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Review Article

Assessment of Intention, Acceptance, and Hesitancy of COVID-19 Vaccination in Nigeria: A Systematic Review and Meta-Analysis

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Abstract

Background: The COVID-19 pandemic took a toll on nations and ravaged the economies of many countries, and Nigeria was not left out. An urgent need was to stem this tide by rolling out effective vaccines. The objectives of the research are to comprehensively assess COVID-19 vaccination intention, acceptance, and hesitancy in Nigeria by reviewing existing literature and conducting a meta-analysis, aiming to identify influencing factors, analyze regional disparities, and provide evidence-based recommendations for enhancing vaccination uptake. Through systematic synthesis and analysis, the research seeks to inform targeted interventions and policy decisions to address vaccine hesitancy and promote widespread COVID-19 immunization across diverse population groups in Nigeria.

Methods: A systematic review and meta-analysis of 42 studies published in Nigeria on COVID-19 vaccine intention, acceptance and hesitancy was conducted in ten databases and Grey literature between 1st January 2020 and 15th March 2022 (PROSPERO CRD42021291092).

Findings: We found that the pooled vaccine intention rate was 48.0% (95% CI 40.2 - 55.8) with a heterogeneity index of 98.8% ($p < 0.01$). The pooled vaccine acceptance rate was 47.7% (95% CI 26.3 - 69.1) with a heterogeneity index of 98.3% ($p < 0.01$). Gender, young age, occupation, tribe, and religion were found to be associated with the acceptance of the COVID-19 vaccine. The pooled vaccine hesitancy rate was 44.2% (95% CI 35.6 - 52.9) with a heterogeneity index of 98.5% ($p < 0.01$). Safety concerns, unreliability

of clinical trials, doubt about the efficacy and effectiveness of the vaccine, disbelief in COVID-19 and mistrust in government and manufacturing companies were associated with COVID-19 vaccine hesitancy.

Interpretation: This review showed a low pooled COVID-19 vaccine acceptance and a high pooled vaccine intention and hesitancy in Nigeria while highlighting factors associated with vaccine acceptance and hesitancy. This study will direct future public health efforts in this regard.

Keywords: COVID-19 Vaccine; Intention; Acceptance; Hesitancy; Nigeria

Introduction

The COVID-19 pandemic has significantly impacted global health, prompting the rapid development of effective vaccines. This unprecedented achievement highlights vaccines' crucial role in stimulating the immune system to prevent diseases. Historically, vaccines have proven to be powerful, cost-effective public health tools, exemplified by the eradication of smallpox and the dramatic reduction in measles deaths in Africa from 2000 to 2009 [1]. Despite their effectiveness, vaccine acceptance remains sub-optimal, particularly in resource-poor countries.

Vaccine acceptance and hesitancy are longstanding issues, influenced by various factors even before the advent of COVID-19 vaccines. Vaccine hesitancy, defined by the WHO as the delay or refusal to vaccinate despite availability [2], poses a significant threat to achieving herd immunity against infectious diseases like SARS-CoV-2. Factors contributing to hesitancy include risk perception, vaccine safety concerns, confidence in immunization programs, convenience, religious beliefs, and inadequate public health messaging.

In resource-rich countries like the USA, vaccine hesitancy is influenced by systemic racism, past unethical healthcare research, and underrepresentation of minorities in vaccine trials, fostering mistrust in vaccination programs [2]. Similar issues of mistrust and cultural insensitivity exist in the UK and Europe, compounded by socioeconomic factors and access barriers.

The success of vaccination programs relies on achieving a high acceptance rate to ensure herd immunity. Studies indicate that at least 80% of the population needs to be vaccinated to achieve sufficient herd immunity [2]. However, vaccine acceptance rates vary significantly across regions. For instance, Nigeria aimed to vaccinate 40% of its population by the end of 2021 but only achieved a 20% acceptance rate [3], lagging behind countries like Ethiopia (31.4%), Ghana (39.3%), DR Congo (55.9%), and Uganda (53.6%) [4].

The overall acceptance rate of the COVID-19 vaccine in Nigeria is 20%, indicating a relatively low uptake across the general population [4]. However, among healthcare workers in Nigeria, the acceptance rate is notably higher, suggesting a greater willingness among this group to receive the vaccine, likely due to their awareness of the importance of vaccination and their frontline exposure to the virus. There are also regional disparities in vaccine acceptance rates, with Kano and Edo states exhibiting significantly higher rates than the national average. In Kano state, the acceptance rate ranges between 32.5% [5], indicating a moderate level of acceptance. In contrast, in Edo state, it reaches as high as between 45.5% and 55.5% [5], indicating a substantially greater acceptance of the COVID-19 vaccine within this population. These findings suggest that factors influencing vaccine acceptance may vary across different segments of the population and geographical regions. Potential factors contributing to higher acceptance rates among healthcare workers include their understanding of the vaccine's efficacy, safety, and importance in controlling the spread of COVID-19. Additionally, factors such as access to accurate information, trust in healthcare systems, and cultural beliefs may influence vaccine acceptance rates differently in various regions of Nigeria. Understanding these variations in vaccine acceptance rates is crucial for designing targeted interventions and communication strategies to address vaccine hesitancy and promote widespread immunization against COVID-19. By tailoring approaches to specific populations and regions, public health authorities can work towards achieving higher vaccination coverage and ultimately mitigating the impact of the pandemic in Nigeria. The aim of this study was to conduct a rapid systematic assessment of the intention, acceptance and hesitancy of the COVID-19 vaccine in Nigeria to provide evidence-based strategies to improve uptake. The objectives of the study are: To systematically review existing literature on COVID-19 vaccination intention, acceptance, and hesitancy in Nigeria, to assess the factors influencing intention to receive COVID-19 vaccination in Nigeria, to evaluate the level of COVID-19 vaccine acceptance and hesitancy across various regions and population groups in Nigeria, to analyze the reasons behind COVID-19 vaccine hesitancy in Nigeria, to synthesize the findings through meta-analysis to estimate the overall prevalence of COVID-19 vaccine acceptance, hesitancy, and intention in Nigeria, and to provide evidence-based recommendations for policy-makers, healthcare providers, and public health practitioners to enhance COVID-19 vaccination uptake in Nigeria.

Materials and Methods

A systematic review including meta-analysis was performed and reported following the Preferred Reporting Items for System-

atic Reviews and Meta-Analyses (PRISMA) guidelines [6]. A review protocol was registered in PROSPERO (CRD42021291092).

Literature search

A comprehensive data base search was conducted in December, 2021 and updated 15th March, 2022 using the search terms: (vaccin*) AND (intent* OR willing* OR hesitan* OR accept* OR refus* OR attitude OR utili*) AND (COVID-19 OR COVID19 OR COVID OR SARS2 OR nCoV-2019 OR SARSCoV* OR SARS-COV-2 OR "Severe Acute Respiratory Syndrome Coronavirus*" OR coronavirus*). Databases included in the search were Academic Search Ultimate, CINAHL, Web of Science, Medline, PubMed, Hinari, Scopus, Direct Open Access Journal, African Index Medicus, African Journal online and Grey literature. Only articles published between 1st January, 2020 to 15th March,2022 were included. Reference harvesting and individual searches for author names were further carried out to identify further relevant articles.

A total of five independent authors were involved in article search. Article search was finalized on 15th March, 2022. Articles from the various databases were uploaded onto the Rayyan software by the authors. Duplicates were excluded prior to screening of titles and abstracts. The data extracted are available on request.

Study eligibility

Inclusion criteria were defined according to the populations, interventions, comparisons, outcomes and study type (PICOS) framework, a model adopted by the Cochrane Library to structure rigorous reviews on health-related questions. The inclusion and exclusion criteria were as follows.

Table 1: Inclusion and Exclusion Criteria.

Inclusion Criteria: Population	All ages, gender, and socioeconomic populations were included. Any studies conducted in Nigeria on COVID-19 vaccine acceptance and willingness were included
Intervention	COVID-19 vaccination
Comparator	None
Outcome of interest	Number of people willing to accept COVID-19 vaccine Risk factors associated with vaccine refusal Risk factors associated with vaccine acceptance COVID-19 vaccine acceptance rate
Study design	Cross-sectional studies

Data extraction, analysis and synthesis

An extraction form was prepared and downloaded for data extraction and synthesis. A total of six authors conducted data extraction and analysis. The information extracted from the articles included: Publication year, study design, funder, conflict of interest, date of collection, settings, state(s) from which data was/were collected, target population, total number of respondents, prevalence of intention to receive COVID-19 vaccine, prevalence of COVID-19 vaccine hesitancy, factors affecting intention to receive COVID-19 vaccine, factors affecting COVID-19 vaccine acceptance, factors affecting COVID-19 vaccine hesitancy, and percentage of those that had at least one dose of COVID-19 vaccine. The tabular presentation was well thought of and worked into such that it would make an appreciation of the intended aims and objectives very clear and succinct. This was followed by the descriptive analysis, narrative synthesis, and overall summary of the clinical and public health importance of the study. A meta-analysis was also conducted. Comprehensive Meta-Analysis software was used to calculate the pooled effect sizes. Inter-study heterogeneity was assessed with I^2 statistics and a random-effects model was used to combine the studies. Publication bias was assessed using Egger's test and funnel plots.

Quality assessment and study selection

The AXIS tool checklists were employed for cross sectional studies as a result of their high recommendation by research guides and broad scope on most relevant study designs [7]. Mixed method was used for Newcastle Ottawa Scale (NOS) that was used to grade all the studies into low (0-3), moderate (4-7), or high risk of bias (8-10). Three reviewers independently provided quality assessment of the articles at all stages. At the initial step, the three reviewers independently scanned through the titles and abstracts of the articles retrieved from the databases. The relevance of the studies was assessed, and the articles selected were further screened. After screening for eligibility, the remaining full texts were assessed for quality. For studies with unclear methods, the authors were contacted to seek clarification. The checklist assessed the aim, risk of bias, statistical methods, measurement of exposures/outcomes, and relevance, among other criteria. The overall sections ask: "Are the results valid?", "what are the results?" and "will the results help locally?". If the study failed to respond to these initial questions or a large flaw regarding a criterion was found, the study was rejected.

Results and Discussion

Results

A total of 1025 articles were retrieved from the data search. A total of 161 duplicates were found and deleted. After title and abstract screening, 57 articles were downloaded for full text screening. A total of 42 articles were included in the final analysis as shown in Figure 1.

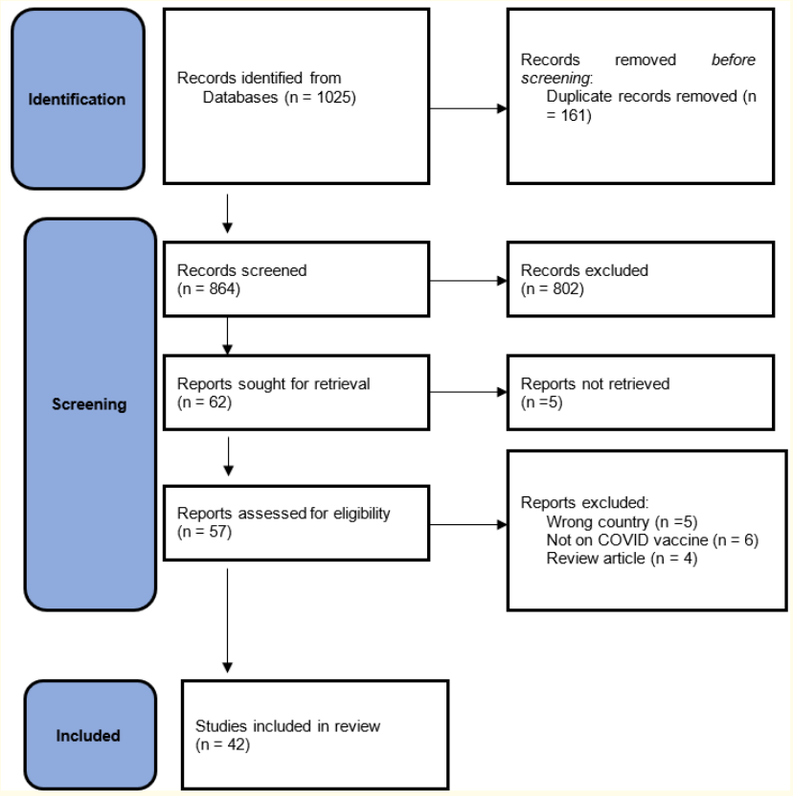


Figure 1: PRISMA flow diagram.

A total of 42 publications met the eligibility criteria and were included in this review. All the studies reviewed were cross sectional studies. Out of the 26 studies that provided data collection date, six were conducted in 2020, while 16 were conducted 2021. The target population for most of the studies was the general population (40%) and health care workers (29%). Other target population of the studies included mothers, employees of tertiary institutions, patients attending outpatients' department, university students, primary school teachers, patients with chronic illnesses, people living with HIV/AIDS that are 18 years or more and security personnel. The studies comprised cross sectional studies on COVID-19 vaccine acceptance, intention and hesitancy from all the states in the country. COVID-19 intention rate was reported in 35 studies. COVID-19 hesitancy rate was reported in 21 studies, while the actual COVID -19 vaccination rate was reported in only five studies. Factors affecting COVID-19 vaccine intention, acceptance and hesitancy were reported in 13, 16 and 20 studies respectively. More than half of the studies (57%) had a sample size of less than 500 respondents, 24% had a sample size of more than 500 but less than 1000, while the remaining studies had a sample size more than 1000, but one of the studies had a large sample size of 11,732. The studies were done most commonly in single states (50%). One-third of the studies (33%) were conducted nationwide and only one study (2·4%) sampled participants from 34 states. Also, one (2·4%) study each studied participants from three states and four states while four of the reviewed studies had participants from two states as shown in Table 2.

Table 2: Studies according to the number of states where participants were sampled.

S/N	States	Number of studies	Frequency
	Nationwide	14	33·3%
	34 states	1	2·4%
	Single states	21	50·0%
	Two states	4	9·5%
	Three states	1	2·4%
	Four states	1	2·4%

Stratified by Nigeria's six geopolitical zones, there were no studies from the North East, while about one-third (35·7%) of the studies sampled participants from across the country. The studies with participants from across the six geopolitical zones were 15. Of the rest, two studies (4·8%) cut across two geopolitical zones; the study by Adejumo., *et al*. was conducted among participants in Ondo State (South-West) and Delta State (South-South) [8] and that of Jimoh., *et al*. conducted in Kwara State (North-Central) and Ogun State (South-West) [9]. Others had participants from only one geopolitical zone as shown in Table 3.

Table 3: Studies according to the Geopolitical Zone where they were conducted.

S/N	Geopolitical Zones	Number of Studies	Frequency (%)
	North Central	4	9·5%
	North East	0	0·0%
	North West	6	14·3%
	South West	5	11·9%
	South East	7	16·7%
	Two zones	2	4·8%
	All the zones	15	35·7%

Table 4 shows all the studies included in the review that reported rates of intention to receive COVID-19 vaccine. The lowest COVID-19 vaccine intention rate was 6·9%, recorded in Ebonyi and Enugu states, South-East Nigeria in 2021 [10], while the highest COVID-19 vaccine intention rate was 81·3% in a study conducted among general population at the Federal Capital Territory Abuja in 2021 [11]. The pooled vaccine intention rate was 48·0% (95% CI 40·2 - 55·8) with a heterogeneity index (I^2) of 98·8% ($p < 0·01$) (Figure 2a), which confirms a substantial heterogeneity across studies. The Egger's regression test was statistically significant ($p = 0·001$). Therefore, there is an evidence of publication bias, as supported by the funnel plot (Figure 2b).

Table 4: COVID-19 vaccine intention rate.

S No.	Study	States(s)	Date of survey	Setting	Target population	Sample size	Vaccine intention rate (%)
1	Adigwe [15]	FCT	Jan-21	Online and physical survey	General population	1767	22·70
2	Okafor., *et al.* [16]	Nationwide	Not available	Online	General population	689	43·30
3	Chinawa., *et al.* [10]	Ebonyi and Enugu	Not available	Hospital	Mothers	577	6·90
4	Dozie., *et al.* [17]	Imo	Not available	Community	General population	436	26·00
5	Udejinta [18]	Oyo	Not available	School	Employees of tertiary institutions	325	14·50
6	Anjorin., *et al.* [19]	Nationwide	Feb - Mar 2021	Online	General population	386	66·00
7	Nri-Ezedia [20]	34 states	Jan-21	Online	Doctors	831	38·80
8	Allagoa., *et al.* [21]	Bayelsa	Jan - Feb 2021	Hospital	Patients attending OPD	1000	24·60
9	Adebisi., *et al.* [22]	Nationwide	Aug-20	Online	General population	517	74·50
10	Obafemi., *et al.* [11]	FCT	Not available	Community	General population	1200	81·30
11	Robinson., *et al.* [23]	Nationwide	Dec 20 - Jan 21	Online	Healthcare workers	1094	32·52
12	Adejumo., *et al.* [8]	Ondo and Delta	Not available	Hospital	Healthcare workers	1470	55·50
13	Iliyasu., *et al.* 24]	Kano	Not available	Community	General population	446	51·10
14	Eze., *et al.* [25]	Nationwide	Nov 2020 - Jan 2021	Community	General population	358	66·20
15	Iliyasu., *et al.* [26]	Kano	Not available	Hospital	PLHIV ≥18 years old	344	46·20
16	Adaranijo., *et al.* [27]	Nasarawa	Not available	Community	General population	385	35·60
17	Uzochukwu., *et al.* [28]	Anambra	Jan - Feb 2021	Online	University Staff and students	349	34·70
18	Adetayo., *et al.* [29]	Osun and Ogun	Not available	Online	University students	521	54·90
19	Ejeh., *et al.* [30]	Nationwide	Mar to Dec 2021	Online	Adults	402	65·67
20	Ibrahim., *et al.* [31]	Jigawa	Aug to Sept 2021	School based	primary school teachers	220	25·50
21	Adedeji-Adenola., *et al.* [32]	Nationwide	April to June 2021	Online	Adult	1058	80·90
22	Ijioma., *et al.* [33]	Imo	May and Jun 2021	School based	Students and staff	304	36·00

23	Ojewale., *et al.* [34]	Oyo	Mar and Apr 2021	Hospital	people living with chronic health conditions	423	46·60
24	Ilori., *et al.* [35]	Nationwide	23rd Mar to 3rd May 2021	Online	Health care workers	309	80·30
25	Jimoh., *et al.* [9]	Ogun and Kwara	Not available	Hospital	Health care workers	115	59·10
26	Tobin., *et al.* [36]	Nationwide	Jun to Aug 2020	Online	General population	1228	50·20
27	Agbo., *et al.* [37]	Plateau	Not available	School based	Nursing students and medical students	315	28·90
28	Ukwenya., *et al.* [38]	Ondo	1st to 9th Oct 2020	Community	General population	691	74·80
29	Olomofe., *et al.* [39]	Nationwide	Not available	Online	General population	451.6	58·20
30	Akinyemi., *et al.* [40]	Osun	Aug to Sept 2020	Community	General population	744	59·10
31	Ekwebene., *et al.* [41]	Nationwide	Not available	Online	Healthcare providers	445	53·50

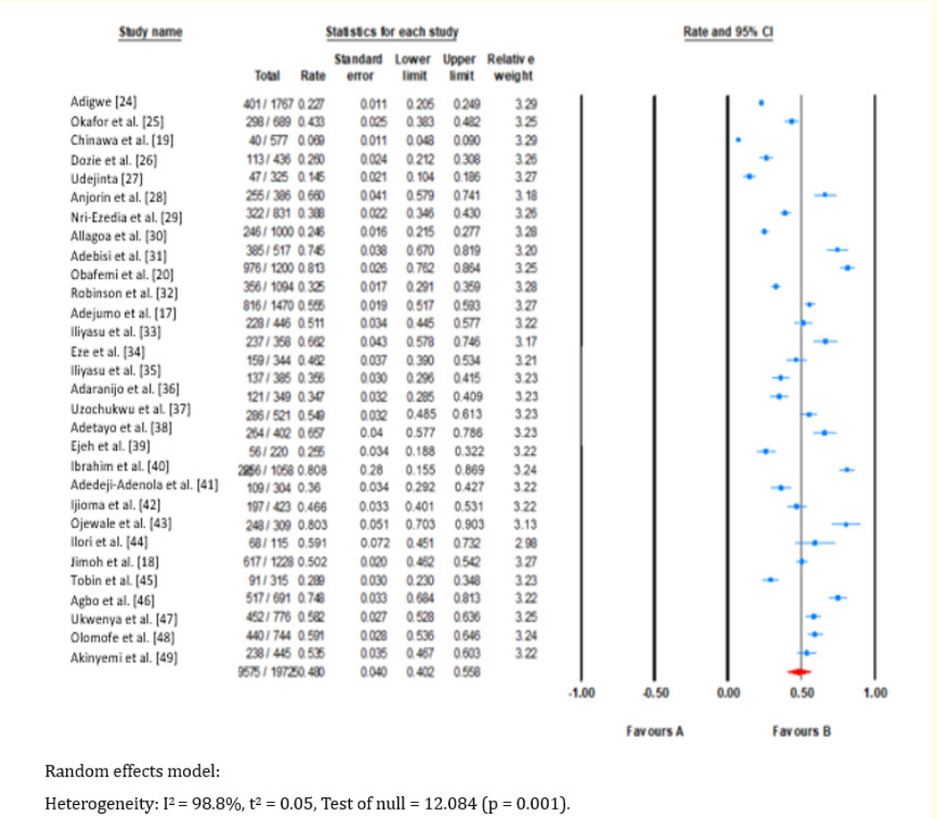


Figure 2a: Forest plot of the pooled vaccine intention rate.

Only five out of the forty-one studies reviewed reported COVID-19 acceptance rates as shown in Table 5. The lowest acceptance rate was 27·4% in a study done at Bayelsa in 2021 [12], while the highest acceptance rate of 50·2% was noted in a study done in Edo state in 2021 [13]. One out of the five studies, which was conducted among health workers reported acceptance rate of first dose of COVID-19 vaccine as 90% in Katsina state [14]. The pooled vaccine acceptance rate was 47·7% (95% CI 26·3 - 69·1) with a heterogeneity index (I^2) of 98.3% (p < 0·01) as shown in Figure 3a this confirms a substantial heterogeneity across studies. The Egger's regression test was not statistically significant (p = 0·774). Therefore, there was no evidence of publication bias, as supported by the funnel plot as shown in Figure 3b.

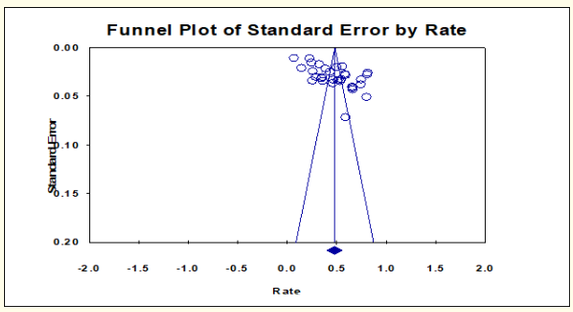
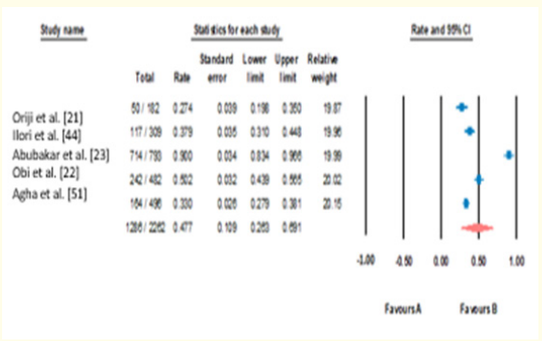


Figure 2b: Bias assessment of funnel plot of studies reporting vaccine intention.



Random effects model
Heterogeneity: I2= 98.3%, t2= 0.05, test of null = 4.362 (p – 0.001).

Figure 3a: Forest plot of the pooled vaccine acceptance rate.

Table 5: COVID-19 vaccine acceptance rate.

S No.	Study	States(s)	Date of survey	Setting	Target population	Sample size	Acceptance rate (%)
1	Agha., *et al.* [42]	Nation wide	Jul 2021	Online	Healthcare workers	496	33·00
2	Ilori., *et al.* [35]	Nation Wide	Mar to May 2021	Online	Health care workers	309	37·90
3	Oriji., *et al.* [12]	Bayelsa	Apr 2021	Hospital	Health Workers (other than Doctors)	182	27·40
4	Ifeanyichukwu Obi., *et al.* [13]	Edo	Feb to May 2021	Community	Security personnel	482	50·20
5	Abubakar., *et al.* [14]	Katsina	May 2021	Online	Health care workers	793	90% had 1st dose

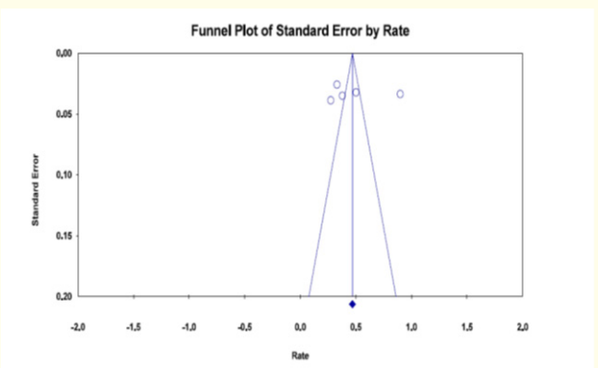


Figure 3b: Bias assessment of funnel plot of studies reporting vaccine acceptance.

Seventeen articles out of the papers reviewed reported on the factors that affect acceptability of COVID-19 vaccine by the various groups studied as shown in Table 6. Factors associated with COVID-19 vaccine acceptability include age, gender, geographic location, contact with COVID-19 positive patient, loss of a relative to COVID-19, perceived contagiousness of COVID-19, perceived threat to life, trust in government, willingness to pay, believe in the efficacy of the vaccine, religion, safety of the vaccine, level of education, occupation, tribe, presence of illness, presence of some of the symptoms of COVID-19, and a good knowledge of COVID-19.

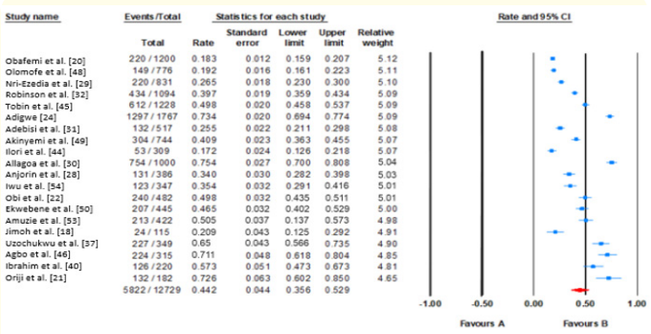
Age was found to be a significant factor in accepting COVID-19 [9,14,20,22,36-38,42]. Participants within the age of 24 and 39 years have higher odds of accepting COVID-19 in 4 studies [14,36,37,43] while in a study conducted in Ondo state participants aged 40 years and above were more likely to accept COVID-19 vaccine [38]. Male gender was found to be significantly associated with COVID 19 vaccine acceptability [20,21,37,39]. Agha., *et al.* in a study amongst health care workers found that level of education was a significant predictor of COVID-19 vaccine acceptance [42]. The result of the review also showed that occupation was a predictor of COVID-19 vaccine acceptance. Healthcare workers and security personnel were more likely to accept COVID-19 vaccine [13,21,35,41,42]. One of the studies reviewed compared acceptability of COVID-19 vaccine among various tribes and found that Igbo and other tribes were 3.962 and 3.631 times more likely, respectively, to accept the COVID-19 vaccine, than the Yoruba tribe [35]. Tobin., *et al.* also found that Muslims were 1.57 times more likely to accept COVID-19 vaccine in the population studied [36]. Good knowledge of COVID-19, belief that is beneficial [39,40,42] perceived contagiousness of the virus, and perceived threat to life [20,35] were also associated with COVID-19 vaccine acceptance.

Other factors associated with COVID-19 vaccine acceptance are presence of preexisting illness or chronic illness [21,38], testing positive for COVID-19 [12,21], loss of smell and taste [21], loss of a relative to COVID-19, [12,21] contact with COVID-19 patient [12] geographic location [22], belief in efficacy of COVID-19 vaccine [9], willingness to pay for the vaccine [43], trust in government [43], and belief that COVID-19 vaccine is safe [15,41].

S No	Study	Target population	Factors affecting acceptance
1	Adigwe [15]	General population	69·1% believe that COVID-19 vaccine is safe and 76·2% believe the benefit of the vaccine outweighs the risk
2	Agha., *et al*. [42]	Healthcare workers	69·0% consider COVID-19 vaccine very important for their health. Level of education, type of healthcare worker and motivation and ability are significant predictors of COVID-19 vaccine acceptance.
3	Nri-Ezedi [20]	Doctors	Age (OR = 0·88; CI: 0·82 - 0·96; p = 0·002), Male gender (OR = 3·36; CI: 2·01-5·61; p = 0·001), perceived contagiousness of the virus (OR = 1·19; CI: 1·01-1·33; p = 0·001),and perceived threat to life (OR = 1·3; CI: 1·2-1·4; p = 0·001)
4	Allagoa., *et al*. [21]	Patients attending OPD	Male gender (OR = 2·34; Cl 1·74 - 3·14; p = 0·001), Occupation - Health workers (OR = 5·02; Cl 2·39 - 10·51; p = 0·001), Security (OR = 7·26; Cl 3·01 - 17·49; p = 0·001), Agric (OR = 3·88, Cl 1·72 - 8·74; p = 0·001) Other significant predictors include presence of chronic illness (2·51), testing positive for COVID 19 (OR = 2·27), loss of taste and smell (OR = 2·96)and loss of a relative to COVID 19 (OR = 3·27)
5	Adebisi., *et al*. [22]	General population	age ($\chi 2$ = 19·04, P = 0·001) and geographical location ($\chi 2$ = 12·01, p = 0·02)
6	Mustapha., *et al*. [43]	University students	Age of 25 years and above (aOR, 2·72; 95% CI, 1·44-5·16; p = 0·002), instructions from heads of institutions (aOR, 11·71; 95% CI, 5·91-23·20; p<0·001), trust in the government (aOR, 20·52; 95% CI, 8·18-51·51; p<0·001) and willingness to pay for the vaccine (aOR, 7·92; 95% CI, 2·63-23·85; p<0·001)
7	Abubakar., *et al*. [14]	Health care workers	Age 30-39yrs AOR 7·06 (2·36, 21·07), COVID-19 testing status AOR 7·64 (3·62, 16·16), Type of health facility AOR 2·91 (1·17, 6·11)
8	Ilori., *et al*. [35]	Nationwide	Previous involvement in the care of COVID-19 patients, tribe, cadre, CHEWs had good acceptability, Lab Scientists had poor acceptability. The Igbo and other tribes are 3·962 and 3·631 times more likely, respectively, to accept the COVID-19 vaccine, than the Yoruba tribe. When compared to Doctors, CHEWS are 0·048 times less likely to accept COVID-19 vaccination. Participants who have been involved in the care of a COVID-19 patient
9	Jimoh., *et al*. [9]	Health care workers	Younger age of the respondents, cadre with admin having the highest acceptability followed by Lab scientist and Pharmacists had the lowest acceptability. Increased efficacy of the vaccine.
10	Tobin., *et al*. [36]	General population	Respondents who were 25-34 years were 1·66times likely to accept a COVID-19 vaccine with acceptability increasing with advancing age. Moslems were 1·57 times more likely to accept than Christians. Females were 0·77 times likely to accept compared to males. Self-employed respondents were 0·68 times likely to accept with government workers. Willingness to travel for vaccine, Willingness to pay for vaccine, having ever received vaccine during an outbreak and trust in the government and other public health
11	Agbo., *et al*. [37]	Nursing students and medical students	Being a medical student; being in 500l and 600l of medical school, not having had a clinical rotation in the year preceding the study, being males, being older than 24 years
12	Ukwenya., *et al*. [38]	General population	older age of the respondents 40 years and above, having pre-existing illness, Lower average monthly income (OR = 2·031, (95%CI = 1·117-3·694)
13	Olomofe., *et al*. [39]	General population 18years and above	Male gender and 'perception that vaccines generally are good' were predictors. Previous history of vaccination and knowledge of COVID-19 were also shown to have a statistically significant association with willingness to receive the vaccine.
14	Akinyemi., *et al*. [40]	General population 18years and above	Positive perception, Being a healthcare worker, having good knowledge of the disease, willingness-to-pay for the vaccine,

Twenty out of the 41 studies reviewed reported COVID-19 vaccine hesitancy rate. The lowest COVID-19 vaccine hesitancy rate (17·2%) was observed in a study done Nationwide in 2020 [35] while the highest Covid-19 vaccine hesitancy rate of 75·4% was documented in a study done at Bayelsa in 2021 [21]. The pooled vaccine hesitancy rate was 44·2% (95% CI 35·6 - 52·9) with a heterogeneity index (I2) of 98·5% (p < 0·01) as shown in Figure 4a, which confirms a substantial heterogeneity across studies. The Egger's regression test was not statistically significant (p = 0·016). Therefore, there is an evidence of publication bias, as supported by the funnel plot in Figure 4b. Twenty-one studies reported factors that affect COVID-19 vaccine hesitancy as shown in Table 7. Factors associated with COVID-19 vaccine hesitancy included age, [44] safety concerns, [12,22,23,26,41,42] unreliability of clinical trials, [12,22,37] doubt on efficacy and effectiveness of the vaccine, [23,28,37] fear of side effect, [9,12,15,23,27,28,36,37,40,41,

45] lack of confidence in the vaccine, [8] belief that the risk of getting COVID-19 is low, [15,24] disbelief in the existence of COVID-19, [15,24,26] mistrust in government and manufacturing companies, [12,24,26,45] cultural and religious disapproval [27,41]. Other factors include belief that immune status can combat the virus, [22] fear and dislike of injection, [11] infertility related myth, [26,27] electronic implant myth, [27] anti-vaccine message in social media, [33] and history of previous COVID-19 infection [45]. Non health-care workers, participants with high income and females were less likely to accept vaccine [30,45]. With respect to age, 4·8% of the studies showed that age is a significant factor associated with vaccine acceptance, with 2·4 % of the studies showing vaccine hesitancy in the younger age group (20 - 29) more than in the older age group (>50), 2·4% showed that the younger age group between 18 - 34 years were willing to receive a COVID-19 vaccine but the middle-age group between 45 - 54 years were unwilling to be vaccinated [12].



Random effects model
Heterogeneity: I^2 = 98.5%, t^2 = 0.04,
Test of null = 10.028 (p = 0.001).

Figure 4a: Forest plot of the pooled vaccine hesitancy rate.

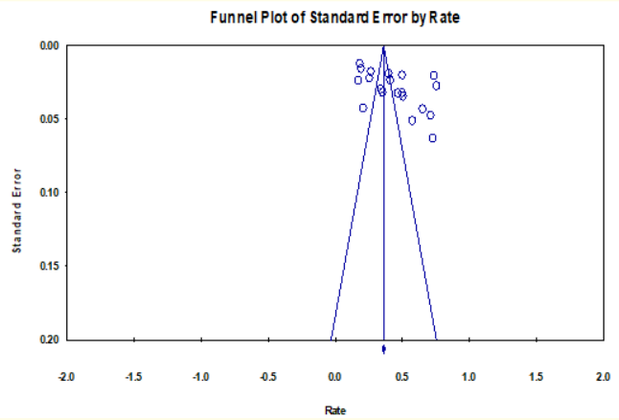


Figure 4b: Bias assessment of funnel plot of studies reporting vaccine hesitancy.

Table 7: Factors affecting COVID-19 vaccine hesitancy.

S No.	Study	Target population	Acceptance rate (%)	Factors affecting hesitancy
1	Adigwe [15]	General population	73·40	Worried about side effect 52·9%, risk of getting COVID-19 is low 8%, against vaccine in general 6·5%, do not believe COVID-19 exist 6%
2	Nri-Ezedia [20]	Doctors	26·50	Safety concerns 50%
3	Amuzie., *et al.* [44]	Health-care workers	50·50	Younger age (aOR = 9·34, 95%CI:2·01-43·39), marital status (single) (aOR = 4·97,95%CI:1·46-16·97), lower income (aOR = 2·84, 95%CI:1·32-6·08), and profession - Doctor (aOR = 0·28,95%CI:0·11-0·70), Nurse (aOR = 0·31, 95%CI:0·15-0·64) and other allied health professionals (aOR = 0·22, 95%CI:0·10-0·44)
4	Adebisi., *et al.* [22]	General population	25·50	Unreliability of the clinical trials (37·1%); belief that their immune system is sufficient to combat the virus (27·3%).
5	Obafemi., *et al.* [11]	General population	18·30	lack of confidence in the vaccine, belief in God for COVID-19 virus safety, and fear and dislike of injectable drugs
6	Robinson., *et al.* [23]	Health-care workers	39·68	concerns of effectiveness, side effects, fear of the unknown, and safety.
7	Uzochukwu., *et al.* [28]	University Staff and students	65·04	Uncertainty about the vaccine's efficacy 34·34%, Safety concern 9·17%, disbelief over the existence of COVID-19 in Nigeria 12·89%,
8	Iwu., *et al.* [45]	Health care workers	35·40	Pentecostal faith (aOR: 2·52, 1·113-5·701, p = 0·027), males (aOR: 2·72), respondents who felt there was enough information about the vaccine and its safety (aOR: 2·77, 1·033-7·419, p ≤ 0·05), do not trust the government (aOR: 2·69).

9	Jimoh., *et al.* [9]	Health care workers	20·90	Presence of side effects
10	Tobin., *et al.* [36]	General population	49·80	Potential side effects
11	Agbo., *et al.* [37]	Nursing students and medical students	71·10	Lack of trust for a COVID-19 vaccine bothering on its efficacy, safety profile, adverse effects, and rapidity of development and testing
12	Agha., *et al.* [42]	Healthcare workers	Not available	Only 32% who find it very easy to get a COVID-19 vaccination for themselves
13	Iliyasu., *et al.* [24]	General population	Not available	Doubts about the existence of COVID-19, mistrust for authorities, and popular credence to rumors and conspiracy theories
14	Iliyasu., *et al.* [26]	PLHIV ≥18 years old	Not available	Doubts about the existence of COVID-19, low-risk perception, anxiety about antiretroviral treatment, vaccine interactions, safety concerns, and infertility-related rumors.
15	Adaranijo., *et al.* [27]	General population	Not available	I do not trust the intent of the vaccine 21·6%, It may have serious side effects 19·5%, I do not trust the Nigerian government 15·3%, It may kill me 15%, It is against my religious beliefs 12·3%, It may be a way of population control 9.5% and It may not be a vaccine but an electronic implant 6·6%
16	Ejeh., *et al.* [30]	Adults	Not available	Non-healthcare workers (OR = 0·300; 95% C.I = 0·137-0·658), high income (OR = 0·075; 95% C.I = 0·019-0·294) and higher educational status ($\chi 2 = 23·220$; $p < 0·001$) were unwilling to accept COVID-19 vaccines.
17	Adedeji-Adenola., *et al.* [32]	Adult	Not available	Those without a prior diagnosis of COVID-19 had a lower willingness to get vaccinated (aOR = 0·210 (95% CI: 0·082-0·536; P = 0·001).
18	Ijioma., *et al.* [33]	Students and staff	Not available	Social Media Facilitating Spread of Anti-Vaccination Messages
19	Akinyemi., *et al.* [40]	General population	40·90	Presence of misconception, out of pocket payment and presence of side effects
20	Oriji., *et al.* [12]	Health Workers (other than Doctors)	72·60	They wanted to see what would happen to those who received the vaccine (70·5%); Others felt the vaccine has not gone through enough clinical trials (62·1%), it would be associated with side effects (60·6%) and it is unsafe (47·7%), Lack of trust in government and manufacturers of the vaccine, it contains the 'mark of the beast', Believe that there are other alternative drugs for COVID-19.
21	Ekwebene., *et al.* [41]	Healthcare providers	46·50	Fear of side effects, vaccine unsafe, cultural disapproval

Discussion

Our review was conducted to find the factors affecting the intention to receive COVID-19 vaccine in Nigeria, the prevalence of COVID-19 vaccine acceptance in Nigeria, factors affecting acceptance and those affecting hesitancy in Nigeria. All the studies reviewed were cross-sectional, mostly conducted in one state, with a third conducted in all the country's states. There were no studies from the North East geopolitical zone of the country. Most of the studies sampled participants from the general population, and about one-third reported data from healthcare workers. From the review, we found that pooled vaccine intention rate, acceptance rate and hesitancy rate were 48·0% with a range of 6·9% to 81·3%, 47·7% with a range of 27·4% to 50·2% and 17·2% with a range of 17·2% to 75·4% respectively.

The pooled vaccine acceptance rate of 47·7% agrees with the findings from previous reviews. Wake reported a pooled prevalence of acceptance toward the COVID-19 vaccine of 48·93% among adults in Africa, similar to our finding [5]. Of the 22 studies reviewed by Wake, six were from West Africa countries and five were from Nigeria [11]. However, our finding was lower than the overall mean acceptance rate of 87.6% (86·4% to 88·8%) reported by Kanyanda., *et al.* from their review of six countries in Sub-Saharan Africa representing 38·0% of the Sub-Saharan population [46].

They reported a nearly universal vaccine acceptance in Ethiopia at 97·9% (95% CI 97·2% to 98·6%) and very high acceptance in Nigeria (86·2%, CI 83·9% to 88·5%), Uganda (84·5%, CI 82·2% to 86·8%), Malawi (82·7%, CI 80·0% to 85·4%), and Burkina Faso (79·5%, CI 76·9% to 82·1%) [46]. The differences in the prevalence rates could be attributed to various reasons. The acceptance rate reported in this current study is a pooled vaccine acceptance rate, unlike the acceptance rate from Kanyanda., *et al*. [46] Also, they analysed responses across the country, from national high-frequency phone surveys with the selection process of respondents not being randomised. As such, the respondents may not represent the general population of adults at the individual level. Their respondents were household heads or spouses of the household heads, tended to be better educated, of higher socioeconomic status, and slightly older than the general population, which may have contributed to the higher acceptance rate reported in the study. In addition, the data collection was in the year 2020 unlike the studies in our review where the dates of survey, where available, were more recent and ranged from January 2021 to December 2021 with only three studies having their data collected in the year 2020.

While a safe and effective vaccine is critical to controlling the COVID-19 pandemic, ensuring widespread acceptance is just as crucial to achieving sufficient herd immunity to end the pandemic. The vaccine acceptance rate of 47·7% obtained in this review is below the recommended 70% to 85% vaccination percentage required for herd immunity during the COVID-19 pandemic [47]. Thus, understanding the drivers of vaccine acceptance and hesitancy becomes paramount so that attention can be focused on promoting the factors associated with vaccine acceptability while working to reduce those factors likely to reduce acceptability or increase hesitancy.

Younger age, male gender, geographic location, contact with a COVID-19 positive patient, perceived contagiousness of the virus, perceived threat to life, trust in government, willingness to believe in the efficacy of the vaccine, religion, safety of the vaccine, level of education, occupation, tribe, presence of illness, presence of some of the symptoms, loss of relative to the pandemic, and good knowledge of the virus were associated with vaccine acceptability. Other factors were the presence of preexisting illness or chronic illness, testing positive for the virus, loss of smell and taste, willingness to pay for the vaccine, and belief that the vaccine is safe. Factors associated with COVID-19 vaccine hesitancy included older age, safety concerns, the unreliability of clinical trials, doubt about the efficacy and effectiveness of the vaccine, fear of side effects, lack of confidence in the vaccine, the belief that the risk of getting COVID-19 is low, disbelief in the existence of COVID-19, mistrust in government and manufacturing companies, cultural and religious disapproval. Other factors included the belief that immune status can combat the virus, fear and dislike of injection, infertility-related myth, electronic implant myth, anti-vaccine messages in social media, and history of previous COVID-19 infection. Non-healthcare workers, participants with high income, and females were also less likely to accept the vaccine.

Of note, we found higher vaccine acceptance among men than women and younger participants (40 years and below) in our review, in contrast to some reports [48]. The myth of the vaccine capable of causing infertility may also be a contributory factor to the low vaccine acceptance among females. Researchers have reported that the relationship between vaccine acceptance and gender varies depending on the country, among other variables. For instance, Lazarus., *et al*. found that women in France, Germany, Russia, and Sweden were significantly more likely to accept a vaccine than men [48]. Similarly, this trend is also reflected in their study's relationship between age and vaccine acceptability. They found that while older individuals (≥50 years) in Canada, Poland, France, Germany, Sweden, and the UK were significantly more favourably disposed to vaccination than younger respondents, the reverse trend held in China [48].

Additionally, we found that health workers were more willing to accept the vaccine than other occupational types, similar to reports from other studies [32]. This is an important positive finding that can be incorporated into improving vaccine acceptability. Participants who had prior COVID-19 diagnosis had higher vaccine acceptance rates. This is similar to findings from the study by Adedeji-Adenola., *et al*. [32]. On the contrary, some reports stated that persons with a previous diagnosis of COVID-19 were less likely to be vaccinated than those who have not previously had COVID-19 [44]. The finding in our review could be because participants with prior infection would be more likely to take the vaccines for self-protection and group protection, particularly if the experience of being infected conflicted with their previous scepticism of the pandemic being a hoax and or a conspiracy.

The positive association between higher levels of education and vaccine acceptance in our study is consistent with findings from similar studies on determinants of vaccine acceptability [49]. People who are more educated are more likely to view the vaccine as safe, with less likelihood of serious side effects and more effective than those with less education [49]. This is important as existing literature cites concerns about the safety of the vaccines as one of the major reasons for vaccine hesitancy, similar to findings from our review. Therefore, educated people in the community can be targeted as resource persons to improve vaccine acceptability.

Limitations of the Study

Our review is not without limitations. The meta-analyses had considerable heterogeneity, and this might have affected the results. Moreover, no study was included from the north-east geopolitical zone of Nigeria and this may have a significant impact on the generalizability of the findings of this study. Also, the perceived

vaccine acceptance, intention and hesitancy rates in the included studies may be different from the actual rates in reality. Therefore, interpretations made with the findings should be cautious.

Conclusion

The findings of this systematic review and meta-analysis demonstrated a low pooled COVID-19 vaccine acceptance and a high pooled vaccine intention and hesitancy in Nigeria while highlighting factors associated with vaccine acceptance and hesitancy. Bearing these findings in mind, there is need to upgrade the vaccine acceptance rate by concentrating on the drivers of vaccine hesitancy. This way, healthcare interventions and resources are properly utilized and cost-effectiveness optimized. Subsequent reviews should focus on vaccine uptake and completion rates in Nigeria.

Conclusion should reflect and elucidate how the results correspond to the study presented and provide a concise explanation of the allegation of the findings.

Conflict of Interest

The authors declare no conflict of interest.

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