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# Global COVID-19 vaccine acceptance rate: Systematic review and meta-analysis

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**Background:** A vaccine against COVID-19 is a vital tool in managing the current pandemic. It is becoming evident that an effective vaccine would be required to control COVID-19. Effective use of vaccines is very important in controlling pandemics and paving the way for an acceptable exit strategy. Therefore, this systematic review and meta-analysis aims to determine the global COVID-19 acceptance rate that is necessary for better management of COVID-19 pandemic.

**Methods:** This review was conducted based on Preferred Reporting Items for Systematic Reviews and Meta-Analysis protocols and considered the studies conducted on acceptance and/or hesitancy of COVID-19 vaccine. Articles were searched using electronic databases including PubMed, Scopus, Web of Science, Embase, CINAHL, and Google Scholar. The quality of the study was assessed using the Joanna Briggs Institute (JBI) critical assessment tool to determine the relevance of each included article to the study.

**Results:** Of the 6,021 articles identified through the electronic database search, 68 articles were included in the systematic review and meta-analysis. The global pooled acceptance rate of the COVID-19 vaccine was found to be 64.9% [95% CI of 60.5 to 69.0%]. Based on the subgroup analysis of COVID-19 vaccine acceptance rate by the World Health Organization's region, the countries where the study was conducted, occupation, and survey period, the prevalence of COVID-19 vaccine acceptance rate was 60.8% [95% CI: 56.3, 65.2%], 61.9% [95% CI: 61.3, 62.4%], 81.6% [95% CI: 79.7, 83, 2%] and 64.5% [95% CI: 60.3, 68.5%], respectively.

**Conclusions:** This review revealed the variation in the level of COVID-19 vaccine acceptance rate across the world. The study found that the overall prevalence of COVID-19 vaccine acceptance was 64.9%. This finding indicated that even if the COVID-19 vaccine is developed, the issue of accepting or taking the developed vaccine and managing the pandemic may be difficult.

#### KEYWORDS

vaccine acceptance, vaccine hesitancy, COVID-19, coronavirus, 2019, SARS-CoV-2, vaccine rejection, global

### Introduction

Corona virus disease 2019 (COVID-19) has spread drastically throughout the world, since the first case of COVID-19 disease was reported in Wuhan, China (1), and has rapidly become a major public health concern (2). Vaccination has played a fundamental role in global public health, leading to increased life expectancy (3) and is one of the most cost-effective ways of avoiding the disease and currently prevents between two and three million deaths per year (4). It is becoming evident that an effective vaccine would be required to control COVID-19 (7). Effective use of vaccines is necessary to reduce the social and economic burden and to prepare the way for an acceptable exit strategy from the COVID-19 pandemic (8). Vaccination hesitancy and anti-vaccination movements are increasing and need critical attention (9-11). Similarly, a vaccine against COVID-19 is a vital tool in managing COVID-19 pandemic (5, 6).

Currently, vaccination rates have fallen and public confidence in vaccines has been inconsistent (6, 13) and various studies have reported a declining level of willingness to accept the COVID-19 vaccine (14). Globally, the intention of being vaccinated against the COVID-19 pandemic is declining from time to time (8). According to the World Health Organization (WHO), vaccine hesitancy has become an emerging global issue and has been identified as one of the top ten threats to global health in 2019 (12).

Although vaccines are developed against COVID-19, many factors compromise the acceptance of the vaccine against COVID-19 and become a public concern (13, 15). Furthermore, transparent and effective communication efforts are essential to reduce misinformation and vaccine hesitancy and build trust to ensure adequate vaccination coverage will be achieved (8).

Previously, several studies have been conducted and many literatures have been published to capture and address many issues regarding the COVID-19 pandemic. However, to the level of our knowledge, there is no adequate studies that have been investigated that provide the global pooled acceptance or hesitancy of the COVID-19 vaccine. Therefore, this systematic review and metaanalysis was aimed to determine the acceptance rate of the COVID-19 vaccine across the world, which is necessary to understand the acceptance or hesitancy of the vaccine in different contexts and can be an input for others pandemics.

# Materials and methods

This systematic review and meta-analysis was conducted under the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines (16).

#### Eligibility criteria

Studies that met the following inclusion criteria were included in the systematic review and meta-analysis. The inclusion criteria considered in this review include:-

- Study population: All populations regardless of their age, occupation, ethnicity, gender, etc.
- Outcomes: The articles aimed to determine COVID-19 vaccine hesitancy and/or acceptance that provided a quantitative outcome were included in the study.
- Language: Articles written in English.
- Types of articles: Peer-reviewed full text, original, and published articles.
- Publication year: Studies published since the emergency of COVID-19 to the study period (March 2020 to June 2022).
- Study regions / locations: Not specified (not limited).

However, articles not freely available, not peer-reviewed articles or preprints, editorial papers, reports, short communications, review articles, the article did not provide an outcome of interest and high risk of bias articles were excluded from this study.

#### Information sources and search strategy

Article searches were performed using main key terms or keywords such as COVID-19, vaccine hesitancy, vaccine acceptance and intention to take vaccine, and Medical Subject Headings (MeSH) in combination with Boolean logic operators ("AND," "OR," and "NOT"). The articles were searched from PubMed, Scopus, Web of Science, Embase, CINAHL, and Google Scholar. References within eligible articles were further screened for additional articles. The articles were searched from February 01 to March 29, 2021 and May 02 to June 26, 2022 on PubMed, Scopus, Embase, and Google Scholars, while the search on Web of Science, CINAHL, and Google was made from 15 February to 31 March 2021. Articles published from March 2021 to June 2022 were searched from the included electronic databases according to their own searching strategies (Supplementary File I).

#### Study selection

The study selection process was performed using the PRISMA flow chart, indicating the number of articles included in the systematic review and articles excluded from the study with the reasons of exclusion. Following the search for articles through the included electronic databases, duplicate articles were removed using the ENDNOTE software version X5 (Thomson Reuters, USA). After duplicated articles were

removed, the authors (DM, YA, and YD) independently screened the articles based on their titles and abstracts by applying the inclusion criteria.

Furthermore, the full text of the relevant articles was further read in detail and the inclusion criteria independently evaluated by the authors (DM, YA, and YD). Any disagreements made with respect to the inclusion of studies were resolved by consensus after discussion. Finally, studies that met the criteria were included in the systematic review and meta-analysis.

#### Data extraction

The data were extracted by the authors (DM, YA, and YD) independently. Predetermined tabular format consisting of study characteristics including publication year, survey period, country where the study was conducted, number of respondents, and outcome (COVID-19 vaccine acceptance/hesitancy rate) using Microsoft Excel, 2016 (Supplementary File II). Any disagreement made between the authors was resolved through discussion after the same procedures were repeated.

#### Data quality assessment

The selected articles were subjected to a rigorous independent assessment using a standardized critical assessment tool, Joanna Briggs Institute (JBI) Critical Assessment Tools for prevalence studies (17). The evaluation tools have the following nine evaluation criteria/ parameters; (1) appropriate sampling frame; (2) proper sampling technique; (3) adequate sample size; (4) description of the study subject and setting description; (5) sufficient data analysis; (6) use of valid methods for identifying conditions; (7) valid measurement for all participants; (8) use of appropriate statistical analysis and (9) adequate response rate.

The authors (DM, YA, and YD) assessed the quality of the included studies. Based on the items in the above appraisal tool, the articles were classified as high quality (80% and above), moderate (60-80% score), and low quality (<60% score). Articles with a score  $\geq 60\%$  (articles has high and moderate quality) were included in the review, while those with low quality were excluded from the study. Finally, the disagreements made among the authors (DM, YA, and YD) were resolved by discussion and repeating the same procedures.

#### Outcome measures

The term "vaccine hesitancy" refers to "delay in acceptance or refusal of vaccines despite the availability of vaccine services (6, 18, 19)." In this review, for articles that did not provide general acceptance of the vaccine among study participants, the prevalence of vaccine acceptance was calculated based on the



response of the participants. The participant responded strongly agree, agree, completely agree, accept, all, accept, some accept, and yes to the questions were considered as accepted. Finally, the prevalence was calculated based on the frequency of responses and the total number of respondents. The same principle was applied to studies which reported results based on the Likert scale and others (18) (Figure 1).

#### Statistical procedures and data analysis

The pooled acceptance rate of the COVID-19 vaccine was performed using Comprehensive Meta-Analysis (CMA) version 3.0 statistical software. Forest plots and random-effects models were used to determine and visualize the pooled acceptance rate of the COVID-19 vaccine. The Cochran Q-test (Q) and *I*-Squared test ( $I^2$  statistics) were used to evaluate the heterogeneity between the included articles. Then, heterogeneity was classified into low ( $I^2$  index < 25%), medium ( $I^2$  index ranging from 25 to 75%), and high heterogeneity ( $I^2$  index > 75%). The random-effects model was used to analyze the data. Furthermore, subgroup analysis was performed based on the year of publication, survey period (when the study was conducted), and study area.

Sensitivity analysis was used to determine the differences in pooled effects by dropping studies that were found to influence the summary estimates, including extreme sample sizes and outcomes.

### Results

#### Study selection

A total of 6,021 short communications, original articles and editorial articles were searched through electronic databases from PubMed, Scopus, Web of Science, Embase, CINAHL, and



Google scholars. The articles were searched from February 01 to March 29, 2021 and May 02 to June 26, 2022 on PubMed, Scopus, Embase, and Google Scholars, while the search on Web of Science, CINAHL, and Google was made from 15 February to 31 March 2021. Then, 1,310 duplicate articles were excluded. Furthermore, 2201 articles were excluded after initial selection based on abstracts and titles. Furthermore, 599 articles were excluded after eligibility for full text articles (n = 601). Finally, a total of 68 articles were included in the systematic review and meta-analysis (Figure 2).

### Characteristics of the included articles

Among the included articles, 35 (50%) had high quality, while the rest (50%) had moderate quality, based on the JBI critical appraisal tools for the prevalence study (17) (Supplementary file III). 143,111 study participants were included in 68 articles, which were published from 2020 to 2022. The included studies were conducted in 38 countries around the world (Figure 3).

Eight studies (14, 20–26) were conducted in China, six studies (27–32) in Saudi Arabia, four studies (2, 33–35) in United States, four studies (36–38) in United Kingdom, and four studies (39–42) in Turkey. Additionally, three studies were conducted in each Malaysia (43–45) and Kuwait (27, 46). Two studies conducted in each Qatar (47, 48), Italy (15, 49), Jordan (27, 50), Bangladesh (51, 52), Ethiopia (53, 54), Taiwan (55, 56), and Germany (57, 58).

However, only one study was conducted in each of the following countries; Republic of Congo (59), Japan (60), Poland (10), Cameroon (7), Israel (61), Mexico (62), Malta (63), Scotland (6), Indonesia (64), England (65), South Korea (66), Iran (67), Nigeria (68), Tunisia (69), Netherlands (70), Thailand



(71), Vietnam (72), United Arab Emirates (73), Botswana (74), Sudan (75), Czechia (76), Uganda (77), France (78), and in Egypt (79).

The included studies were cross-sectional studies with a sample size ranging from 123 (63) to 23,582 (31) study participants. In general, the overall global acceptance rate of the COVID-19 vaccine, regardless of occupation, was 63.4% and ranged from 15.4% (7) to 95.6% (14) (Supplementary File IV).

#### COVID-19 vaccine acceptance

This systematic review and meta-analysis was performed using Comprehensive Meta-Analysis (CMA) version 3 statistical software to determine pooled COVID-19 vaccine acceptance and hesitancy rates.

# The overall pooled prevalence/rate of COVID-19 vaccine acceptance

The pooled prevalence of COVID-19 vaccine acceptance rate was found to be 64.9% [95% CI: 60.5 to 69.0%];  $I^2 = 99.57\%$  with a *p*-value of <0.001 (Figure 4).

# Subgroup analysis of the pooled prevalence of COVID-19 vaccine acceptance rate

Based on the subgroup analysis based on the World Health Organization's Region, the overall pooled prevalence of COVID-19 vaccine acceptance rate was 60.8% [95% CI: 56.3, 65.2%]. The lowest prevalence of COVID-19 vaccine acceptance rate was reported in the Eastern Mediterranean Region, accounting for 60.8% [95% CI: 43.4, 57.2%], whereas the highest prevalence was reported in the South East Asian Region, which accounted for 81.0% [95% CI: 59.9, 92.4%] (Figure 5).

Based on the countries where the study was conducted, the lowest prevalence of COVID-19 vaccine acceptance rate was reported in Cameroon, accounted for 15.4% [95% CI: 14.0, 16.9], while the highest prevalence [95.6% (95% CI: 93.8, 96.9%] was reported in Thailand followed by Indonesia [93.3% (95% CI: 91.8, 94.5%) (Figure 6).

Based on the study participants, the highest COVID-19 vaccine acceptance rate was reported among healthcare workers, which accounted for 71.4% [95% CI: 59.9, 80.7%], followed by students accounted for 64.7% [95% CI: 32.6, 89.2%]. The lowest prevalence of COVID-19 vaccine acceptance rate was reported among patients [51.8% (95% CI: 36.8, 66.6%] (Figure 7).

Based on the survey period, the pooled prevalence of COVID-19 vaccine acceptance was 64.5% [95% CI: 60.3, 68.5%]. Relatively, the lowest prevalence [57.9% (95% CI: 49.2, 66.2%)] of vaccine acceptance was reported from September to November 2020, whereas the highest prevalence [81.0% (95% CI: 57.3, 93.1%] was reported between September to November 2021 (Figure 8).

#### Sensitivity analysis

Sensitivity analysis was performed by removing low outcome, high outcome, and small sample sizes. However, the sensitivity analysis did not show a substantial change in the prevalence of COVID-19 acceptance compared to the pooled prevalence without sensitivity analysis [61.1% (95% CI 53.8 to 67.9%)] (Table 1).

#### Discussion

We conducted a systematic review and meta-analysis using data extracted from 68 studies conducted on 143,111 study participants. The study revealed that the pooled prevalence of COVID-19 vaccine acceptance was 64.9% [95% CI of 60.5 to 69.0%]. Some studies were conducted by the same authors across various countries (6, 27). The sensitivity analysis was employed to assess the cause of high heterogeneity and found no substantial difference in the prevalence of COVID-19 vaccine acceptance.

The utility of the vaccine to control COVID-19 pandemics depends on the acceptance of the vaccine (80, 81). Currently, vaccine hesitancy represents a serious threat to health. Similarly, the current study found that the global pooled prevalence of COVID-19 vaccine acceptance was 64.9% [95% CI of 60.5 to 69.0%], which was lower than the finding of the global survey, which reported about 71.5% of COVID-19 vaccine acceptance rate (62). The possible reason for the disparity in the prevalence estimate could be related to the variation in

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Wong et al         0.42           Cose et all         0.68           Cose et all         0.68           Yoda et al         0.65           Freeman         0.71           Williams et al         0.86           Alabdulla         0.60           Reiter         0.69           Vang et al         0.34           Gerussi et al         0.31           Geressi et al         0.37           Dinga et al         0.31           Poliga et al         0.91           Dror et al         0.75           Dickerson et al         0.29           Lazarus et al         0.61           Williams et al         0.23           Atarapan et al         0.93           Vang et al         0.91           Chubchandani et al         0.79           Chube         0.83           Alarupan et al         0.52           Sallam et al         0.70           Vathostin-Ansari et al         0.70           Vathostin-Ansari et al <td< td=""><td>:         0.394           :         0.658           :         0.6628           :         0.628           :         0.594           :         0.594           :         0.594           :         0.594           :         0.328           :         0.328           :         0.328           :         0.342           :         0.140           :         0.253           :         0.724           :         0.756           :         0.2077           :         0.8259           :         0.559           :         0.559           :         0.552           :         0.552           :         0.552           :         0.555           :         0.552           :         0.550           :         0.552           :         0.550           :         0.530           :         0.813</td><td>0.450 0.712 0.684 0.729 0.887 0.616 0.710 0.369 0.396 0.396 0.396 0.396 0.396 0.399 0.169 0.775 0.330 0.775 0.330 0.267 0.945 0.533 0.808 0.850 0.620 0.544 0.303</td><td>-5.382 12.235 10.233 29.946 14.460 18.432 16.574 -13.531 -4.477 -4.409 30.057 -5.863 30.057 15.863 30.057 15.865 30.819 30.057 15.865 2.592 2.59</td><td>0.000 0.000</td><td></td><td></td><td></td></td<>	:         0.394           :         0.658           :         0.6628           :         0.628           :         0.594           :         0.594           :         0.594           :         0.594           :         0.328           :         0.328           :         0.328           :         0.342           :         0.140           :         0.253           :         0.724           :         0.756           :         0.2077           :         0.8259           :         0.559           :         0.559           :         0.552           :         0.552           :         0.552           :         0.555           :         0.552           :         0.550           :         0.552           :         0.550           :         0.530           :         0.813	0.450 0.712 0.684 0.729 0.887 0.616 0.710 0.369 0.396 0.396 0.396 0.396 0.396 0.399 0.169 0.775 0.330 0.775 0.330 0.267 0.945 0.533 0.808 0.850 0.620 0.544 0.303	-5.382 12.235 10.233 29.946 14.460 18.432 16.574 -13.531 -4.477 -4.409 30.057 -5.863 30.057 15.863 30.057 15.865 30.819 30.057 15.865 2.592 2.59	0.000 0.000			
.ose et all         0.68           'oda et al         0.65           'oda et al         0.65           'oda et al         0.65           'oda et al         0.65           'oda et al         0.86           labdulla         0.60           eiter         0.69           Vang et al         0.34           eerussi et al         0.31           eleszko et al         0.37           binga et al         0.15           Vang et al         0.91           voro et al         0.75           bickerson et al         0.29           .azarus et al         0.76           irreche et al         0.77           allam et al         0.23           farapan et al         0.93           karsu et al         0.79           hen         0.83           alarmenghi         0.59           vang         0.52           allam et al         0.23           alarnet al         0.28           allam et al         0.28           alarnet al         0.59           vang         0.52           liwi et al         0.83           chapwa et al	0.658           0.704           0.828           0.704           0.828           0.704           0.828           0.594           0.328           0.328           0.328           0.328           0.329           0.328           0.329           0.329           0.329           0.724           0.725           0.756           0.207           0.918           0.462           0.771           0.825           0.559           0.559           0.559           0.559           0.559           0.559           0.529           0.529           0.529           0.529           0.529           0.529           0.520           0.520           0.520           0.520           0.530           0.530	0.712 0.684 0.729 0.887 0.616 0.710 0.369 0.448 0.399 0.448 0.399 0.169 0.924 0.792 0.330 0.792 0.330 0.792 0.699 0.793 0.267 0.945 0.333 0.808 0.850 0.620 0.544 0.303	12.235 10.233 29.946 14.460 18.432 16.574 -13.531 -4.477 -4.409 -8.390 -30.819 30.057 15.863 9.398 13.102 2.592 23.189 -13.851 24.275 -0.165 33.866 34.227	0.000 0.000			
oda et al         0.65           reeman         0.71           Villiams et al         0.86           (labdulla         0.60           teiter         0.69           Vang et al         0.31           elestration et al         0.31           elestex ot al         0.37           binga et al         0.15           Vang et al         0.91           pror et al         0.75           pickerson et al         0.29           Lazarus et al         0.76           pickerson et al         0.21           D'ror et al         0.76           pickerson et al         0.23           Jarapan et al         0.49           Lubuchandani et al         0.73           Vang         0.52           alamenghi         0.59           Vang         0.52           allam et al         0.23           valamenghi         0.52           allam et al         0.252           allam et al         0.252           allam et al         0.252           allam et al         0.40           Vakhostin-Ansari et al         0.69           Vakhostin-Ansari et al         0.40	0.628           0.704           0.828           0.594           0.669           0.328           0.342           0.140           0.724           0.724           0.725           0.729           0.729           0.729           0.729           0.729           0.729           0.729           0.729           0.729           0.729           0.756           0.253           0.759           0.759           0.750           0.755           0.559           0.559           0.559           0.550           0.530           0.530	0.684 0.729 0.887 0.616 0.710 0.369 0.448 0.396 0.396 0.924 0.792 0.699 0.793 0.267 0.945 0.267 0.945 0.533 0.808 0.850 0.620 0.544 0.303	$\begin{array}{c} 10.233\\ 29.946\\ 14.460\\ 18.432\\ 16.574\\ -13.531\\ -4.477\\ -4.409\\ -30.819\\ 30.057\\ 15.863\\ -9.398\\ 13.102\\ 2.592\\ 23.189\\ 13.851\\ 24.275\\ -0.163\\ -0.3386\\ 34.227\\ \end{array}$	0.000 0.869 0.000			
reeman         0.71           villiams et al         0.86           Alabdulla         0.60           Vang et al         0.34           jerussi et al         0.41           jallam et al         0.31           jeleszko et al         0.37           jinga et al         0.91           yror et al         0.91           pror et al         0.75           Dickerson et al         0.29           Lazarus et al         0.76           Oickerson et al         0.29           Lazarus et al         0.77           Jallam et al         0.73           Jallam et al         0.73           Villiams et al         0.79           Lubchandani et al         0.79           Chubchandani et al         0.79           Chubchandani et al         0.79           Vang         0.52           allalm et al         0.52           allalm et al         0.28           Lehl et al         0.63           Vang         0.52           allalm et al         0.28           Lehl et al         0.69           Mushostin-Ansari et al         0.69           Mushostin-Ansari et al	0.704 0.828 0.669 0.328 0.328 0.328 0.329 0.342 0.724 0.724 0.724 0.725 0.729 0.725 0.756 0.756 0.771 0.462 0.771 0.825 0.462 0.771 0.859 0.559 0.	0.729 0.887 0.616 0.710 0.396 0.396 0.396 0.396 0.396 0.396 0.396 0.924 0.775 0.330 0.792 0.699 0.792 0.699 0.792 0.699 0.267 0.345 0.326 0.267 0.945 0.533 0.8850 0.620 0.543 0.8850 0.520 0.533 0.533 0.533 0.533 0.533 0.533 0.533 0.533 0.533 0.533 0.555 0.555 0.533 0.555 0.533 0.555 0.555 0.533 0.555 0.555 0.533 0.555 0.555 0.555 0.533 0.555	29.946 14.460 18.432 16.574 -13.531 -4.477 -4.409 -8.390 -30.819 30.057 15.863 -9.398 13.102 2.592 23.189 13.851 24.275 -0.165 23.386 34.227	0.000 0.0000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000000			
Williams et al         0.86           Alabdulla         0.600           Reiter         0.690           Vang et al         0.34           Gerussi et al         0.34           Gallam et al         0.31           Teleszko et al         0.37           Dinga et al         0.31           Vang et al         0.91           Dror et al         0.75           Dickerson et al         0.29           Lazarus et al         0.61           Williams et al         0.73           Jalam et al         0.73           Jarapan et al         0.73           Atarsu et al         0.74           Chubchandani et al         0.79           Chen         0.83           Palamenghi         0.52           Sallam et al         0.23           Palamenghi         0.55           Vang         0.52           Sallam et al         0.70           Vathostin-Ansari et al         0.70           Vathostin-Ansari et al         0.40           Vashostin-Ansari et al         0.40           Jossain et al         0.42	0.828           0.628           0.594           0.669           0.328           0.328           0.328           0.328           0.329           0.342           0.140           0.724           0.724           0.752           0.756           0.207           0.910           0.752           0.756           0.207           0.918           0.462           0.755           0.559           0.559           0.550           0.530           0.813	0.887 0.616 0.710 0.369 0.396 0.399 0.169 0.924 0.775 0.330 0.775 0.330 0.793 0.267 0.945 0.533 0.808 0.850 0.620 0.544 0.303	14.460 18.432 16.574 -13.531 -4.477 -4.409 -30.819 30.057 15.863 -9.398 13.102 2.592 2.592 2.592 2.592 2.592 2.592 2.585 2.592 2.585 2.592 2.592 2.585 2.592 2.585 2.592 2.585 2.592 2.585 2.592 2.585 2.592 2.592 2.585 2.592 2.585 2.592 2.585 2.592 2.592 2.585 2.592 2.585 2.592 2.585 2.592 2.592 2.585 2.592 2.586 3.865 2.592 2.592 2.592 2.592 2.592 2.592 2.586 2.592 2.592 2.586 2.592 2.592 2.586 2.592 2.586 2.592 2.586 2.592 2.586 2.592 2.586 2.592 2.586 2.592 2.586 2.592 2.586 2.586 2.592 2.586 2.5	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.869 0.000			
Labdulla         0.60           viang et al         0.34           verussi et al         0.31           verussi et al         0.31           eleszko et al         0.37           pinga et al         0.91           vor et al         0.75           vickerson et al         0.29           varge et al         0.76           vickerson et al         0.29           Lazarus et al         0.76           vickerson et al         0.29           Lazarus et al         0.76           villiams et al         0.77           allam et al         0.23           Iarapan et al         0.93           karsu et al         0.79           "Chen         0.83           alamenghi         0.59           Vang         0.52           allam et al         0.28           iell et al         0.55           Juvi et al         0.83           ichapya et al         0.70           Vakhostin-Ansari et al         0.49           fustapha et al         0.40           Jossain et al         0.42	0.594         0.669           0.328         0.369           0.328         0.369           0.3249         0.342           0.349         0.342           0.342         0.140           0.0253         0.724           0.2533         0.729           0.529         0.756           0.918         0.462           0.7559         0.559           0.559         0.550           0.550         0.550           0.553         0.530           0.530         0.530	0.616 0.710 0.369 0.448 0.399 0.169 0.924 0.775 0.330 0.792 0.793 0.792 0.793 0.267 0.945 0.533 0.808 0.850 0.620 0.544 0.303	18.432 16.574 13.531 -4.477 -4.409 -8.390 -30.819 30.057 15.863 -9.398 13.102 2.592 23.189 -13.851 24.275 -0.1386 34.227	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.869 0.000			
Celler         0.69           Wang et al         0.34           Gerussi et al         0.40           Sallam et al         0.31           Feleszko et al         0.37           Dinga et al         0.91           Dror et al         0.75           Dickerson et al         0.29           Lazarus et al         0.76           Dickerson et al         0.61           Williams et al         0.73           Jallam et al         0.23           Alarapan et al         0.49           Chubchandani et al         0.79           Chen         0.83           Vang         0.52           Sallam et al         0.53           Vehang we et al         0.70           Vakhostin-Ansari et al         0.69           Vakshostin-Ansari et al         0.69           Waspha et al         0.70           Sallam et al         0.40           Horisgin et al         0.40           Jossain et al         0.40	0.669         0.369           0.328         0.369           0.342         0.409           0.342         0.900           0.724         0.900           0.723         0.729           0.529         0.529           0.756         0.275           0.918         0.462           0.7559         0.559           0.559         0.559           0.559         0.550           0.550         0.530           0.530         0.530	0.109 0.369 0.448 0.396 0.396 0.924 0.775 0.330 0.792 0.699 0.792 0.699 0.793 0.267 0.945 0.533 0.808 0.850 0.620 0.544 0.303	16.5/4 -13.531 -4.477 -4.409 -8.390 -30.819 30.057 15.863 -9.398 13.102 2.592 23.189 -13.851 24.275 -0.165 23.386 34.227	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000			
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refussi et al       0.40         allam et al       0.31         eleszko et al       0.37         pinga et al       0.15         Vang et al       0.91         pror et al       0.76         Dickerson et al       0.29         _azarus et al       0.76         Pickerson et al       0.77         Dickerson et al       0.76         retch et al       0.61         Villiams et al       0.73         alam et al       0.23         farapan et al       0.93         karsu et al       0.79         then       0.83         alamenghi       0.59         Vang       0.52         allam et al       0.28         iell et al       0.55         Jwi et al       0.83         chapwa et al       0.70         Vaspan et al       0.70         Vashostin-Ansari et al       0.40         Iossain et al       0.42         erichun et al       0.42	0.369         0.369           0.342         0.342           0.140         0.900           0.724         0.140           0.253         0.729           0.529         0.529           0.756         0.207           0.462         0.771           0.8559         0.559           0.559         0.559           0.559         0.560           0.2650         0.500           0.2650         0.530           0.813         0.825	0.448 0.396 0.399 0.169 0.924 0.775 0.330 0.792 0.699 0.793 0.267 0.945 0.533 0.808 0.850 0.624 0.303	-4.4// -4.409 -8.390 -30.819 30.057 15.863 -9.398 13.102 2.592 23.189 -13.851 24.275 -0.165 23.386 34.227	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000			
allam et al       0.31         vallam et al       0.37         Dinga et al       0.15         Vang et al       0.16         Dror et al       0.75         Dickerson et al       0.29         Lazarus et al       0.76         Siretch et al       0.61         Villiams et al       0.77         Siallam et al       0.23         Lazarus ut al       0.49         Chubchandani et al       0.79         Chen       0.83         Valarenghi       0.59         Vang       0.52         Sallam et al       0.23         Valarenghi       0.52         Valarenghi       0.52         Vallam et al       0.83         valarenghi       0.52         Vallam et al       0.61         Vary et al       0.83         vehangy et al       0.70         Vakhostin-Ansari et al       0.69         Justapha et al       0.40         Jossain et al       0.42	0.249         0.342           0.342         0.140           0.900         0.724           0.0253         0.253           1.029         0.724           1.0253         0.729           1.0253         0.756           1.0275         0.253           1.029         0.756           1.029         0.756           1.029         0.7559           1.02559         0.559           1.0559         0.550           1.0550         0.530           1.0265         0.530           1.0265         0.530	0.396 0.399 0.169 0.924 0.775 0.300 0.792 0.699 0.793 0.267 0.533 0.808 0.850 0.533 0.808 0.850 0.544 0.303	-4.409 -8.390 -30.819 30.057 15.863 -9.398 13.102 2.592 23.189 -13.851 24.275 -0.165 23.386 34.227	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.869 0.000			
veleszkö et al         0.37           Dinga et al         0.15           Vang et al         0.91           Pror et al         0.75           Dickerson et al         0.29           Lazarus et al         0.76           Dickerson et al         0.73           Lazarus et al         0.76           Sillam et al         0.73           Jallam et al         0.23           Jarapan et al         0.93           kkarsu et al         0.49           Chubchandani et al         0.79           Chen         0.83           valamenghi         0.59           Vang         0.52           Sallam et al         0.252           Sallam et al         0.254           Sallam et al         0.55           Vang         0.52           Sallam et al         0.63           Vachangwa et al         0.70           Vakhostin-Ansari et al         0.69           Mustapha et al         0.40           Fossain et al         0.40	0.342         0.342           0.900         0.724           0.253         0.729           0.729         0.529           0.756         0.275           0.275         0.275           0.275         0.275           0.275         0.275           0.2918         0.462           0.559         0.559           0.559         0.550           0.550         0.530           0.530         0.813	0.399 0.169 0.924 0.775 0.330 0.792 0.699 0.793 0.267 0.945 0.533 0.808 0.850 0.544 0.303	-8.390 -30.819 30.057 15.863 -9.398 13.102 2.592 23.189 -13.851 24.275 -0.165 23.386 34.227	0.000 0.000 0.000 0.000 0.000 0.000 0.010 0.000 0.000 0.000 0.869 0.000			
Juga et al         0.15           Vang et al         0.91           Dror et al         0.75           Dickerson et al         0.29           Lazarus et al         0.76           Gretch et al         0.61           Williams et al         0.73           Jarapan et al         0.23           Jarapan et al         0.49           Chubchandani et al         0.79           Chen         0.83           Palamenghi         0.59           Vang         0.52           Sallam et al         0.23           Palamenghi         0.59           Vang         0.52           Sallam et al         0.23           Acarsu et al         0.79           Vang         0.52           Sallarn et al         0.59           Vang constructure         0.53           Achangwa et al         0.70           Vakhostin-Ansari et al         0.40           Hossain et al         0.40           Jossain et al         0.42	0.140         0.253           0.724         0.253           0.729         0.729           0.729         0.726           0.729         0.756           0.756         0.207           0.918         0.761           0.762         0.772           0.756         0.207           0.756         0.207           0.752         0.752           0.752         0.752           0.752         0.752           0.559         0.559           0.559         0.530           0.530         0.530           0.813         0.753	0.169 0.924 0.775 0.330 0.792 0.699 0.793 0.267 0.945 0.533 0.808 0.850 0.620 0.544 0.303	-30.819 30.057 15.863 -9.398 13.102 2.592 23.189 -13.851 24.275 -0.165 23.386 34.227	0.000 0.000 0.000 0.000 0.000 0.010 0.000 0.000 0.000 0.869 0.000			
Auge of all         0.91           Prore et al         0.75           Dickerson et al         0.29           Lazarus et al         0.76           Gretch et al         0.61           Villiams et al         0.77           Sallam et al         0.23           Harapan et al         0.93           Akarsu et al         0.49           Chubchandani et al         0.79           Chubchandani et al         0.79           Chan         0.83           Palamenghi         0.59           Wang         0.52           Sallam et al         0.28           Bell et al         0.55           Alwi et al         0.83           Achangwa et al         0.70           Vakhostin-Ansari et al         0.69           Mustapha et al         0.40           Hossain et al         0.42	0.500 0.724 0.253 0.729 0.529 0.529 0.559 0.918 0.462 0.755 0.0559 0.559 0.559 0.559 0.559 0.559 0.559 0.559 0.559 0.755 0.0559 0.559 0.755	0.324 0.775 0.330 0.792 0.699 0.793 0.267 0.945 0.533 0.808 0.850 0.620 0.544 0.303	15.863 -9.398 13.102 2.592 23.189 -13.851 24.275 -0.165 23.386 34.227	0.000 0.000 0.000 0.010 0.000 0.000 0.000 0.869 0.000	1		
Dickerson et al         0.75           Dickerson et al         0.29           Lazarus et al         0.76           Sretch et al         0.61           Williams et al         0.77           Sallam et al         0.23           Harapan et al         0.93           kkarsu et al         0.49           Chubchandani et al         0.79           Chen         0.83           Palamenghi         0.52           Sallam et al         0.23           Sell et al         0.55           Alwin et al         0.83           Sell et al         0.55           Alwin et al         0.61           Vathostin-Ansari et al         0.69           Mustopha et al         0.70           Vashostin-Ansari et al         0.40           Hossain et al         0.40           Serihun et al         0.42	0.729 0.253 0.729 0.529 0.756 0.918 0.462 0.771 0.825 0.750 0.462 0.771 0.825 0.550 0.550 0.265 0.550 0.265 0.550 0.265 0.813	0.773 0.330 0.792 0.699 0.793 0.267 0.945 0.533 0.808 0.850 0.620 0.544 0.303	-9.303 -9.398 13.102 2.592 23.189 -13.851 24.275 -0.165 23.386 34.227	0.000 0.000 0.010 0.000 0.000 0.000 0.869 0.000			
Accession et al         0.29           Lazarus et al         0.76           Gretch et al         0.61           Williams et al         0.73           Jarapan et al         0.93           Jarapan et al         0.93           Karsu et al         0.49           Chubchandani et al         0.79           Chen         0.83           Palamenghi         0.52           Jallam et al         0.23           Jalarnenghi         0.55           Vang         0.52           Jallam et al         0.23           Jell et al         0.55           Vilvi et al         0.83           Achangwa et al         0.70           Vakhostin-Ansari et al         0.60           Jossain et al         0.40           Jossain et al         0.42	0.255 0.729 0.729 0.529 0.756 0.207 0.918 0.462 0.771 0.462 0.771 0.825 0.559 0.559 0.550 0.265 0.550 0.265 0.530 0.813 0.813	0.530 0.792 0.699 0.793 0.267 0.945 0.533 0.808 0.850 0.620 0.544 0.303	13.102 2.592 23.189 13.851 24.275 -0.165 23.386 34.227	0.000 0.010 0.000 0.000 0.000 0.869 0.000			
Damie of the         0.76           Dretch et al         0.61           Williams et al         0.77           Sallam et al         0.93           Harapan et al         0.93           Karsu et al         0.49           Chubchandani et al         0.79           Dalamenghi         0.59           Vang         0.52           Sallam et al         0.28           Bell et al         0.55           Alwi et al         0.83           Achangwa et al         0.70           Vastostin-Ansari et al         0.69           Justapha et al         0.70           Sallam et al         0.49           Gensain et al         0.40           Hossain et al         0.40	0.729           0.529           0.756           0.207           0.918           0.462           0.771           0.825           0.559           0.559           0.559           0.559           0.559           0.559           0.559           0.559           0.559           0.500           0.265           0.530           0.813           0.772	0.792 0.699 0.793 0.267 0.945 0.533 0.808 0.850 0.620 0.544 0.303	2.592 23.189 -13.851 24.275 -0.165 23.386 34.227	0.010 0.000 0.000 0.000 0.869 0.000			
Aktion of all and the set of	0.756         0.756           0.207         0.918           0.462         0.771           0.825         0.559           0.559         0.500           0.265         0.530           0.813         0.672	0.793 0.267 0.945 0.533 0.808 0.850 0.620 0.544 0.303	23.189 -13.851 24.275 -0.165 23.386 34.227	0.000 0.000 0.000 0.869 0.000			
Allam et al         0.23           Atarapan et al         0.23           Harapan et al         0.93           Karsu et al         0.49           Chubchandani et al         0.79           Pilen         0.83           Palamenghi         0.59           Wang         0.52           Sallam et al         0.28           Sell et al         0.55           Alwi et al         0.83           Achangwa et al         0.70           Vakhostin-Ansari et al         0.69           Mustapha et al         0.40           Hossain et al         0.42	0.753         0.207           0.918         0.918           0.462         0.771           0.825         0.559           0.559         0.500           0.265         0.530           0.813         0.813	0.267 0.945 0.533 0.808 0.850 0.620 0.544 0.303	-13.851 24.275 -0.165 23.386 34.227	0.000 0.000 0.869 0.000			
Janzani et al     0.25       Larapan et al     0.93       Akarsu et al     0.49       Chubchandani et al     0.79       Chen     0.83       Palarmenghi     0.59       Vang     0.52       Sallam et al     0.28       Bell et al     0.55       Alwi et al     0.83       Achangwa et al     0.70       Vakhostin-Ansari et al     0.69       Justapha et al     0.40       Jossain et al     0.42	0.207 0.918 0.462 0.771 0.825 0.559 0.559 0.550 0.265 0.530 0.813 0.813	0.207 0.945 0.533 0.808 0.850 0.620 0.544 0.303	24.275 -0.165 23.386 34.227	0.000 0.869 0.000			
Akarsu et al         0.495           Akarsu et al         0.49           Chubchandani et al         0.79           Chen         0.83           Palamenghi         0.59           Wang         0.52           Sallam et al         0.28           Sell et al         0.55           Alwi et al         0.83           Achangwa et al         0.70           Vashostin-Ansari et al         0.69           Josain et al         0.40           Hossain et al         0.42           Serihun et al         0.42	0.462 0.771 0.825 0.559 0.559 0.265 0.530 0.813	0.533 0.808 0.850 0.620 0.544 0.303	-0.165 23.386 34.227	0.869			
Aussie et al         0.49           Chubchandani et al         0.79           Chen         0.83           Palarmenghi         0.59           Vang         0.52           Sallarm et al         0.28           Sell et al         0.55           Alwi et al         0.83           Achangwa et al         0.70           Vashostin-Ansari et al         0.69           Jossain et al         0.49           Jossain et al         0.49           Serihun et al         0.49	0.462 0.771 0.825 0.559 0.559 0.500 0.265 0.530 0.813	0.808 0.850 0.620 0.544 0.303	23.386 34.227	0.000			
hen0.83alamenghi0.59yang0.52allam et al0.28ell et al0.55lwi et al0.83changwa et al0.70yakhostin-Ansari et al0.40cossain et al0.42erihun et al0.52	0.825 0.559 0.500 0.265 0.530 0.813	0.850 0.620 0.544 0.303	34.227	0.000			
Vang 0.52 Vang 0.52 Vallam et al 0.28 Bell et al 0.55 Uwi et al 0.83 Achangwa et al 0.70 Vakhostin-Ansari et al 0.69 Austapha et al 0.40 Bossain et al 0.42 Berihun et al 0.55	0.559 0.500 0.265 0.530 0.813	0.620 0.544 0.303		0.000			
Vang 0.52 allam et al 0.28 Sell et al 0.55 Uwi et al 0.65 Achangwa et al 0.70 Jakhostin-Ansari et al 0.69 Austapha et al 0.40 Iossain et al 0.42 serihun et al 0.59	0.500 0.265 0.530 0.813	0.544	5 672	0.000			
Sallam et al     0.28       3ell et al     0.55       Alwi et al     0.83       Achangwa et al     0.70       Vakhostin-Ansari et al     0.69       Mustapha et al     0.40       Hossain et al     0.42       Serihun et al     0.52	0.265	0.303 -	1 995	0.046			
Bell et al     0.55       Alwi et al     0.83       Achangwa et al     0.70       Vakhostin-Ansari et al     0.69       Mustapha et al     0.40       Jossain et al     0.42       Berihun et al     0.59	0.530	··- · ·	-19 438	0 000			
Alwi et al     0.83       Achangwa et al     0.70       Vakhostin-Ansari et al     0.69       Mustapha et al     0.40       Jossain et al     0.42       Berihun et al     0.59	0.813	0.585	4.095	0.000			
Achangwa et al0.70Nakhostin-Ansari et al0.69Mustapha et al0.40Jossain et al0.42Berihun et al0.59	0 (73	0.852	22.515	0.000			
Vakhostin-Ansari et al 0.69 Mustapha et al 0.40 Hossain et al 0.42 Berihun et al 0.59	00/5	0 740	10 730	0.000			
Mustapha et al 0.40 Hossain et al 0.42 Berihun et al 0.59	0.676	0.703	25.109	0.000			
Hossain et al 0.42 Berihun et al 0.59	0.355	0.447	-4.167	0.000			
Berihun et al 0.59	0.404	0.454	-5.475	0.000			
	0.546	0.640	3.811	0.000			
Alibrahim and Awad 0.73	0.724	0.751	29.325	0.000			
Huang et al 0.84	0.833	0.855	39.829	0.000			
Chiari et al 0.35	0.287	0.419	-4.176	0.000			
Antwi-Berko et al 0.69	0.620	0.762	4.819	0.000			
Qin et al 0.88	0.869	0.899	27.020	0.000			
Sirikalyanpaiboon et al 0.95	0.938	0.969	16.765	0.000			
Nguyen et al 0.60	0.566	0.641	5.268	0.000			
Viohamed et al 0.64	0.620	0.670	10.714	0.000			
Saddik et al 0.58	0.537	0.622	3.622	0.000			
flale et al 0.73	0.722	0.746	32.651	0.000			
Huang et al 0.74	0.721	0.775	14.665	0.000			
Roberts et al 0.85	0.839	0.860	41.710	0.000			
Barry et al 0.70	0.676	0.723	15.098	0.000			
Raja et al 0.55	0.491	0.623	1.705	0.088			
Paul et al 0.60	0.590	0.620	13.467	0.000			
Boche et al 0.72	0.676	0.773	7.803	0.000			
Riad et al 0.70	0.653	0.747	7.456	0.000			
Nohl et al 0.57	0.543	0.597	5.023	0.000			
Bongomin et al 0.70	0.648	0.749	6.945	0.000			
Al-Mulla et al 0.62	0.581	0.669	5.357	0.000			
kiişik et al 0.54	0.497	0.596	1.839	0.066			
Almaghaslah et al 0.22	0.197	0.253	-15.209	0.000			
Yahia et al 0.61	0.576	0.658	5.386	0.000			
Isai et al 0.52	0.496	0.558	1.724	0.085			
Han et al 0.89	0.877	0.904	30.190	0.000			
Iharake et al 0.64	0.643	0.655	45.050	0.000			
allee et al 0.71	0.652	0.767	6.337	0.000			
Alfageeh et al 0.48	0.459	0.501	-1.849	0.065			
ao et al 0.77	0.751	0.795	19.209	0.000			
Holzmann-Littig et al 0.91	0.909	0.925	44.458	0.000			
falle et al 0.91	0.909	0.928	37.638	0.000			
El-Elimatetal 0.37	0.357	0.391	-13.877	0.000			
saled et al 0.54	0.519	0.561	3.691	0.000			
Ayhan et al 0.37	0.317	0.426	-4.451	0.000			
0.64	0.605	0.69	6.467	0.000	I	1	I.
Heteriogeniety (I square)= 99. 574	, a p-value	of<0.001	1		-1.00	-0.50	0.00

Group by	Study name	Statistics for each study		Event rate and 95% CI	
VHO region		Event LowerUpper	alue		
		rate munt munt S . and P .			
AfR	Ditekemena	0.559 0.544 0.574 7.566 0.000			
AfR	Dinga et al	0.154 0.140 0.169-30.819 0.000			
AR	Mustapha et al	$0.400 \ 0.355 \ 0.447 \ -4.167 \ 0.000$			
AfR	Berihun et al	0.594 0.546 0.640 3.811 0.000		<del>_</del>	- 1
AfR	Tlale et al	0.734 0.722 0.746 32.651 0.000			= I
AfR	Boche et al	0.727 0.676 0.773 7.803 0.000			<b>z</b>
AfR.	Bongomin et al	0.701 0.648 0.749 6.945 0.000			-
AIR		0.548 0.363 0.720 0.499 0.618			-
AfM	Shekhar et al	0.360 0.345 0.375-17.641 0.000			.
AmR	Malik et al	0.670 0.634 0.705 8.632 0.000			- 1
AmR	Reiter	0.690 0.669 0.710 16.574 0.000			- 1
AmR	Lazarus et al	0.762 0.729 0.792 13.102 0.000			- Tel - I
ame	Khubchandani et al	0.790 0.771 0.808 23.386 0.000			
AmR		0.664 0.458 0.823 1.571 0.116			
EMR	Alabdulla	0.605 0.594 0.616 18.432 0.000			
EMR	Sallam et al	0.318 0.249 0.396 -4.409 0.000			
EMR	Sallam et al	0.236 0.207 0.267-13.851 0.000			
EMR	Sallam et al	0.284 0.265 0.303-19.438 0.000			-
MR	Nakhostin-Ansari et	al0.690 0.676 0.703 25.109 0.000			- I
SMR	Alibrahim and Awa	a 0.738 0.724 0.751 29.325 0.000			- 1
MR	Kniari et al	0.350 0.287 0.419 -4.176 0.000			
IMR	Saddik et al	0.580 0.537 0.622 3.622 0.000		<b>−</b>	_
IMR	Barry et al	0.700 0.676 0.723 15.098 0.000			-
IMR	Raja et al	0.558 0.491 0.623 1.705 0.088			
IMR	Al-Mulla et al	0.020 0.581 0.669 5.357 0.000			
ENR	Aimagnasian et al	0.224 0.197 0.253-15.209 0.000			
IMR	Yahia et al				
IMR	Emarake et al	0.649 0.643 0.655 45.050 0.000			
IMR	Allageen et al	0.480 0.459 0.501 -1.849 0.065		1 1 1	
	El-Elimat et al	0.374 0.357 0.391-13.877 0.000			
IMR	Saled et al	0.540 0.519 0.561 3.691 0.000			
IVIR	Vaca at al	$0.505 \ 0.434 \ 0.572 \ 0.091 \ 0.927$			- 1
uR uP	Kose et al	0.000 0.000 0.712 12.200 0.000			
2.D	Williama at al	0.717 0.704 0.729 29.946 0.000			
and and a second se	Comuciat al	$0.800 \ 0.828 \ 0.887 \ 14.400 \ 0.000$			
EuR	Falaszko at al	0.408 0.369 0.448 -4.477 0.000			
anD.	Peleszkő et al	0.370 0.342 0.399 -8.390 0.000			-
and and a second s	Dickerson et al	0.750 0.724 0.775 15.805 0.000			
anD and a state of the state of	Gretch et al	0.290 $0.233$ $0.330$ $-9.398$ $0.000$			-
SurC SuD	Williams at al	0.775 0.756 0.703 23 189 0.000			- 1
EnR	Akarsu et al	0.497 0.462 0.533 -0.165 0.869		+	
SuR .	Palamenghi	0.590 0.559 0.620 5.672 0.000		-	
nR	Bell et al	0.558 0.530 0.585 4.095 0.000			
RuR	Antwi-Berko et al	0.696 0.620 0.762 4.819 0.000			-
EnR	Roberts et al	0.850 0.839 0.860 41.710 0.000			
EuR	Riad et al	0.702 0.653 0.747 7.456 0.000			-
anR	Nohl et al	0.570 0.543 0.597 5.023 0.000			
uR	İkiisik et al	0.547 0.497 0.596 1.839 0.066		I I  ⊷	
EuR	Vallée et al	0.713 0.652 0.767 6.337 0.000			•
EuR	Holzmann-Littig et	al 0.917 0.909 0.925 44.458 0.000			-
uR	Gallè et al	0.919 0.909 0.928 37 638 0.000			- 1
EuR	Ayhan et al	0.370 0.317 0.426 -4.451 0.000			
uR	,	0.663 0.573 0.743 3.467 0.001			
SEAR	Harapan et al	0.933 0.918 0.945 24.275 0.000			
SEAR	Hossain et al	0.429 0.404 0.454 -5.475 0.000			_
SEAR	Sirikalyanpaiboon et a	al 0.956 0.938 0.969 16.765 0.000			
SEAR	Paul et al	0.605 0.590 0.620 13.467 0.000			
SEAR		0.810 0.599 0.924 2.707 0.007			
VPR	Wong et al	0.945 0.930 0.957 22.072 0.000			•
VPR	Wong et al	0.422 0.394 0.450 -5.382 0.000		· · ·	
VPR	Yoda, et al	0.657 0.628 0.684 10.233 0.000			
VPR	Wang et al	0.348 0.328 0.369-13.531 0.000			
VPR	Wang et al	0.913 0.900 0.924 30.057 0.000			
VPR	Chen	0.838 0.825 0.850 34.227 0.000			
VPR.	Wang	0.522 0.500 0.544 1.995 0.046			_
VPR	Alwi et al	0.833 0.813 0.852 22.515 0.000			-
VPR	Achangwa et al	0.708 0.673 0.740 10.730 0.000			• _
VPR	Huang et al	0.844 0.833 0.855 39.829 0.000			
VPR.	Qin et al	0.885 0.869 0.899 27.020 0.000			-
VPR	Nguyen et al	0.604 0.566 0.641 5.268 0.000		+	
VPR	Mohamed et al	0.645 0.620 0.670 10.714 0.000			
VPR	Huang et al	0.749 0.721 0.775 14.665 0.000			-
VPR	Tsai et al	0.527 0.496 0.558 1.724 0.085			
VPR	Han et al	0.891 0.877 0.904 30.190 0.000			
<i>N</i> PR	Tao et al	0.774 0.751 0.795 19.209 0.000			-
VPR		0.747 0.652 0.823 4.657 0.000			
			-		

#### FIGURE 5

Forest plot shows the subgroup analysis of the pooled COVID-19 vaccine acceptance rate based on World Health Organization classification of the region 2022. ArR, African region; AmR, American region; EMR, Eastern Mediterranean Region; SEAR, South East Asian Region; WPR, Western Pacific Region; EuR, European Region.

Group by	Study name	Statistics for each study	Event rate and 95% CI
Countrylregion		Event Lower Upper	
		rate limit limitZ-Valuep-Value	
Bangladesh Bangladesh	Paul et al	0.429 $0.404$ $0.454$ $-5.475$ $0.0000.605$ $0.590$ $0.620$ $13.467$ $0.000$	
Bangladesh		0.518 0.348 0.683 0.201 0.841	
Botswana Botswana	Tlale et al	0.734 0.722 0.746 32.651 0.000 0.734 0.722 0.746 32.651 0.000	
Cameroon	Dinga et al	0.154 0.140 0.169-30.819 0.000	
Cameroon	Wong et al	0.154 0.140 0.169-30.819 0.000	
China	Wang et al	0.348 0.328 0.369-13.531 0.000	-
China	Wang et al Chan	0.913 0.900 0.924 30.057 0.000	
China	Wang	0.522 0.500 0.544 1.995 0.046	
China	Huang et al	0.844 0.833 0.855 39.829 0.000	
China	Han et al	0.885 0.869 0.899 27.020 0.000 0.891 0.877 0.904 30.190 0.000	
China	Tao et al	0.774 0.751 0.795 19.209 0.000	
Czechia	Riad et al	0.756 0.598 0.866 5.027 0.002 0.702 0.653 0.747 7.456 0.000	
Czechia		0.702 0.653 0.747 7.456 0.000	
Egypt Egypt	Saied et al	0.540 0.519 0.561 3.691 0.000	
Ingland	Bell et al	0.558 0.530 0.585 4.095 0.000	
England Sthiopia	Berihun et al	0.558 0.530 0.585 4.095 0.000 0.594 0.546 0.640 3.811 0.000	
Ethiopia	Boche et al	0.727 0.676 0.773 7.803 0.000	-
Ethiopia France	Vallée et al	0.663 0.522 0.780 2.252 0.024 0.713 0.652 0.767 6.337 0.000	
Trance		0.713 0.652 0.767 6.337 0.000	_₹
Germany Germany	Nohl et al Holzmann Littic et al	0.570 0.543 0.597 5.023 0.000	
Germany	. orzinanii-Entrig et al	0.793 0.324 0.968 1.266 0.206	
ndonesia	Harapan et al	0.933 0.918 0.945 24.275 0.000	
ran	Nakhostin-Ansari et al	0.690 0.676 0.703 25.109 0.000	
ran	Dron at al	0.690 0.676 0.703 25.109 0.000	•_
srael	DIOT et al	0.750 0.724 0.775 15.863 0.000	
taly	Gerussi et al	0.408 0.369 0.448 -4.477 0.000	
taly	Gallè et al	0.590 0.559 0.620 5.672 0.000 0.919 0.909 0.928 37.638 0.000	
taly	Vada at al	0.692 0.303 0.921 0.963 0.335	
lapan	roda et al	0.657 0.628 0.684 10.233 0.000	
lordan	Sallam, et al	0.284 0.265 0.303-19.438 0.000	
fordan	EI-Elimat et al	0.374 0.357 0.391-13.877 0.000 0.328 0.246 0.421 -3.510 0.000	
Kuwait	Sallam et al	0.236 0.207 0.267-13.851 0.000	• •
Kuwait	Alibrahim and Awad	0.738 0.724 0.751 29.325 0.000	
Malaysia	Wong et al	0.945 0.930 0.957 22.072 0.000	•
Malaysia Malaysia	Alwi et al Mohamed et al	0.833 0.813 0.852 22.515 0.000	
Malaysia	Monanieu et al	0.843 0.639 0.942 2.969 0.003	
Malta	Gretch et al	0.618 0.529 0.699 2.592 0.010	
Mexico	Lazarus et al	0.762 0.729 0.792 13.102 0.000	
Mexico	· · · · · · · · · · · · · · · · · · ·	0.762 0.729 0.792 13.102 0.000	
Netherlands	Antwi-Berko et al	0.696 0.620 0.762 4.819 0.000	
Nigeria	Mustapha et al	0.400 0.355 0.447 -4.167 0.000	
Poland	Feleszko et al	0.400 0.355 0.447 -4.167 0.000 0.370 0.342 0.399 -8.390 0.000	
Poland		0.370 0.342 0.399 -8.390 0.000	
Datar Datar	Alabdulla Al-Mulla et al	0.605 0.594 0.616 18.432 0.000 0.626 0.581 0.669 5.357 0.000	
Qatar		0.606 0.596 0.617 19.173 0.000	
Republic of congo	Ditekemena	0.559 0.544 0.574 7.566 0.000	
Saudi Arabia	Sallam et al	0.318 0.249 0.396 -4.409 0.000	
Saudi Arabia Saudi Arabia	Barry et al Almaghaslah et al	0.700 0.676 0.723 15.098 0.000 0.224 0.197 0.253-15.209 0.000	
Saudi Arabia	Yahia et al	0.618 0.576 0.658 5.386 0.000	
Saudi Arabia Saudi Arabia	Elharake et al Alfageeh et al	0.649 0.643 0.655 45.050 0.000 0.480 0.459 0.501 -1.849 0.065	
Saudi Arabia		0.496 0.374 0.620 -0.055 0.956	
Scotland Scotland	Williams et al	0.775 0.756 0.793 23.189 0.000 0.775 0.756 0.793 23.189 0.000	
South Korea	Achangwa et al	0.708 0.673 0.740 10.730 0.000	
South Korea	Raia et al	0.708 0.673 0.740 10.730 0.000	
Sudan	ixaja et ai	0.558 0.491 0.623 1.705 0.088	
faiwan	Huang et al	0.749 0.721 0.775 14.665 0.000	
faiwan	isai etai	0.646 0.410 0.827 1.218 0.223	
Thailand S	sirikalyanpaiboon et al	0.956 0.938 0.969 16.765 0.000	
Tunisia	Khiari et al	0.350 0.287 0.419 -4.176 0.000	│
Funisia Funksia	K and at al	0.350 0.287 0.419 -4.176 0.000	
furkey	Akarsu et al	0.686 0.658 0.712 12.235 0.000 0.497 0.462 0.533 -0.165 0.869	
Furkey	İkiışık et al	0.547 0.497 0.596 1.839 0.066	
furkey furkev	Aynan et al	0.570 0.317 0.426 -4.451 0.000 0.528 0.395 0.657 0.407 0.684	
Uganda	Bongomin et al	0.701 0.648 0.749 6.945 0.000	
Jganda United Arab Emirates	Saddik et al	0.701 0.648 0.749 6.945 0.000 0.580 0.537 0.622 3.622 0.000	
United Arab Emirates	Judgin Crui	0.580 0.537 0.622 3.622 0.000	
United Kingdom	Freeman Williams at al	0.717 0.704 0.729 29.946 0.000	
United Kingdom	Dickerson et al	0.290 0.253 0.330 -9.398 0.000	
Jnited Kingdom	Roberts et al	0.850 0.839 0.860 41.710 0.000	
United Kingdom United States	Shekhar et al	0.710 0.513 0.851 2.078 0.038 0.360 0.345 0.375-17.641 0.000	
United States	Malik et al	0.670 0.634 0.705 8.632 0.000	
United States	Reiter Khubchandani et al	0.690 0.669 0.710 16.574 0.000 0.790 0.771 0.808 23.386 0.000	
United States	and changen et al	0.637 0.400 0.822 1.141 0.254	
Vietnam	Nguyen et al	0.604 0.566 0.641 5.268 0.000	
Desamoli		0.000 0.000 0.000 0.000	

FIGURE 6

Forest plot shows the subgroup analysis of the pooled COVID-19 vaccine rate based on the country where the studies were conducted, 2022.

Froup by	Study name	Statistics for each study	Event rate and 95% CI
udy participants		EventLowerUpper rate limit limit Z-Value <sub>p-Value</sub>	2
hild caregivers	Oin et al	0.885 0.869 0.899 27.020 0.000	
child caregivers	,	0.885 0.869 0.899 27.020 0.000	
Iealthcare workers	Shekhar et al	0.360 0.345 0.375-17.641 0.000	
lealthcare workers	Kose et al Gratch at al	0.686 0.658 0.712 12.235 0.000	
lealthcare workers	Sirikalyannaihoon et al	0.018 0.329 0.099 2.392 0.010	
Healthcare workers	Saddik et al	0.580 0.537 0.622 3.622 0.000	
Healthcare workers	Barry et al	0.700 0.676 0.723 15.098 0.000	
Iealthcare workers	Boche et al	0.727 0.676 0.773 7.803 0.000	
Iealthcare workers	Nohl et al	0.570 0.543 0.597 5.023 0.000	
lealthcare workers	Holzmann-Littig et al	0.049 0.043 0.055 45.050 0.000	
Healthcare workers	Holzmann-Entrig et al	0.714 0.599 0.807 3.483 0.000	
atients	Gerussi et al	0.408 0.369 0.448 -4.477 0.000	
atients	Berihun et al	0.594 0.546 0.640 3.811 0.000	
Patients	Khiari et al	0.350 0.287 0.419 -4.176 0.000	
Patients	vallee et al	0.518 0.368 0.666 0.234 0.815	
Population	Malik et al	0.670 0.634 0.705 8.632 0.000	
Population	Ditekemena	0.559 0.544 0.574 7.566 0.000	
opulation	Wong et al	$0.945 \ 0.930 \ 0.957 \ 22.072 \ 0.000$	
Population	Wong et al	0.422 0.394 0.450 -5.382 0.000	
Population	Freeman	0.057 0.028 0.084 10.235 0.000	
Population	Williams, et al	0.860 0.828 0.887 14.460 0.000	
Population	Alabdulla	0.605 0.594 0.616 18.432 0.000	
Population	Reiter	0.690 0.669 0.710 16.574 0.000	
Population	Wang et al	0.348 0.328 0.369-13.531 0.000	
Population	Sallam et al	0.318 0.249 0.396 -4.409 0.000	
Population	Dinga et al	0.154 0.140 0.169-30.819 0.000	
Population	Wang et al	0.913 0.900 0.924 30.057 0.000	
Population	Dror et al	0.750 0.724 0.775 15.863 0.000	
Population	Dickerson et al	0.290 0.253 0.330 -9.398 0.000	
Population	Williams et al	0.775 0.756 0.793 23 189 0.000	
Population	Sallam et al	0.236 0.207 0.267-13.851 0.000	
Population	Harapan et al	0.933 0.918 0.945 24.275 0.000	
Population	Akarsu et al	0.497 0.462 0.533 -0.165 0.869	
Population	Khubchandani et al	0.790 0.771 0.808 23.386 0.000	
Population	Palamenghi	0.838 0.825 0.850 34.227 0.000	
Population	Wang	0.522 0.500 0.544 1.995 0.046	
Population	Sallam et al	0.284 0.265 0.303-19.438 0.000	
Population	Bell et al	0.558 0.530 0.585 4.095 0.000	
Population	Alwi et al	0.833 0.813 0.852 22.515 0.000	
Population	Nakhostin-Ansari et al	0.708 0.675 0.740 10.730 0.000	
Population	Hossain et al	0.429 0.404 0.454 -5.475 0.000	
Population	Alibrahim and Awad	0.738 0.724 0.751 29.325 0.000	
Population	Huang et al	0.844 0.833 0.855 39.829 0.000	
Population	Antwi-Berko et al	0.696 0.620 0.762 4.819 0.000	
Population	Tale et al	0.734 0.722 0.746 32 651 0.000	
Population	Huang et ala	0.749 0.721 0.775 14.665 0.000	
Population	Roberts et al	0.850 0.839 0.860 41.710 0.000	
Population	Paul et al	0.605 0.590 0.620 13.467 0.000	
Population	Bongomin et al	0.701 0.648 0.749 6.945 0.000	
Population	Ikiisiket al	0.547 0.497 0.596 1.839 0.066	
Population	Almaghaslah et al	0.224 0.197 0.253-15.209 0.000	
Population	Yahia et al	0.618 0.576 0.658 5.386 0.000	
opulation	Tsai et al	0.527 0.496 0.558 1.724 0.085	
Population	Han et al	0.891 0.877 0.904 30.190 0.000	
Population	Fl-Elimat at al	0.480 0.459 0.501 -1.849 0.065	
Population	El-Eliniat et al	0.639 0.584 0.691 4.790 0.000	
PL Women	Nguyen et al	0.604 0.566 0.641 5.268 0.000	-
PL Women	Riad et al	0.702 0.653 0.747 7.456 0.000	
PL Women	Tao et al	0.774 0.751 0.795 19.209 0.000	
PL Women	Aynan et al	$0.570 \ 0.517 \ 0.420 \ -4.451 \ 0.000 \ 0.622 \ 0.450 \ 0.768 \ 1.398 \ 0.162$	
Students	Mustapha et al	0.400 0.355 0.447 -4.167 0.000	
Students	Raja et al	0.558 0.491 0.623 1.705 0.088	
Students	Gallè et al	0.919 0.909 0.928 37.638 0.000	
Students	Saied et al	0.540 0.519 0.561 3.691 0.000	
Sudents		0.847 0.326 0.874 0.892 0.373	
eran		0.010 0.797 0.032 24.924 0.000	-1.00 -0.50 0.00 0.50 1.0
			-0.00 0.00 0.00 1.0

arvey beriou	Study name	1	Statistics f	or each s	udy		Eve	ent rate and 95% CI
		Event rate	Lower limit	Upper limit	Z-Value	p-Value		
ecember 2020 to February 2021	Sallam et al	0.236	0.207	0.267	-13 851	0.000	I I	I – I
cember 2020 to February 2021	Sallam et al	0.284	0.265	0.303	-19.438	0.000		
cember 2020 to February 2021	Alwi et al	0.833	0.813	0.852	22.515	0.000		
ecember 2020 to February 2021	Nakhostin-Ansari et al	0.690	0.676	0.703	25.109	0.000		
ecember 2020 to February 2021	Hossain et al	0.429	0.404	0.454	-5.475	0.000		
cember 2020 to February 2021	Huang et al	0.844	0.833	0.855	39.829	0.000		
cember 2020 to February 2021	Khiari et al	0.350	0.287	0.419	-4.176	0.000		
ecember 2020 to February 2021	Antwi-Berko et al	0.696	0.620	0.762	4.819	0.000		-
ecember 2020 to February 2021	Nguyen et al	0.604	0.566	0.641	5.268	0.000		+
ecember 2020 to February 2021	Mohamed et al	0.645	0.620	0.670	10.714	0.000		
ecember 2020 to February 2021	Saddik et al	0.580	0.537	0.622	3 622	0.000		-
ecember 2020 to February 2021	Tlale et al	0.734	0.722	0.746	32.651	0.000		
ecember 2020 to February 2021	Roberts et al	0.850	0.839	0.860	41 710	0.000		
ecember 2020 to February 2021	Paul et al	0.605	0.590	0.620	13 467	0.000		.
comber 2020 to February 2021	Nobl et al	0.570	0.543	0.597	5 023	0.000		_
cember 2020 to February 2021	Al-Mulla et al	0.676	0.591	0.669	5 357	0.000		
cember 2020 to February 2021	Ibicit et al	0.547	0.407	0.505	1 820	0.066		
cember 2020 to reordary 2021	Almanhadah et al	0.047	0.107	0.390	15 200	0.000		
comber 2020 to reoruary 2021	Nahia at al	0.224	0.19/	0.233	-13.209	0.000		
ember 2020 to reordary 2021	1 ana et al	0.018	0.570	0.058	15.050	0.000		+
emper 2020 to February 2021	Einarake et al	0.649	0.043	0.055	45.050	0.000		
cember 2020 to rebruary 2021	vallee et al	0.713	0.052	0.767	0.557	0.000		
cemper 2020 to rebruary 2021	Allageen et al	0.480	0.439	0.501	-1.849	0.005		1 1
cember 2020 to rebruary 2021	rioizmann-Littig et al	0.917	0.909	0.925	44.458	0.000		
cember 2020 to February 2021	Galle et al	0.919	0.909	0.928	37.038	0.000		
cember 2020 to February 2021	Saled et al	0.540	0.519	0.561	3.691	0.000		*
cember 2020 to February 2021	Ayhan et al	0.370	0.317	0.426	-4.451	0.000		· · · · ·
cemper 2020 to February 2021		0.619	0.548	0.685	3.254	0.001		
e to August 2020	Wong et al	0.422	0.394	0.450	-5.382	0.000		
e to August 2020	Feleszko et al	0.370	0.342	0.399	-8.390	0.000		
e to August 2020	Dinga et al	0.154	0.140	0.169	-30.819	0.000		
e to August 2020	Lazarus et al	0.762	0.729	0.792	13.102	0.000		
e to August 2020	Williams et al	0.775	0.756	0.793	23.189	0.000		
e to August 2020	Akarsu et al	0.497	0.462	0.533	-0.165	0.869		I +
e to August 2020	Khubchandani et al	0.790	0.771	0.808	23.386	0.000		
e to August 2020	Chen	0.838	0.825	0.850	34.227	0.000		
e to August 2020	Achangwa et al	0.708	0.673	0.740	10.730	0.000		
e to August 2020		0.601	0.405	0.769	1.013	0.311		
e to August 2021	Huang et al	0.749	0.721	0.775	14.665	0.000		
e to August 2021	Raja et al	0.558	0.491	0.623	1.705	0.088		
e to August 2021	Boche et al	0.727	0.676	0.773	7.803	0.000		
e to August 2021		0.685	0.571	0.781	3.100	0.002		
rch to May 2020	Malik et al	0.670	0.634	0.705	8.632	0.000		
rch to May 2020	Wong et al	0.945	0.930	0.957	22.072	0.000		
rch to May 2020	Williams et al	0.860	0.828	0.887	14.460	0.000		
rch to May 2020	Reiter	0.690	0.669	0.710	16.574	0.000		
rch to May 2020	Sallam et al	0.318	0.249	0.396	-4.409	0.000		_ <b>_</b> _
rch to May 2020	Wang et al	0.913	0.900	0.924	30.057	0.000		
ch to May 2020	Dror et al	0.750	0.724	0.775	15.863	0.000		
to May 2020	Harapan et al	0.933	0.918	0.945	24.275	0.000		
rch to May 2020	Wang	0.522	0.500	0.544	1.995	0.046		L
rch to May 2020	Bell et al	0.558	0 530	0.585	4 095	0.000		- I I-
rch to May 2020	Jon of m	0.765	0.647	0.853	4 016	0.000		I*
rch to May 2020	Mustanha et al	0.400	0.355	0.333	-4 167	0.000		
ch to May 2021	Berihim et al	0.594	0.546	0.640	3 811	0.000		<sup>-</sup>  _
ch to May 2021	Alibrahim and Amad	0.324	0.724	0.751	20 225	0.000		<b>_</b>
ich to May 2021	Sinkalyanasihaan at al	0.756	0.029	0.051	16 765	0.000		
rch to May 2021	Bongomin at al	0.930	0.538	0.749	6 0.45	0.000		
reli to May 2021	Ponformi et si	0.701	0.048	0.249	2 545	0.000		
ten to May 2021	Challen and	0.720	0.000	0.849	2.343	0.011		
ember to November 2020	Sneknar et al	0.500	0.545	0.375	-17.041	0.000		· · .
temper to November 2020	Direkemena	0.559	0.044	0.5/4	12,000	0.000		
temper to November 2020	Nose et al	0.080	0.058	0.712	12.235	0.000		
temper to November 2020	1 oda et al	0.657	0.628	0.684	10.233	0.000		
temper to November 2020	Freeman	0.717	0.704	0.729	29.946	0.000		
otember to November 2020	Alabdulla	0.605	0.594	0.616	18.432	0.000		I •
tember to November 2020	Wang et al	0.348	0.328	0.369	-13.531	0.000		
tember to November 2020	Gerussi et al	0.408	0.369	0.448	-4.477	0.000		
tember to November 2020	Dickerson et al	0.290	0.253	0.330	-9.398	0.000		
tember to November 2020	Gretch et al	0.618	0.529	0.699	2.592	0.010		-•
tember to November 2020	Barry et al	0.700	0.676	0.723	15.098	0.000		
tember to November 2020	Tsai et al	0.527	0.496	0.558	1.724	0.085		
tember to November 2020	Han et al	0.891	0.877	0.904	30,190	0.000		
tember to November 2020	Tao et al	0.774	0.751	0.795	19.209	0.000		
tember to November 2020	El-Elimat et al	0.374	0.357	0.391	-13.877	0.000		· · · ·
tember to November 2020		0 579	0.492	0.662	1.776	0.076		
atember to november 2021	Oin et al	0.885	0.869	0.899	27.020	0.000		
ntember to november 2021	Riad et al	0.303	0.653	0 747	7 456	0.000		
	Addu ut di	0.810	0 573	0.931	2 458	0.014		
internher to november 2021		0.010	0.275	0.751	2.400	0.017		
eptember to november 2021 verall		0.645	0.603	() 685	6 508	0.000		

Criteria	Acceptance rate/prevalence	Heterogeneity	95% Confidence interval		P-value
			Upper limit	Lower limit	
After removing three articles with small sample size	65.2%		60.8	69.3	< 0.001
After removing one article with small sample size	64.85		60.0	69.3	< 0.001
After removing one article with low outcome	65.5%		61.5	69.4	< 0.001
After removing four articles with high prevalence rate	62.0%		57.8	66.1	< 0.001
After removing one article with low and four articles	65.8%		58.8	66.6	< 0.001
with high prevalence rate					

TABLE 1 Results of sensitivity analysis for COVID-19 vaccine acceptance, 2022.

the study participants or the survey period. The former study was mainly conducted in a specific study period, whereas the present study's findings depend on the studies conducted during COVID-19 pandemic.

The lowest prevalence of COVID-19 vaccine acceptance rate was reported in Cameroon [15.4% (95% CI: 14.0, 16.9], while the highest prevalence [95.6% (95% CI: 93.8, 96.9%] was reported in Thailand, followed by Indonesia [93.3% (95% CI: 91.8, 94.5%]. The variation may be due to the difference in sources of information and types of study participants. Because, the study conducted in Thailand involved healthcare workers, whereas the study conducted in Cameroon involved the general population.

Furthermore, the current study found a slight difference in the pooled prevalence of COVID-19 vaccine acceptance rate among the studies conducted in the United States [60.4% (95% CI 56.6, 64.1%)], United Arab Emirates [58.0% (95% CI 53.7, 62.2%)], Taiwan [64.6% (95% CI 41.0, 82.7%)], and Qatar [60.6% (95% CI 59.6, 61.7%)].

Similarly, there was slight difference in the prevalence of COVID-19 acceptance rate among the studies conducted in the United Kingdom [71% (95% CI: 51.3, 85.1%)], South Korea [70.8% (95% CI: 67.3, 74.0%)], Netherland [69.6% (95% CI: 62.0,76.2%)], Italy [69.2% (95% CI: 30.3, 92.1%)], Iran [69.0% (95% CI: 67.6, 70.3%)], France [71.3% (95% CI: 65.2, 76.7%)] and Czechia [70.2% (95% CI: 65.3, 74.7%)]. However, in some countries there was a lower prevalence, such as Cameroon and Jordan, which reported 15.4 and 32%, respectively. In general, the variation in the estimate of the vaccine acceptance rate may be due to the difference in the information and sociodemographic characteristics of the study participants (Supplementary File V).

Based on World Health Organization Region, the overall COVID-19 vaccine acceptance rate was 60.8% [95% CI: 56.3, 65.2%] that was slightly lower than our findings without subgroup analysis. The lowest COVID-19 vaccine acceptance rate was reported in the Eastern Mediterranean Region accounted for 60.8% [95% CI: 43.4, 57.2%], followed by the Western Pacific [74.7% CI: 65.2, 82.3%] and American region (66.4%: CI: 59.4, 82.3%).

However, the highest prevalence was reported in South East Asian Region, which accounted for 81.0% [95% CI: 59.9, 92.4%]. The variation in vaccine acceptance rate may be related to the level of risk perception, study participants involved, and access to information (Supplementary File VI).

Based on the survey period, the COVID-19 acceptance rate was 76.5, 60.1, 57.9, 61.9, 72.6, 68.5, and 81.0% for the articles conducted from March to May 2020, June to August 2020, September to November 2020, December 2020 to February 20211, March to May 2021, June to August 2021 and September to November 2021, respectively. This indicates that there is a decline in COVID-19 vaccine acceptance rate from March to November 2020. The current study is supported by various studies (country or region-specific studies), which reported a decline in willingness to accept COVID-19 vaccine (6, 13, 14).

Similarly, this finding was in line with the findings of another study, which reported a decline in the acceptance rate of the COVID-19 vaccine from more than 70.0% in March to <50% in October (82). However, there was an increasing in COVID-19 vaccine acceptance rate from December 2020 to November 2021. It could be related to an increase in awareness, a change in risk perception, and the round of vaccines given across the world. The variation in the vaccine acceptance rate based on the survey period is indicated in the figure below (Supplementary File VII).

In general, the current study found that there was a declining in COVID-19 vaccine acceptance rate in 2020 and increasing in 2021. However, the overall COVID-19-vaccine acceptance rate was 64.9%. This indicates that there is a need to improve community awareness in order to increase COVID-19-vaccine acceptance rate. The authors recommend the need to take appropriate actions to manage the COVID-19 pandemic. Thus, local and international government should take appropriate action in collaboration with non-governmental organizations and community members to build trust in the community and to ensure adequate vaccination coverage. Furthermore, transparent and effective communications are essential to reduce misinformation and vaccination hesitancy, build trust, and ensure adequate vaccination coverage (8). Additionally, novel decision models for vaccine selection need to be developed.

#### Implications of finding

The current study revealed that only about six out of ten study participants accepted the COVID-19 vaccine. This indicates that even if the COVID-19 vaccine is developed, the issue of accepting or taking the developed vaccine and managing the pandemic may be difficult. Not only for COVID-19, it must be used as input and considered to control other pandemics. These findings can be used as an input for concerned bodies, including health program planners, researchers, policymakers, and decision-makers, to take appropriate actions that can contribute to vaccine acceptance, ensure adequate vaccination coverage, and promote health.

#### Limitations

There was an unequal distribution of the studies conducted across the world. Furthermore, the acceptance rates of the COVID-19 vaccine in many countries of the world were not included because of the lack of studies that met the eligibility criteria. Similarly, as a result of variation in the unit of measurement/statistical analysis employed for data analysis, we could not able to determine the factors associated with COVID-19 acceptance rate. Furthermore, cross-sectional studies were included and causal relationships between the acceptance rate of the COVID-19 vaccine and the determinant factors cannot be established.

# Conclusion

This review found a decline in the acceptance rate of the COVID-19 vaccine in 2020 and increasing acceptance in 2021. About 6 in 10 study participants accepted COVID-19 vaccine that needs critical attention to manage the COVID-19 pandemic. This finding indicated that even if the COVID-19 vaccine is developed, the issue of accepting or taking the developed vaccine and managing the pandemic will be difficult unless appropriate measures are taken when it is necessary. Furthermore, we recommend further studies, particularly on the determinants or factors that lead to hesitancy.

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# Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author/s.

#### Author contributions

DM conceived the idea and had a major role in the review, extraction, analysis of the data, writing, drafting, and editing of the manuscript. YD has contributed to data extraction, analysis, and editing. All authors read and approved the final version of the manuscript to be published and agreed on all aspects of this work.

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# **Conflict of interest**

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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# Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh. 2022.1044193/full#supplementary-material

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