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Review article

COVID-19 vaccine acceptance in sub-Saharan African countries: A systematic review and meta-analysis

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ABSTRACT

Vaccination is the most effective intervention for the primary prevention of COVID-19. Several studies have been conducted in sub-Saharan African countries on the acceptance and associated factors of COVID-19 vaccine. This review and meta-analysis aimed to recapitulate the pooled magnitude of vaccine acceptance and its favoring factors in sub-Saharan African countries. PUBMED, MEDLINE, Science Direct, Web of Science, and SCOPUS were the main databases searched from 15 March to 5 June 2022; and all the articles written in the English language were included. Also, some articles were retrieved from biomedical peer-reviewed journal sites and Google scholar. The quality of thirty-five selected articles was evaluated using an adapted scale for evaluating cross-sectional studies based on the Newcastle-Ottawa Scale. The result of the review and meta-analysis revealed that COVID-19 vaccine acceptance rate varied across studies. In a pooled analysis, factors such as; higher-level perception of infection risk (OR (95% CI (2.7 (2.1, 3.4))), perceived vaccine safety (13.9 (9.2, 20.9)), virus-related good knowledge (2.7 (2.3, 3.2)) and appropriate attitude (5.9 (4.4, 7.8)), adherence to safety precautions (5.5 (4.8, 6.2)), and infection experience (4.4 (2.8, 6.9)) were positively affected the COVID-19 vaccine acceptance. Also, vaccine acceptance was found to be high among males and chronically ill individuals. Thus, understanding factors that enhance vaccine acceptance would support planners to augment vaccine uptake in the region.

1. Introduction

The novel coronavirus disease 2019 (COVID-19) was first identified in one of China's cities, Wuhan, in December 2019 [1]. Thereafter, the infection spread to more than 200 countries around the world and the World Health Organization finally declared the disease a pandemic [2]. COVID-19 has had extraordinary influences on the health and well-being of people all over the world and on the economy of many countries [3,4]. The lasting solution to COVID-19 would be, most likely, a safe and globally implemented vaccination program [5]. Mass vaccination is a crucial step in decreasing the spread of infectious diseases by inducing herd immunity [6,7]. Similarly, the spread of COVID-19 could be reduced or controlled by effective vaccines and widespread vaccination. However, trust is a significant factor in either acceptance or hesitance of vaccines [8,9] in general and the COVID-19 vaccine in particular.

Globally, COVID-19 vaccine acceptance varies widely. It was reported as greater than 90% in Malaysia [10,11], 74% in South-East Asia, 52% in Eastern Mediterranean [12], and as low as 43% in Greece [11], and about 20% in Lebanon [10]. In sub-Saharan African

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countries, the level of acceptance ranged from 28% [13] in the Democratic Republic of Congo (DRC) to 92% [14,15] in Ethiopia. The acceptance rate was found to be below 50% in most studies that surveyed healthcare workers [13,16–18] and university and school communities [19–22].

Studies identified that acceptance, intention, and willingness to get vaccinated significantly varied between the sex of respondents [13,15,17,19,20,23–27]. Also, some studies identified that a higher perceived level of COVID-19 risk positively contributed to the acceptance [23,28–32]. Moreover, good knowledge [13,26,30,33–35], appropriate attitude [13,28,33], and a higher level of adherence to safety precautions [34,36,37] were found to positively influence vaccine acceptance. Some studies pointed out that participants who had been infected by COVID-19 [21,29,38] have a better acceptance of the vaccine.

Despite the fatality of disease and free-of-charge distribution of vaccines in developing countries, the level of acceptance of vaccines in most cases remained low. This systematic review and meta-analysis aimed to assess the pooled prevalence of acceptance and to identify collective predictors of acceptance of the COVID-19 vaccines. The findings could provide insight for policymakers to focus intervention on significant factors that increase vaccine acceptance and hence increase vaccine uptake and vaccination levels and combat the spread of infection.

2. Materials and methods

2.1. Review protocol

A review protocol was not done for this review and meta-analysis and it was not registered. However, we checked frequently whether it was registered so far or not and confirmed that there is no registered protocol with the same title in sub-Saharan African studies in PROSPERO (https://www.crd.york.ac.uk/prospero/#searchadvanced).

2.2. Search strategy

In this systematic review and meta-analysis, research articles were searched irrespective of the study setting. We searched articles from the 15th of March to the 5th of June 2022. PUBMED, MEDLINE, Science Direct, Web of Science, and SCOPUS were the main databases used to search the articles. In addition, some articles were further identified from biomedical peer-reviewed journal sites and Google scholar. We used a search term ((((((((((COVID-19) OR Coronavirus) OR Corona) AND Vaccine) OR Immunization) AND Acceptance) OR Willingness) OR intention) OR Intent) AND Associated factors) AND Africa) OR sub-Sharan Africa and identified about 61,169 articles published up to May 31, 2022.

2.3. Evidence evaluation

All identified articles were first evaluated based on their titles and abstracts by both authors. Then, the selected 191 studies were fully evaluated for eligibility again by both authors. Finally, the quality of eligible articles was evaluated by using an adapted scale for evaluating cross-sectional studies based on the Newcastle-Ottawa Scale (NOS) [39–41]. NOS is one of the most common scales to assess quality and risk of bias in observational studies [42,43]. Each article was evaluated for clearly stated objectives, subject selection, comparability, and outcome. The scores are categorized as very good (9–10 points), good (7–8 points), satisfactory (5–6 points), and unsatisfactory (0–4 points). Then, both authors evaluated each article individually and in case of disagreement, the final evaluation result was made based on a common consensus.

2.4. Inclusion criteria

We included articles for review and meta-analysis based on the following criteria.

- **Publication year:** all published articles up to the 31st of May 2022 were included.
- **Place of study:** all studies conducted in sub-Saharan African countries
- **Language:** articles reported/published in the English language were used (articles written in a non-English language were not found).
- **Study design:** all studies were conducted using a cross-sectional design and all eligible articles are included in the review and meta-analysis.
- **Outcome:** in the included articles, concepts such as “acceptance”, “intention”, and “willingness” were used interchangeably to measure a similar idea “whether participants were willing to get vaccinated when vaccines are available” and we considered both terms as acceptance.

2.5. Data analysis

The main findings of each study were described in the table and narrated in texts. In addition, the data from each identified article were extracted on the Microsoft Excel spreadsheet and exported to STATA 14 software for meta-analysis.

The analysis to determine the pooled prevalence of the COVID-19 vaccine acceptance was done on 35 articles. Then, the pooled odds ratio of factors associated with the acceptance was done on different explanatory variables and the statistical significance was

determined at the p-value of <0.05 of the estimates and >0.05 of the I^2.

2.6. Heterogeneity and publication bias

Heterogeneity among the included studies was checked by its corresponding I^2 test statistics. For significant variability between studies as of $I^2 > 75\%$ and its corresponding p-value of <0.05, subgroup analysis was done to minimize variability. The presence of publication bias was checked by Egger's statistics, and a p-value of >0.05 was used to determine the absence of bias.

3. Results

3.1. Description of the studies

A total of 61,164 articles were identified through database searching and 5 more articles were identified through google scholar search. After removing 33,805 duplicates and 27,173 unrelated papers, 191 articles were identified for further screening. Then, the identified 191 related articles were fully evaluated for eligibility and 156 of them were excluded with reasons. Finally, 35 articles that fulfilled the selection criterion were included in the review, and 26 of them were further screened for meta-analysis of factors associated with acceptance of COVID-19 vaccine [Fig. 1]. Out of 35 studies, 13 were online surveys. Only six studies were conducted at the community level and the rest 16 were done in the facility settings. Details of the description of selected articles were presented in the table [Table 1].

3.2. Acceptance of COVID-19 vaccine

Among 35 studies included in this review, all of them were cross-sectional quantitative studies. In these studies, the COVID-19 vaccine acceptance rate ranged from 28% (95% CI: 24%–31%) in DRC [13] to 92% (95% CI: 91%–93%) in Ethiopia [14]. In about

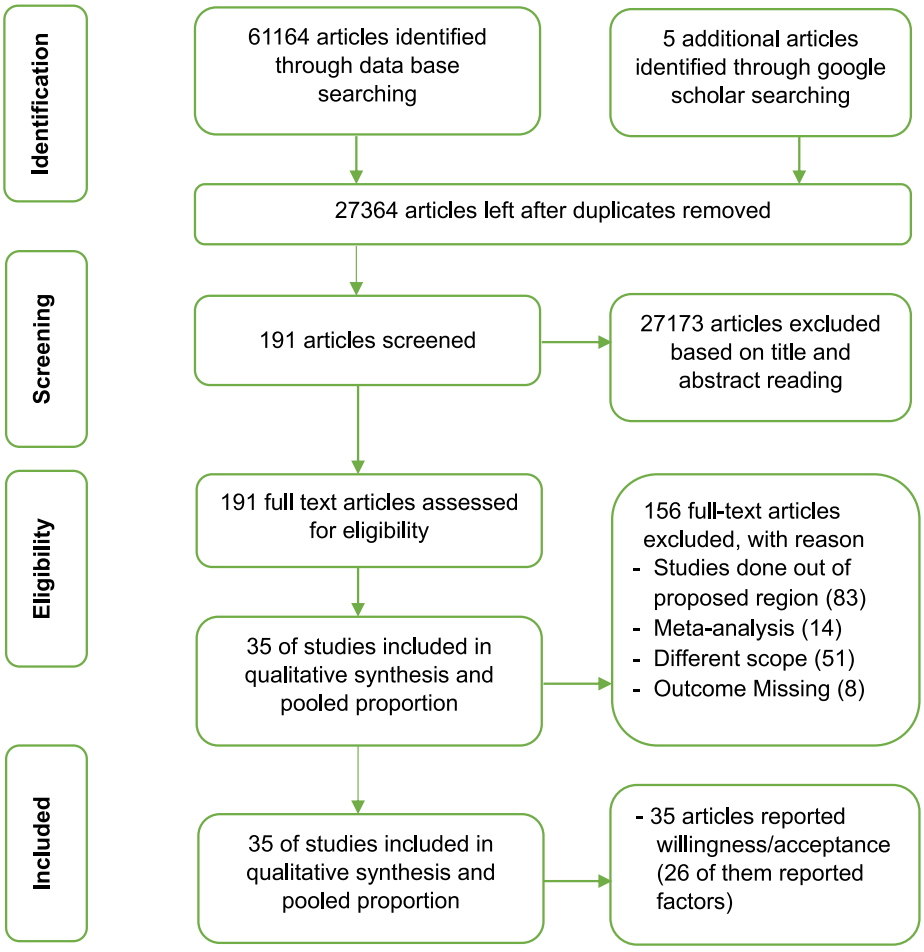

Fig. 1. Flow diagram of the studies selection process.

Table 1
COVID-19 vaccine acceptance rate in sub-Saharan African countries, results from cross-sectional studies conducted between 2020 and 2021.

Study	Country	Year of survey	Outcome	Type of survey	Study population	Quality score (10)	Total population	Acceptance	Acceptance rate (%)
Emmanuel Lamptey et al. [23]	Ghana	Oct.–Dec./2020	Acceptance	Online	GP[3]	8	1000	541	54.1
Tlale LB et al. [36]	Botswana	Feb./2021	Acceptance	Community	GP[3]	9	5300	3689	69.6
Mesele M. [24]	Ethiopia	Apr./2021	Acceptance	Community	GP[3]	8	415	189	45.5
Ahmed M.A.M. et al. [44]	Somalia	Dec.–Jan./2021[1]	Acceptance	Online	GP[3]	7	4543	3488	76.8
Dula J. et al. [45]	Mozambique	Mar./2021	Acceptance	Online	GP[3]	7	1878	1340	71.4
Ditekemena J.D. et al. [46]	DRC[2]	Aug.–Sep./2020	Acceptance	Online	GP[3]	8	4131	2310	55.9
Eze U A et al. [25]	Nigeria	Nov.–Jan./2021[1]	Acceptance	Community	GP[3]	7	358	237	66.2
Acheampong T. et al. [47]	Ghana	Feb./2021	Willingness	Online	GP[3]	7	2345	1197	51.0
McAbee L. et al. [48]	Zimbabwe	May/2021	Intention	Community	GP[3]	8	551	307	55.7
Adedeji-Adenola H. et al. [38]	Nigeria	Jun./2021	Willingness	Online	GP[3]	7	1051	856	81.4
Echoru et al. [49]	Uganda	Jul.–Sep./2020	Acceptance	Online	GP[3]	7	1067	572	53.6
Amo-Adjei et al. [50]	Ghana	Apr.–May/2021	Willingness	Community	GP[3]	7	415	291	70.1
Abebe et al. [30]	Ethiopia	Mar./2021	Acceptance	Community	GP[3]	7	492	308	62.6
Belsti et al. [27]	Ethiopia	Feb.–Mar./2021	Willingness	Online	GP[3]	7	1184	372	31.4
Oyekale A.S. et al. [14]	Ethiopia	Feb./2021	Willingness	Online	GP[3]	7	2178	2011	92.3
Kabamba Nzaji et al. [13]	DRC[2]	Mar.–Apr./2020	Acceptance	Facility	HCW[4]	7	613	170	27.7
Adeniyi O.V. et al. [51]	South Africa	Nov.–Dec./2020	Acceptance	Facility	HCW[4]	9	1308	1179	90.1
Alle Y.F. et al. [16]	Ethiopia	Feb.–Mar./2021	Acceptance	Facility	HCW[4]	8	327	135	41.3
Alhassan et al. [17]	Ghana	Sep. – Oc./2020	Willingness	Facility	HCW[4]	8	1142	520	45.5
Oduwole E.O. et al. [52]	South Africa	Feb.–Mar./2021	Willingness	Online	HCW[4]	7	1015	781	76.9
F.A. Gbeasor-Komlanvi et al. [18]	Togo	Feb.–Mar./2021	Acceptance	Online	HCW[4]	7	1115	492	44.1
Berihun et al. [33]	Ethiopia	May/2021	Acceptance	Facility	CD[5]	8	416	247	59.4
Mesfin et al. [26]	Ethiopia	Mar.–Apr./2021	Intention	Facility	CD[5]	7	398	134	33.7
C. Kassa Mekonnen et al. [35]	Ethiopia	Feb.–Mar./2021	Intention	Facility	CD[5]	7	423	270	63.8
Tadele Admasu [29]	Ethiopia	May–Aug./2021	Willingness	Facility	CD[5]	8	422	230	54.5
Kanyike et al. [19]	Uganda	Mar./2021	Acceptance	Facility	UC[6]	7	600	224	37.3
Sahile et al. [20]	Ethiopia	May–Jul./2021	Acceptance	Facility	UC[6]	8	407	162	39.8
Handebo S et al. [53]	Ethiopia	Dec.–Jan./2021[1]	Intention	Facility	UC[6]	8	301	165	54.8
Mustapha M. et al. [21]	Nigeria	Mar.–Jun./2021	Acceptance	Online	UC[6]	7	440	176	40.0
Zewude and Habtegiorgis [31]	Ethiopia	Mar./2021	Willingness	Facility	UC[6]	7	319	147	46.1
Uzochukwu IC et al. [22]	Nigeria	Jan.–Feb./2021	Willingness	Online	UC[6]	7	349	121	34.7
Taye E.B. et al. [28]	Ethiopia	Aug.–Sep./2021	Acceptance	Facility	PL[7]	8	519	322	60.0
Mose A. et al. [34]	Ethiopia	Jan./2021	Acceptance	Facility	PL[7]	8	396	280	70.7
Mose [37]	Ethiopia	Feb.–Mar./2021	Willingness	Facility	PL[7]	7	630	384	60.9
Hailemariam S. et al. [32]	Ethiopia	Feb.–Mar./2021	Intention	Facility	PL[7]	7	412	129	31.3

[1] Study was started in 2020 end ended in 2021;
[2] Democratic Republic of Congo;
[3] General Population;
[4] Health Care Workers;
[5] Chronic Disease sick patients,
[6] University/College/School Community;
[7] Pregnant/Lactating Mothers

65% of the studies, the COVID-19 vaccine acceptance rate was more than 50%. Among the total population of 38,460 of 35 studies, 26, 908 were general population and 5520 were health care workers. The pooled prevalence of the vaccine acceptance that was derived from Random Effect Analysis (REA) was 68% (95% CI: 67%–68%). In the pooled prevalence, there was considerable heterogeneity between studies ($I^2 = 99.5\%$, $p < 0.001$) that couldn't be resolved by a sub-group analysis. However, in a sub-group analysis, the pooled prevalence of vaccine acceptance from REA among healthcare workers was 54% (95% CI: 33%–76%), while it was 63% (95% CI: 54%–71%) among the general population [Fig. 2].

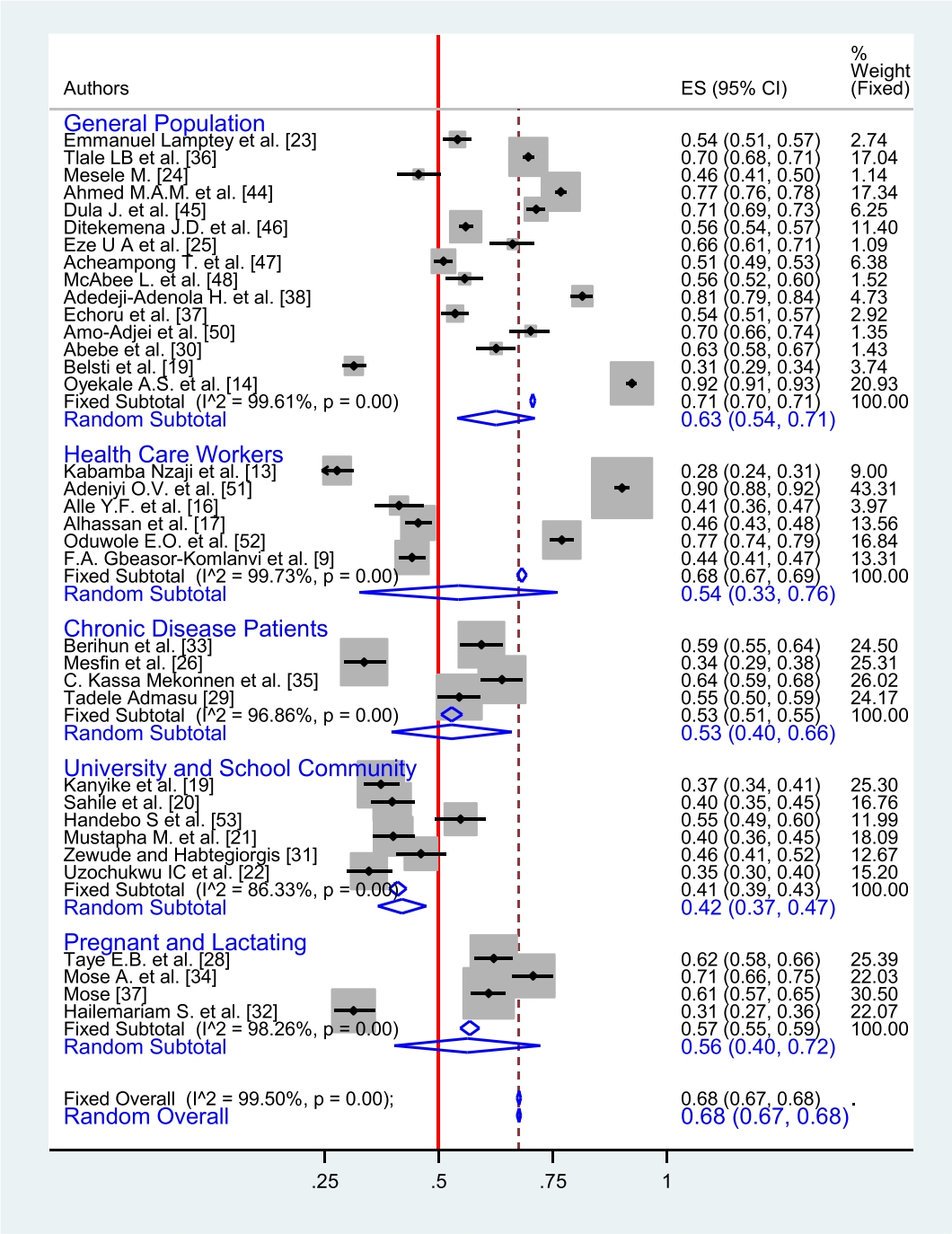

Fig. 2. Subgroup analysis of the prevalence of COVID-19 vaccine acceptance in sub-Saharan African countries, 2020–2021.

3.3. Factors associated with COVID-9 vaccine acceptance

A forest plot of six studies [28–33] was done to assess the pooled effect of the perceived level of COVID-19 risk on vaccine acceptance. The studies showed no significant evidence of small study bias (Egger's p = 0.188). The REA displayed that moderate heterogeneity was observed between studies (I^2 = 50.2%, p = 0.074). As a result, the pooled effect of higher-level perception of disease risk was found to increase vaccine acceptance ((coff. (0.98 (0.75, 1.21))) [OR: 2.7, 95% CI: 2.1, 3.4]) [Fig. 3].

In two studies [24,33] (I^2 = 32.0%, p = 0.225), knowing someone who was infected with COVID-19 increased vaccine acceptance ((coff. (1.11 (0.68, 1.54))) [OR: 3.0, 95% CI: 1.9, 4.7]). Similarly, in four studies [21,24,29,38] (I^2 = 0.0%, p = 0.430, Egger's p = 0.054), self-experience of COVID-19 infection increased vaccine acceptance ((coff. (1.49 (1.03, 1.94))) [OR: 4.4, 95% CI: 2.8, 6.9]). Also, in two studies [48,51] having substantial heterogeneity (I^2 = 83.2%, p = 0.015), a high level of perception of vaccine safety was found to increase vaccine acceptance ((coff. (2.63 (2.22, 3.04))) [OR: 13.9, 95% CI: 9.2, 20.9]) [Fig. 3].

COVID-19-related level of knowledge and attitude was found to determine vaccine acceptance. Eight studies [13,20,26,30,33–35,37] (I^2 = 93.9%, p = 0.000, Egger's p = 0.758), revealed that good level of COVID-19 related knowledge predicted vaccine acceptance ((coff. (1.01 (0.85, 1.17))) [OR: 2.7, 95% CI: 2.3, 3.2]). At the time, five studies that evaluated the attitude [13,28,33,34,37] (I^2 = 83.0%, p = 0.000, Egger's p = 0.131) showed that appropriate level of attitude towards COVID-19 increased vaccine acceptance ((coff. (1.77 (1.48, 2.06))) [OR: 5.9, 95% CI: 4.4, 7.8]). Likewise, a good level of adherence to COVID-19 precautions in four studies [13,34,36,37] (I^2 = 97.3%, p = 0.000, Egger's p = 0.189), found to increase vaccine acceptance ((coff. (1.70 (1.57, 1.83))) [OR: 5.5, 95% CI: 4.8, 6.2]) [Fig. 3].

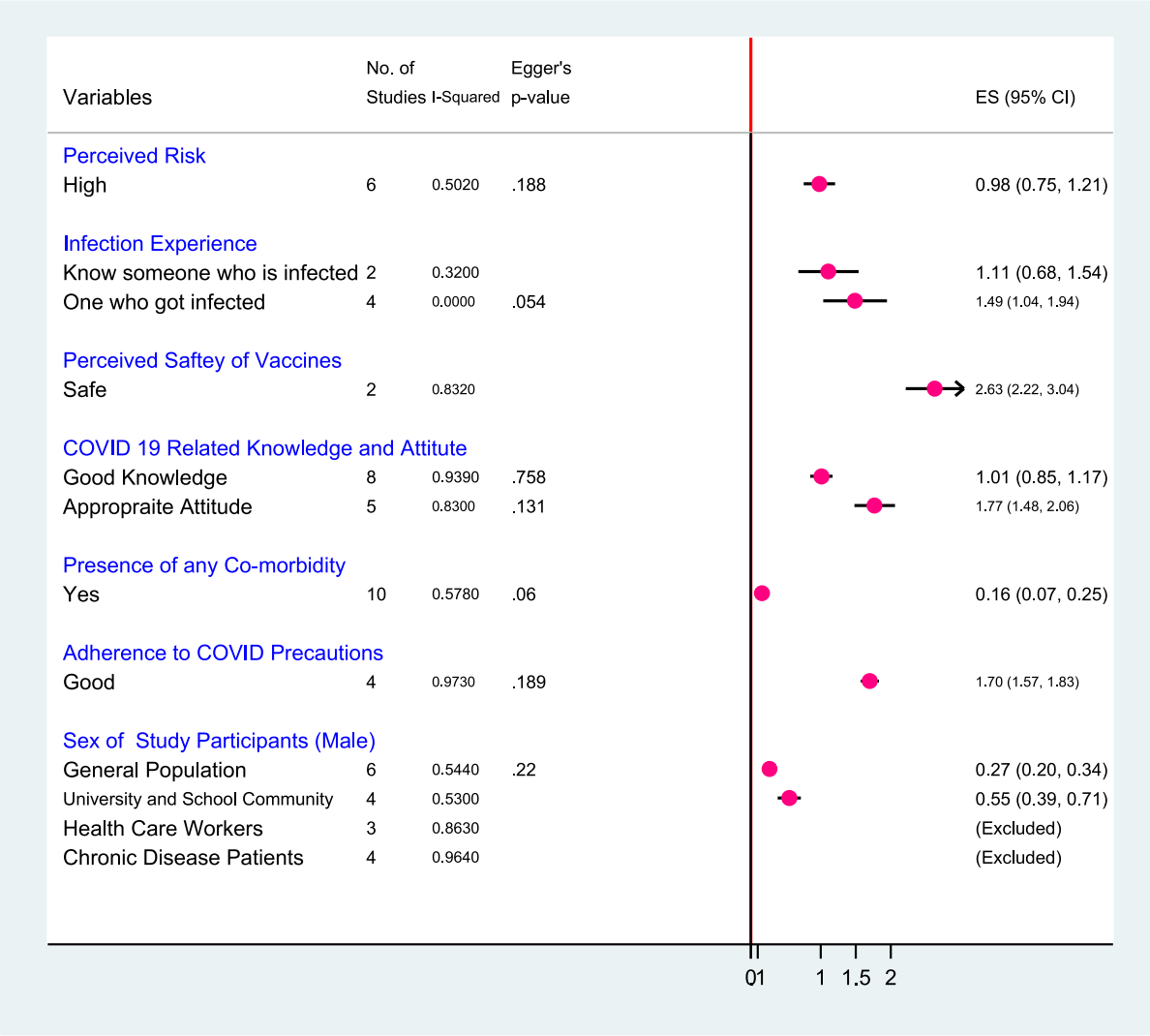

Fig. 3. A meta-analysis of factors associated with the COVID-19 vaccine acceptance in sub-Saharan African countries, 2020–2021.

Ten studies [21,26,30,34,36,38,44–46,51] ($I^2 = 57.8\%$, $p = 0.011$, Egger's $p = 0.06$), revealed that the presence of any comorbidity increases vaccine acceptance ((coff. (0.16 (0.07, 0.25))) [OR: 1.2, 95% CI: 1.1, 1.3]). On the other hand, six [23–25,27,36,38] ($I^2 = 54.4\%$, $p = 0.052$, Egger's $p = 0.22$) and four [19–21,31] ($I^2 = 53.0\%$, $p = 0.095$, Egger's $p = 0.22$) studies showed that being male sex increased vaccine acceptance among general population and University/School community respectively [Fig. 3].

4. Discussion

According to scientific estimates, depending on the vaccine efficacy and population heterogeneity, about 60–90% protected or immune population would be needed to break the alarming level of spread of the COVID-19 virus [7,54,55]. Thus, estimating the COVID-19 vaccine acceptance and identifying its determinants can be helpful for administrators and policymakers to plan intervention measures required to increase community awareness and ensure vaccine coverage, which in turn would help to control virus spread and reduce the negative impact of the disease [56,57].

In this review and meta-analysis, the COVID-19 vaccine acceptance rate in sub-Saharan African countries was considerably heterogeneous. In the region, a pooled prevalence of vaccine acceptance was 68% in aggregate and 63% among the general population, and 54% among healthcare workers. Though acceptance rates largely vary, irrespective of the surveyed population, the pooled vaccine acceptance rate of the eligible studies done early in 2020 (before midyear) and those included in this review was 78%. The acceptance rate has fallen to 54% in studies conducted in late 2020 (after midyear). Similarly, the pooled vaccine acceptance rate from studies conducted early in 2021 raised to 69% and dropped to 59% in studies done in late 2021. From this pattern, one can understand that early 2020 was the time World Health Organization declared COVID-19 a pandemic [2], and its devastating impact forced individuals to accept survival measures. People's cultural beliefs, trust in government, and actual observation of disease progression, as well as reported findings [58,59] of slow progress, might have altered an individual's attitude towards vaccination.

A pooled analysis of determinants of the COVID-19 vaccine acceptance identified that knowledge about the virus, its severity, and being infected or having relatives who were infected, were positively increased vaccine acceptance. It is acceptable that people who knew about the disease or had an infection experience would value their health. Those who believe nothing worth more than health; could accept interventions that improve their health [45,60]. Also, people's vaccine acceptance behavior could be affected by healthcare workers' knowledge and perception [61]. Healthcare workers' knowledge and confidence were found to be related to their level of education [61–63]. Which in turn is associated with vaccine confidence, and may contribute to higher vaccine acceptance, trust, and uptake [64,65].

An appropriate attitude about COVID-19 and a good level of compliance with its safety measures appears to be associated with vaccine acceptance. Attitude and compliance are mainly related to knowledge as evidenced by other findings [66]. Knowledge, predominantly of healthcare providers has a paramount impact in modeling the behavior of the general population [61]. Good adherence and attitude could also be linked with trust in institutions and government [67].

Besides, vaccine acceptance in this review was found affected by the sex of respondents. Males are more willing to accept the vaccine than females as a finding from similar studies [12,68,69]. Studies pointed out that males have relatively good health-seeing behavior [70,71], a lower belief in rumors, and a higher risk perception for the disease [72,73]; while females were reported to have adopted more negative views about vaccination [74]. In addition, health-related knowledge and treatment awareness coupled with socio-cultural factors such as beliefs and traditions are factors affecting African women's health seeing behavior in general [75].

Due to few articles reporting vaccine hesitance and uptake, this review and meta-analysis mainly focused on the acceptance of COVID-19 vaccine in sub-Saharan African countries. Some socio-demographic factors such as age, education, and income were not analyzed in this review for the reason of mismatching categories used to measure them among studies.

5. Conclusion

COVID-19 vaccine acceptance rate varied among studies in sub-Saharan African countries. The analysis revealed that modifiable and actionable factors played a significant role in determining vaccine acceptance.

Author contribution statement

All authors listed have significantly contributed to the development and the writing of this article.

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Data availability statement

Data included in article/supp. material/referenced in article.

Declaration of interest's statement

The authors declare no competing interests.

Abbreviations

DRC Democratic Republic of Congo
REA Random Effect Analysis

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e13037.

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