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"It's easier to deal with the vaccines you know than the ones you don't know": A qualitative study on healthcare workers' vaccine confidence in Nigeria☆

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1. Introduction

Vaccination is a cost-effective public health intervention that has saved many lives and improved well-being [1]. Between 2011 and 2020, over 20 million deaths were believed to have been averted due to vaccinations in GAVI supported countries [2]. Moreover, globally, Carter et al. estimated additional 51 million deaths are expected to be prevented from vaccines between 2021 and 2030 [3]. Yet, despite the importance of vaccines, there have been concerns about low uptake of vaccines globally [4,5]. This concern was accentuated during the COVID-19 pandemic. Waning vaccine confidence has been recognized as a leading threat to global health [4–6].

Vaccine hesitancy has been defined as a delay in acceptance or refusal of vaccines, despite their availability [7]. It is a complex social phenomenon, which may vary by vaccine type, context, and time [8]. In contrast, vaccine confidence is trust in vaccines, providers, and the processes and policies behind vaccine recommendation [7,9]. Building trust in vaccines is needed to reduce vaccine hesitancy. Healthcare workers are a trusted source of information about vaccines, and they play an important role in shaping public perception and confidence in vaccines [10,11]. However, studies have shown that vaccine confidence is waning among healthcare workers [12–15]. As healthcare workers are central to immunization program delivery, decreasing vaccine confidence among them can have far-reaching negative effects on vaccine uptake.

Nigeria has the second highest number of zero-dose children in the world [6]. Parts of Nigeria also have a long history of low vaccine confidence [16,17]. The most notable example is the boycott of the polio vaccine in 2003 in Northern Nigerian, where the population refused uptake due to concerns around vaccine contamination with infertility agents, HIV, and cancerous agents [18,19]. Reasons for the boycott stemmed from multiple complex factors: i) long standing distrust of biomedical medicine; ii) concerns around the US wars in the Middle East; iii) not trusting anything free; iv) a Pfizer clinical trial failing to follow ethical approvals; v) broad political distrust [18,19]. Many of these same challenges have contributed to the current low vaccine confidence and uptake in Nigeria [19]. Specifically, COVID-19 vaccine confidence was observed as low among Nigerian healthcare workers. Some of the distrust could be attributable to the implementation challenges faced by the COVAX (COVID-19 Vaccines Global access) alliance's efforts to provide innovative and equitable access to the COVID-19 vaccine [20]. They failed to reach this laudable goal and generated increased distrust due to issues relating to vaccine nationalism and property rights.

As newer vaccines have recently been rolled out or are planned in Nigeria (e.g. rotavirus vaccine in August 2022, HPV in 2023, and

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malaria in December 2024) [21,22], ensuring healthcare workers confidence in new vaccines is important for achieving rapid coverage. Despite their importance, there is limited literature on how healthcare workers from Africa, and Nigeria specifically, perceive vaccines today. This knowledge can support the development of theoretical frameworks on healthcare worker vaccine confidence, as well as interventions to improve their confidence in the existing and newer vaccines, along with eventually improving vaccine uptake overall. We therefore aimed to understand healthcare workers perception of existing and emerging vaccines, their concerns, or fears, reasons for these and how these influence their confidence in vaccines.

2. Methods

2.1. Study design

This is a qualitative narrative study using reflexive thematic analysis with an interpretivist approach [23]. We conducted semi-structured interviews with healthcare workers in Jigawa and Oyo states between May 2023 and September 2023. These interviews formed the formative phase for the development of a survey tool to measure healthcare worker vaccine confidence and for a feasibility study on use of a social media intervention to improve vaccine confidence among Nigerian healthcare workers. We followed the Consolidated Criteria for Reporting Qualitative Research guidelines for reporting of this study [24].

2.2. Conceptual framework

We used the WHO "3 Cs" model as a guiding framework for this study – confidence, complacency, and convenience [7]. In the model, confidence is the trust in the effectiveness and safety of vaccines, the system that delivers them and the motivation of policymakers who decide on the needed vaccine. Complacency is when vaccination is deemed as unnecessary and convenience relates to when physical availability, affordability, and willingness to pay, and geographical accessibility affect vaccine uptake [7]. The framework guided the development of our semi-structured interview guide but was not utilized for the analysis as that was done inductively.

2.3. Setting

We conducted the study in Oyo and Jigawa states which are in southwest and north-west geopolitical zones of Nigeria, respectively. In Oyo, participants were selected across different facilities in Ibadan, which is the capital of Oyo state. Oyo state has poor vaccine performance indicators compared to other neighboring states, with 39.4 % of children 12–23 months of age having received all basic immunizations.

Jigawa state is an agrarian region with an estimated population of 7.9 million people. Under-five mortality rate in Jigawa is 174 deaths per 1000 live births [25]. There is renewed political commitment towards vaccination which has resulted in improvement in vaccine coverage. Among children aged 12–23 months in Jigawa in 2021, 43.2 % received all basic vaccines compared to just 1.8 % in 2016 [25].

2.4. Participants and sampling

We recruited healthcare workers who provided clinical and preventive healthcare services to patients in public and private health facilities. We purposively selected healthcare workers with questions or concerns about some vaccines to better understand these views. We used purposive and snowball sampling approaches. Maximum variation sampling was used to include participants of various health professions (doctors, nurses, community health workers), who work at different levels of care (primary, secondary, and tertiary), and have different levels of education and work experience (see Table 1). In Nigeria, doctors undergo six years of undergraduate medical training followed by a mandatory one-year internship program to become a medical officer. Postgraduate medical training involves another 4–6 years of residency in a teaching hospital. Doctors primarily provide medical care in secondary and tertiary healthcare facilities. While their direct involvement in vaccine delivery is limited they are important community leaders whose views are influential. The nurses complete three to five years of training, either through diploma programs or university degrees, and are directly involved in patient care and vaccine administration at primary, secondary or tertiary health facilities. The community health workers, include Community Health Officers (CHOs) and Community Health Extension Workers (CHEWs), are trained for two to four years and serve as frontline healthcare providers in the primary healthcare settings, where they are fully involved in vaccine delivery and community engagement. In states with low human resources for health care, community health workers provide clinical care in secondary or tertiary healthcare facilities.

Table 1
Summary Statistics of Healthcare Work Interview Participants Characteristics.

Characteristics	Jigawa ($N = 8$)	Oyo ($N = 11$)
Gender		
Female	6	9
Male	2	2
Profession		
Community health workers	5	4
Nurse	3	3
Doctor	0	4
Level of care		
Primary	3	4
Secondary	4	2
Tertiary	1	5
Level of education		
National diploma	5	3
Tertiary	3	6
Postgraduate	0	2
Involved in immunization programme delivery		
No	6	4
Yes	3	7

After 4 pilot interviews in Oyo State and 5 in Jigawa State, a snowballing sampling approach was used. The sampled healthcare workers needed to have expressed or were known to have concerns about vaccines identified through fellow colleagues and peers. These participants were independently approached by the researchers for participation. Patients or the public were not involved in the design, conduct, reporting, or dissemination plans of our research.

2.5. Data collection

The interviews were conducted face-to-face ($n = 14$) or via videoconference ($n = 5$) depending on the participant's preference. Interviews lasted between 28 min and 1 h 34 min, the variation in duration of interviews were determined by the depth of participant responses and level of engagement. To ensure data quality, face-to-face interviews were conducted at the participant's place of work in a separate private room. Video conferences were conducted at the participant's home or in a private place at their place of work depending on the participant's preference and convenience. All interviews were audio-recorded with the participants' consent. Prior written consent was obtained before the interviews. Then verbal consent was sought before commencement of the recording during the interview. Participants were allowed to withdraw at any time and were informed that the interviews were for research purposes. The participants were reimbursed for transport/internet credit after participating in the interviews. Confidentiality was maintained by de-identifying transcripts and storing recordings securely in cloud storage folder accessible to the research team only. The audio recordings were archived for transcription and verification purposes only. Data was collected until informational power was reached. Interviews were conducted by two researchers, KOA and HU respectively.

Both are female researchers with a master's degree and experience in qualitative interview techniques. They are fluent in English language and local dialects. The interviewers had no formal relationship with the participants. For each interview session, a second researcher was present to serve as a note-taker. We did not conduct repeat interviews. A few pilot interviews (5 in Jigawa and 4 in Oyo) with HCWs were conducted to test the interview guide and determine the sampling approach, which were not included in the results. A semi-structured interview guide was developed based on our theoretical framework to answer the research question and understand perceptions of vaccines and underlying factors influencing these perceptions s (see Appendix 1). The interview process allowed for open-ended probing based on the participants responses and included an activity to have participants rate their level of trust in authorities, pharma industry, regulatory boards (international and national), scientific evidence, and faith-leaders in the community regarding vaccination.

Data analysis All data was analyzed using Braun and Clarke's inductive thematic analysis by AAB, EG, KOA, and SHvW with input and support from the rest of the author team [26]. Following translation and transcription, EG, HU, and KOA first independently reviewed the data for completeness and accuracy. Next, EG and KOA both blindly coded the data to generate initial descriptive codes. Each coder created categories and an initial coding mind map, which were presented and discussed with AAB and SHvW to search for themes. EG and KOA then collaboratively returned to the data to review and refine the themes. New mind maps were generated based on the observed data and discussed with the entire team. From there the themes were further defined and named by cross checking with the original data and then discussed again. There was a total of four rounds of theme refining and discussion. Each theme was linked back to the original codes and data text, which allowed us to finalize the coding tree and report using specific participant ideas and quotes. The analysis was done using Nvivo software [27].

2.6. Trustworthiness

Throughout the research process, the team followed the four core strategies for ensuring trustworthiness in qualitative research of credibility, transferability, dependability, and confirmability [28].

Credibility was first sought by having extended engagement during data collection and having an established relationship with some healthcare workers and facilities in both Jigawa and Oyo that proceed the study timeline. A system of triangulation was also used between the interview recording, interviewer reflections, and the note taker data to ensure accurate capturing of the data. Importantly, the team also engaged in active reflexivity through all stages of study from conceptualization and data collection to analysis and write up. Overall, the project is a collaboration between Karolinska Institute, a medical university in Sweden, and Oxygen for Life Initiative, a non-profit organization associated with University of Ibadan in Nigeria, which allowed us to reflect on the insider and outsider position throughout the process. Whilst the insider position allowed us to analyze perspectives from the point of view of a Nigerian healthcare worker, the outsider position allowed for exploration of topics or ideas that were perhaps not apparent in the Nigerian healthcare system. More specifically, KOA and JS are Nigerian and have master's degrees in public health, and EG is an American/Italian female with a master's degree in health economics, management, and policy. AAB is a community health physician and ShvW is a social scientist with extensive experience in qualitative research and vaccine hesitancy. These various cultural and disciplinary perspectives helped us to reflect on the methods and data throughout the analysis process.

Then to improve the transferability of the data we have provided detailed contextual information in the background and setting sections and then reflected on these factors in the discussion. Additionally, in the above section we provide information on the sampling strategy and recruitment process to provide context for which populations the findings might be similarly applicable.

For dependability, detailed documentation was kept throughout the study. All data is being securely stored, and a key is available to link pseudo anonymized data with participants. Notes and decisions on methodology and analysis from team meetings and discussions are all documented. This also assisted us to provide a detailed process of data collection in the section above. Lastly, for confirmability, the team practiced active peer debriefing together and with colleagues and then also constant reflection on positionality, biases, and ideas.

2.7. Ethics

The study follows the ethical principles laid out in the Helsinki Declaration. All data is being stored at Oxygen for Life Initiative per data management regulations. We received approval from Jigawa state ethics committee (ref: JGHREC/2023/151), Jigawa Ministry of Health (ref: MOH/PH/PHRAT/MN/23/003), Oyo State Research Ethics Review Committee (ref: AD/13/479/362 A), UI/UCH ethics committee (ref: UI/EC/23/308) and from the Swedish National Ethics review board (2023–04772–01-471,058).

3. Results

The analysis of the 19 interviews (Oyo = 11, Jigawa = 8) generated four themes and fourteen subthemes (illustrated in Fig. 1). Below we describe each theme in more detail, discuss the subthemes, and provide selected quotes from the data that are illustrative of the theme or category.

3.1. Healthcare worker vaccine hesitancy primarily towards new vaccines

Even though we purposively selected healthcare workers with some level of vaccine hesitancy, many of the healthcare workers had positive sentiments towards the routine immunizations program, and felt they were an effective strategy for reducing disease morbidity. Several even described advocating for vaccination among their patients. One repeatedly called themself "pro-vaccine." Another healthcare worker described the importance of vaccines as prevention. For many of the healthcare workers, the lack of confidence was not due to general issues but was directed towards newer vaccines.

My opinion is [that a] vaccine is a very good aspect of medical care because we all believe that prevention is better than cure. So, we have various vaccines and I think for so many of them, I completely erm subscribe to vaccination and to so many of them. So, I am positively inclined to most but not all. (Oyo #16).

This quote highlights confidence in some vaccines but not all. The main concerns about vaccines were surrounding vaccines offered to healthcare workers such as Hep B and newer vaccines, such as COVID-19 and HPV. The healthcare workers argued that with a new vaccine there are more unknowns surrounding safety, efficacy, and side effects. This indicates that the pace of vaccine introduction is overburdening the healthcare workers and there is not sufficient space and time to understand all the complexities surrounding the vaccine. As one participant explains,

But for new vaccines, we all know, the deal is that once new things [vaccines] are available, what you do is that you worry for yourself and your patient. Let me take covid for example and the usual vaccine for children. You will see that it's easy to deal with the ones you know than the ones you don't know because you are expecting an effect… (Oyo, #11).

The new vaccines are cause for more concern both among the healthcare workers and patients. With routine immunizations, the healthcare workers knew to tell patients or caregivers what side effects to anticipate and how to deal with them, but they felt unable to do that with newer vaccines. These healthcare workers were generally confident about vaccines they have administered for a long time.

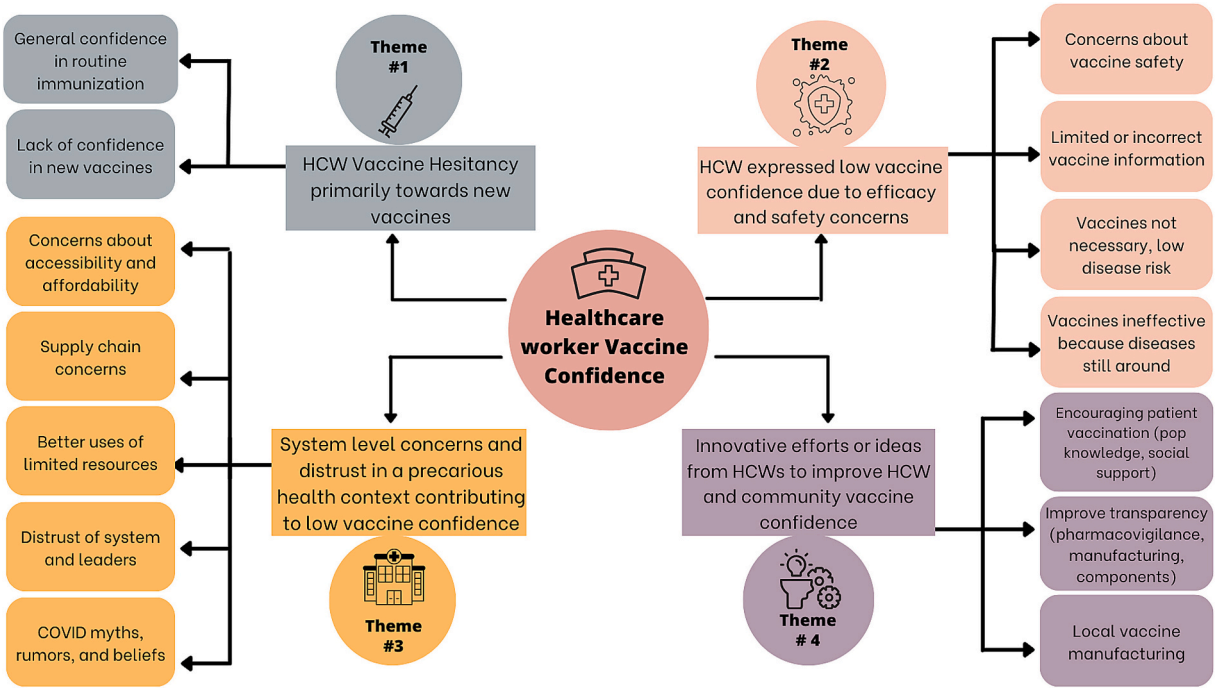

Fig. 1. Nigerian healthcare worker Vaccine Confidence Coding Tree. (Developed with Canvas.com)

3.2. Healthcare workers expressed low vaccine confidence due to efficacy and safety concerns

On the other hand, there were also some healthcare workers who expressed low vaccine confidence across all or most vaccines. It is critical to note that all, except one (Oyo #12), who were hesitant or resistant to all vaccines were from Jigawa state. The reasoning for the low confidence varied, but included limited knowledge, fears around safety, efficacy concerns, even not believing they are necessary at all, and believing vaccine rumors. A few expressed that they did not have sufficient information to feel comfortable recommending vaccination. Such as this healthcare worker from Jigawa who stated:

Let me say, I have partial information on the vaccines…what they use to tell us about new vaccines is just superficial, so I tell my patient based on what I was told. But I don't have deeper understanding of the immunization. (JIG #10).

Limited knowledge and receiving only partial information on vaccination was a persistent finding across the data. Some of the healthcare workers thought the vaccine could make one sick or that only children already diagnosed with the disease should be vaccinated. A particular concern was that healthcare workers mentioned that vaccines were not effective because the diseases were not eradicated. The limitations of the training and only a partial understanding of vaccines contributes to some of the healthcare workers failing to see the benefits of vaccines. For example, a few healthcare workers cited recent measles outbreaks or knowing people vaccinated against COVID-19 who still got sick as evidence of vaccine inefficacy. A healthcare worker believed that the continued existence of measles means they are an ineffective strategy for improving health.

…because when you look at most of these vaccines being produced, despite the vaccines are available the virus is still affecting the health of people, many people are still contracting the virus, so I feel there's no need of producing these vaccines since the virus is still in progress, since there's no positive effect, I feel there's no essence of producing these vaccines (JIG #13).

The healthcare worker lacks confidence in the efficacy of the vaccine. This belief that if the virus is still affecting people's health then there is no need for vaccines, highlights a misunderstanding around epidemiological concepts such as thresholds or herd immunity, time lag, disease severity reduction, and efficacy.

In addition to beliefs of vaccine inefficacy, healthcare workers also had concerns about vaccine safety. These concerns were particularly acute for new vaccines, such as COVID-19 and HPV vaccines. Some felt that these vaccines were designed to make people sick. In a particularly clear example, a healthcare worker explains,

I feel the aim of introducing the HPV vaccine is to damage the immune system of the upcoming youths because if they dominate them from their youthful age, they will succeed in having their systems malfunctioning which will later on lead to problem in their future lifetime. (JIG #13).

Here there is a clear misconception and belief in rumors around vaccines' harms. Beyond not trusting the safety or efficacy of the vaccines, a few healthcare workers were complacent and did not think the disease risk warranted vaccination. Illustratively, some did not think that COVID-19 exists in Africa or that it does not affect the Nigerian population since they were used to heat and other infectious diseases.

…like the COVID-19 vaccine, the outcome of covid in Nigeria cannot be compared with the ones outside Africa, so the vaccine is not needed in the country…(JIG #12).

Two mentioned that they do not think HPV or cervical cancer exists because they have never seen it. Thus, vaccines are not needed for these diseases in Nigeria.

But I don't really know the specific disease condition that is been made for. I have not seen anybody that has human papilloma virus. (JIG #10).

This illustrates a lack of knowledge and gaps in the training. Additionally, among those with lower confidence there was complacency about vaccination and thinking that they do not need to actively participate in encouraging vaccination. This was either because they did not believe in the vaccines or since vaccination was not an active part of their duties then it was not their role to encourage vaccination.

3.3. System level concerns and distrust in a precarious health context contributing to low vaccine confidence

Healthcare workers vaccine concerns appeared to be attributable to

the precarious nature of their health contexts. A lack of trust in vaccines and the health systems is illustrated through the healthcare expressed distrust of relevant groups. In describing their level of trust, several ranked their trust of government, authorities, pharma industry, regulatory boards, and scientific evidence as low. Some felt that authorities and the pharmaceutical industry, specifically, were acting out of their own best interest rather than the interest of the population.

Faith leaders in the communities; Authorities, scientific evidence, pharma industry and all of them I will place them on low trust: because they are just be[ing] used to convince people to accept the vaccines. Like I said earlier, in Nigeria, these vaccines are not useful to us, the government is just doing this for her benefits. (Oyo #12).

Another concern was that as a resource limited setting, healthcare workers could not always trust that the vaccines were easily available. They expressed concerns about the accessibility and affordability of certain vaccines. Particularly they mentioned the HPV vaccine as difficult to access and quite costly for the patient, especially as it was not yet introduced into the national immunization program at the time of this study [29,30]. There also seemed to be concerns about vaccine access in rural areas,

I suggest, because when you get to know, that is when you look into it deeply, people in the remote area may not be having good access to quality vaccines.(Oyo #18).

Compounding these accessibility concerns, were worries surrounding the vaccine supply chain. There were also several who mentioned concerns about cold chain management, even among those confident in vaccination overall. There appears to be a sentiment that the vaccines they receive may be of lower quality, expired, or ruined.

For me, I think cold chain has been somewhat challenging in some part, so in primary health care settings it is actually cool, but you know there are some private hospital[s] especially in the rural areas that needs to be educated more on cold chain. (Oyo #11).

Additionally, healthcare workers felt there might be a better use of the limited resources than vaccines. A few, especially those concerned about effectiveness of vaccines, felt that the investment in vaccines could be better utilized by providing protective equipment, drugs for sick patients, and reducing patient out-of-pocket costs. Describing the wasted resources, a healthcare worker said,

Instead, use the money to make our environment clean and free from disease causing agents or buying of drugs for existing diseases and make free in the hospital or make provision of nutritious food for the poor masses. Instead, our [money] is been wasted on vaccines. (Jigawa #10).

Another example of the overall system level distrust are the many rumors, myths, and misinformation surrounding the COVID-19 vaccine. The healthcare workers mentioned that they had heard of different rumors about the COVID-19 vaccine from it making you sick, it kills people, being forced birth control and having a magnet in it. Many of the healthcare workers did not believe these rumors, but some did. In one example, a healthcare worker did not believe in COVID-19 or the vaccine and thought:

All those big countries manufactured the vaccines and they sold it to us at a higher price and they force other countries to buy. So, you see they collected our money and gave us vaccines by force. But I know that the virus was created. Nigeria has to borrow money to buy the covid-19 vaccines. All African countries were forced to buy the covid-19 vaccines and as such they have succeeded in destroying our economy. (JIG #10).

The healthcare workers perspective illuminates the way that the COVID-19 vaccine and some of the gaps in the COVAX effort triggered mistrust in the international commitment and global vaccination efforts.

3.4. Innovative efforts or ideas from healthcare workers to improve healthcare worker and community vaccine confidence

In the face of these system level concerns and misinformation, both generally confident and highly hesitant healthcare workers had ideas on how to improve vaccine confidence in Nigeria. Among those who generally trusted vaccines, they believed their role as healthcare workers is to encourage vaccination and provide information on side effects to patients and the general population. Thus, they would support patients' decision-making during appointments, share information online, and try to keep themselves up-to-date on vaccine developments. Importantly, they expressed a desire for more training and appropriate vaccine information.

Another suggestion was to provide social and economic supports to patients for side effects to encourage vaccination by lessening the burden of concern.

I feel the national program should provide free pain relief to these children so that it will lessen the pain…will reduce much complaints from the parents and other parents who don't usually take their children for immunization will see that something has been done concerning the side effect and they will start taking their own children for immunization too. (Oyo #9).

Going even a step further, a couple of healthcare workers described that more overall social support to reduce hardship among patients could increase vaccination. They described that when people are struggling to provide food, housing, and water to their families, then vaccination is not a top concern. This illustrates the multi-sectoral nature of vaccination.

Also, from a system lens, the healthcare workers expressed wanting improved transparency from authorities, government, pharmaceuticals, and regulatory boards about vaccines. They requested more information about what is in the vaccines, how they are produced, and the side effects. Another healthcare workers mentioned that providing more information on efficacy and clinical trials could improve vaccine confidence.

Another strategy suggested by a few healthcare workers is to have local Nigerian manufacturing. The healthcare workers implied that this would reduce concerns about external influences and the motivations of the pharmaceutical industry and manufacturers.

But, some of those questions wouldn't have arisen if assuming Nigeria has a plant and everybody knows that this production is done among ourselves, there will be less myth in regards to that [vaccine concerns]. (Oyo #18).

Building trust regarding health systems and vaccination, is complex but improving transparency and having local manufacturing could support those efforts.

4. Discussion

This qualitative study aimed to understand vaccination perceptions and reasons for vaccine hesitancy among Nigerian healthcare workers. Data analysis revealed that, one, vaccine hesitancy is primarily a problem with regards to newer vaccines,two, vaccine hesitancy was due to efficacy and safety concerns, three, system level concerns and distrust due to precarious health system constraints influence vaccine hesitancy, and, four, healthcare workers are keen to strengthen vaccine confidence through innovative local solutions.

Our first key finding illustrates that it is rather newer vaccines than vaccines in general that pose a challenge for healthcare workers' vaccine confidence. This is consistent with research from other context that have been traditionally vaccine confident such as Ethiopia where confidence in newer vaccines has caused vaccine hesitancy among healthcare workers and the population [31,32]. Concerns over new vaccines may be correlated with the COVID-19 pandemic where healthcare workers had concerns over the pace of which COVID-19 vaccines were developed and introduced, concerns over being given inferior quality products than high-income countries, and concerns over side-effects in their populations, since trials were conducted elsewhere [33,34]. Such concerns may have accentuated questions and concerns over the introduction of other new vaccines.

Our second key finding suggests that reasons for low confidence in new vaccines are associated with healthcare workers' concerns over

safety and efficacy. Our study showed that healthcare workers lacked confidence promoting newer vaccines as the vaccine benefits and its side effects were poorly understood. This finding echoes studies from COVID-19 vaccine implementation where healthcare workers resisted the implementation of the vaccine due to fears over lack of evidence on risks in their populations [33]. Moreover, this finding is consistent with a recent systematic review on healthcare worker HPV vaccine confidence, which highlighted that healthcare workers hesitate to recommend the HPV vaccine over safety, side effects and efficacy concerns [35]. The review found that since the HPV vaccine presents with supply interruptions, healthcare workers are less confident in recommending it [35,36].

Our third key finding relates to healthcare worker's trust in authorities and the health system as an influencing factor for vaccine hesitancy. While some healthcare workers expressed concerns over authorities' motives when introducing new vaccines, other healthcare workers expressed more practical concerns over the precariousness of the health system, for example the cold chain or the functioning of the pharmacovigilance system. Trust in the healthcare system has been described as an important factor influencing healthcare worker's vaccine confidence [37,38]. However, few studies describe the perspective of African healthcare workers. While our study confirms the importance of trust in the health system, it also highlights how healthcare workers are navigating a precarious healthcare system where cold chains fail, and vaccine supply is unpredictable. Additionally, in the precarious health contexts some felts that there were better uses of funding than vaccines such as medicines, treatment, or improved health workforce.

It is important to contextualize our findings. In Nigeria, low vaccine confidence is not a new phenomenon. Other historical events have generated distrust and may therefore be partly attributed to our findings. This includes the 2003 polio vaccine boycott and unethical Pfizer clinical trials in Northern Nigeria [16,18,19]. This could explain our somewhat different findings between healthcare workers in Oyo and Jigawa. In Jigawa, the unethical Pfizer trials may have influenced healthcare workers to be more vaccine hesitant given that history than in Oyo [19,39,40]. Thus, as described elsewhere, contextual historical factors strongly influence trust and confidence in new vaccines [41].

4.1. Recommendations

It is interesting to note that many of the healthcare workers in this study expressed that they only had partial vaccine information or lacked a complete understanding of newer vaccines. Thus, our findings underscore the importance of solid training around the introduction of new vaccines where healthcare workers can voice their questions and get responses. Specifically, there should be further education on the importance of herd immunity. Several of the healthcare workers were focused on the individual level impact of the vaccine, rather than the community benefits. Furthermore, health system level concerns leading to volatile availability and potential sub-standard quality need to be addressed. These system level adaptions such as improved cold chain management, increased supply chain control, and enhanced pharmacovigilance could reduce concerns around the safety and efficacy of vaccines they receive and administer.

Lastly, local Nigerian or Africa-based vaccine manufacturing could be strategy to increase vaccine confidence. Increasing Africa based vaccine production is a priority for the African Union and many international organizations since the onset of COVID to improve self-sufficiency and vaccination access [42–44]. Our data suggests that manufacturing in Africa and building partnership with regional manufacturing companies may increase vaccine confidence, in addition to the other benefits of local manufacturing such as reduced costs, improved accessibility, and local biotechnology development [44].

4.2. Areas for further research

This study provides an insight into Nigerian healthcare workers perceptions of vaccines and some of their concerns that contribute to low vaccine confidence. To provide further nuance, a study should be done to determine the origin of rumors and myths, maybe through an analysis of social media platforms. Another potential study is to conduct a stakeholder analysis and interviews with relevant policy makers to understand the vaccine roll out process more in Nigeria. This research would be complimented well by a cross-sectional study looking at healthcare worker vaccine hesitancy trends quantitatively. Lastly, it would be beneficial to conduct an implementation science study with participatory methods working closely with healthcare workers to determine and evaluate strategies to improve their vaccine confidence.

4.3. Strengths and limitations

Our study provides a unique lens on Nigerian healthcare workers vaccine confidence illustrating the complexities of trusting vaccines within a precarious and complex health system. The semi-structured nature of the interviews allowed space for the participants to open about their perceptions. To improve the trustworthiness of the results the interviews were all conducted with researchers from same state of Nigeria and utilized a combination of local languages (Yoruba and Hausa) to make the participants more comfortable. The snowballing sampling approach allowed us to concentrate on the inclusion criteria of healthcare workers who had expressed concerns around vaccines but limits the representativeness of the study population. There is also some reporting bias, the participants knew the purpose of the study, and thus might be less willing to report vaccine hesitant opinions.

5. Conclusion

This research highlights that vaccine hesitancy among healthcare workers in Nigeria is primarily an issue concerning newer vaccines. The study highlights concern over safety and efficacy of such vaccines as well as their distrust in authorities and the precariousness of the health system as key reasons for healthcare worker's hesitancy to accept and recommend new vaccines. Their hesitancy is therefore targeted to specific vaccines and stems from legitimate concerns for their communities. As healthcare worker's vaccine recommendations are an important factor determining populations vaccine uptake, they are a particularly influential group. Improving healthcare worker training around vaccines, especially given novel vaccines, is needed. However, addressing their concerns should go beyond just improving education to also including forums where healthcare workers can raise questions and concerns to addressing wider weaknesses in the health system which influence trust. The educational and information sharing efforts should be coupled with regional empowerment in vaccine production, antigen prioritization, and local program ownership.

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CRediT authorship contribution statement

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Usman: Writing – review & editing, Data curation. **Claudia Hanson:** Writing – review & editing, Methodology. **Adegoke G. Falade:** Writing – review & editing, Supervision, Conceptualization. **Sibylle Herzig van Wees:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Appendix

HEALTHCARE WORKER-TRUST: Qualitative Interview Guide for Healthcare workers

✓ Introduce the study (explain confidentiality) and yourself
✓ Get consent
✓ Get consent for recording
✓ Explain that there are no right or wrong answers

1. In general, what is your opinion on vaccines in the national immunization programme? (this is a warm up question, don't spend too much time on it since the focus of the research is on new vaccines)
2. Do you have concerns about vaccines that are part of the national programme? (ask for specific examples)
3. What do you think about the recently introduced HPV vaccine?
   a. Is it safe?
   b. Is it important/effective?
   c. Is it available?
4. What do you think about the recently introduced COVID-19 vaccine?
5. Can you think of a rumour you faced about the COVID-19 vaccine when it was introduced.
   a. What did you think about it?
   b. Did it scare you?
   c. What did you do about it?
   d. Did your views affect whether you recommend the vaccine or not?
   e. Did your views change?
6. What is your role as a healthcare worker in promoting new vaccines?
7. In recent years there have been some new vaccines introduced. How do you feel when new vaccines get introduced? (Can you use specific examples to illustrate your experience). (There may be some overlap with above. It is ok if there is a bit of overlap). **[If healthcare workers describe that it is hard to introduce new vaccines, make sure to follow up: why was it hard, what was hard, how did you overcome it, what was your role?]**
   a. Are you confident about them?
   b. Do you have enough information about them to recommend them to your patients?
8. If you are faced with rumors about vaccine side effects by your patients, how do you deal with them?
9. If you are faced with rumors about vaccine side effects by your friends and family, how do you deal with them?

Now we will talk a little bit about your engagement with information on different platforms.

10. Where do you get your information about scientific knowledge on new vaccines? (Please give specific examples)
11. Are you personally active on social media [insert appropriate local word/slang word]? Can you describe what platforms you use (e.g. WhatsApp, Facebook, Twitter etc.)
12. On these platforms, have you seen messages related to healthcare advice? (ask for examples, including which social media platform)
13. On these platforms, have you seen messages related to the introduction of new vaccines? (ask for examples, including which social media platform)
14. [If questionable health or vaccine information was shared, ask follow up questions: What did you do when you saw this poor information? What do you think is your role when you see wrong information in social media platforms?]
15. Can you comment on these institutions (lay out cards) and explain to what extent you trust them (in relation to vaccines) (order them in three groups: high trust, medium trust, no/low trust – please take a picture of it.)
    a. Authorities, pharma industry, regulatory boards (international and national), scientific evidence, faith-leaders in the community (others: context specific ones/leave a blank card for this)

Data availability

Data will be made available on request.

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