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'Why Should I Take the COVID-19 Vaccine after Recovering from the Disease?' A Mixed-methods Study of Correlates of COVID-19 Vaccine Acceptability among Health Workers in Northern Nigeria

Zubairu Iliyasu[a], Muhammad R. Garba[a], Auwalu U. Gajida[a], Taiwo G. Amole[a], Amina A. Umar[a], Hadiza M. Abdullahi[a], Aminatu A. Kwaku[a], Hamisu M. Salihu[b] and Muktar H. Aliyu[c]

[a]Department of Community Medicine, Bayero University, Kano, Nigeria; [b]Department of Family and Community Medicine, Baylor College of Medicine, Houston, Texas, USA; [c]Department of Health Policy and Vanderbilt Institute for Global Health, Vanderbilt University Medical Center, Nashville, Tennessee, USA

ABSTRACT

We assessed the acceptability of COVID-19 vaccine, predictors, and reasons for vaccine hesitancy among clinical and non-clinical staff at a tertiary hospital in Kano, northern Nigeria.

Using a mixed-methods design, structured questionnaires were administered to 284 hospital staff, followed by 20 in-depth interviews with a purposive sub-sample. Logistic regression and the framework approach were used to analyze the data.

Only 24.3% (n = 69) of the respondents were willing to accept the COVID-19 vaccine. Acceptance was lower among females (Adjusted Odds Ratio (aOR) = 0.37, 95% Confidence Interval (95%CI): 0.18–0.77 (male vs. female), nurses/midwives (aOR = 0.41, 95%CI:0.13–0.60, physicians vs. nurses/midwives), persons not tested for COVID-19 (aOR = 0.32, 95%CI 0.13–0.79) (no vs. yes) and those who perceived themselves to be at low risk of COVID-19 (aOR = 0.47, 95% CI,0.21–0.89, low vs. high). In contrast, vaccine acceptance was higher among more experienced workers (aOR = 2.28, 95%CI:1.16–8.55, ≥10 vs. <5 years). Vaccine acceptance was also higher among persons who did not worry about vaccine efficacy (aOR = 2.35, 95%CI:1.18–6.54, no vs. yes), or about vaccine safety (aOR = 1.76, 95%CI: 1.16–5.09, no vs. yes), side effects (aOR = 1.85, 95%CI:1.17–5.04, no vs. yes), or rumors (aOR = 2.55, 95%CI:1.25–5.20, no vs. yes). The top four reasons for vaccine hesitancy included distrust, inadequate information, fear of long-term effects, and infertility-related rumors.

Concerted efforts are required to build COVID-19 vaccine confidence among health workers in Kano, Nigeria.Our findings can help guide implementation of COVID-19 vaccination in similar settings.

KEYWORDS

COVID-19; vaccine hesitancy; vaccine acceptance; health workers

Introduction

BACKGROUND

An outbreak of a pneumonia-like illness in December 2019 attributed to a novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) quickly evolved into one of the most devastating pandemics in recent memory [1]. By the end of April 2021, coronavirus disease 2019 (COVID-19) had claimed over 3 million lives, with over 150 million confirmed cases [2,3]. Globally, as of May 2020 there were 152,888 reported COVID-19 cases and 1,413 deaths among health-care workers (HCWs) [4], with a crude median mortality of 0.05 per 100,000 [5]. In Africa, more than 10,000 frontline health-care professionals were infected [6], with over 800 cases in Nigeria and 10 deaths among physicians [7,8].

Unprecedented global efforts led to the development and approval of several vaccines for emergency use within 1 year [9]. Countries including Nigeria prioritized high-risk HCWs, strategic leadership, and first responders to receive the vaccines [10]. Apart from being potential victims of COVID-19 and spreaders, HCWs constitute trusted key stakeholders and role models [11]. Their opinions on COVID-19 vaccine safety and efficacy could influence both public perception and uptake of the vaccine [12]. Beyond that, vaccinating HCWs against COVID-19 could reassure the skeptical public [13]. However, COVID-19 vaccine hesitancy including among health-care workers could constitute a major obstacle for attaining herd immunity [14]. The acceptance of COVID-19 vaccine among HCWs and reasons for vaccine hesitancy could be context-specific and vary among the health-care professions [15]. Understanding the complex mix of the drivers, motivations, and concerns about COVID-19 vaccines among clinical and non-clinical workers is key to designing targeted interventions to enhance COVID-19 vaccine uptake.

COVID-19 vaccine hesitancy among health-care workers worldwide ranges from 4.3% to 72%, with a pooled mean of 22.5% [16]. The top three reasons

CONTACT Zubairu Iliyasu ziliyasu@yahoo.com Epidemiology & Biostatistics Division Department of Community, Medicine Bayero University, Kano, Nigeria

offered for COVID-19 vaccine hesitancy among health workers include concerns about vaccine safety, efficacy, potential side effects, and accelerated vaccine approval process [16,17]. Prior studies suggest that males and older physicians are more likely to accept COVID-19 vaccines [16]. Other predictors of COVID-19 vaccine acceptance include higher COVID-19 risk perception, direct patient care, and receipt of influenza vaccination [18]. COVID-19 vaccine acceptance rates among HCWs range from 27.7% to 39.3% [19,20] in sub-Saharan Africa and 50.2% to 53.5% in Nigeria [21].

The distrust of vaccines in northern Nigeria is rife, and led to setbacks with the polio eradication program there [22]. We therefore set out to assess the acceptability of the COVID-19 vaccine, and the predictors and reasons for vaccine hesitancy among clinical and non-clinical staff in a major teaching hospital in Kano, Nigeria. We hypothesize that being at high risk of exposure to COVID-19 and being more informed, a substantial proportion of health-care workers should be willing to be vaccinated. In addition, we sought to understand COVID-19 risk perception, facilitators, and barriers to vaccine uptake. Findings reported here can help guide implementation of COVID-19 vaccination in similar settings.

METHODS

Study area and population

The study was conducted over a two-week period in March 2021 at Aminu Kano Teaching Hospital, Nigeria (AKTH), a tertiary referral center for over 13 million people located in Kano, in northern Nigeria [23]. AKTH has a bed capacity of 750 and 3,432 employees. The AKTH immunization clinic operates daily and has cold-chain facilities for vaccines.

The study population includes consenting hospital staff providing clinical care, and non-clinical staff providing administrative and support services at AKTH. The clinical staff included physicians, nurses/midwives, pharmacists, laboratory scientists, physiotherapists, community health officers, and ward attendants. The second category of participants included administrative, management, and support services. Eligible participants had to fulfill the following criteria (1) Employed at Aminu Kano Teaching Hospital as a clinical (physician, nurses/midwives, pharmacists, laboratory scientists, physiotherapists, community health officers, and ward attendants) or non-clinical staff (administrative, management, and support services), and 2) Provided written informed consent. Staff on study/sick leave and those who withheld consent were excluded.

Study design and sampling

This was a sequential, explanatory mixed-methods study deploying a pragmatic paradigm [24]. A structured survey was followed by in-depth semi-structured interviews with a sub-sample of survey respondents. The aim of the in-depth interviews was to illuminate the survey responses [25]. The target sample size for the survey was obtained using Fisher's formula [26], vaccine acceptance among health-care workers from a previous study (27.7%) [19], 95% confidence level, and 5% margin of error. The sample size (n = 308) was increased by 10% to account for the non-response, giving a final sample size of 343.

For the qualitative phase, a stratified purposive sub-sample of 20 survey participants was interviewed to further clarify the responses regarding acceptability, concerns COVID-19 vaccine hesitancy. We interviewed two survey respondents willing to accept the COVID-19 vaccine and two vaccine hesitant participants from each of the following categories: physicians, nurse/midwives, other clinical (pharmacists, laboratory scientists, physiotherapist, community health officers, ward attendants), administrators and other support staff.

Participant recruitment and sampling

We used a two-stage sampling method. In the first stage, the 3,432 staff were categorized as physicians (n = 606), nurses/midwives (n = 1,101), other clinical (pharmacists, physiotherapists, laboratory scientists, community health officers) (n = 596), and non-clinical staff (administrative, management, support services) (n = 1,129). Sample sizes were allotted proportionate to stratum population with samples of 60, 110, 60, and 113 allocated to physicians, nurse/midwives, other clinical and non-clinical staff, respectively. In stage two, after determining eligibility, systematic sampling was used to select participants in each category. After obtaining a sampling interval for each stratum, the first respondent was randomly selected between serial number 1 and the group's sampling interval. Subsequent respondents were obtained by adding the group's sampling interval to the previous respondent's serial number. Sampled workers were then recruited into the study after providing detailed study information and obtaining informed consent.

Measures and data collection

For the survey, we adapted validated structured survey questionnaires from previous studies [27–30]. The first section documented socio-demographic characteristics, including age, sex, marital status, ethnicity, education, religion, number of children, professional category, work experience, and general health status. The second section

assessed self-perceived risk of COVID-19 using the question "How would you assess your chance of getting COVID-19? The responses were on a 5-point Likert scale dichotomized as ('high' [likely, highly likely, extremely likely] or 'low' [unlikely, very unlikely]), whether or not respondent is worried about getting COVID-19, and whether respondent had direct COVID-19 patient care responsibilities and documented previous COVID-19 test. The third section elicited facilitators and barriers to vaccination, including whether respondent was concerned about vaccine efficacy, safety, side effects and rumors. Finally, the fourth section determined vaccine acceptability by asking 'Are you willing to take the COVID-19 vaccine or not?'. Response options include 'I am very keen', 'I am pretty positive', 'not sure', 'I am quite uneasy' and 'I am against it'. Participants who chose "I am very keen' or 'I am pretty positive' were considered as willing to receive the vaccine.

A 10% sample was used for pretest and assessment of the psychometric properties (re-validation and reliability) of the questionnaires at another hospital (Abdullahi Wase Specialist Hospital, Kano, Nigeria). All scales were reliable and sections consistent, with Cronbach's alpha of ≥0.80.

To elucidate survey findings, the qualitative interview guide had open-ended questions with probes for detailed descriptions. The guide explored the motivations for vaccine acceptance and the roots of vaccine hesitancy. All participants provided written informed consent. Confidentiality in reporting qualitative findings was ensured by removing identifiers.

The study protocol was reviewed and approved by the AKTH research ethics committee. Potential participants were individually contacted by trained research assistants and provided detailed information on the study objectives and what participation entailed. They were informed that participation was voluntary. Those who signed an informed consent form were provided a self-administered questionnaire that was retrieved after completion. Two data entry clerks checked and independently entered the data in a password-protected database. To ensure confidentiality, serial numbers were assigned. Research assistants were trained in human research participant protection and the consent process.

Statistical analysis

Data were analyzed using SPSS Version 22 (IBM Corp., Armonk, NY). Means and standard deviation were used to summarize numeric data. Frequencies and percentages were obtained for categorical variables. Pearson's Chi-square or Fisher's exact test as appropriate was used to assess the association between socio-demographic variables, professional categories, work experience, risk perception, and concerns about efficacy, safety, side effects and rumors and the primary outcome, (willingness to be vaccinated against COVID-19) [31]. Type I error was fixed at 5% for all tests. Binary logistic regression models were developed for willingness to be vaccinated. Independent variables with $p < 0.10$ at the bivariate level were included in the logistic regression model [32]. We selected the final model through a backward stepwise approach. Adjusted odds ratios (aORs) and their 95% confidence intervals (CIs) were used to measure the strength and direction of the effect of the independent variables on the outcome. Hosmer–Lemeshow statistic and Omnibus tests were conducted to determine model fitness, with a Hosmer–Lemeshow chi-square yielding p-value of >0.05 considered a good fit [33].

Qualitative data analysis

Qualitative interviews were recorded and transcribed verbatim. Thematic analysis was performed based on the 'Framework Approach' [34] and included familiarization through repeated reading, coding, theme generation, applying the codes to the transcripts, matrix formation, and interpretation. Findings from the two components of the mixed-methods study were integrated [35].

RESULTS

Approximately 83% ($n = 284$) of the 343 sampled workers completed the questionnaire. Less than half of the respondents (46.1%, $n = 131$) were female and the mean age (±standard deviation, SD) was 37.9 ± 10.36 years. Physicians, nurses/midwives, other clinical and non-clinical staff comprised 13.7%, 32.4%, 16.2%, and 37.7% of the respondents, respectively. About one-quarter (26.1%, $n = 74$) of the respondents had direct COVID-19 patient care responsibility, and 15.8% ($n = 45$) had tested for COVID-19 (Table 1).

COVID-19 risk perception, facilitators, and barriers to vaccine uptake

The majority of respondents considered themselves to be at high-risk for COVID-19 infection (68.3%, $n = 194$) and viewed COVID-19 complications as serious (89.7%, $n = 253$).

Most respondents regarded vaccines as generally safe (82.0%, $n = 233$), and of high quality (72.9%, $n = 207$), but the majority considered immunity following COVID-19 infection as superior to vaccination (80.6%, $n = 229$). Similar proportions were worried about COVID-19 vaccine side effects (88.7%), efficacy (80.6%), and safety (83.5%). However, lower proportions were concerned about the vaccine causing the disease (27.8%) and rumors relating the vaccine to infertility and population control (52.8%). Furthermore, lower

Table 1. Characteristics of clinical and non-clinical hospital workers, Kano, Nigeria, 2021.

Characteristics	Frequency No. (%) N = 284
Sex	
Male	153 (53.9)
Female	131 (46.1)
Age group	
<30	71 (25.0)
30–39	94 (33.1)
≥40	119 (41.9)
Ethnicity	
Hausa/Fulani	233 (82.0)
Others*	51 (18.0)
Religion	
Islam	264 (93.0)
Christianity	20 (7.0)
Marital status	
Single	57 (20.1)
Ever Married	225 (79.2)
Professional category	
Physician	39 (13.7)
Nurse/Midwife	92 (32.4)
Other Clinical**	46 (16.2)
Non-Clinical	107 (37.7)
Years of experience	
<5	87 (30.6)
5–9	45 (15.9)
≥10	152 (53.5)
No. of children	
0	80 (28.2)
1	23 (8.1)
2–4	116 (40.9)
≥5	65 (22.9)
Ever tested for COVID-19	
Yes	45 (15.9)
No	239 (84.2)
Has direct COVID-19 patient care responsibilities	
Yes	74 (26.1)
No	210 (73.9)

Others* = Egbira, Igala, Edo, Kanuri, Nupe, Urhobo, Gong, Mwaghawul, Bajju, Babur, Legbo, Margi, Gbagyi, and Bade; Other clinical** = pharmacists, physiotherapists, laboratory scientists, and community health officers

Table 2. COVID 19-risk perception and vaccination willingness (N = 284).

	Frequency n (%)
COVID-19 Risk perception	
Feels his/her chance of getting COVID-19 is high	194 (68.3)
Worried about getting COVID-19	196 (70.0)
Those who get COVID-19 can become very sick	250 (88.0)
Complications of COVID-19 can be serious	253 (89.7)
Facilitators of COVID-19 vaccination	
Vaccines have higher safety standards than other drugs	207 (72.9)
Pharmaceutical companies test vaccines carefully	200 (70.4)
Vaccines are generally safe	233 (82.0)
Vaccination will make me feel less worried about COVID-19	164 (57.7)
Vaccination will decrease my risk of getting COVID-19	168 (60.9)
Will take COVID-19 vaccine when given adequate information on efficacy and safety	197 (69.4)
Barriers to COVID-19 vaccination	
Natural immunity is stronger than vaccine induced immunity	229 (80.6)
The currently approved COVID-19 vaccines can cause the disease	76 (27.8)
Worried about the side effects of COVID-19 vaccine	252 (88.7)
Concerned about the efficacy of COVID-19 vaccines	229 (80.6)
Concerned about the safety of COVID-19 vaccines	237 (83.5)
Concerned about rumors of depopulation & infertility related to COVID-19 vaccines	150 (52.8)
Willingness to be vaccinated	
Very keen/pretty positive about receiving COVID-19 vaccine	69 (24.3)
Will encourage family and friends to take COVID-19 vaccine	100 (35.2)

proportions agreed that vaccines decrease disease risk (60.9%) and would accept to be vaccinated when provided with adequate information (69.4%) (Table 2).

Willingness to be vaccinated for COVID-19

Almost a quarter (24.3%, *n* = 69) of the respondents were very keen/ positive about receiving the COVID-19 vaccine, and only about a third (35.2%, *n* = 100) would encourage family members and friends to take the COVID-19 vaccine.

Predictors of COVID-19 vaccine acceptability

Bivariate analyses showed increasing trends in vaccine acceptability among males, older and married respondents. Significant associations at the bivariate level were also observed with professional category, work experience, direct COVID-19 patient care, COVID-19 testing, risk perception, and concerns about the vaccine safety, efficacy, side effects, and rumors ($p < 0.05$). At the multivariate level, respondent's sex, profession, work experience, previous COVID-19 test, risk perception, and concerns about the vaccine safety, efficacy, side effects, and rumors remained independent predictors of vaccine acceptability.

Female respondents were 63% less likely to accept the COVID-19 vaccination (adjusted odds ratio, aOR = 0.37, 95% confidence interval CI: 0.18–0.77). Non-clinical staff, nurses/midwives, and other clinical staff were 67% (aOR = 0.33, 95% CI, 0.11–0.91), 59% (aOR = 0.41, 95% CI, 0.13–0.60), and 26% (aOR = 0.74, 95% CI, 0.24–0.76) less likely to accept vaccination compared to physicians. Those that had ≥10 years' work experience had over two-fold increased likelihood of getting vaccinated relative to those with <5 years work experience (aOR = 2.28, 95% CI: 1.16–8.55). Respondents not previously tested for COVID-19, and those who perceive their risk as low were 68% (aOR = 0.32, 95% CI: 0.13–0.79) and 53% (aOR = 0.47, 95% CI: 0.21–0.89) less likely to accept COVID-19 vaccination, respectively. Lack of concern for vaccine safety and side effects increased the chance of accepting the vaccine by 76% (aOR = 1.76, 95% CI, 1.16–5.09) and 85% (aOR = 1.85, 95% CI, 1.17–5.04), respectively. Finally, respondents that were not worried about vaccine efficacy (aOR = 2.35, 95% CI: 1.18–6.54) and not concerned about rumors (aOR = 2.55, 95% CI, 1.25–5.20) had over two-fold increased odds of accepting the vaccine (Table 3).

Qualitative findings

Themes from qualitative interviews indicate that HCWs were aware of colleagues and patients who had COVID-19:

'Yes, I am aware of some clinical staff that got infected with COVID-19. Though some had mild symptoms, I know of a senior colleague that suffered to the extent that he was placed on mechanical ventilation.' – Physiotherapist, 39 years old

'Yes, so many hospital workers got infected. The ones I know are clinical staff, even some of our doctors here in the GOPD got infected and I have seen like three or four patients who tested positive for COVID-19.' Physician, Family Medicine, 50 years old

A HCW narrated her experience after contracting COVID-19, but expressed doubt about the need for vaccination following the natural infection:

'After exposure to COVID 19, I was isolated for three weeks and tested negative repeatedly. I know I have developed antibodies against the virus, but can't say how long the antibodies will be protective. The main question is why would I get vaccinated after recovering from COVID-19? What is the difference between a person who recovered from the disease and someone who receives the vaccine? If there is no difference, I think probably there is no need for me to take the vaccine. If however, the vaccine provides stronger immunity of longer duration and is safe, then I welcome the idea of vaccination.' – Medical laboratory scientist, 53 year old

Themes also indicated that some health workers considered rumors as misconceptions with no evidence, while some non-clinical staff considered them as facts:

'Many people hold negative views against the vaccine and there are lots of misconceptions that it is laced with chemicals to control population by interfering with fertility and all sort of things. I think that is probably not true. There is a need for awareness creation as the acceptability, for now, is still very low.' – Physician, Internal Medicine, 34 years old

'Most people do not trust it. We are thinking that it could have long term effects. From our perception, the white man always has long-term plans when he is giving something free to the third world. So, our fear is that this vaccine might have an effect just as the polio vaccine, it might contain something that will cause infertility to achieve population control. That is why we don't trust this vaccine, honestly.' Information manager, 43 years old

Regarding HCW's readiness to accept the COVID-19 vaccination, themes indicate that, while some non-clinical staff had no intention of getting vaccinated, some were ambivalent, while others, especially the physicians were enthusiastic:

'No single person trusts the vaccine. From those around me, no one is interested and everybody is scared of it, honestly. Even family members, office colleagues, nobody is interested in getting this vaccine.' – Information Manager, 43 years old

"Absolutely, I am eager and I am waiting for the arrival of the vaccine. I have already booked an appointment for my first shot. Physician, Internal Medicine, 34 years old

'No, I don't see myself taking this vaccine, but I will not discourage others from taking it. Maybe if somebody sits me down and explains what the vaccine is all about properly and what it will do, maybe, I will change my mind, but right now with the little I know I don't feel like I want to have it.' Staff Nurse, 49 years old

DISCUSSION

In this mixed-methods study we found that only about a quarter of the respondents were very keen/pretty positive about receiving the COVID-19 vaccine, with over three-fourths concerned about side effects, safety, and efficacy, while half were worried about rumors relating the vaccine to infertility and population control. COVID-19 vaccine acceptability was predicted by respondent's sex, profession, work experience, previous COVID-19 test, risk perception, and concerns about vaccine safety, efficacy, side effects, and rumors. The top four reasons for vaccine hesitancy or rejection were distrust, inadequate information, and concerns regarding long-term effects and infertility-related stories.

The acceptability of the COVID-19 vaccine (24.3%) among hospital staff in Kano was lower than in other parts of Nigeria (50.2%–53.5%) [21], sub-Saharan Africa (27.7%–39.3%) [20], and the Middle East (50.52%–95%) [36–38]. Furthermore, vaccine acceptance in our sample was lower than the figures from parts of Europe (76.9% in France [39],, 91.7% in Germany [40] and 48.6% high acceptance and 23.0% moderate acceptance in France, French-speaking Belgium, and Quebec, Canada [41], and the United States (36%–92.0%) [27,28]. Apart from the timing and composition of the study population, these differences could be attributed to the epidemiological burden of COVID-19, risk perception, access to accurate information, and concerns about vaccine safety, side effects, and rumors. The difference between the US, Europe, and Asia and sub-Saharan Africa in the burden of COVID-19 among HCWs [4,5] could influence risk perception, which is central to the Health Belief Model [42]. Similarly, higher proportions of our participants expressed concern about vaccine safety, side effects, efficacy, and conspiracy theories compared to previous reports from south-east Nigeria [43] and the United States [27]. Likewise, limited access to scientific information about COVID-19 vaccine development, the approval process and the infodemic of social media propagated rumors and misinformation regarding COVID-19 vaccines could contribute to vaccine hesitancy [44]. Previous studies also identified broader political, religious, social, and historical influences on vaccine hesitancy [45].

Table 3. Logistic regression model for predictors of hospital workers' acceptability of COVID-19 vaccination, Kano, Nigeria (N = 284).

Characteristics	N	Hospital workers' willing to accept COVID-19 vaccination No. (%)	p-value	Crude OR (95% CI)	Adjusted OR (95% CI)	p-value
Sex			0.001*			
Male	153	49 (32.0)		Referent	Referent	
Female	131	20 (15.3)		0.38 (0.21–0.69)	0.37 (0.18–0.77)	0.002*
Age group			0.005*			
<30	71	7 (9.9)		Referent	Referent	
30–39	94	28 (29.8)		3.88 (1.58–9.51)	1.45 (0.37–5.70)	0.99
≥40	119	34 (28.6)		3.66 (1.52–8.78)	1.01 (0.19–5.39)	0.46
Ethnicity			0.56			
Hausa/Fulani	233	55 (23.6)		–	–	
Others*	51	14 (27.5)		–	–	
Religion			0.94			
Islam	264	64 (24.2)		–	–	
Christianity	20	5 (25.0)		–	–	
Marital status			0.012*			
Single	59	7 (11.9)		0.35 (0.15–0.82)	1.10 (0.30–4.00)	0.89
Ever Married	225	62 (27.6)		Referent	Referent	
Professional Category			<0.001*			
Physician	39	22 (56.4)		Referent	Referent	
Nurse/Midwife	92	13 (14.1)		0.13 (0.05–0.30)	0.41 (0.13–0.60)	0.037*
Other Clinical**	46	14 (30.4)		0.34 (0.14–0.82)	0.74 (0.24–0.76)	0.031*
Non-clinical staff	107	20 (18.7)		0.18 (0.08–0.39)	0.33 (0.11–0.91)	0.033*
Years of experience			0.007*			
<5	87	11 (12.6)		Referent	Referent	
5–9	45	11 (24.4)		2.24 (1.18–5.66)	1.32 (0.11–4.40)	0.22
≥10	152	47 (30.9)		3.09 (1.51–6.35)	2.28 (1.16–8.55)	0.024*
Number of children			0.12			
0	80	12 (15.0)		–	–	
1	23	5 (21.7)		–	–	
2–4	116	33 (28.5)		–	–	
≥5	65	19 (29.2)		–	–	
Direct COVID-19 patient care responsibilities			0.001*			
Yes	74	29 (39.2)		Referent	Referent	
No	210	40 (19.1)		0.37 (0.20–0.65)	0.65 (0.30–1.41)	0.28
Ever tested for COVID-19			<0.001*			
Yes	45	21 (46.7)		Referent	Referent	
No	239	48 (20.1)		0.29 (0.15–0.56)	0.32 (0.13–0.79)	0.014*
COVID-19 risk perception			0.008*			
High	194	56 (28.9)		Referent	Referent	
Low	90	13 (14.4)		0.42 (0.21–0.81)	0.47 (0.21–0.89)	0.027*
Concerned about COVID-19 vaccine safety			0.005*			
Yes	237	50 (21.1)		Referent	Referent	
No	47	19 (40.4)		2.54 (1.31–4.91)	1.76 (1.16–5.09)	0.039*
Concerned about COVID-19 vaccine efficacy			0.001*			
Yes	229	46 (20.1)		Referent	Referent	
No	55	23 (41.8)		2.86 (1.53–5.35)	2.35 (1.18–6.54)	0.012*
Concerned about side effects of COVID-19 vaccine			<0.001*			
Yes	252	53 (21.0)		Referent	Referent	
No	32	16 (50.0)		3.75 (1.76–8.00)	1.85 (1.17–5.04)	0.023*
Concerned about rumors related to infertility/de-population			<0.001*			
Yes	150	19 (12.7)		Referent	Referent	
No	134	50 (37.3)		4.10 (2.26–7.44)	2.55 (1.25–5.20)	0.01*

*Significant at $p < 0.05$; OR: Odds Ratio, CI: confidence interval

Hosmer-Lemeshow Chi-square = 10.7, p = 0.22

The logistic model includes the following variables: Respondent's sex, age group, marital status, professional category, years of experience, previous COVID-19 test, COVID-19 risk perception, concern about COVID-19 vaccine safety, concern about COVID-19 vaccine efficacy, concern about COVID-19 vaccine side effects, and concern about rumors related to infertility/depopulation.

The low overall acceptance of COVID-19 vaccines among HCWs has implications for the general public, considering the strong influence of HCWs on societal health behavior. It is expedient to develop communication strategies to overcome vaccine hesitancy among health workers. This recommendation is buttressed by themes hinging vaccine acceptance on the provision of more information about the COVID-19 vaccine safety. There is also a need for continuous professional education to boost vaccine confidence and uptake among HCWs.

Gender differences with lower acceptance among female respondents were also reported in other studies from the Democratic Republic of Congo [19]

Ghana [20] and the United States [27]. This could be due to a higher disease risk perception among men [19], and the fear of unknown effects of the COVID-19 vaccine on the female reproductive process, especially considering the rumors linking vaccines to infertility and population control [46]. Variations by professional category could also be attributed to differences in exposure to vaccinology courses, clinical and personal experiences with new vaccines [20]. Paradoxically, though nurse/midwives provide immunization services in the study setting, with physicians and pediatricians dealing only with referrals, nurses/midwives had the lowest COVID-19 acceptance among HCWs. This finding concurs with reports from Hong Kong [47] and France [48]. This trend is worrisome, considering nurses' direct and prolonged contact with patients, and constituting the majority of the health workforce in developing countries. Understanding the drivers of vaccine hesitancy among health-care professionals would entail exploring and strengthening the pre-qualification vaccinology curriculum and addressing vaccine misconceptions and misinformation. Cumulative knowledge and work experience could operate through enhancing vaccine confidence and acceptance [19,49]. The predictive role of a prior COVID-19 test could also be linked to risk perception, as those at increased risk are more likely to be tested and accept the vaccine [50]. In contrast, concerns about efficacy, safety [49], as well as side effects reported in Ghana [20], the Eastern Mediterranean region [49] and United States [51], and rumors could inhibit vaccine uptake. Rumors and distrust could be part of the legacy of the controversy that trailed the polio eradication efforts, where vaccination was discontinued in northern Nigeria following false claims that the polio vaccine was laced with chemicals meant to sterilize Muslim girls [52,53]. In addition, the fallout of a clinical trial among children during a meningitis outbreak raised concerns about new drugs and vaccines. Regarding vaccine efficacy, the dilemma of frontline professionals on the necessity for vaccination following recovery from COVID-19 could be related to the uncertainty about duration of immunity from vaccination and natural infection [54]. This knowledge gap could explain the high proportion of respondents indicating that natural infection confers better immunity than the vaccine. Other concerns were that the vaccine was still in a trial, as reported by others [49], and the fast-tracked approval expressed during in-depth interviews [6].

A strength of our study is the mixed-methods design and its timely conduct just before COVID-19 vaccine roll out in Nigeria. In addition, the inclusion of non-clinical staff as a sub-group also provides valuable information from an important subgroup of health workers. However, there were limitations. First, the study was conducted in one tertiary hospital in northern Nigeria, necessitating caution when extrapolating the findings to other parts of the country and lower levels of the health system. Second, the survey was conducted at a single point in time during a rapidly evolving pandemic – attitudes toward vaccination could change over time as more people are vaccinated with no untoward effects.

CONCLUSION

Covid-19 vaccine acceptance was low in our study population, especially among nurses and non-clinical staff and was positively influenced by male gender, work experience, risk perception, and prior of the COVID-19 test. In contrast, concerns about the vaccine safety, efficacy, side effects, and rumors had negative effects on vaccine uptake. We recommend concerted efforts to better understand the origins of vaccine hesitancy and develop effective ways to reduce fear and build public confidence in COVID-19 vaccines using experienced, eloquent peers. Health-care workers and other support staff should be well informed about vaccines and the approval process through continuous professional education, get vaccinated, and be able to effectively communicate the benefits of vaccinations to their patients and community members.

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ORCID

Muhammad R. Garba http://orcid.org/0000-0001-6365-7091
Aminatu A. Kwaku http://orcid.org/0000-0003-3604-231X

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