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COVID-19 vaccination acceptance among community members and health workers in Ebonyi state, Nigeria: study protocol for a concurrent-independent mixed method analyses of intention to receive, timeliness of the intention to receive, uptake and hesitancy to COVID-19 vaccination and the determinants

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ABSTRACT

Introduction The COVID-19 pandemic has gravely affected the lives and economies of the global population including Nigeria. The attainment of herd immunity through mass COVID-19 vaccination is the foremost control strategy, however, the deployments of COVID-19 vaccinations are facing challenges of non-acceptance. Despite the efforts of the Nigerian government and COVAX facility in making COVID-19 vaccination more available/accessible, the vaccination rate remains unexpectedly very low in Nigeria/Ebonyi state. Therefore, it is important to investigate the acceptability of COVID-19 vaccination to elucidate the explanations for the very low coverage rate. This study aims to evaluate/explore COVID-19 vaccination acceptance and the determinants among community members and health workers in Ebonyi state, Nigeria.

Methods and analyses The study is an analytical cross-sectional survey with a concurrent-independent mixed method design. Quantitative data will be collected from all consenting/assenting community members aged 15 years and above, in 28 randomly selected geographical clusters, through structured interviewer-administered questionnaire household survey using KoBoCollect installed in android devices. Quantitative data will be collected from all consenting health workers, selected via convenience and snowball techniques, through structured self-administered questionnaire survey distributed via WhatsApp and interviewer-administered survey using KoBoCollect installed in android devices. Qualitative data will be collected from purposively selected community members and health workers through focus group discussions. Quantitative analyses will involve descriptive statistics, generalised estimating equations (for community members data) and generalised linear model (for health workers data). Qualitative analyses will employ the thematic approach.

Ethics and dissemination Ethical approval for this study was obtained from the Ebonyi State Health Research and Ethics Committee (EBSHREC/15/01/2022–02/01/2023) and Research and Ethics Committee of Alex Ekwueme Federal University Teaching Hospital Abakaliki (14/12/2021–17/02/2022), and verbal consent will be obtained from participants. Study findings will be reported at local, national and international levels as appropriate.
Trial registration number ISRCTN16735844.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Our study will be the first geographical community-based study, using mixed method approach, to investigate COVID-19 vaccination acceptance (the intention to receive, timeliness of the intention to receive, uptake and hesitancy) in the context where there is very low vaccination rate despite relative vaccine availability and public access to vaccination.

⇒ The study will be implemented after prospective registration with ISRCTN and based on available/accessible or disseminated protocol.

⇒ The study is prone to reporting bias due to the questionnaire-based data collection method. The convenience and snowballing sampling will make the health worker survey prone to selection bias.

INTRODUCTION

COVID-19, a severe acute respiratory syndrome disease caused by SARS-CoV-2,

emerged by the end of 2019 and became a pandemic. By 7 August 2022, the COVID-19 pandemic had affected more than 581 million persons and had resulted in the death of over 6.4 million persons globally with more than 9.2 million cases and over 174 000 deaths in Africa.[1] By 10 August 2022, the total number of recorded confirmed cases of COVID-19 and COVID-19-related deaths were, respectively, 262 402 and 3147 in Nigeria and 2064 and 32 in Ebonyi state.[2] The pandemic has overstretched the capacity of many countries' healthcare delivery and disrupted the global economy due to lockdown measures.[3–7]

Among the available control measures, perhaps the most cost-effective and sustainable control strategy is mass COVID-19 vaccination (with safe and effective vaccines). COVID-19 vaccination reduces the incidence, severity and death from COVID-19[8–11] and is perhaps the foremost means of achieving herd immunity especially when all population groups, including adults and children are vaccinated[9–14] because both adults and children are susceptible to COVID-19 infection.[15–17] However, the deployments of COVID-19 vaccinations are facing some challenges such as non-acceptance and misinformation propagated by antivaccine campaigners. Refusal and/or delay in accepting vaccinations (vaccine hesitancy) has become a major public health challenge over the past decade[18 19] and was noted as one of the top 10 threats to global health in 2019.[20] Moreover, the unprecedented disruptive impact of the pandemic with the associated conspiracy theories being propagated in conventional and social media and the unprecedented rapid development and introduction of COVID-19 vaccines have generated an atmosphere of uncertainty and confusion, which have further limited the acceptance of COVID-19 vaccination.[21–23]

COVID-19 vaccination started in March 2021 in Nigeria under the COVAX initiative.[24 25] Although the Nigerian government, with the support of the COVAX facility, is scaling up the availability/access to COVID-19 vaccination, the coverage rate is still very low in Nigeria, including Ebonyi state and Nigeria was not among the only five countries in Africa expected to meet the target of about 40% COVID-19 vaccination coverage by end of 2021.[26] As of 26 January 2022 (before this study was implemented), only about 4.6% of eligible Nigerians had received the second dose of COVID-19 vaccination,[27] about 10.5% had received the first dose,[28] and Ebonyi state had about the least coverage rate in Nigeria.[29] As of 11 August 2022, about 25.2% of eligible Nigerians had received the second dose (fully vaccinated)[30] and about 10.6% had received the first dose (partially vaccinated)[31] and as of 12 August 2022, Ebonyi state had the second least coverage rate in Nigeria.[32] Moreover, these coverage rates were only among the current eligible population of 18 years and above and the rates among the population at risk (which is what is considered with regards to herd immunity) would be a fraction of the above.

Although the incidence of COVID-19 in Nigeria has been relatively lower compared with many other countries, high acceptance of COVID-19 vaccination among Nigerians is important in order to prevent any possible upsurge of the disease especially due to new strains of the virus. Resurgence of COVID-19 infections and COVID-19-related deaths are common, especially among populations with low COVID-19 vaccination coverage.[9–11]

Although the issue of stock-out of COVID-19 vaccines and vaccination syringes cannot be ignored in Nigeria and other African countries,[26] the slow pace of coverage may be partly due to non-acceptance/hesitancy among the populace and health workers as we have observed anecdotally in Ebonyi state. However, to our knowledge, the extent of COVID-19 vaccination acceptance and the determinants among community members and health workers as well as the degree to which the very low COVID-19 vaccination coverage is explained by non-acceptance as against non-availability/non-access, have not been rigorously investigated especially in Nigeria and particularly in Ebonyi state. Such investigation has become more imperative since the introduction and scale up of COVID-19 vaccination across Nigeria. The understanding of context-specific determinants of vaccination acceptance is a necessary strategy in addressing the problem of non-acceptance of new vaccines such as the current COVID-19 vaccines.[33]

COVID-19 vaccination intentions among populations were assessed at the early phase of the pandemic by studies across the world[12–14 34–63] and in Nigeria (mostly based on social media platforms and among health workers)[64–70] during the development/clinical trial stage of COVID-19 vaccines. Few studies were done at the early stage of the introduction and deployment of COVID-19 vaccination.[71 72] However, these studies were done when COVID-19 vaccination had not been introduced for public use or was just being introduced. Thus, the perceptions of vaccination-related attributes such as importance, safety or side-effects and effectiveness were perhaps largely distal. Moreover, the findings of those studies might markedly vary from that of studies conducted in situations where COVID-19 vaccination is readily/relatively available/accessible and there are close/real experiences/perceptions of vaccination activities and vaccination-related adverse events. Also, since the implementation of COVID-19 vaccination in Nigeria, the amplification of reports of serious side-effects and deaths following vaccination is common in the social and conventional media and on the grapevine.

Moreover, decline in the intention to receive COVID-19 vaccination after the vaccine became available has been reported across countries.[73] Anecdotal evidence shows that the initial waves of fear of COVID-19 among the people, including health workers, have markedly waned overtime, especially in Ebonyi state and Nigeria as a whole where the pandemic has been much less severe compared with some other climes. As a result, it is not surprising that COVID-19 vaccination uptake is reportedly very low and,

more importantly, the drive to scale up the availability and uptake of COVID-19 vaccination may be up against an unexpected bottle-neck if there is hesitancy or no intention to receive the vaccination among the people.

Only few studies have assessed the uptake of actual COVID-19 vaccination among the general adult population[55 74 75] and among health workers[76–79] but most were among subpopulations and when the vaccination was still relatively less available and accessible.

This study aims to evaluate and explore COVID-19 vaccination acceptance (the intention to receive, timeliness of the intention to receive, uptake and hesitancy) and the determinants among community members and health workers in Ebonyi state, Nigeria, in order to generate evidence to inform policy interventions and strategies on optimal COVID-19 vaccination acceptance and coverage.

Study objectives

The primary objectives are to evaluate and explore the following among community members and health workers in Ebonyi state, Nigeria:
1. The intention to receive COVID-19 vaccination and the determinants.
2. Timeliness of the intention to receive COVID-19 vaccination and the determinants.
3. The uptake of COVID-19 vaccination and the determinants.
4. The hesitancy to COVID-19 vaccination and the determinants.
5. The predictive power of acceptance factor compared with availability/access factor regarding the intention to receive, timeliness of the intention to receive and uptake of COVID-19 vaccination.

The secondary objectives are to evaluate and explore the following among community members and health workers in Ebonyi, Nigeria:
1. The COVID-19 experiences and perceptions and their determinants.
2. The COVID-19 vaccination expectations and perceptions and their determinants.
3. The COVID-19 vaccination process experiences and perceptions (availability/access factor) and their determinants.
4. The knowledge, attitude and practices about COVID-19 and their determinants.
5. The sources of information about COVID-19 and their determinants.
6. The perceptions about COVID-19, COVID-19 vaccine/vaccination and COVID-19 vaccination process.

Study hypotheses

The primary hypotheses include:
1. Strong COVID-19 experience and perception increases COVID-19 vaccination acceptance (increases the intention to receive, timeliness of the intention to receive and uptake and reduces hesitancy) compared with not strong COVID-19 experience and perception.

2. Increase in COVID-19 experiences and perceptions score increases COVID-19 vaccination acceptance.
3. Good COVID-19 vaccination expectation and perception increases COVID-19 vaccination acceptance compared with poor COVID-19 vaccination expectation and perception.
4. Increase in COVID-19 vaccination expectations and perceptions score increases COVID-19 vaccination acceptance.
5. Acceptance factor (COVID-19 risk-COVID-19 vaccination benefit perception or disease risk-remedy benefit perception (DR-RB or DRRB perception)) is significantly associated with COVID-19 vaccination acceptance.
6. Positive COVID-19 vaccination process experience and perception (positive availability/access factor) increases the intention to receive, timeliness of the intention to receive and uptake of COVID-19 vaccination compared with negative COVID-19 vaccination process experience and perception (negative availability/access factor).
7. Increase in COVID-19 vaccination process experiences and perceptions score increases the intention to receive, timeliness of the intention to receive and uptake of COVID-19 vaccination.
8. Acceptance-availability/access factor is significantly associated with the intention to receive, timeliness of the intention to receive and uptake of COVID-19 vaccination.
9. Increase in acceptance factor score increases the intention to receive, timeliness of the intention to receive and uptake of COVID-19 vaccination compared with increase in availability/access factor score.
10. The positive categories of COVID-19 experiences and perceptions, COVID-19 vaccination expectations and perceptions and COVID-19 vaccination process experiences and perceptions, respectively, increase COVID-19 vaccination acceptance compared with the negative categories (as depicted in table 1).

The secondary hypotheses include:
1. Knowledge, attitude and practices about COVID-19 are significantly associated with COVID-19 vaccination acceptance; COVID-19 experiences and perceptions; COVID-19 vaccination expectations and perceptions and COVID-19 vaccination process experiences and perceptions.
2. Sources of information about COVID-19 are significantly associated with COVID-19 vaccination acceptance; COVID-19 experiences and perceptions; COVID-19 vaccination expectations and perceptions; COVID-19 vaccination process experiences and perceptions and knowledge, attitude, and practices about COVID-19.
3. Sociodemographic characteristics are significantly associated with: COVID-19 vaccination acceptance; COVID-19 experiences and perceptions; COVID-19 vaccination expectations and perceptions; COVID-19 vaccination process experiences and perceptions;

Table 1 Independent factors and their categories and category scores and grading among community members and health workers

	Independent factors	Categories (scores)				
		Positive category			**Negative category**	
A	COVID-19 experiences and perceptions					
1.	How fearful are you about getting COVID-19?	Very fearful (4)	A little fearful (3)	Not sure (2)	Not fearful (1)	Not fearful at all (0)
2.	How possible is it for you to get COVID-19?	Highly possible (4)	A bit possible (3)	Not sure (2)	Not possible (1)	Not possible at all (0)
3.	How possible is it for you to get severe COVID-19?	Highly possible (4)	A bit possible (3)	Not sure (2)	Not possible (1)	Not possible at all (0)
4.	Have you ever had COVID-19?	Yes, surely (4)	Yes, think so (3)	Not sure (2)	No, think so (1)	No, surely (0)
5.	Have you ever had severe COVID-19?	Yes, very serious (4)	Yes, a bit serious (3)	Not sure (2)	No, not serious (1)	No, not serious at all (0)
6.	Do you know any person who have had COVID-19?	A very close person (4)	A close person (3)	A distant person (2)	A very distant person (1)	No person (0)
7.	Do you know any person who have had severe COVID-19?	A very close person (4)	A close person (3)	A distant person (2)	A very distant person (1)	No person (0)
8.	Do you know any person who have died from COVID-19?	A very close person (4)	A close person (3)	A distant person (2)	A very distant person (1)	No person (0)
	Total	(32[H])	–	–	–	(0[L])
9.	COVID-19 experiences and perceptions score					
10.	Extent of COVID-19 experience and perception (COVID-19 risk perception)[A]	Strong experience and perception (high risk perception)	–	–	–	Not strong experience and perception (low risk perception)
B	COVID-19 vaccination expectations and perceptions					
11.	How important is it for you to receive COVID-19 vaccination?	Very important (4)	Important (3)	Not sure (2)	Not important (1)	Not important at all (0)
12.	How fearful are you about having severe side-effect from COVID-19 vaccination?	Not fearful at all (4)	Not fearful (3)	Not sure (2)	A little fearful (1)	Very fearful (0)
13.	What protection against COVID-19 will you get from receiving COVID-19 vaccination?	Full protection (4)	Partial protection (3)	Not sure (2)	No protection (1)	No protection at all (0)
14.	How do you trust the health workers who give COVID-19 vaccination?	Trust them very much (4)	Trust them (3)	Not sure (2)	Do not trust them (1)	Do not trust them at all (0)
15.	How do you trust the government who made COVID-19 vaccination available?	Trust them very much (4)	Trust them (3)	Not sure (2)	Do not trust them (1)	Do not trust them at all (0)
	Total	(20[HH])	–	–	–	(0[LL])
16.	COVID-19 vaccination expectations and perceptions score					
17.	COVID-19 vaccination expectation and perception level (COVID-19 vaccination benefit perception)[B]	Good expectation and perception (high benefit perception)	–	–	–	Poor expectation and perception (low benefit perception)
C	COVID-19 vaccination process experiences and perceptions (availability/access factor)					
18.	Ever heard about COVID-19 vaccination?	Many times (4)	Once/few times (3)	Not sure (2)	No time (1)	No time at all (0)
19.	Know a COVID-19 vaccination place?	A very close place (4)	A close place (3)	A far place (2)	A very far place (1)	No place (0)
20.	Frequency of COVID-19 vaccination at the vaccination place?	Daily, down to twice a week (4)	Once a weekly (3)	Once in two-4 weeks (2)	No fixed time (1)	Do not know (0)

Continued

Table 1 Continued

		Categories (scores)				
	Independent factors	**Positive category**		**Negative category**		
21.	Queue at the vaccination place?	No queue (4)	Short queue (3)	Do not know (2)	Long queue (1)	Very long queue (0)
22.	How caring are the health workers at the vaccination place?	Very caring (4)	Caring (3)	Not sure (2)	Not caring (1)	Not caring at all (0)
	Total	(20[HHH])				(0[LLL])
23.	COVID-19 vaccination process experiences and perceptions score (availability/access factor score)					
24.	COVID-19 vaccination process experience and perception level (availability/access factor level)[C]	Positive experience and perception (availability and access factor)	–	–	–	Negative experience and perception (availability and access factor)
D25.	Acceptance factor level	Defined as COVID-19 risk-COVID-19 vaccination benefit perception or disease risk-remedy benefit perception level. Categories: High disease risk-high remedy benefit perception or high–high DR-RB perception, high–low DR-RB perception, low–high DR-RB perception and low–low DR-RB perception				
26.	Acceptance factor score	Defined as COVID-19 risk perception score plus COVID-19 vaccination benefit perceptions score or DR-RB perception score				
E27.	Acceptance-availability/access factor level	High–high-positive, high–high-negative, high–low-positive, high–low-negative, low–high-positive, low–high-negative, low–low-positive, low–low-negative				
		Categories (scores)				
	Independent factors	**Positive category**		**Negative category**		
F	Knowledge, attitude, and practice					
28.	Knowledge score					
29.	Level of knowledge of COVID-19[D]	Good knowledge		–	–	–	Poor knowledge
30.	Attitude score					
31.	Level of attitude towards COVID-19 and COVID-19 vaccination[E]	Good attitude		–	–	–	Poor attitude
32.	Practice score					
33.	Level of practices about COVID-19[F]	Good practice		–	–	–	Poor practice
G	Source of information about COVID-19	Interpersonal (family members/relatives/friends, other health workers, place of work, place of worship/religious forums); traditional media (television, radio, prints (newspaper/magazine)); internet, social media, & SMS (WhatsApp, Facebook, Internet sites, Bulk SMS/Text messages)				
34.	Main source of information	Interpersonal; traditional media; Internet, social media and SMS				
35.	Most trusted source of information	Interpersonal; traditional media; Internet, social media and SMS				
H	Sociodemographic characteristics					
36.	Gender	Male, female				
37.	Age					
38.	Marital status	Married, divorced, separated, widowed, never married (single)				
39.	Educational level	No formal education, some primary, completed primary, some secondary, completed secondary, tertiary (diploma, first degree, masters/PHD/other equivalent)				
40.	Occupation*	Farmer, trader, other-self-employment, private paid work, government paid work, housewife, student, apprentice, youth service (corper), none				
41.	Residence*	Rural, semi-urban/urban				
42.	Usual monthly income (NGN) and income score*	Income categories: 'no income' up to 'more than 300 000' with interval of 20 000, giving 18 categories. 'no income' is scored 'one' and the score increases by 'one' for each higher category up to the highest score of 17				
I	Professional or work-related attributes†					
43.	Professional cadre or work category	Non-Clinical staff, Clinical staff (PMV, health attendant, JCHEW, CHEW, CHO, nurse/midwife, medical laboratory scientist, medical laboratory technologist, pharmacist, pharmacy technician, house officer, medical officer, medical doctor in specialist training, specialist medical doctor)				

Continued

Table 1 Continued

	Independent factors	Categories (scores)	
		Positive category	Negative category
44.	Years of working experience		
45	Primary place of work	Public and private	
46.	Level of primary place of work	Primary healthcare level (facility), secondary healthcare level (facility), and tertiary healthcare level (facility)	

[H]Highest attainable COVID-19 experiences and perceptions score for each participant ([L]Lowest attainable score). [A]COVID-19 experiences and perceptions score of ≥50% of the highest attainable score of 32 is strong experience and perception, <50% is not strong experience and perception. [HH]Highest attainable COVID-19 vaccination expectations and perceptions score for each participant ([LL]Lowest attainable score). [B]COVID-19 vaccination expectations and perceptions score of>=50% of the highest attainable score of 20 is good expectation and perception, <50% is poor expectation and perception. [HHH]Highest attainable COVID-19 vaccination process experiences and perceptions score ([LLL]Lowest attainable score). [C]COVID-19 vaccination process experiences and perceptions score of ≥50% of the highest attainable score of 20 is positive experience and perception, <50% is negative experience and perception. [D]Knowledge score of ≥75% of the highest attainable score of 44 is good knowledge, <75% is poor knowledge (lowest attainable score is 0) (44 knowledge items scored '1' for each correct response and '0' for each incorrect response). [E]Attitude score of ≥75% of the highest attainable score of 80 is good attitude, <75% is poor attitude (lowest attainable score is 16) (each of 16 attitude items respectively scored from '1' to '5' or '5' to '1' as appropriate for 'strongly disagree', 'disagree', 'not sure', 'agree' and 'strongly agree'). [F]Practice score of ≥75% of the highest attainable score of 24 is good practice, <75% is poor practice (lowest attainable score is 0) (24 practice items scored '1' for each correct response and '0' for each incorrect response).
*Among only community members.
†Among only health workers.
CHEW, Community Health Extension Worker; CHO, Community Health Officer; JCHEW, Junior Community Health Extension Worker; PMV, Patent Medicine Vendor.

knowledge, attitude and practices about COVID-19 and sources of information about COVID-19.

4. Professional or work-related attributes of health workers are significantly associated with COVID-19 vaccination acceptance, COVID-19 experiences and perceptions; COVID-19 vaccination expectations and perceptions; COVID-19 vaccination process experiences and perceptions; knowledge, attitude and practices about COVID-19 and sources of information about COVID-19.

The hypothesised relationships between the independent factors and the outcome measures are shown in the study's conceptual framework in figure 1. The conceptual framework was designed based on the study hypotheses which were informed by published data on COVID-19 and COVID-19 vaccination and the '3Cs' Vaccine Hesitancy Model by The SAGE Working Group on Vaccine Hesitancy.[18]

In the conceptual framework (figure 1), strong COVID-19 experience and perception (compared with not strong experience and perception), increase in COVID-19 experiences and perceptions score and the positive categories of COVID-19 experiences and perceptions (compared with the negative categories) are expected to be associated with decrease in complacency about COVID-19 vaccination and this will result in increase in the intention to receive, timeliness of the intention to receive and uptake and decrease in hesitancy to COVID-19 vaccination (increase in COVID-19 vaccination acceptance). Likewise, good COVID-19 vaccination expectation and perception (compared with poor expectation and perception), increase in COVID-19 vaccination expectations and perceptions score and the positive categories of COVID-19 vaccination expectations and perceptions (compared with the negative categories) are

expected to be associated with increase in confidence in COVID-19 vaccination and this will lead to increase in COVID-19 vaccination acceptance.

Positive COVID-19 vaccination process experience and perception (compared with negative experience and perception), increase in COVID-19 vaccination process experiences and perceptions score and the positive categories of COVID-19 vaccination process experiences and perceptions (compared with the negative categories) are expected to be associated with increase in convenience in COVID-19 vaccination and then increase in the intention to receive, timeliness of the intention to receive and uptake of COVID-19 vaccination. Acceptance factor is expected to be associated with increase in COVID-19 vaccination acceptance compared with availability/access factor.

As depicted in the conceptual framework (figure 1), knowledge, attitude and practice about COVID-19; sources of information about COVID-19; sociodemographic characteristics and professional or work-related attributes are expected to be associated with decrease in complacency, increase in confidence and increase in convenience in COVID-19 vaccination and then increase in COVID-19 vaccination acceptance. These background characteristics are also expected to be associated with COVID-19 experiences and perceptions, COVID-19 vaccination expectations and perceptions and COVID-19 vaccination process experiences and perceptions (figure 1).

METHODS AND ANALYSES
Design
The study is an analytical cross-sectional survey with a concurrent-independent mixed data collection and data analysis and interpretation method. In this design, the
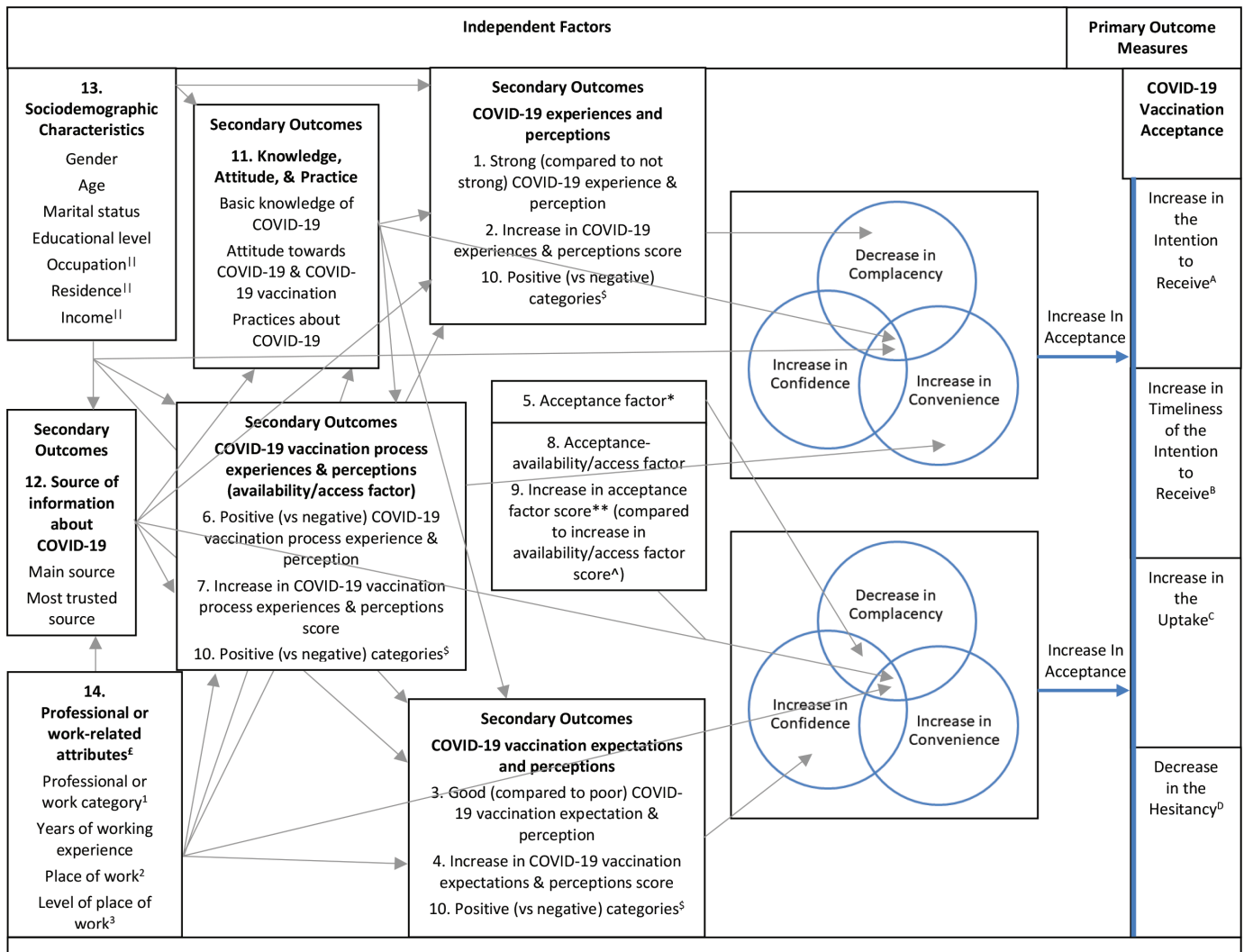
Figure 1 Study conceptual framework. [A]Measured as the proportion of participants who intended to receive covid-19 vaccination. [B]Measured as the time (in days) the participants, who intended to receive covid-19 vaccination, intended to take before they go and receive the COVID-19 vaccination (increase in timeliness means decrease in the intended days to vaccination). [C]Measured as the proportion of participants who had received covid-19 vaccination (including those who had completed the doses and those who had not). [D]Measured as the proportion of participants who had not received covid-19 vaccination due only to non-acceptance factor (perceptions that the vaccination was not important, vaccine was not safe, vaccine was not effective etc) rather than real or perceived non-availability (non-access) factor (ignorance of vaccination availability, long distance to place of vaccination, vaccine stock-out etc) or both. [$]As depicted in table 1. *COVID-19 risk-COVID-19 vaccination benefit perception or disease risk-remedy benefit perception (DR-RB or DRRB perception)). **Increase in COVID-19 risk-COVID-19 vaccination benefit perceptions score or DR-RB perception score. ^Increase in COVID-19 vaccination process experience & perception score. [||]Among only community members. [£]Among only health workers. [1]Clinical and non-clinical. [2]Public and private. [3]Primary, secondary, and tertiary.

quantitative and qualitative aspects of the study will be implemented simultaneously and independently of each other.[80] The study protocol development was guided by the Standard Protocol Items: Recommendations for Interventional Trials 2013 checklist and the Strengthening the Reporting of Observational Studies in Epidemiology 2007 checklist for cross-sectional studies.

Study area

The study is planned to be implemented between March and April 2022, in Ebonyi state which is located in southeastern geopolitical zone of Nigeria with land area of

5953 km^2. The population of the state was projected to be 3 313 229 in 2021 based on the 2006 national census figure and a growth rate of 2.8% and christianity is the most practiced religion. Ebonyi state has 13 Local Government Areas (LGAs) including the state capital (Abakaliki LGA) and 171 political wards.[81] Each LGA is made up of political wards and autonomous communities. Each autonomous community is made up of larger villages called autonomous villages, which consist of smaller villages or settlements. Each village/settlement has a head or traditional leader. Most parts of Ebonyi state are rural and there are

only six towns (urban or semiurban areas), five of which are LGAs capitals with the adjoining areas.[82]

The federal ministry of health (FMOH) and its agencies provide the overarching guidance and policy framework for public and private health service delivery in all states in Nigeria including Ebonyi state. The FMOH provides health services in the state through tertiary health facilities, while the state ministry of health (SMOH) provides health service through secondary health facilities (general hospitals). The SMOH and the state primary healthcare development agency (SPHCDA) provide healthcare in the local governments through primary healthcare (PHC) facilities. There is at least one PHC centre in each political ward. The national primary healthcare development agency (NPHCDA) provides policy guidance and coordination for immunisation/vaccination services in all states in Nigeria including Ebonyi state. The NPHCDA provides vaccines and related products while the SMOH and SPHCDA coordinates the implementation of immunisation/vaccination service delivery in the state (and LGAs) through the tertiary, secondary, and PHC facilities.

Participants

The participants include clusters, the community members within clusters and health workers in Ebonyi state. A cluster in this study is a geographical community (village(s)/settlement(s)), which is the immediate catchment area of a PHC centre. Eligible clusters for inclusion in the study are those with at least 200 households or a population of 1000 people, whose PHC centres are providing basic maternal and child healthcare services, including routine childhood immunisation, which can be easily accessed with a car, and where the cluster heads give verbal consent/permission. In each of the selected clusters, community members aged 15 years and above who give verbal consent/assent will be eligible to participate in a population-based household survey. Health workers (both clinical and non-clinical staff) in public and private healthcare sectors, including the patent medicine vendors, who work or live in Ebonyi state and give verbal consent, will be eligible to participate in a health worker survey. Community members aged 15 years and above who have resided in the community for at least 1 year and who give verbal consent/assent will be eligible to participate in community-based focus group discussions (FGDs) while health workers (both clinical and non-clinical staff), who work or live in Ebonyi state, have at least 1 year of working experience and give verbal consent will be eligible to participate in health worker-based FGDs.

Independent factors and outcome measures
Independent factors, categories, scoring and grading
The independent factors among community members and health workers (see table 1) are almost the same with few differences, which include: occupation, monthly income and residence among the community members; and professional or work category/cadre, years of

working experience, place of work and level of place of work among the health workers.

The independent factors are listed under nine headings labelled A–I: COVID-19 experiences and perceptions; COVID-19 vaccination expectations and perceptions; COVID-19 vaccination process experiences and perceptions (availability/access factor); Acceptance factor (COVID-19 risk-COVID-19 vaccination benefit perception); Acceptance-availability/access factor; Knowledge, attitude, and practice about COVID-19; Source of information about COVID-19; Sociodemographic characteristics; and Professional or work-related attributes. These three factors—COVID-19 experiences and perceptions; COVID-19 vaccination expectations and perceptions and COVID-19 vaccination process experiences and perceptions—will be respectively measured using eight, five and five questionnaire items each having five categories grouped into positive and negative and scored from 0 to 4 as depicted in table 1.

The scoring will create three new continuous variables, including COVID-19 experiences and perceptions score (ranging from 0 to 32 for each participant); COVID-19 vaccination expectations and perceptions score (ranging from 0 to 20) and COVID-19 vaccination process experiences and perceptions score (ranging from 0 to 20). These continuous variables will then be graded on a two-level scale such that scores ≥50% of the total versus <50% will, respectively, be considered to be: strong versus not strong COVID-19 experience and perception; good versus poor COVID-19 vaccination expectation and perception and positive versus negative COVID-19 vaccination process experience and perception.

Acceptance factor will be created as the combination of COVID-19 experiences and perceptions plus COVID-19 vaccination expectations and perceptions and defined as COVID-19 risk-COVID-19 vaccination benefit perception (disease risk-remedy benefit perception (DR-RB/DRRB perception)) Acceptance factor will be in contrast to availability/access factor (COVID-19 vaccination process experience and perception). Acceptance-availability/access factor will be created as the combination of acceptance and availability/access factors. Acceptance factor score (ranging from 0 to 52 for each participant as the sum of disease-risk perception score (0–32) and remedy-benefit perception score (0–20)) and availability/access factor score (ranging from 0 to 20) will be converted to percentages of the maximum attainable score for each participant, so that the power of acceptance factor and availability/access factor in predicting COVID-19 vaccination acceptance can be compared by comparing how unit increase in the percentage scores (percentage point increase) affects COVID-19 vaccination acceptance. The predictive power of disease-risk perception and remedy-benefit perception will also be compared using similar technique.

Basic knowledge, attitude and practices about COVID-19 will be assessed, scored and categorised as stated in the legend of table 1.

Outcome measures

The outcome measures are as defined in table 2. The primary outcomes among community members and health workers include the intention to receive, timeliness of the intention to receive, uptake and hesitancy to COVID-19 vaccination. Hesitancy was conceptualised as: non-receipt of a vaccination that is really available and accessible and perceived to be available and accessible because one did not want to receive it and either intends to receive it at a later time (delay) or intends not to receive it at a later time (refusal).

Hesitancy to COVID-19 vaccination was measured among the unvaccinated based on the concepts of 'non-acceptance factor' and real or perceived 'non-availability (non-access) factor' and delay versus refusal was measured based on intention versus non-intention to receive among those who were hesitant (table 2).

The secondary outcomes include COVID-19 experiences and perceptions, COVID-19 vaccination expectations and perceptions, COVID-19 vaccination process experiences and perceptions, knowledge of COVID-19, attitude towards COVID-19 and COVID-19 vaccination, practices about COVID-19 and main source and most trusted source of information about COVID-19 (table 2).

Measurement of independent factors and study outcomes

Quantitative data will be measured through population-based household survey using structured community members' questionnaire (online supplemental file 1) and health workers survey using structured health workers' questionnaire (online supplemental file 2). The community members' questionnaire and the health workers' questionnaire are virtually the same except for the absence of identification section and the professional/work-related attributes in the sociodemographic section of the health workers' questionnaire. The questionnaire was designed with the guide of data published by other studies,[12 34 42 47] the Report of the SAGE Working Group on Vaccine Hesitancy,[18] the WHO vaccination coverage questionnaire[83] and basic facts about COVID-19 on WHO website.[84] The electronic versions of both questionnaires were programmed using the KoBoToolbox software and were pre-tested in non-participating clusters and among health workers who will later be exempted from the study.

The community members' questionnaire will be interviewer administered. The interviewers will administer the electronic questionnaire with KoBoCollect installed in their android phones or tablet devices. The interviewers will receive 2 days training on how to administer the electronic questionnaire. The training will include a detailed review and explanation of the questionnaire items, how to obtain consent from respondents, interview techniques, the translation of key words in the questionnaire to local language, household revisiting techniques and how to collect data and upload completed forms with KoBoCollect.

During the household survey, all the households will be enumerated and household members aged 15 years and above in households where verbal consent is given by the heads of households will be enlisted and assigned unique numbers on a separate paper form before administering the anonymised electronic questionnaire. To enhance coverage and response, local residents who have good knowledge of the cluster environment will preferably be the interviewers, so that they can visit households when household members are expected to be around and revisit up to three times as necessary. The community members' questionnaire has seven sections: identification (including cluster number, household number, participant number); sociodemographic characteristics; COVID-19 vaccination acceptance; COVID-19 experiences and perceptions; basic knowledge of COVID-19; attitude towards COVID-19 and COVID-19 vaccination and practices about COVID-19 (online supplemental file 1).

The health workers' questionnaire will be both self-administered and interviewer-administered. The web link for the electronic questionnaire will be distributed to health workers via social media platform such as WhatsApp. However, interviewers will administer the health workers questionnaire via KoBoCollect installed in android devices to health workers who do not have online contact and those living in remote areas with poor internet access. The health workers' questionnaire has six sections: Sociodemographic characteristics; COVID-19 vaccination acceptance; COVID-19 experiences and perceptions; Basic knowledge of COVID-19; Attitude towards COVID-19 and COVID-19 vaccination; and Practices about COVID-19 (online supplemental file 2).

Qualitative data will be measured through FGDs with community members and health workers. A total of 20 FGDs with community members will be carried out across 10 clusters with two FGDs (one male-FGD and one female-FGD) per cluster. A total of 14 FGDs with health workers will be conducted, five with non-clinical staff and nine with clinical staff (five at PHC facilities and four at secondary/tertiary health facilities). The investigators will conduct the FGDs using FGD guide (online supplemental file 3) prepared in English and pre-tested in non-participating clusters and among some health workers who will later be exempted from the study. The FGD guides (online supplemental file 3) contain step-by-step instructions and both open-ended and more targeted questions designed to explore the participants' perceptions about COVID-19, COVID-19 vaccine/vaccination, COVID-19 vaccination process, and the determinants of COVID-19 vaccination acceptance.

Before commencement of each FGD, the investigators will collect background data of participants including age, sex, marital status, level of education, occupation or cadre and years of working experience as appropriate. The community members' FGDs will be conducted in local language and the health workers' FGDs in English. Each FGD will consist of 7–8 participants (comprising a moderator, a note taker and the respondents) and will last for about 45 min. The FGDs will be audio-recorded,

Table 2 Outcome measures and their definitions

SN	Primary outcomes	Definitions
	Among community members	
1.	The intention to receive COVID-19 vaccination	The proportion of community members aged 15 years and above, who have not received COVID-19 vaccination, who intend (or plan) to receive COVID-19 vaccination that is available for them to receive. The component outcomes are those who will surely go and receive and those who think they will go and receive the vaccination. This outcome is in contrast to those who do not intend (or plan) to receive COVID-19 vaccination that is available for them to receive—consisting of those who are not sure, those who think they will not go and receive, and those who will surely not go and receive the vaccination.
2.	Timeliness of the intention to receive COVID-19 vaccination	The time (in days) that community members aged 15 years and above, who intend (or plan) to receive COVID-19 vaccination, intend (or plan) to take before they go and receive the vaccination. The component outcomes are the intended time to vaccination among those who will surely go and receive and those who think they will go and receive the vaccination.
3.	The uptake of COVID-19 vaccination	The proportion of community members aged 18 years and above who have received COVID-19 vaccination
4.	The hesitancy to COVID-19 vaccination (delay or refusal to receive)	The proportion of community members aged 18 years and above who have not received COVID-19 vaccination due to reasons that include only non-acceptance factor rather than only real/perceived non-availability/non-access factor or both non-acceptance and real/perceived non-availability/non-access factors. Non-acceptance factor is defined as consisting of one or more of: perceptions that the vaccination is not important, vaccine is not safe, vaccine is not effective, vaccine is new and/or waiting for others to take it first, and hearing of many bad stories about the vaccine. Real/perceived non-availability/non-access factor is defined as consisting of one or more of: ignorance of vaccination availability, ignorance of place and/or time of vaccination, long distance to vaccination site, being too busy, being ill and did not go for vaccination, being ill and went for vaccination but was not given, long waiting time, vaccine stock-out, absence of vaccinator, closure of health facility. The non-acceptance and real/perceived non-availability/non-access factors will be measured as the reasons given by respondents regarding why they have not received COVID-19 vaccination. Delay in receiving COVID-19 vaccination is the intention to receive the vaccination among those that are hesitant. Refusal to receive COVID-19 vaccination is the intention not to receive the vaccination among those that are hesitant.
5.	The intention for the children to receive COVID-19 vaccination	The proportion of community members aged 15 years and above who intend (or plan) for their children to receive COVID-19 vaccination if it is available for them to receive. The component outcomes are those who will surely take their children to receive and those who think they will take their children to receive the vaccination. This outcome is in contrast to those who do not intend (or plan) for their children to receive COVID-19 vaccination—consisting of those who are not sure, those who think they will not take their children to receive, and those who will surely not take their children to receive the vaccination
6.	Timeliness of the intention for the children to receive COVID-19 vaccination	The time (in days) that community members aged 15 years and above, who intend (or plan) for their children to receive COVID-19 vaccination, intend (or plan) to take before they take their children to receive the vaccination. The component outcomes are the intended time to vaccination for their children among those who will surely take their children to receive and those who think they will take their children to receive the vaccination
	Among health workers	
7.	The intention to receive COVID-19 vaccination	As for community members above
8.	Timeliness of the intention to receive COVID-19 vaccination	As for community members above
9.	The uptake of COVID-19 vaccination	As for community members above
10.	The hesitancy to COVID-19 vaccination	As for community members above
SN	**Secondary outcomes**	**Definitions**
	Among community members	
1.	COVID-19 experiences and perceptions	COVID-19 experiences and perceptions score among community members aged 15 years and above
2.		The proportion of community members aged 15 years and above who have strong COVID-19 experience and perception (in contrast to those who have not strong experience and perception)

Continued

Table 2 Continued

SN	Secondary outcomes	Definitions
3.		The proportion of community members aged 15 years and above who have the positive categories of COVID-19 experiences and perceptions (in contrast to those who have the negative categories)
4.	COVID-19 vaccination expectations and perceptions	COVID-19 vaccination expectations and perceptions score among community members aged 15 years and above
5.		The proportion of community members aged 15 years and above who have good COVID-19 vaccination expectation and perception (in contrast to those who have poor expectation and perception)
6.		The proportion of community members aged 15 years and above who have the positive categories of COVID-19 vaccination expectations and perceptions (in contrast to those who have the negative categories)
7.	COVID-19 vaccination process experiences and perceptions	COVID-19 vaccination process experiences and perceptions score among community members aged 15 years and above
8.		The proportion of community members aged 15 years and above who have positive COVID-19 vaccination process experience and perception (in contrast to those who have negative experience and perception)
9.		The proportion of community members aged 15 years and above who have the positive categories of COVID-19 vaccination process experiences and perceptions (in contrast to those who have the negative categories)
10.	The knowledge of COVID-19	Knowledge score among community members aged 15 years and above
11.		The proportion of community members aged 15 years and above who have good knowledge of COVID-19 (in contrast to those who have poor knowledge)
12.	The attitude towards COVID-19 and COVID-19 vaccination	Attitude score among community members aged 15 years and above
13.		The proportion of community members aged 15 years and above who have good attitude towards COVID-19 and COVID-19 vaccination (in contrast to those who have poor attitude)
14.	The practices about COVID-19	Practice score among community members aged 15 years and above
15.		The proportion of community members aged 15 years and above who have good practice about COVID-19 (in contrast to those who have poor practice)
16.	The main source of information about COVID-19*	The proportion of community members aged 15 years and above whose main source of information about COVID-19 is interpersonal; traditional media; or Internet, social media, & SMS
17.	The most trusted source of information about COVID-19*	The proportion of community members aged 15 years and above whose most trusted source of information about COVID-19 is interpersonal; traditional media; or Internet, social media, & SMS
	Among health workers	
18.	COVID-19 experiences and perceptions	As for community members above
19.	COVID-19 vaccination expectations and perceptions	As for community members above
20.	COVID-19 vaccination process experiences and perceptions	As for community members above
21.	The knowledge of COVID-19	As for community members above
22.	The attitude towards COVID-19 and COVID-19 vaccination	As for community members above
23.	The practices about COVID-19	As for community members above

Continued

Table 2	Continued	
SN	Secondary outcomes	Definitions
24.	The main source ofinformation about COVID-19	As for community members above
25.	The most trusted source ofinformation about COVID-19	As for community members above

*Interpersonal source includes family members/relatives/friends, other health workers, place of work, place of worship/religious forums; traditional media source includes television, radio, prints (newspaper/magazine)); Internet, social media and SMS source includes WhatsApp, Facebook, Internet sites, Bulk SMS/Text messages.

the health workers FGDs will be transcribed and community members FGDs will be translated and transcribed verbatim into English.

Data management and quality control

The skip logic and validation criteria in KoBoToolbox software were used when programming the electronic questionnaire to enhance the quality of data collection. To minimise the potential bias in assessing the association between COVID-19 and COVID-19 vaccination-related experiences and perceptions and uptake of COVID-19 vaccination, the questionnaire items on these factors are subdivided into two subgroups: 'have not received COVID-19 vaccination' and 'have received COVID-19 vaccination' and the items in each subgroup are framed differently, respectively, in present tense versus in past tense. For example, those whose response to a preceding question indicate that they have not received COVID-19 vaccination will subsequently respond to the questions: 'How fearful are you that you may have very serious side-effects if you receive COVID-19 vaccination?' 'How fearful are you about getting COVID-19?', etc. In contrast, those who have received COVID-19 vaccination will subsequently respond to the questions: 'Regarding your experiences and perceptions before the day you received the first dose of COVID-19 vaccination: How fearful were you that you might have very serious side-effects if you received COVID-19 vaccination?' 'How fearful were you about getting COVID-19?'

To enhance the validity of the questionnaires, after the first drafts, there were several rounds of systematic review–discussion–correction–redrafting by the research team. During this iterative process, attention was paid to relevance of the questionnaire items to the study objectives and the logical flow and order, wording, framing, clarity and appropriateness of the questions. The validation process continued until the final version of the questionnaires which were then pretested. During the pretest, respondents' understanding and interpretation of the items and the options, their response time to individual items and time taken to complete a questionnaire were assessed and the completed questionnaires were reviewed for any problems. Minor adjustments were made thereafter.

The household interviewers will upload only completed anonymised questionnaires to the online survey records at the end of each day's survey and the transmitted questionnaires will be reviewed for missing, incoherent and illogical data. Any identified error will immediately be communicated to the respective interviewers for correction by cross-checking with the respective respondents. The investigators will supervise the household survey interviewers and will revisit at least 20 eligible households per cluster with a specialised form of the survey questionnaire to double check on responses and coverage.

Multiple submissions of the self-administered electronic questionnaire from a health worker on the same device and browser will be prevented by deploying the questionnaire through the online-only (once per respondent) option in KoBoToolbox. However, in any case where a health worker who has completed the questionnaire agrees to give the android phone to any coworker—who do not have android phone or online address but is willing to participate in the survey—to respond to the questionnaire, a web link for online-only (single submission) will be sent to such health worker. The data utility in Stata will be used to check for duplicated submissions (observations) and if found, only one will be kept, the duplicates will be deleted from the data set. Participation of study participants in the FGDs before the questionnaire surveys will be prevented. During the translation and transcribing of the community members FGDs, exact and meaning-based translation will be used. The FGD transcripts will be compared with the original recording to check for 'accuracy' before conducting analyses.

Sample size

Sample size is estimated using Stata/SE V.15·1 (Stata Corp, College Station, Texas). For the community members survey, assuming a conservative estimate of 50% for the primary outcome (the proportion of community members who have not received COVID-19 vaccination who intend (or plan) to receive COVID-19 vaccination that is available for them to receive) among the community members who have not strong COVID-19 experience and perception and 56% among those who have strong COVID-19 experience and perception, 80% power at 2.5% probability of type 1 error (to correct for multiple

comparisons),[85] 2630 is the minimum total sample size required to detect the 6%-point difference in this primary outcome between both comparison groups. Allowance for 70% response rate will increase the sample size to 3758. To account for cluster sampling, 3758 is multiplied by a conservative estimate of design effect of 4 to give a final minimum total sample size of 15032. As the clusters that will be selected to participate in the study are those with minimum population size of 1000 per cluster, and with 540 (54%) of the population expectedly falling withing the age group of 15 years and above,[86] the study requires 28 clusters (15 032/540) for the community members survey.

Using similar parameters, the health workers' survey requires a minimum total sample size of 940 to detect a 10%-point difference in this primary outcome between both comparison groups (50% vs 60%). Because of the nature of the survey, such as the use of social media platforms for distribution of the (self-administered) questionnaire, the length of the questionnaire and the sampling technique (convenience and snowball), allowance for 50% acceptance rate to account for both non-response and incomplete response will increase the minimum total sample size for the health worker survey to 1880. Also, due to the nature of the survey, the 1880 is perhaps more of the number of health workers who will be targeted for distribution of the questionnaire rather than for selection to participate in the survey.

Sampling technique (recruitment)

Community members will be selected by stratified cluster sampling technique. The sampling frame will be the list of clusters obtained from the Ebonyi SMOH. The eligible clusters will be stratified into two: rural and urban/semi-urban. A random sample of 21 clusters will be selected from the rural stratum and a random sample of seven clusters will be selected from the urban/semiurban stratum using the 'sample' command in Stata. This will give a 3:1 rural to urban ratio. If verbal consent/permission is not given by any of the selected cluster(s) head(s) before commencement of household survey, replacement cluster(s) will be selected from the remaining list of eligible clusters using the same technique. The study profile is shown in figure 2. In each of the selected clusters, all the households will be enumerated and all individuals aged 15 year and above in each household will be selected for the community members' survey. About five to six eligible male and female community members, both those who have received and those who have not received COVID-19 vaccination, in 10 clusters, will be selected purposively for FGDs.

Health workers will be selected by convenience and snowballing techniques. To increase acceptance rate, the research team will first make a physical and or phone contact with as many health workers as possible to invite them to participate in the survey and seek their consent and permission for the web link for the self-administered
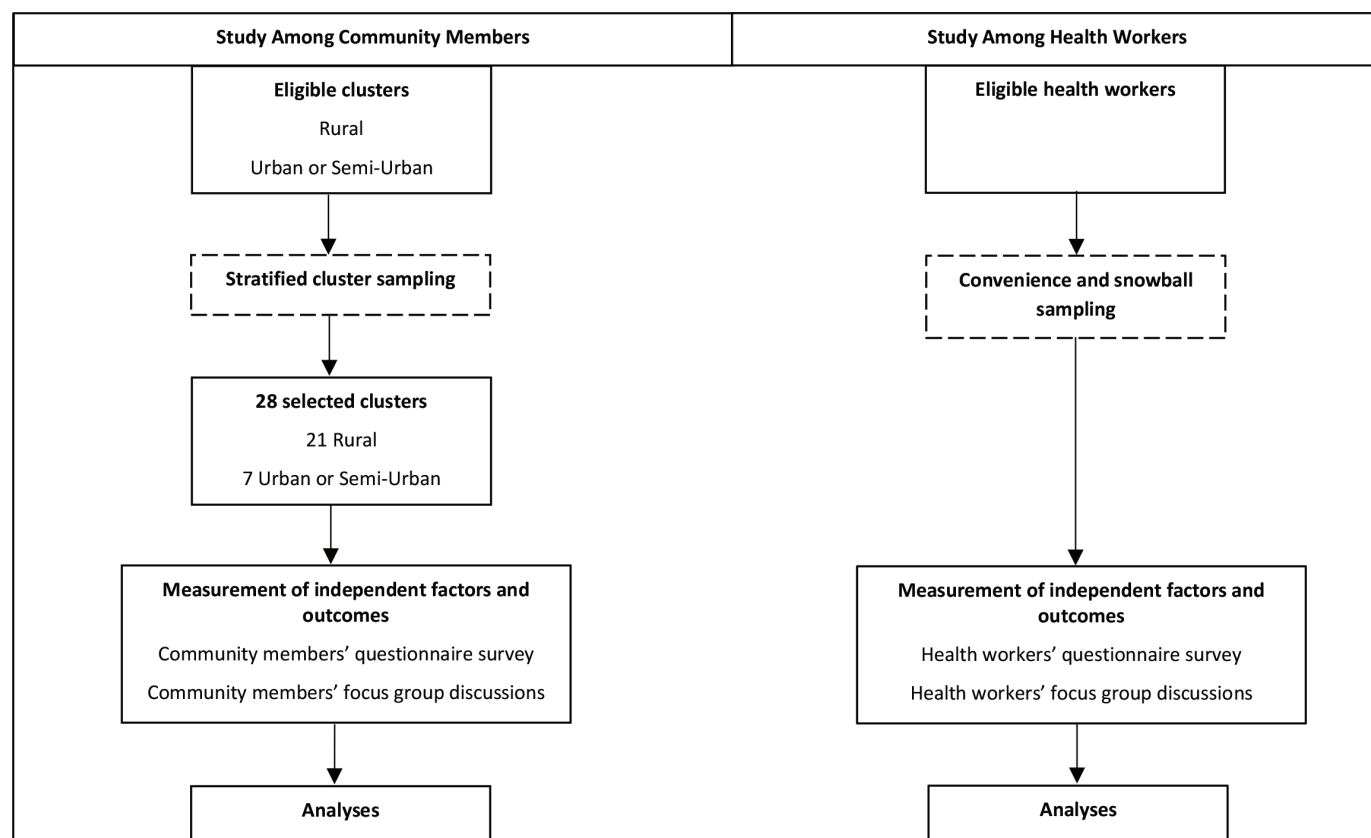

Figure 2 Summary of study profile.

Table 3 Independent factors to input into multivariate models in adjusted analyses

	Independent factors under test	Independent factors to control for (as appropriate)
	Primary hypotheses	
1.	Extent of COVID-19 experience and perception	COVID-19 vaccination expectation and perception level; COVID-19 vaccination process experience and perception level; basic knowledge of COVID-19; attitude towards COVID-19 and COVID-19 vaccination; practices about COVID-19; source of information about COVID-19 (main source and most trusted source of information about COVID-19); sociodemographic characteristics (gender, age, marital status, educational level, occupation*, residence*, monthly income/income score*); professional or work-related attributes† (work category (clinical and non-clinical), years of working experience, primary place of work (public and private), level of primary place of work (primary, secondary, and tertiary))
2.	COVID-19 experiences and perceptions score	COVID-19 vaccination expectations and perceptions score; COVID-19 vaccination process experiences and perceptions score; basic knowledge of COVID-19, attitude towards COVID-19 and COVID-19 vaccination; practices about COVID-19; source of information about COVID-19; sociodemographic characteristics; work-related attributes†
3.	COVID-19 vaccination expectation and perception level	Extent of COVID-19 experience and perception; COVID-19 vaccination process experience and perception level; basic knowledge of COVID-19; attitude towards COVID-19 and COVID-19 vaccination; practices about COVID-19; source of information about COVID-19; sociodemographic characteristics; work-related attributes†
4.	COVID-19 vaccination expectations and perceptions score	COVID-19 experiences and perceptions score; COVID-19 vaccination process experiences and perceptions score; basic knowledge of COVID-19; attitude towards COVID-19 and COVID-19 vaccination; practices about COVID-19; source of information about COVID-19; sociodemographic characteristics; work-related attributes†
5.	Acceptance factor level (COVID-19 risk-COVID-19 vaccination benefit perception or disease risk-remedy benefit perception level)	Availability/access factor level (COVID-19 vaccination process experience and perception level); basic knowledge of COVID-19; attitude towards COVID-19 and COVID-19 vaccination; practices about COVID-19; source of information about COVID-19; sociodemographic characteristics; work-related attributes†
6.	COVID-19 vaccination process experience and perception level	Extent of COVID-19 experience and perception; COVID-19 vaccination expectation and perception level; basic knowledge of COVID-19; attitude towards COVID-19 and COVID-19 vaccination; practices about COVID-19; source of information about COVID-19; sociodemographic characteristics; work-related attributes†
7.	COVID-19 vaccination process experiences and perceptions score	COVID-19 experiences and perceptions score; COVID-19 vaccination expectations and perceptions score; basic knowledge of COVID-19; attitude towards COVID-19 and COVID-19 vaccination; practices about COVID-19; source of information about COVID-19; sociodemographic characteristics; work-related attributes†
8.	Acceptance-availability/access factor level	Basic knowledge of COVID-19; attitude towards COVID-19 and COVID-19 vaccination; practices about COVID-19; source of information about COVID-19; sociodemographic characteristics; work-related attributes†
9.	Acceptance factor score and availability/access factor score	Basic knowledge of COVID-19; attitude towards COVID-19 and COVID-19 vaccination; practices about COVID-19; source of information about COVID-19; sociodemographic characteristics; work-related attributes†
10.	COVID-19 experiences & perceptions‡, COVID-19 vaccination expectations & perceptions§, COVID-19 vaccination process experiences and perceptions¶	COVID-19 experiences and perceptions‡, COVID-19 vaccination expectations and perceptions§, COVID-19 vaccination process experiences and perceptions¶ (as appropriate); basic knowledge of COVID-19, attitude towards COVID-19 and COVID-19 vaccination; practices about COVID-19; source of information about COVID-19; sociodemographic characteristics; work-related attributes†
	Secondary hypotheses	
1.	Knowledge of COVID-19	Attitude towards COVID-19; practices about COVID-19; source of information about COVID-19; sociodemographic characteristics; work-related attributes†; extent of COVID-19 experience and perception; COVID-19 vaccination expectation and perception level; COVID-19 vaccination process experience and perception level
2.	Attitude towards COVID-19	Knowledge of COVID-19; practices about COVID-19; source of information about COVID-19; sociodemographic characteristics; work-related attributes†; extent of COVID-19 experience and perception; COVID-19 vaccination expectation and perception level; COVID-19 vaccination process experience and perception level
3.	Practices about COVID-19	Knowledge of COVID-19; attitude towards COVID-19; source of information about COVID-19; sociodemographic characteristics; work-related attributes†; extent of COVID-19 experience and perception; COVID-19 vaccination expectation and perception level; COVID-19 vaccination process experience and perception level
4.	Main source of information about COVID-19	Most trusted source of information about COVID-19; sociodemographic characteristics; work-related attributes†; extent of COVID-19 experience and perception; COVID-19 vaccination expectation and perception level; COVID-19 vaccination process experience and perception level

Continued

Table 3 Continued

	Independent factors under test	Independent factors to control for (as appropriate)
5.	Most trusted source of information about COVID-19	Main source of information about COVID-19; sociodemographic characteristics; work-related attributes†; extent of COVID-19 experience and perception; COVID-19 vaccination expectation and perception level; COVID-19 vaccination process experience and perception level
6.	A sociodemographic characteristic	Other sociodemographic characteristics; source of information about COVID-19; work-related attributes†; extent of COVID-19 experience and perception; COVID-19 vaccination expectation and perception level; COVID-19 vaccination process experience and perception level
7.	A professional or work-related attribute†	Other professional or work-related attributes†; source of information about COVID-19; sociodemographic characteristics; extent of COVID-19 experience and perception; COVID-19 vaccination expectation and perception level; COVID-19 vaccination process experience and perception level

*Among only community members.
†Among only health workers.
‡Fear of getting COVID-19, possible to get (severe) COVID-19, ever had COVID-19, and knowledge of any person who have had COVID-19.
§Importance of COVID-19 vaccination, fear of having severe side-effects from COVID-19 vaccination, protection from receiving COVID-19 vaccination, trust for the health workers who give COVID-19 vaccination, trust for the government who made COVID-19 vaccination available.
¶Ever heard COVID-19 vaccination was available for receipt and knowledge of a COVID-19 vaccination place.

electronic questionnaire to be sent to them via online platforms. For those who give consent and permission, the address or phone number of their preferred online platform will be recorded and the web link for the questionnaire will be sent to their private online pages. They will be implored to forward the web link to other health workers that they know within the study area after they have completed the questionnaires. The research team will send the web link for the questionnaire to the online contacts (such as WhatsApp phone numbers) of as many eligible health workers as possible, including both private and group pages. Interviewers will also use convenience sampling in administering the health workers' questionnaire (via KoBoCollect installed in android devices) to those who do not have online contact and those living in remote areas with poor internet connectivity. About five to six eligible health workers, both those who have received and those who have not receive COVID-19 vaccination, will be selected purposively for FGDs.

Data analyses

Data will be analysed using Stata/SE V.15.1 (Stata Corp, College Station, Texas). Analyses of the community members data will be based on population-averaged models that account for clustering. Point estimates of the outcome measures will be computed for each comparison group as defined in the study hypotheses. Each hypothesis with dichotomous or categorical independent factor will be tested by computing prevalence difference (with 97.5% CI and p values) in binary outcome measure using binomial identity, and mean difference (with 97.5% CI and p values) in continuous outcome measure using Gaussian identity, generalised estimating equations (GEE) with an exchangeable correlation matrix and robust standard errors. Each hypothesis with continuous independent factor will be tested by computing coefficient (with 97.5% CI and p values) in binary and continuous outcome measures, respectively, using the binomial identity and Gaussian identity GEE models.

For each independent factor (in a hypothesis) being tested, adjusted analysis will be done by inputting into the GEE model the other independent factors as appropriate. For clarity, the potential independent factors to control for are presented in table 3. Both unadjusted and adjusted results will be reported. If the binomial identity GEE model fails to run or convergence is not achieved, Gaussian identity GEE model or generalised least square random-effects linear regression model (with robust standard errors) or maximum likelihood random-effects linear regression model will be used instead.[87]

The same analytic technique will be used for the analyses of the health workers' data except that generalised linear model with robust SEs will be used in place of GEE model because of the absence of cluster design in the health worker survey.

Summary statistics will be used to assess COVID-19 vaccination acceptance (the intention to receive, timeliness of the intention to receive, uptake and hesitancy); COVID-19 experiences and perceptions; COVID-19 vaccination expectations and perceptions; COVID-19 vaccination process experiences and perceptions; knowledge, attitude and practices about COVID-19 and sources of information about COVID-19 among community members and health workers.

The qualitative data (FGD transcripts) will be analysed thematically based on predetermined themes in the study's conceptual framework. The qualitative data will be analysed, interpreted and presented independently of the quantitative data.

Ethics and dissemination

Ethical approval for this study was obtained from the Ebonyi State Health Research and Ethics Committee (EBSHREC/15/01/2022–02/01/2023) and Research and Ethics Committee of Alex Ekwueme Federal University Teaching Hospital Abakaliki (14/12/2021–17/02/2022). The investigators will obtain verbal consent/permission from the heads of the selected clusters.

During the household survey, the interviewers will obtain verbal consent from the household members aged 18 years and above and assent from household members aged less than 18 years (after obtaining consent from the heads of households). The health workers will be informed that only those that give consent should take the online survey. The moderators of the FGDs will obtain verbal consent from the respondents before each FGD.

The purpose the study, the kind of participation, likely duration of participation, voluntary nature of participation, absence of potential harm, potential benefit and confidential nature of the study will be communicated to participants as required. The online record of the anonymised quantitative data will be passworded and the audio recordings and the electronic verbatim transcript of the FGDs will be stored in a passworded computer to prevent unauthorised access.

Study findings will be reported at local, national and international levels in high impact peer-reviewed journals and conferences as appropriate.

Patients and public involvement

Patients or the public were not involved in the design and reporting or dissemination plans and will not be involved in the conduct of our research.

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