




# BMJ Open Assessing knowledge, attitude, practice and training related to COVID-19: a cross-sectional survey of frontline healthcare workers in Nigeria

Theddeus Iheanacho,<sup>1</sup> Elina Stefanovics ,<sup>1</sup> Ugochi Genevieve Okoro,<sup>2</sup> Udo Ego Anyaehie,<sup>3</sup> Paschal Okuchi Njoku,<sup>4</sup> Anthony Ikenna Adimekwe ,<sup>5</sup> Kingsley Ibediro,<sup>6</sup> Glenn A Stefanovics,<sup>7</sup> Angela Haeny ,<sup>1</sup> Asti Jackson,<sup>1</sup> Norbert Ndubuisi Unamba,<sup>8</sup> Godsent Isiguzo,<sup>9</sup> Chinedu Chukwukiro Chukwu,<sup>10</sup> Ugochukwu Bond Anyaehie,<sup>11</sup> Thomas Terence Mbam,<sup>12</sup> Chinyere Osy-Eneze,<sup>13</sup> Ebere Otuomasirichi Ibezim<sup>14</sup>

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For numbered affiliations see end of article.

## Correspondence to

Dr Theddeus Iheanacho;  
[theddeus.iheanacho@yale.edu](mailto:theddeus.iheanacho@yale.edu)

## ABSTRACT

**Objectives** Healthcare workers (HCWs) are at the frontline of efforts to treat those affected by COVID-19 and prevent its continued spread. This study seeks to assess knowledge, attitude and practice (KAP) as well as training needs and preferences related to COVID-19 among frontline HCWs in Nigeria.

**Setting** A cross-sectional survey was carried out among 1852 HCWs in primary, secondary and tertiary care settings across Nigeria using a 33-item questionnaire.

**Participants** Respondents included doctors, nurses, pharmacy and clinical laboratory professionals who have direct clinical contact with patients at the various healthcare settings.

**Analysis** Exploratory factor analysis (EFA) was used to establish independent factors related to COVID-19 KAP. Analysis of variance was used to identify any differences in the factors among different categories of HCWs.

**Results** EFA identified four factors: safety and prevention (factor 1), practice and knowledge (factor 2), control and mitigation (factor 3) and national perceptions (factor 4). Significant group differences were found on three factors: Factor 1 ( $F(1,1655)=5.79$ ,  $p=0.0006$ ), factor 3 ( $F(1,1633)=12.9$ ,  $p<0.0001$ ) and factor 4 ( $F(1,1655)=7.31$ ,  $p<0.0001$ ) with doctors scoring higher on these three factors when compared with nurses, pharmaceutical workers and medical laboratory scientist. The most endorsed training need was how to reorganise the workplace to prevent spread of COVID-19. This was chosen by 61.8% of medical laboratory professionals, 55.6% of doctors, 51.7% of nurses and 51.6% of pharmaceutical health workers. The most preferred modes of training were webinars and conferences.

**Conclusion** There were substantial differences in KAP regarding the COVID-19 pandemic among various categories of frontline HCWs surveyed. There were also group differences on COVID-19 training needs and preferences. Tailored health education and training aimed at enhancing and updating COVID-19 KAP are needed, particularly among non-physician HCWs.

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This is a nationwide study with representation of healthcare workers (HCWs) across various regions of the country.
- ⇒ We completed exploratory factor analysis to identify key domains related to COVID-19 knowledge, attitude, practice and prevention strategies among HCWs in Nigeria.
- ⇒ Analysis of covariance was conducted using the four key factors (safety and prevention, practice and knowledge, control and mitigation, national perceptions) and not individual survey items.
- ⇒ Distribution of the survey electronically through the health professional associations' WhatsApp groups, Facebook pages and Twitter accounts enabled wider reach.
- ⇒ The study used voluntary, non-random, convenience sample of respondents with varying educational backgrounds working in different healthcare settings and locations across Nigeria.

## INTRODUCTION

COVID-19 is caused by a novel human coronavirus (SARS-COV-2).<sup>1</sup> COVID-19 was declared a pandemic by the WHO on 11 March 2020 and since then it has continued to have disruptive impact worldwide on healthcare delivery, public health and economic activities.<sup>2</sup> As of 23 November 2020, according to the Johns Hopkins University Coronavirus Resource Center, WHO and Nigeria Center for Disease Control (NCDC), the disease had affected 58 751 191 individuals globally with 1 389 770 deaths recorded. Out of 191 countries, regions and sovereignty being tracked, Nigeria ranked 81st with the number of confirmed cases at 85 560 and death rate of 1.5% with 1267 deaths as of 30 December

2020.<sup>3-5</sup> Additionally, the number of confirmed cases in Nigeria continued to rise daily.<sup>5</sup> Among healthcare workers (HCWs) in Nigeria, data for COVID-19 infections and deaths are sparse. On 30 December 2020, media reports showed that at least 2175 HCWs contracted the disease and 22 doctors died from it though overall fatality among HCWs remain unknown.<sup>6-8</sup>

Various teams of HCWs (namely, nurses, doctors, laboratory staff and pharmacists) who have direct, face-to-face contact with patients are at the frontline of the medical response to the COVID-19 pandemic.<sup>9</sup> These HCWs are also sources of health education for the public especially those who have symptoms and are seeking care. Thus, HCWs' knowledge, attitude and practice (KAP) related to COVID-19 can have direct impact on their own health as well as on the government's effort to contain the spread of the disease and mitigate its public health consequences.<sup>10</sup> Misunderstanding of the disease among HCWs, negative attitudes towards governments' effort to manage it and any underestimation of its risks can all result in increased spread of infection and worse clinical, economic and social outcomes. Frontline HCWs in Nigeria include doctors, nurses, midwives, medical laboratory scientists, pharmacists and in a lot of rural and semiurban communities, patent and proprietary medicine vendors who are often the first point of contact for the medical care-seeking public and a main source of treatments for acute conditions.<sup>11-14</sup>

Understanding HCWs' KAP about the COVID-19 pandemic at different healthcare delivery settings can help policy-makers and healthcare agencies understand their knowledge gaps and training needs. It can also help in the planning, design and implementation of mitigation strategies such as contact tracing, compliance with universal precautions, vaccine advocacy and immunisation campaigns.<sup>15 16</sup>

There are few studies on the KAPs related to COVID-19 among various cadres of frontline HCWs in Nigeria. In their study, Ejeh *et al*<sup>17</sup> reported 'excellent knowledge' about COVID-19 among HCWs but noted some areas of 'poor knowledge, negative attitudes and unacceptable practices'. Notably, there was poor knowledge about potential protection from COVID-19 due to Africans' genetic makeup, the role of prayer in curing COVID-19 and the protective effect of mask wearing. However, a majority of their samples were veterinary doctors. In their study of HCWs, Mbachu *et al*<sup>18</sup> reported 'good knowledge' and 'preventive practice' but 'poor and indifferent attitude' (exemplified by lack of interest in work and fear of going to work due to COVID-19) among their respondents. However, it was conducted in one state in south eastern Nigeria.

This is a national study to evaluate the KAPs related to COVID-19 among frontline HCWs across different regions in Nigeria including their perceived COVID-19 training needs and preferences. We hypothesised that KAPs will vary by region or work setting, while training needs and preferences will vary by professional group.

## METHODS

### Study design and study participants

This was a nationwide, cross-sectional, secure, anonymous online survey conducted from 16 July to 1 August 2020, with electronic link of the survey shared with HCWs associations in Nigeria on their WhatsApp groups, Facebook pages and Twitter accounts after formal emails, letters, phone outreach and consultation with the leadership of each association by members of the research group. The survey was designed to take an average of 10 min to complete. The study survey link was sent electronically to all the target professional organisations across the six geopolitical zones in Nigeria (south-east, south-south, south-west, north-west, north-east and north-central) and the Federal Capital Territory, Abuja. Respondents were eligible to participate if they were nurses, doctors, clinical laboratory scientists or pharmacists actively working in any clinical setting with direct patient contact. Data collection was done through the electronic link and automatically transmitted and stored on Yale University's Yale Qualtrics Survey Secure Database.

### KAP survey design

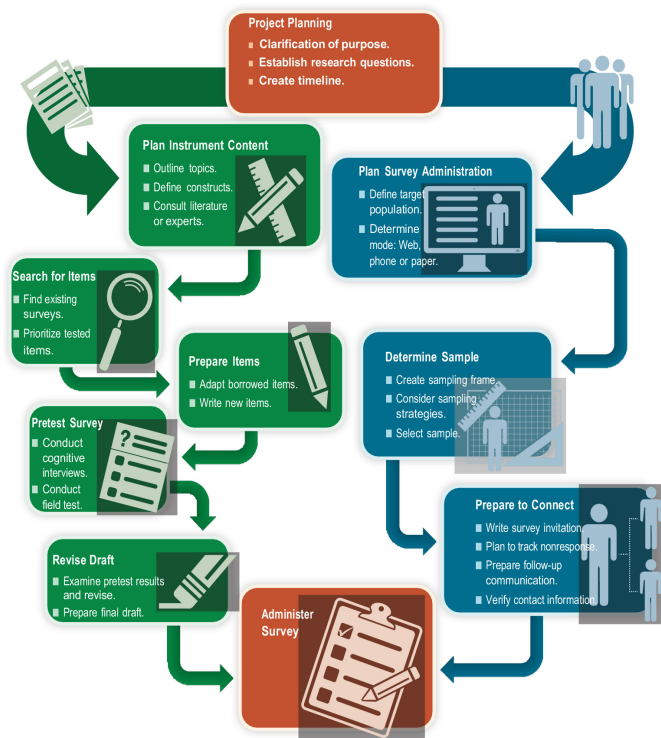
The survey consisted of two parts, the first part contained six items covering respondents' sociodemographics and work setting. The second part of the survey contained 33 items that assessed the respondents' KAP and training needs and preferences related to the COVID-19 pandemic.

There were nine items that focused on knowledge of COVID-19 symptoms, transmission, treatment and prevention. Attitude and beliefs about the pandemic were assessed by 10 items, while personal and clinical practice were assessed by 12 items. The final two items asked about respondents' COVID-19 training needs and preferred mode of receiving the training. All KAP items (except two items that pertained to source of information on COVID-19 and knowledge of the clinical symptoms) were recorded on a Likert Scale ranging from 1 to 5 (strongly agree to strongly disagree). The two items on source of information and clinical symptoms as well as the last two items on training needs and preferences offered multiple-choice answers with respondents able to select more than one answer. The items also had a free-text option (online supplemental appendix 1).

The items were developed using the 2020 WHO and NCDC guidelines about the pandemic<sup>2 5</sup> with some items adapted from previously published surveys.<sup>18 19</sup> Overall survey development and design was guided by framework from the US Department of Education's Institute of Educational Sciences<sup>20</sup> (figure 1). The survey items were pretested among eight volunteer representative HCWs, then were piloted among additional 20 volunteer representative HCWs. Iterations to the survey items, design and administration were made based on the feedback from the pretesting and piloting.

### Statistical analysis

First, data cleaning was completed to identify errors and to remove data that were incorrect, incomplete, irrelevant,



**Figure 1** Study survey development and design process. The figure outlines the process from project planning, survey content development, testing to administration.

duplicated or improperly formatted. Only data from respondents who completed all items of the survey were included in the data analysis. Next, descriptive statistics were computed to summarise respondents' self-reported sociodemographic characteristics including gender, age, category of health worker, level of education, years in practice and location of practice. Age groups, HCWs groups and educational attainment were organised for clarity and simplification of analysis. Second,  $\chi^2$  tests were conducted to compare four groups of HCWs across all sociodemographic characteristics.

Third, an exploratory factor analysis (EFA) with the maximum likelihood extraction method was used to identify the underlying set of dimensions of survey responses to the KAP questions. Orthogonal rotations were applied to the initial factor solution to identify the simple structure for interpretation.<sup>21</sup> Sampling adequacy for factor analysis was assessed with the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test.<sup>22</sup> Individual loadings of 0.4 or greater were used in the factor determination. Extracted factors were examined and named based on analysis of the items loading on each factor. Cronbach's  $\alpha$  was calculated to estimate the internal consistency of the items constituting each factor.<sup>23</sup> Factors scores were calculated.

Fourth, analysis of covariance using general linear modelling procedure was used to identify differences in factor score among four groups of HCWs with factor scores as a dependent variable and group membership as an independent variable. These analyses were adjusted for significant differences in sociodemographic

characteristics (at  $p < 0.05$ ). T-tests were then used to examine factor scores of the groups in pairwise comparisons. All analyses were performed using SAS V.9.4 statistical software (SAS Institute). Statistical significance was evaluated at the 0.05 level.

### Patient and public involvement

No patient involved.

### RESULTS

Analytic sample consisted of 1852 individuals out of a possible 2500 (response rate of 74%) participants from the professional associations' membership list. Among them, 52% ( $n=923$ ) were female. Majority of the respondents (69.2%) were young (18–33 years old), 23.4% were 34–49 years old and 7.4% were 50 years and older.

Over two-thirds of the sample reported a hospital as a primary place of work (72%), with others reporting workplaces as being a health centre (12.1%) or pharmacy and medicine shop (15.9%). The majority of the samples (68.3%) were practicing in the southern part of the country, 23.4% in the north and 8.3% were in the federal capital territory. One-third of the sample had a fellowship certificate, diploma or MBBS (35.5%); 25.7% had bachelor's degree; 20.3% had nurse certificate (registered nurse or Bachelor of Nursing); 9.2% had a primary or secondary school certificate; 6.9% had master's degree and 2.3% had a PhD diploma.

For the subsequent analysis, respondents were subcategorised into four groups: doctors (36.6%;  $n=616$ ), nurses (37%;  $n=623$ ), pharmaceutical professionals (12.9%;  $n=217$ ) and laboratory technician or scientist (13.5%;  $n=228$ ). Significant differences between the groups were observed in age, gender, education, place of practice and place of work (table 1).

Maximum likelihood EFA was performed on the sample of 1852 individuals, to extract the underlying factor structure of KAP survey. The number of participants was considered reasonable for factor analysis, exceeding the minimum number of 300 cases as suggested by Tabachnick & Fidell (2007). An examination of the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (MSA) suggested that the sample was factorable (overall measure of sampling adequacy (MSA)=0.87).<sup>22</sup> Inspection of the pattern of eigenvalues and the scree plot suggested that four factors explained most of the variability and were retained for investigation. Based on the orthogonal rotation factor solution with a 0.4 factor loading criterion and scree plot criterion, four factors were identified representing KAP and prevention related to COVID-19. High loadings were evident for the eight positive outcome items on the first factor that included eight items related to safety and prevention of COVID-19 and was labelled safety and prevention (factor 1) (Cronbach's  $\alpha=0.78$ ). The second factor included six items reflecting knowledge about risk factors of COVID-19 transmission and was labelled



practice and knowledge (factor 2) (Cronbach's  $\alpha=0.77$ ). The third factor included four items that focus on use of personal protective equipment (PPE) and access to COVID-19 testing. It was labelled control and mitigation (factor 3) (Cronbach's  $\alpha=0.70$ ). The fourth factor included four items specifically related to perceptions about COVID-19 in the Nigerian national environment and was labelled national perceptions (factor 4) (Cronbach's  $\alpha=0.66$ ). Individual factor loading and factor patterns are shown in [table 2](#).

Significant differences between the four groups of HCWs were found on three factors: safety and prevention (factor 1) ( $F_{1,1655}=5.79$ ,  $p=0.0006$ ), control and mitigation (factor 3) ( $F_{1,1633}=12.9$ ,  $p<0.0001$ ) and national perceptions (factor 4) ( $F_{1,1655}=7.31$ ,  $p<0.0001$ ) with doctors scoring significantly higher on these three factors compared with other groups ([table 3](#)). More specifically, doctors scored higher than nurses and pharmaceutical workers on safety and prevention (factor 1); doctors also scored higher than nurses, pharmaceutical workers and laboratory workers on control and mitigation (factor 3), with nurses having a higher score than pharmaceutical workers. Additionally, doctors had a higher score on national perceptions (factor 4) as compared with laboratory workers and nurses.

Regarding identification of the main clinical symptoms of COVID-19, the most popular response was fever as identified by 78.6% of HCWs followed by cough (69.3%), sneezing (58.4%), sore throat (52.2%), headache (49.1%), runny nose (37.5%), smell disturbance (33.7%), taste disturbance (30.2%), muscle pain (20.8%), diarrhoea (17.7%) and confusion (7.1%). These items were not mutually exclusive.

Overall, the most endorsed sources of information about COVID-19 were official governmental sites (eg, the NCDC, ministry of health) (61.7% of respondents). However, others received this information through the news media (eg, television, radio, newspaper) (53.2%), official international health organisations (eg, WHO) websites (52.4%), social media (eg, Facebook, Twitter, WhatsApp) (45.1%), seminars (30%), a friend (17.6%) and journals (17.5%). Doctors reported that they received COVID-19-related information from WHO (60.9%) and official government websites (64.3%), news media (50.0%), social media (45.0%), scientific journals (27.3%) and seminars (32.9%). Nurses reported that they received majority of the information about COVID-19 from NCDC (60.1%), WHO (47.7%), news media (58.6%), social media (47.7%), seminars (26.8%) and journals (10.9%). Most popular source of

**Table 1** Sociodemographic characteristics stratified by groups of healthcare workers

Variable	Doctors (n=166; 36.6%)		Nurse (n=623; 37%)		Pharma (n=217; 12.9%)		Laboratory workers (n=228; 13.5%)		Statistical test	
	n	%	n	%	n	%	n	%	$\chi^2$	P
Age groups (years)									114.41	<0.0001
18–33	334	54.22	484	77.69	159	73.27	191	83.77		
34–49	213	34.58	115	18.46	41	18.89	26	11.40		
50 and older	69	11.20	24	3.85	17	7.83	11	4.82		
Gender									145.79	<0.0001
Male	369	59.90	183	29.37	120	55.3	143	62.72		
Female	247	40.10	440	70.63	97	44.70	85	37.28		
Education									849.02	<0.0001
School certificate	35	5.80	48	7.80	45	21.03	9	3.96		
Bachelor's degree	250	34.00	217	35.28	110	51.40	188	82.82		
Master's degree	46	7.63	29	4.72	26	12.15	13	5.73		
PhD	24	3.98	3	0.49	6	2.80	4	1.76		
Nurse certificate	27	4.48	306	49.76	11	5.14	3	1.32		
Medical degree	266	44.11	12	1.95	16	7.48	10	4.41		
Region of practice									73.814	<0.0001
FCT Abuja	76	12.34	25	4.01	18	8.29	22	9.65		
North region	183	29.71	101	16.21	59	27.19	55	24.12		
South region	357	57.95	497	79.78	140	64.52	151	66.23		
Place of work									512.79	<0.0001
Hospital	466	75.65	500	80.26	62	28.57	189	82.89		
Health centre	92	14.94	72	11.56	8	3.69	29	12.72		
Pharmacy/patent medicine store	58	9.42	51	8.19	147	67.74	10	4.39		

**Table 2** Factor pattern and items loading

<b>Safety and prevention (factor 1)</b>	<b>Factor 1</b>	<b>Factor 2</b>	<b>Factor 3</b>	<b>Factor 4</b>
Using alcohol-based hand sanitizers can prevent one from contracting COVID-19.	0.7665			
Washing hands with soap and running water for 20 s can prevent one from contracting COVID-19.	0.7410			
Wearing face mask can prevent COVID-19 infection.	0.6065			
Isolation of people who are infected with the COVID-19 is an effective way to reduce the spread of the virus.	0.5641			
To prevent spread of COVID-19, people should avoid going to crowded places (eg, marketplace, shopping mall, banks, etc).	0.5275			
My safety will be my concern if I must attend to a patient with signs and symptoms of COVID-19.	0.4591			
To finally defeat COVID-19, the use of a vaccine is critical and should be encouraged.	0.4520			
When it is available, I will readily accept COVID-19 vaccine and recommend it to my patients.	0.4026			
<b>Practice and knowledge (factor 2)</b>				
I am aware that my workplace has sent at least one patient to be tested for COVID-19.		0.7181		
I know where to send someone for COVID-19 test.		0.6553		
I have worn a mask whenever I am in contact with patients.		0.6032		
I have worn a mask whenever I am in a public place.		0.5235		
I have not been shaking hands with people.		0.5235		
I have avoided contacting family members immediately after coming home from work.		0.4166		
<b>Control and mitigation (factor 3)</b>				
All staff at work have been trained on how to put on and take off the PPE.			0.7966	
At my place of work, PPE is easily accessible to all staff that need them to see patients.			0.7943	
Any healthcare worker in my place of work exposed to COVID-19 gets tested for COVID-19.			0.5737	
In recent days, I have avoided patients with signs and symptoms that look like COVID-19.			0.4051	
<b>National perceptions (factor 4)</b>				
COVID-19 is not a 'big man's' disease.				0.7932
COVID-19 is not a 'white man's' disease and so Africans are not protected from it.				0.7797
COVID-19 is worse than the problems of hunger and poverty in Nigeria.				0.6162
If a person with COVID-19 does not have fever, he/she can transmit the virus to others.				0.4087
PPE, personal protective equipment.				

information among pharmaceutical workers were NCDC (62.7%), WHO (48.4%), news media (53.0%), social media (45.2%), seminars (24%), and scientific journals (14.3%). Finally, for medical laboratory scientists, the most endorsed sources of information were NCDC (79.4%), WHO (67.5%), news media (61.4%), social media (57.5%), health educational seminars (50.4%) and scientific journals (19.3%). The choices were not mutually exclusive.

With regards to training needs, doctors would like to have additional trainings in all aspects of COVID-19 mitigation strategies indicated, specifically on how to use PPE (55.6%), how to reorganise workplace to prevent spread of the infection (52.8%), how to disinfect workplace to prevent spread (51.8%) and how to screen the patients (49.5%). The most preferred mode of training was webinars (51.9%), followed by conferences (47.4%), staff ward meetings (40%) and in-person hands-on training (34.7%).

**Table 3** Comparison of healthcare workers groups on COVID-19-related knowledge, attitude and practice factors

Variable	Doctors (n=166; 36.6%)		Nurses (n=623; 37%)		Pharmacy workers (n=217; 12.9%)		Medical laboratory workers (n=228; 13.5%)		Statistical test		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	F	P	tdiff
Factor 1	4.33	0.52	4.22	0.45	4.32	0.48	4.26	0.43	5.79	0.0006	1>2,3
Factor 2	4.23	0.60	4.22	0.56	4.17	0.60	4.17	0.48	0.83	0.4781	
Factor 3	3.78	0.90	3.57	0.81	3.94	0.81	3.79	0.58	12.9	<0.0001	1,3,4>2
Factor 4	3.74	0.89	3.53	0.70	3.62	0.86	3.57	0.59	7.31	<0.0001	1,4,>2

Nurses similarly requested additional training on workplace reorganisation (51.7%), screening (50.9%), PPE use (47.7%) and disinfection (42.2%). They preferred to receive additional training through conferences (55.1%), webinars (49.1%), staff meetings (46.4%) and hands-on training (31.5%).

Pharmaceutical professionals indicated need for more training in workplace reorganisation (51.6%), screening (50.7%), disinfection (49.3%) and use of PPE (46.1%). Many of them wanted to receive the trainings in forms of conferences (52.2%) or webinars (45.2%), staff meetings (31.8%) and hands-on training (29.5%).

The medical laboratory professionals mostly indicated need of additional training workplace reorganisation (61.8%) and disinfection (43%). Other medical laboratory professionals cited need for training on use of PPE (35.1%) and screening (39.5%). They preferred to receive these trainings at conferences (74.5%) or through webinars (63.2%). Staff meetings (23.1%) and in-person hands-on training (17.1%) were the least chosen options. Respondents could select multiple answers; thus, choices do not sum up to 100%.

## DISCUSSION

In this cross-sectional national survey of various cadres of frontline HCWs from all parts of Nigeria, factor analysis of the questionnaire items and subsequent inspection of eigenvalues and the scree plot suggested a four-factor structure related to their COVID-19 KAP as follows: safety and prevention, practice and knowledge, control and mitigation and national perceptions. Although there were some significant differences among different cadres of HCWs, most respondents had a good understanding of the basic facts about COVID-19 including its clinical presentation, mode of spread and prevention measures. These findings suggest that public health campaigns embarked on by the responsible health agencies since the beginning of the COVID-19 pandemic have had the expected positive impact on HCWs. However, our findings show differences in KAPs across HCWs with doctors scoring higher on safety and prevention, control and mitigation and national perceptions relative to other groups. This suggests that more efforts should be geared towards enhancing KAP related to COVID-19 among non-physician frontline HCWs through educational interventions tailored to their specific training needs and

delivered through accessible platforms. Addressing this knowledge gap is important as non-physician HCWs such as nurses have relatively more frequent direct contact with patients and are therefore more likely to contract COVID-19 especially in acute care settings.<sup>24 25</sup> Nurses scored higher than medical laboratory scientists on factor 3 which include items related to PPE indicating that nurses are more knowledgeable about PPE and its usage perhaps due to more direct experience with patients with COVID-19.

The most recognisable symptoms/signs of COVID-19 among respondents were fever, cough, sneezing and sore throat. The least recognised symptoms/signs were confusion, diarrhoea, muscle pain and sensory disturbance. While evidence on the various acute manifestations of COVID-19 is accumulating, current data suggest that these commonly recognisable individual symptoms have poor diagnostic properties.<sup>26</sup> Continuing professional education for HCWs is necessary to keep them up to date on the various symptoms and signs of COVID-19 as data become available. Additionally, because these easily recognisable symptoms and signs can be presentations of other viral respiratory or systemic illnesses, wide availability of definitive tests for COVID-19 is essential for early identification, treatment, contact tracing and prevention protocols.<sup>27</sup> The need for high testing capacity is particularly relevant in low-income and middle-income countries such as Nigeria that have limited capacity for intensive care for severe illness but higher capacity for prevention, early identification and treatment of mild COVID-19 symptoms.<sup>28</sup> Lessons learnt during the 2014 Ebola outbreak in Nigeria, namely, instituting local, immediate and culturally sensitive public health measures accompanied by massive public enlightenment campaign tailored to the local environment, are particularly relevant here as the country grapples with the scale and impact of the COVID-19 pandemic.<sup>29</sup>

Notably, a vast majority of participating HCWs were aged less than 40 years with laboratory scientists and nurses having the largest proportion of those under age 40 years. This reflects perhaps the largely young population and workforce in Nigeria.<sup>30</sup> This finding has relevance in the mode of delivery of public health information, training and staff engagement related to COVID-19. As shown in our results and other studies of health information-seeking behaviour in Nigeria, younger people are more

likely to seek information and engage with topical issues on social media compared with more formal sources of information such as scientific journals and government websites.<sup>31 32</sup> Therefore, continuing professional development and training on COVID-19 targeted at HCWs should incorporate strategies for social media engagement, online sources of accurate information and support for internet access.

Our results showed that all groups of HCWs surveyed wanted additional trainings on COVID-19 screening, prevention and mitigation strategies. However, different groups emphasised different areas of training reflecting the need to adapt and tailor COVID-19 training to the local needs of specific groups of HCWs such that it will be relevant to their everyday practice. This approach is supported by recent studies on COVID-19 and HCWs in low-resource settings.<sup>33 34</sup> Different groups also endorsed varying preference for modes of training. The most popular modes of training among all the groups were scientific conferences and webinars and the least popular was in-person hands-on training. This is an indication of the HCWs' yearning for accurate data related to the COVID-19 pandemic and the popularity of remote/online learning necessitated by related social distance requirements and lockdowns.<sup>35</sup>

One of the limitations of this study is the non-random sampling procedure used. This was a convenience sample of frontline HCWs who were willing and able to complete the electronic survey and therefore may not be representative of all frontline HCWs in Nigeria. Also, there could have been potential selection effects among doctors, those working in hospital settings, southern Nigeria and younger people who were more likely to complete this survey. However, it was a large sample and had respondents with varying educational backgrounds working in different healthcare settings and locations across Nigeria. A second limitation relates to the non-standardised questionnaire. Items were adapted from the WHO COVID-19 diagnosis criteria and published literature. However, four factors with high internal consistency were identified that adequately represented COVID-19 KAP and prevention strategies.

Third, we used limited number of questions based on early and evolving data on COVID-19 to measure KAP.

Further studies are needed on KAP among frontline HCWs that incorporate current data on COVID-19 risk factors, presentation, spread, prevention and treatment. It will also be insightful to complete a follow-up survey among the same respondents to assess any changes in their KAP as more knowledge accumulate and medical practice related to COVID-19 changes.

## CONCLUSION

Our study is the first nationwide, cross-sectional survey of frontline HCWs in Nigeria on the COVID-19 pandemic. It established a four-factor structure on HCWs KAP related to COVID-19. Our findings show that as the COVID-19

outbreak in Nigeria continues to evolve, HCWs displayed good basic knowledge of COVID-19, a positive attitude and adherence to good practices regarding the pandemic but with substantial differences among different groups. There were also group differences on COVID-19 training needs and preferences. There is need for tailored health education and training aimed at improving COVID-19 KAP, particularly among non-physician HCWs. As the pandemic continues to evolve, continuing professional development policies by various professional licensing agencies should consider changes that make continued licensing contingent on up-to-date education and training on all aspects of the COVID-19 pandemic.

## Author affiliations

<sup>1</sup>Department of Psychiatry, Yale University School of Medicine, New Haven, Connecticut, USA

<sup>2</sup>Department of Family Medicine, Franciscan Physician Network, Crown Point, Indiana, USA

<sup>3</sup>Department of Orthopaedics, National Orthopaedic Hospital Enugu, Enugu, Nigeria

<sup>4</sup>Department of Internal Medicine, University of Nigeria Teaching Hospital, Enugu, Nigeria

<sup>5</sup>Department of Family Medicine, Catterick and Colburn Medical Group, Richmondshire, NHS North Yorkshire, Yorkshire and Humber, England, UK

<sup>6</sup>Department of Family Medicine, Meadow Primary Health Care Center, Saskatchewan Health Authority, Regina, Saskatchewan, Canada

<sup>7</sup>Department of Psychiatry, VA Connecticut Healthcare System, West Haven, Connecticut, USA

<sup>8</sup>Department of Cardiology, University of Port Harcourt Teaching Hospital, Port Harcourt, Nigeria

<sup>9</sup>Department of Medicine, Alex Ekwueme Federal Teaching Hospital Abakaliki, Abakaliki, Ebonyi, Nigeria

<sup>10</sup>Department of Radiology, University of Calabar Teaching Hospital, Calabar, Nigeria

<sup>11</sup>Department of Physiology, University of Nigeria, Enugu, Enugu, Nigeria

<sup>12</sup>Department of Otorhinolaryngology, Alex Ekwueme Federal University Teaching Hospital Abakaliki, Abakaliki, Ebonyi, Nigeria

<sup>13</sup>Department of Medicine, Abbeyfields Medical Center, Colchester, East England, UK

<sup>14</sup>Department of Radiology, Imo State University Teaching Hospital, Orlu, Nigeria

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#### ORCID iDs

Elina Stefanovics <http://orcid.org/0000-0002-4536-433X>

Anthony Ikenna Adimekwe <http://orcid.org/0000-0003-1986-4258>

Angela Haeny <http://orcid.org/0000-0003-3004-6977>

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