaccine acceptance rate in the general population was 68.5 (95% CI 62.5–74.5; $P < 0.001$, $I^2 = 99.8$) and among healthcare workers (HCWs) was 55.9 (95% CI 47.8–64.1; $P < 0.001$, $I^2 = 99.6$). The lowest COVID-19 vaccine acceptance rate was in the Middle East (46.1% (35.1–57.0)), and the highest coverage rate was (85% (71–99.1)) in South America.

Conclusion COVID-19 vaccine acceptance rate among HCWs is lower than the general population. More studies are recommended to identify related factors to the COVID-19 vaccine acceptance rate.

Keywords Global · COVID-19 · Vaccine acceptance rate · Meta-analysis

Background

Vaccines are one of the most successful and cost-effective public health tools that have largely helped eliminate or control several serious diseases in the past century. Therefore, to control the epidemic of COVID-19 disease, in addition to effective public health measures, such as social distancing, using face masks, washing hands, avoiding closed crowded spaces, and educating the general population, effective vaccination is necessary to reduce the disease and prevent mortality. However, despite the safety and effectiveness of immunization practices, hesitancy to vaccination has become an emerging global problem (Syed Alwi et al. 2021). Several COVID-19 vaccines are currently in human trials, and many are available for administration(Lazarus et al. 2021). Despite all the advances in vaccination, some people still do not believe in vaccination. They doubt the benefits of vaccines and worry about their safety (Salathé and Bonhoeffer 2008). Vaccine hesitancy is a delay in accepting or refusing vaccination despite the availability of this service. Vaccine hesitancy varies across time, place, and vaccines. It is influenced by many factors such as complacency, convenience, and confidence (MacDonald 2015). The vaccine acceptance rate in the general population and HCWs plays an important role in controlling pandemics (Sallam 2020). There are several reasons for being hesitant to get vaccinated. Possible risks, religious beliefs, and lack of awareness are the most common reasons (Karafillakis and Larson 2017; Pelčić et al.

✉ Mojtaba Sepandi
msepandi@gmail.com

[1] Health Research Center, Life Style Institute, Baqiyatallah University of Medical Sciences, Tehran, Iran

[2] Department of Infectious Diseases, Baharloo Hospital, Tehran University of Medical Sciences, Tehran, Iran

[3] Department of Epidemiology and Biostatistics School of public health, Tehran University of Medical Science, Tehran, Iran

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Table 1 Characteristics of articles included in the study

Author	Country	Sample size	Population	Vaccine acceptance rate (%)
Wang et al. (2020)	China	2058	General population	91.3
Harapan et al. (2020)	Indonesia	1359	General population	93.3
Dror et al. (2020)	Israel	388	Doctors	78.1
Detoc et al. (2020)	France	3259	General population	77.6
Dror et al. (2020)	Israel	1112	General population	75
Detoc et al. (2020)	France	3259	General population	77.6
Dror et al. (2020)	Israel	1112	Nurses	61
Kwok et al. (2021)	Hong Kong	1205	Nurses	63
Dror et al. (2020)	Israel	211	Nurses	61.1
Nzaji et al. (2020)	Congo	613	Healthcare workers	27.7
Gagneux-Brunon et al. (2021)	France	2047	Healthcare workers	76.9
Sarasty et al. (2020)	Ecuador	1050	General population	97
Wong et al. (2020)	Malaysia	1159	General population	94.3
Neumann-Böhme et al. (2020)	Denmark	1000	General population	80
Neumann-Böhme et al. (2020)	UK	1000	General population	79
Neumann-Böhme et al. (2020)	Italy	1500	General population	77.3
Ward et al. (2020)	France	5018	General population	76
Neumann-Böhme et al. (2020)	Portugal	1000	General population	75
Neumann-Böhme et al. (2020)	Netherland	1000	General population	73
Neumann-Böhme et al. (2020)	Germany	1000	General population	70
Neumann-Böhme et al. (2020)	France	1000	General population	62
Fisher et al. (2020)	USA	1003	General population	56.9
Salali and Uysal (2020)	UK	1088	General population	83
Lazarus et al. (2021)	Brazil	717	General population	85.4
Lin et al. (2020)	China	3541	General population	83.5
Taylor et al. (2020)	Canada	1902	General population	80
Taylor et al. (2020)	US	1772	General population	75
Salali and Uysal (2020)	Turkey	3946	General population	66
Reiter et al. (2020)	USA	2006	General population	68.5
Malik et al. (2020)	USA	672	General population	67
Lazarus et al. (2021)	China	712	General population	88.6
Barello et al. (2020)	Italy	735	university student	86.1
Lazarus et al. (2021)	South Africa	619	General population	81.6
Lazarus et al. (2021)	South Korea	752	General population	79.8
Lazarus et al. (2021)	Mexico	699	General population	76.3
Lazarus et al. (2021)	USA	773	General population	75.4
Lazarus et al. (2021)	India	742	General population	74.5
Lazarus et al. (2021)	Spain	748	General population	74.3
Lazarus et al. (2021)	Ecuador	741	General population	71.9
Lazarus et al. (2021)	UK	768	General population	71.5
Lazarus et al. (2021)	Italy	736	General population	70.8
Lazarus et al. (2021)	Canada	707	General population	68.7
Lazarus et al. (2021)	Germany	722	General population	68.4
Lazarus et al. (2021)	Singapore	655	General population	67.9
Lazarus et al. (2021)	Sweden	650	General population	65.2
Lazarus et al. (2021)	Nigeria	670	General population	65.2
Lazarus et al. (2021)	France	669	General population	58.9
Lazarus et al. (2021)	Poland	666	General population	56.3
Lazarus et al. (2021)	Russia	680	General population	54.9

Table 1 (continued)

Author	Country	Sample size	Population	Vaccine acceptance rate (%)
Rhodes et al. (2021)	Australia	2018	Parents	75.8
Bell et al. (2020)	UK	1252	Parents	89.1
Sherman et al. (2021)	UK	1500	General population	64
Zhang et al. (2020)	China	1052	parents	77.6
Gretch et al. (2020)	Malta	123	GP	61.8
La Vecchia et al. (2020)	Italy	1055	General population	53.7
Gretch et al. (2020)	Malta	1002	Health worker	52
Gretch and Gauci (2020)	Malta	852	University student	44.2
Freeman et al. (2020)	UK	3114	General population	71.7
Al-Mohaithef and Badhi (2020)	Saudi	992	General population	64.7
Sallam et al. (2021b)	Jordan	2173	General population	28.4
Sallam et al. (2021a)	Kuwait	771	General population	23.6
Van D. TRAN et al. (2021)	Russia	876	General population	41.7
Qunaibi et al. (2021)	Arab countries	3620	General population	12.6
Yigit et al. (2021)	Turkey	428	General population	62.6
Yigit et al. (2021)	Turkey	428	General population	33.9
Alabdulla et al. (2021)	Qatar	7859	General population	44.7
Saied et al. (2021)	Egypt	727	Medicine Students	35.9
Saied et al. (2021)	Egypt	732	Physical medicine	33.5
Saied et al. (2021)	Egypt	256	Dentistry	27.7
Saied et al. (2021)	Egypt	274	Nursing	47.4
Saied et al. (2021)	Egypt	144	Pharmacy	27.1
Meyer et al. (2021)	USA	16,292	Employees	55.3
Shekhar et al. (2021)	USA	3479	HCW	36
Machida et al. (2021)	Japan	2956	General population	62.1

2016; Yaqub et al. 2014). The highest acceptance rate of the COVID-19 vaccine in the general population was observed in East Asia. However, Kuwait and Jordan had the lowest rate of acceptance of the COVID-19 vaccine. In the study by Lazarus et al., people in 19 countries were surveyed to determine the potential acceptance of the COVID-19 vaccine; 71.5% of participants reported that they were very or somewhat likely to receive the COVID-19 vaccine, and 48.1% reported that they would accept their employer's recommendation (Lazarus et al. 2021).

High coverage of the COVID-19 vaccination in the community is critical to ending the epidemic. A meta-analysis is needed to address the range of vaccine acceptance rates. Addressing the extent of vaccine hesitancy in different countries is the first step. Considering the variable values of the acceptance of the COVID-19 vaccine in different regions, the pooled estimate of this rate is very important. Therefore, we conducted a systematic review and meta-analysis to investigate the worldwide acceptance of the COVID-19 vaccine.

Methods

Search strategy

We conducted this study based on PRISMA guidelines. Several electronic databases were selected for the search, including PubMed, Scopus, and Web of Science. We searched the COVID-19 vaccine acceptance rate and related keywords such as "COVID-19," "acceptance rate," "SARS-COV2 vaccine," "COVID-19 vaccine," and "COVID-19 vaccine acceptance" comprehensively and systematically.

Inclusion and exclusion criteria

In the present review, the outcome was the COVID-19 acceptance rates. We included all original studies that reported an estimate for COVID-19 vaccine acceptance rate as a percentage, regardless of time and location, age, type of studied population, and publication language of the studies. Letter to the editors, case reports and case series, reviews, and meta-analyses were excluded.

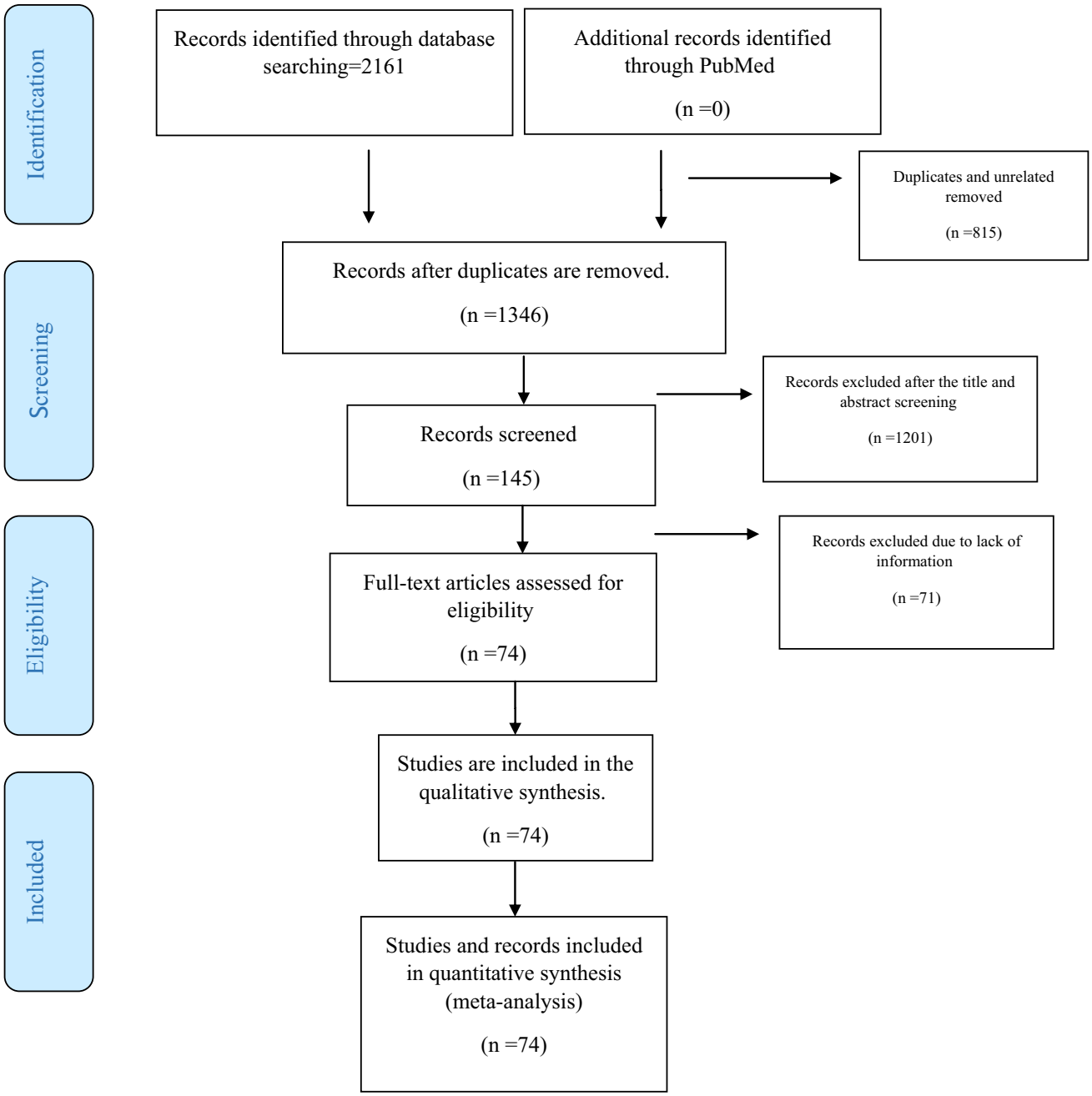


Fig. 1 PRISMA flow diagram for included studies in the current meta-analysis

Study selection and data extraction

Studies were entered into Endnote X8 software for the screening process. After extraction of duplicate articles, the title of studies was checked out, and unrelated studies were excluded. In the second step, abstracts of all studies were screened, and those that met the inclusion criteria entered the full-text review step. In the final step, the full texts of the studies were assessed.

Two authors screened the final full texts independently, and a third review author was consulted in cases of disagreement. The extracted data included: the first

Table 2 Pooled estimation of vaccine acceptance rate according to different variables

Subgroups	Number of records	Vaccine acceptance rate (95% CI)	tau^2	I^2	$P > Q$
Study year					
2020	66	68.6 (64.4–72.9)	0.03	99.6	<0.001
2021	7	36.0 (18.4–53.7)	0.02	99.7	<0.001
Region					
Africa	2	58.2 (26.6–89.7)	0.07	99.6	<0.001
Asia	9	74.6 (65.8–84.3)	0.02	99.5	<0.001
Australia	1	75.8 (73.9–77.7)	0	–	<0.001
Europe	30	70.0 (66.0–73.9)	0.01	98.8	<0.001
Middle East	16	46.1 (35.1–57.0)	0.05	99.7	<0.001
North America	10	69.0 (58.7–78.3)	0.02	99.6	<0.001
South America	3	84.8(70.5–99.1)	0.01	99.3	<0.001
Study population					
General population	54	68.5(62.5–74.5)	0.05	99.8	<0.001
HCWs	20	55.9(47.8–64.1)	0.03	99.6	<0.001
Pooled estimation	74	65.1(60.1–70.1)	0.04	99.8	<0.001

author's last name, study year, region, sample size, study population and vaccine acceptance rate. Data extraction was done by the same two review authors who conducted the study selection independently.

The assessment of methodological quality and risk of bias

The Newcastle–Ottawa Scale (NOS) was applied to evaluate the quality of selected studies (Peterson et al. 2011). The NOS consists of three domains. These domains are selection of studies, comparability of study groups, and description of exposure and outcome. This scale includes eight items, and it has a star rating system. The total score of each article was calculated. Studies were ranked as high (7–10), medium (5–6), or low quality (< 4). Two review authors completed quality assessments independently. A third review author was involved in cases of disagreement.

Statistical analysis

Cochran's Q test with a significance level of $P < 0.05$ and I^2 statistic values >75% were considered as heterogeneity between different studies. To deal with high heterogeneity ($I^2 = 99.7\%$ and Cochran's Q ($P < 0.001$), the random-effects meta-analysis model was used to estimate pooled vaccine acceptance rate.

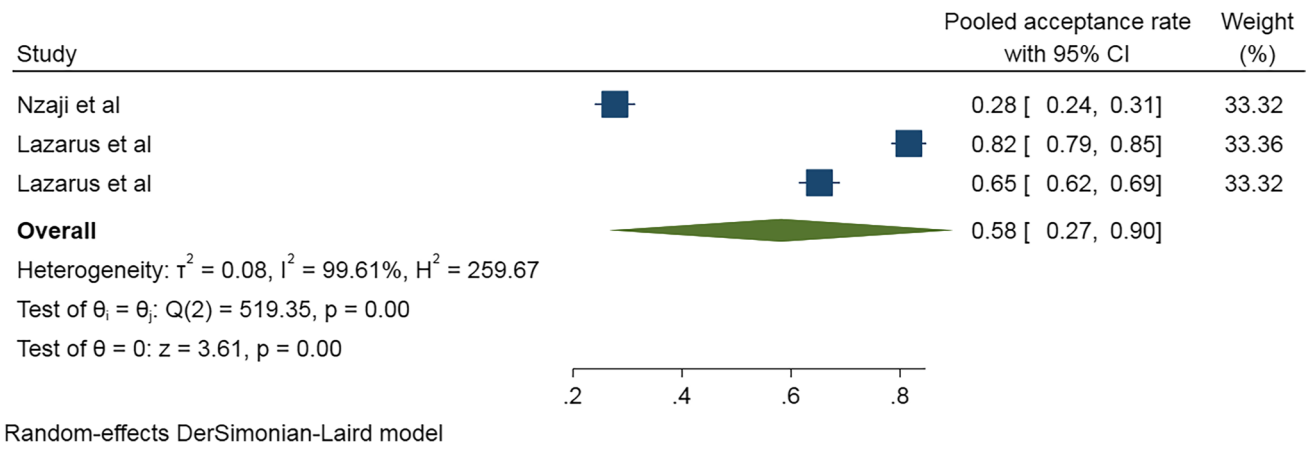


Fig. 2 Pooled estimation of vaccine acceptance rate in Africa

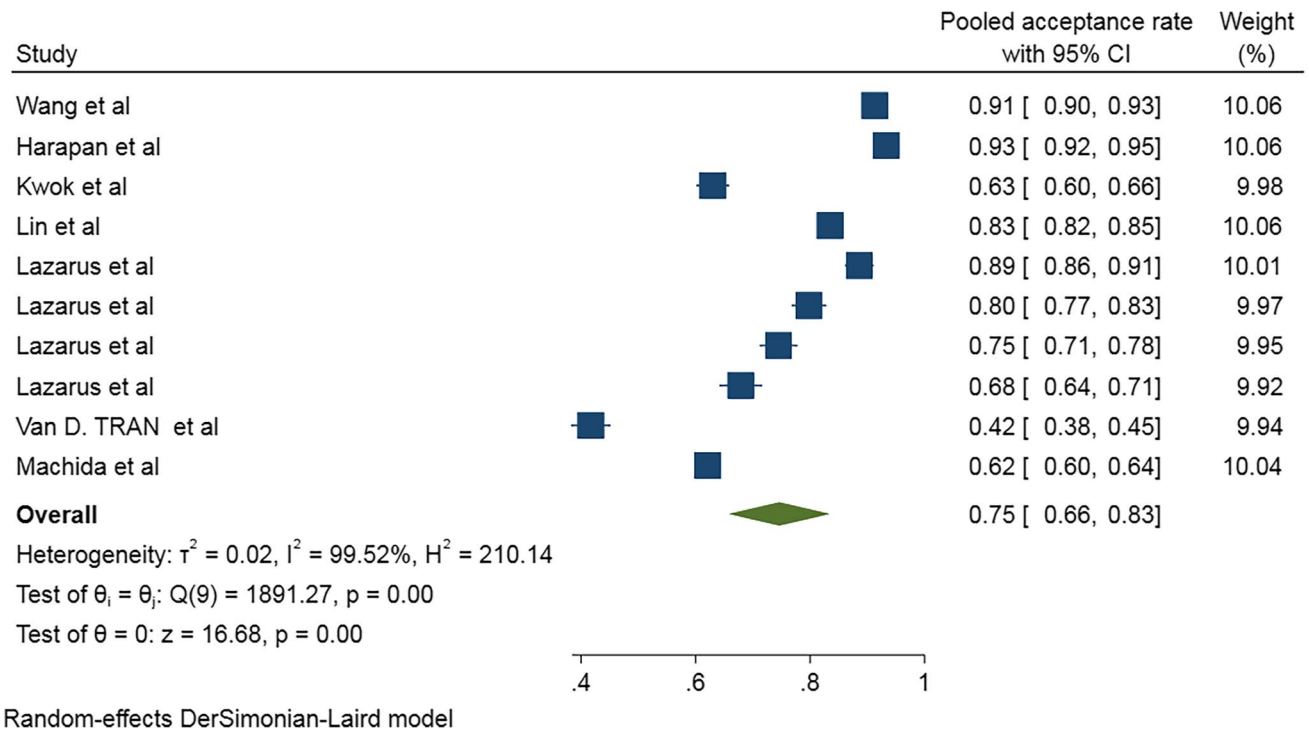


Fig. 3 Pooled estimation of vaccine acceptance rate in Asia

Meta-regression

A meta-regression model was used to assess the effect of different factors on the heterogeneity of pooled vaccine acceptance rate. Publication bias was evaluated by Beggs and Eggers tests. Data were analyzed by STATA version 11 (StataCorp, College Station, TX, USA).

Ethics statement

Ethical issues was not sought because this review was based on published articles.

Results

Description of included studies

A total of 1346 records were retrieved through an electronic databases search, PubMed, Scopus, and Web of Science; possibly relevant articles were identified after removing 815 articles due to duplication and irrelevance for the review purpose. In the second step, 1201 articles were excluded after the title and abstract were screened for the inclusion and exclusion criteria. Of the remaining 145 articles, 71 were excluded due to lack of relevant information or they were not original articles. Finally, 74 records that reported the COVID-19 vaccine acceptance rate were included in the final analysis) Table 1 and Fig. 1).

The overall pooled estimated of COVID-19 vaccine acceptance rate was 65.1 (95% CI 60.1–70.1; $P < 0.001$, $I^2 = 99.8$). This estimation in the general population and HCWs were 68.5 (95% CI 62.5–74.5; $P < 0.001$, $I^2 = 99.8$) and 55.9 (CI 47.8–64.1; $P < 0.001$, $I^2 = 99.6$), respectively. The lowest COVID-19 vaccine acceptance rate was in the Middle East, 46.1 (35.1–57.0), and African regions, 58.2 (26.6–89.7), respectively. The highest pooled estimated COVID-19 vaccine acceptance rate was 84.8 (95% CI 70.5–99.1; $P < 0.00$; $I^2 = 99.3$) in the South American region. Other information is shown in Table 2 and Figs. 2, 3, 4, 5, 6, and 7.

Meta-regression

To identify the cause of different factors on heterogeneity between studies, the variables like sample size, study region, and the target population were assessed. Only the target population significantly affected heterogeneity between studies (P :0.01). (Table 3). The distribution

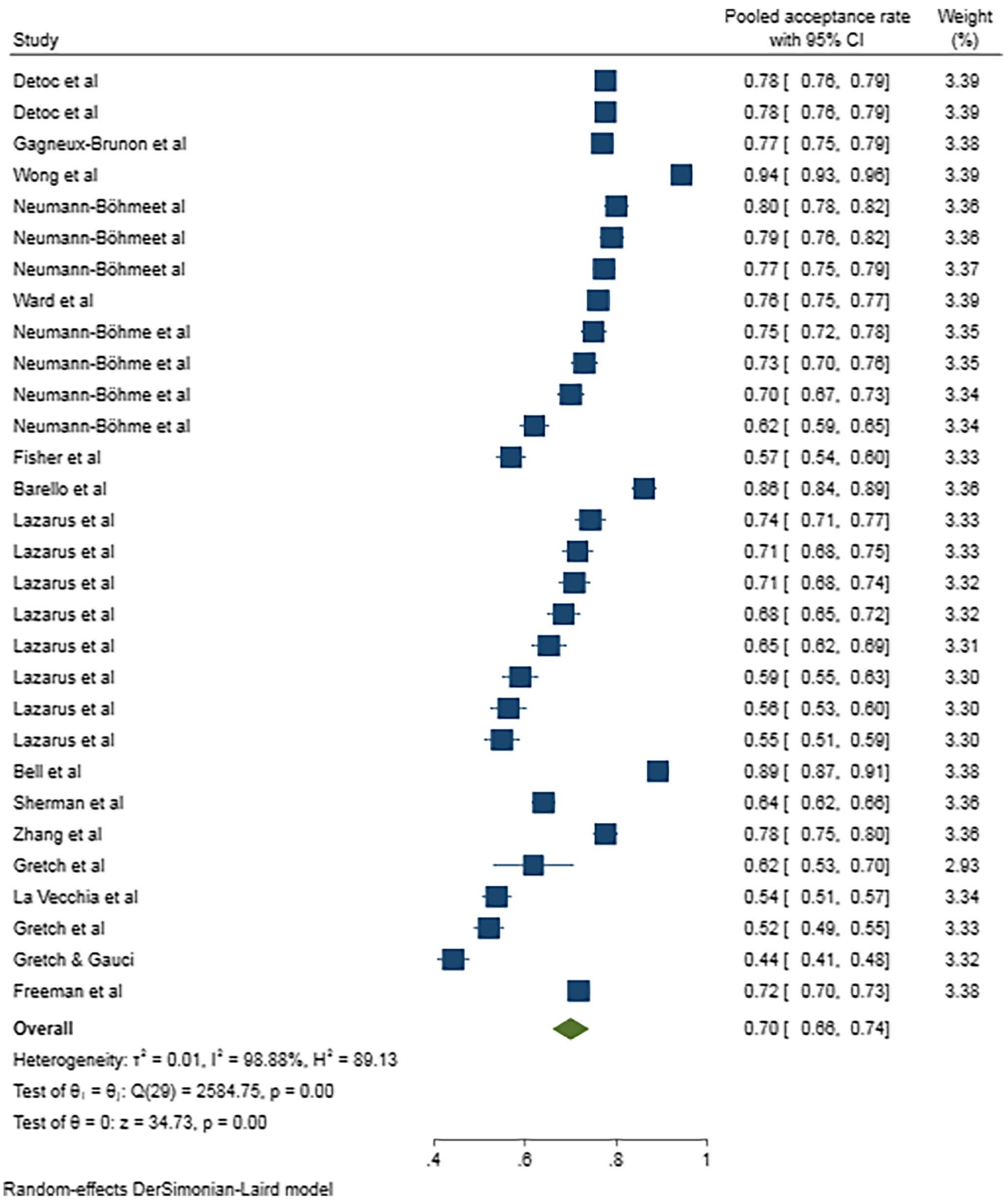


Fig. 4 Pooled estimation of vaccine acceptance rate in Europe

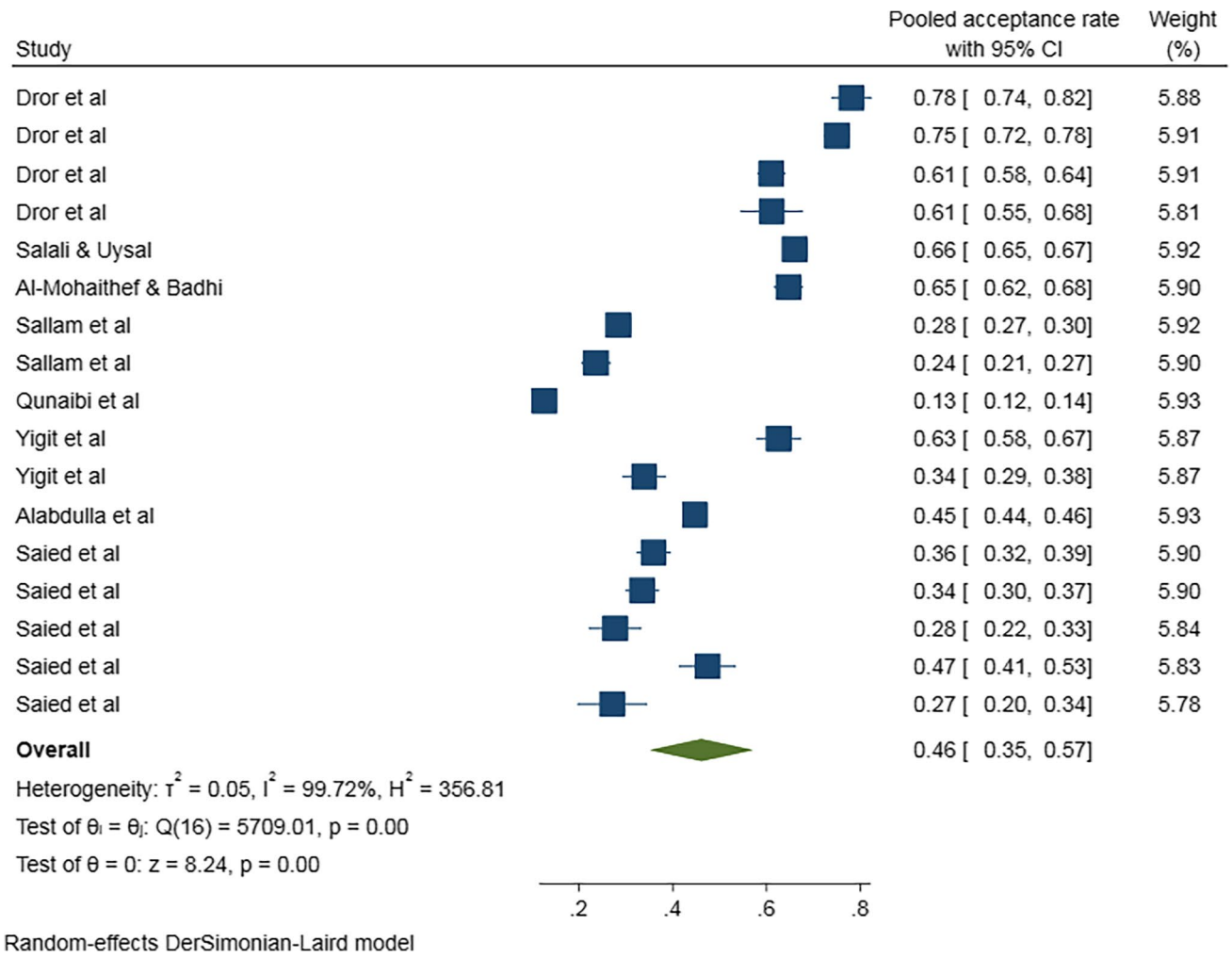


Fig. 5 Pooled estimation of vaccine acceptance rate in the Middle East

of vaccine acceptance rates based on the sample size is shown in Fig. 8. According to this figure, the COVID-19 vaccine acceptance rate had a decreasing trend with an increased sample size.

Publication bias

According to Begg's and Egger's test, there was significant publication bias about the understudied subject (Fig. 9).

Discussion

More than 11 billion doses of the COVID-19 vaccine have been injected into the world. The highest amount of vaccine injection was in China, with more than 3 billion doses (Lazarus et al. 2021). Vaccine hesitancy is an old concern representing a serious threat to global health (Phadke et al. 2016). Our study demonstrated that the COVID-19 Vaccine acceptance rate in the general population and health care workers was 68.5 and 55.9, respectively. Generally, the minimum COVID-19 vaccine acceptance rate was in Africa (58.2) and the Middle East (46.1), and the maximum rate was in South America (84.8). The overall pooled estimated COVID-19 vaccine acceptance rate was 65.1. The highest pooled estimated COVID-19 vaccine acceptance rate was 85 in the South American region. Also, the estimated COVID-19 vaccine acceptance rate in Asia and Europe were 74.6 and 70, respectively. The vaccine acceptance rate can vary depending on various variables such as gender, region of residence, religion, ethnicity, cultural, economic factors, etc. (Patwary et al. 2022). In a study by Sallam et al., the result revealed low rates of COVID-19 vaccine acceptance in the Middle East, Russia, Africa, and several

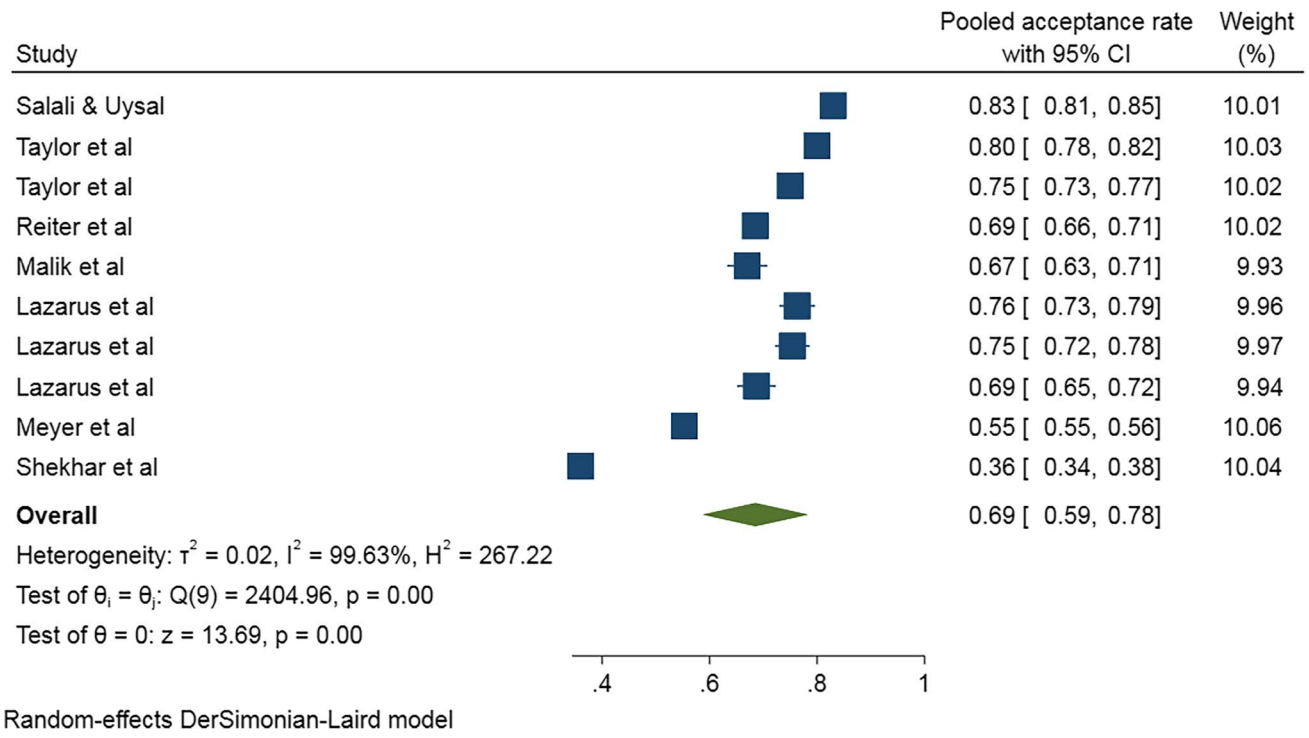


Fig. 6 Pooled estimation of vaccine acceptance rate in North America

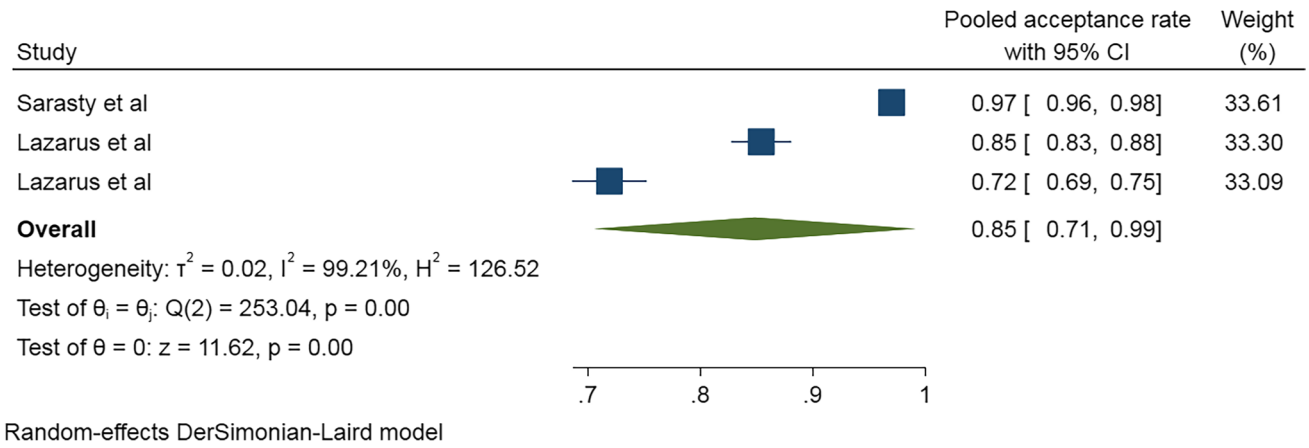


Fig. 7 Pooled estimation of vaccine acceptance rate in South America

Table 3 The meta-regression results to identify the cause of different factors on heterogeneity between studies

Vaccine acceptance rate	Coefficient	se	t	*P* > t	[95% CI]	
Sample size	0.00	0.00	−0.32	0.75	0.00	0.00
Study region	−1.12	1.52	−0.74	0.46	−4.14	1.91
Target population	−12.43	4.74	−2.62	0.01	−21.89	−2.97
Constant coefficient	86.07	8.89	9.69	0.00	68.35	103.80

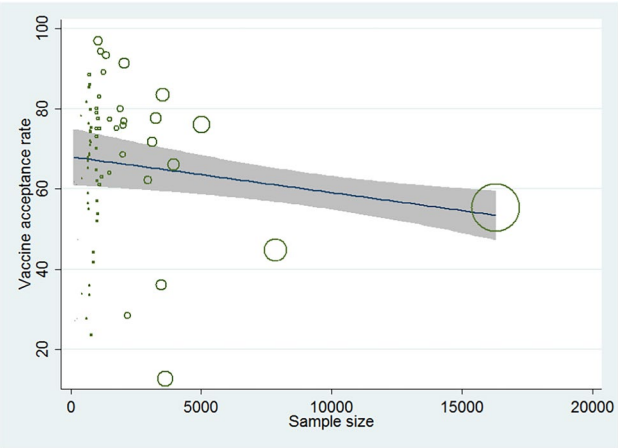


Fig. 8 The distribution of vaccine acceptance rates based on the sample size

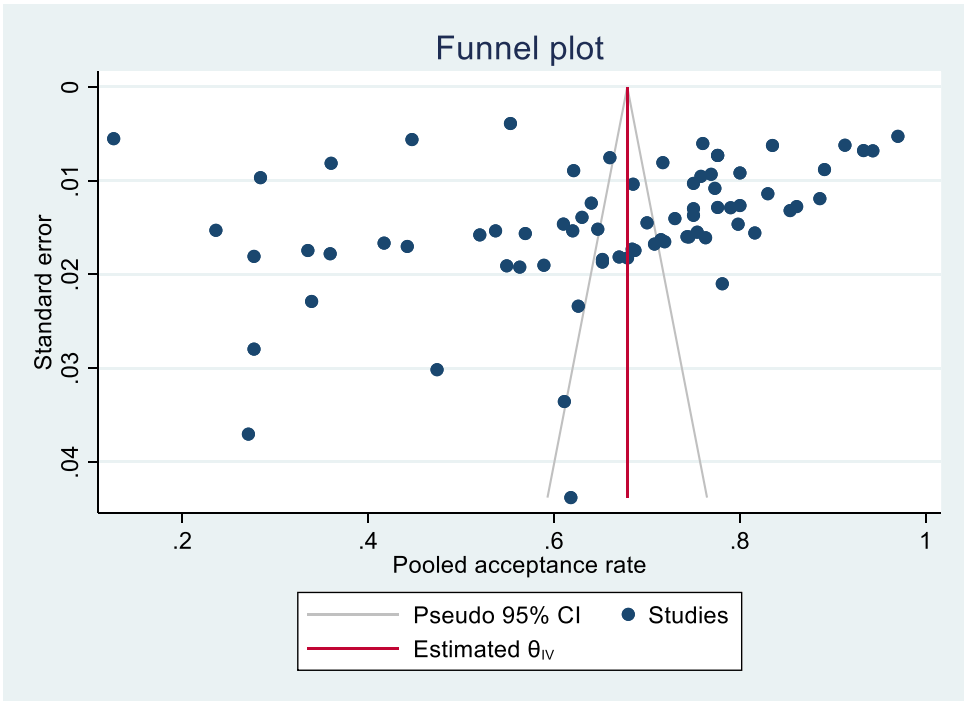
European countries (Sallam 2021). Another study on the Malaysian population showed that the overall acceptance rate of vaccination among the understudied population was 83.3%. The lowest rates were reported by people aged 60 and above. Occupation, income, age, and marital status were reported to be among the effective factors in the vaccine acceptance rate (Syed Alwi et al. 2021). The COVID-19 vaccine acceptance rate across Africa, South Asia, and Latin America has been reported to be 80.3%. Russia and the United States demonstrated low COVID-19 vaccine acceptance (Solís Arce et al. 2021). Sallam et al. 2022 reported high rates of COVID-19 vaccine acceptance in Asia despite the high hesitancy rate in the Middle East and North Africa (Sallam et al. 2022).

Although public society assumed that HCWs would have no hesitation in taking the COVID-19 vaccine (Biswas et al. 2021), according to our results, the COVID-19 vaccine acceptance among HCWs was lower than the general population. Salomoni et al. reported a variable vaccine acceptance rate among HCWs (Salomoni et al. 2021). The vaccine acceptance rate among Kuwaity HCWs has been reported to be 83.3. Unlike physicians, the vaccine acceptance rate among nurses was the lowest (Al-Sanafi and Sallam 2021). Another study in Saudi Arabia showed that half of the HCWs hesitated to be vaccinated against COVID-19 (Qattan et al. 2021).

In Turkey, HCWs were more likely "to not consider vaccination" if they were infected with COVID-19 recently. Physicians showed the highest acceptance rates (Yurttas et al. 2021). The HCWs are more knowledgeable about the side effects of the vaccines. Guidry et al., in the USA, listed adverse events (Guidry et al. 2021). While Giao Huynh et al. demonstrated that the HCW's acceptance rate was high to get a vaccine when available (Huynh et al. 2021).

The current review had some limitations that included all related studies in the final analysis regardless of the quality. Different studies with different quality, sample sizes, and precision may affect the pooled estimate.

Fig. 9 The funnel plot to assess the presence of publication bias



Conclusion

Our study results showed that HCW's COVID-19 vaccine acceptance rate was lower than the general population. Also, the COVID-19 vaccine acceptance rate in some regions was less than in others. To identify related factors to the COVID-19 vaccine acceptance rate, more primary studies are recommended.

Authors' contributions YA and: MS conception of the idea, data analysis, manuscript writing. HHR and EH: searching, data extraction, manuscript writing. All authors read and approved the final manuscript.

Data availability All data are available in the manuscript.

Code availability Not applicable.

Declarations

Ethics approval The present study was a systematic review based on published articles and therefore does not require the ethical approval of the ethics committee.

Consent to participate Not applicable.

Consent for publication Not applicable.

Conflicts of interest The authors declare that they do not have any conflict of interest.

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