ORIGINAL ARTICLE | COVID-19 DISEASE

COVID 19: Evaluating the Knowledge, Attitude and Preventive Practices of Healthcare Workers in Northern Nigeria

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ABSTRACT

Background: Although much is known about the rapidly spreading COVID-19 disease, a lot of knowledge is still evolving. The knowledge, attitude and practice (KAP) of healthcare workers (HCWs) towards COVID-19 remain key in protecting themselves and in fighting the "war" against the disease. This study assessed the KAP of HCWs in Kano, northern Nigeria.

Methodology: A cross-section of different cadre of healthcare workers was recruited online via google forms. Using a link, the participants completed an adapted from a similar study, pre-tested questionnaire on KAP regarding COVID-19. Predictors of KAP were assessed using logistic regression modelling.

Results: Among the 651 HCWs invited to participate, 233 respondents responded giving a response rate of 35.8%. Of these, 195 (83.7%) had good knowledge, 183 (78.9%) had a positive attitude and 180 (77.6%) had good practice towards prevention of COVID-19. The odds of having good knowledge were significantly lower among Community Health Officers/Community Health Extension workers (aOR=0.2, 95% CI: 0.1-0.6; $p<0.001$) and other health workers compared to doctors. Positive attitude was predicted by good knowledge (aOR=4.8, 95% CI:1.7-010.2; $p=0.003$), being in the fifth decade of life (aOR=5.5, 95% CI: 1.1–29.3, $p=0.04$), female gender (aOR=3.0, 95% CI: 1.1-8.3; $p=0.04$), Christian faith (aOR=7.0, 95% CI: 1.3-40.4; $p=0.03$), and having a bachelors' or medical degree (aOR=4.6, 95% CI: 1.3-16.5). The only predictor of good practice was good knowledge on COVID-19 (aOR=7.8, 95% CI 2.8-12.4; $p<0.001$).

Conclusion and Global Health Implications: Majority of the HCWs at the study site have good knowledge, attitude and practice regarding COVID-19. Continuous dissemination of information on prevention of spread of COVID-19 to all HCWs will strengthen the health workforce in the fight against it.

Key words: • Knowledge • Attitude • Practice • Health care practitioners • Medical doctors • Pharmacists • Corona virus • COVID-19 • COVID-19 pandemic • Healthcare workers • Northern Nigeria • Nigeria

1. Introduction

The emergence of the coronavirus disease (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has been a source of alarm globally and was declared a pandemic by the World Health Organisation.[1,2] It is highly infectious and spread by human-to-human transmission via droplets or direct contact.[3] Although the disease is zoonotic, the intermediate host for transmission is yet to be identified.[1, 4] The ongoing outbreak started in December 2019 in Hubei Province of the People's Republic of China and has spread to many other countries with over 6 million confirmed cases and rising worldwide.[5] In Africa, over 100,000 confirmed cases have been reported with all countries within the continent affected. Nigeria with more than 10,000 confirmed cases is the second country with the highest number of cases in Africa.[5] It is important to understand the dynamics underlying transmission and the human response emanating therein to guide a robust response to the epidemic.

Being in the frontline of response to the COVID-19 outbreak, healthcare workers (HCWs) are at increased risk of becoming infected and possibly transmitting to patients and visitors to health facilities. Studies have identified lapses in infection prevention and control in healthcare settings as major drivers of uninterrupted transmission of certain diseases.[6, 7] This becomes more pronounced in situations where an outbreak exists. Worldwide, healthcare associated infections affect more than 1.4 million with a burden that is 2–20 times higher in developing countries.[8] Failure to adhere to proper infection prevention practices may expose healthcare workers, patients and communities to increased risk. Although the extent of COVID-19 infection in health care settings is still under investigation, the disease with a mean reproductive number of 3.28,[4] may contribute significantly to healthcare-associated transmission, especially in settings like ours Nigeria, adjudged to have a moderate capacity to deal with the spread of the disease.[9].

In Nigeria, more than 800 HCWs have been infected with the virus.[10] Personal behaviors affect HCWs' response to the prevention and control of hospital infections. These behaviors are in turn influenced by their knowledge, attitude, and practice on the specific issue. As such, what healthcare professionals know, believe, and do concerning the prevention of COVID-19 is bound to influence their infection control strategies and action plans. A study from the Middle East revealed that 42.9% of health professionals were not sure that the standard surgical mask would protect them from H1N1, 22.1% did not believe that washing hands with water and soap is protective, and 27.3% were undecided.[11] A survey on health care workers' knowledge, attitudes, and practices regarding COVID-19 in China noted that the majority (>89%) had sufficient knowledge and followed correct practices regarding COVID-19.[12] While a similar study from Pakistan noted comparable levels of knowledge and practice (93.2% and 88.7% respectively),[13] another from Uganda noted lower levels (69% and 74%).[14]

Insufficient personal protection equipment for HCWs and isolation facilities, environmental contamination and overcrowding have worsened COVID-19 response and management strategies in various locales including Nigeria.[15] Consequently, HCWs are required to adhere to the standard infection prevention procedures in order to lessen the rising number of COVID-19 cases. Understanding the knowledge, attitude, and practice of health care professionals towards prevention of COVID-19 is essential to maintain a sustained change in behavior and to improve practices when designing setting-congruent interventions. Kano State, being one of the most populous states in Nigeria, stands at higher risk if health care workers do not comply with infection control measures.

Kano State is located in the North-western geo-political zone of Nigeria. It is one of the most populous states in the country with a 2019 projected population of 13,065,294 people based on the 2006 National Population Census.[16] Health services are provided via three tiers of government namely; primary health care by the Local Government, secondary health care by the State Government, tertiary care by the Federal Government, and then there are private facilities that provide different

services. Currently, there are 239 private health facilities (HFs) in the state, two tertiary, 64 secondary, and 1,241 primary health care institutions. Different cadres of healthcare workers work within these facilities with community health workers being the most ubiquitous. The state with over one thousand confirmed cases has the second largest number of COVID-19 cases in Nigeria. Consequently, this study seeks to assess the knowledge, attitude, and practice (KAP) of HCWs regarding COVID-19 in Kano, Nigeria. Findings could inform policy dialogue and provide useful information on the prevention of transmission within and outside the healthcare setting.

2. Methods

2.1. Study Design and Population

This is a cross-sectional study with data collected online between 1st April and 31st May 2020, during the Covid-19 pandemic. Healthcare workers of all levels comprising doctors, nurses, midwives, pharmacists, physiotherapists, laboratory scientists, community health officers/community health extension workers, environmental health officers, dental technicians, and health rehabilitators working within Kano state were included in the study. Based on the number of members of health professionals in targeted online platforms, a study population of 651 was obtained.

2.2. Study Instrument and Procedure

To maintain physical and social distancing during the COVID-19 pandemic, google forms were used to develop an adapted (from a similar study)[13], self-administered, structured questionnaire. The questionnaire was pretested for appropriateness of wording and simplicity among 30 final year medical students. The reliability of the questionnaire was measured by calculating Cronbach's alpha for each of the scales assessing knowledge, attitude, and practice. The questionnaire was designed on google forms (docs.google.com/forms) and sent to participants in the form of a link via WhatsApp messenger (Facebook, Inc.). All responses were collated online on a Microsoft Excel sheet. The questionnaire asked about socio-demographic and workplace characteristics of study participants,

their knowledge on the transmission, their attitudes towards the disease, and their practices towards prevention of the disease.

2.3. Outcome Variables

Knowledge of COVID-19 was assessed using 12 elements on the questionnaire. A score of 1 was awarded to a correct answer and a score of 0 was awarded to a wrong answer. The highest possible score was 12 and the least possible score was 0. Bloom's cut-off [17] of 80% was adopted to categorize knowledge and a score of ≥9.6 was considered good knowledge. Attitude was assessed using 10 items on the questionnaire. Positive responses were scored as 1 and negative responses were scored as 0. Scores of ≥8.0 were considered a positive attitude. Practice was assessed using 4 items on the questionnaire. Participants were asked which of the three major practices for prevention of COVID-19 (i.e. hand washing, use of face mask, and maintaining social distancing/reducing travels) they practiced. In this study, practicing all three was considered as good practice towards prevention of COVID-19.

2.4. Explanatory Variables

Explanatory variables used in this study were socio-demographic information (age, gender, religion, tribe, and marital status) and work-place characteristics (Highest educational qualification, professional cadre, years in service, type of facility worked in, and involvement in direct patient care).

2.5. Statistical Analysis

All analyses were conducted using Stata/IC 15.0 (Stata Corp, College Station, TX, USA). Frequencies and proportions were described for categorical variables and means (with standard deviation, SD) were reported for numerical measures. Univariate analysis was conducted to identify the variables associated with knowledge, attitude, and practice. A crude measure was obtained for the association between each variable and the respective outcome. Covariates that were associated with the outcomes at the bivariate level were then included in the multivariable analysis. To generate adjusted odds ratios, a forward selection approach to modelling was employed, and a parsimonious model was built

with retention of those variables that changed the odds ratio by at least 10%. A likelihood ratio test was used to compare the goodness-of-fit of nested models. A p-value <0.05 was considered statistically significant. The effect of the variables not included in the multivariable analysis was also checked to identify negative confounding by these variables.

2.6. Ethical Approval

Ethical approval was obtained from the Kano State Health Research Ethics Committee (Reference-MOH/Off/797/T.I/2005). Signed informed consent was obtained from all the respondents and participation was voluntary.

3. Results

The link to the questionnaire was sent to 651 HCWs and 233 of them completed the online questionnaire giving a response rate of 35.8%. The age of the respondents ranged from 21 to 57 years with a mean and SD of 35.5± 7.9 years. The majority were Muslims (85.8%) with three-quarters (75.0%) of them from Hausa/Fulani tribe. Almost half (41.6%) were in their fourth decade of life and another half (50.2%) had a Bachelor's degree or a medical degree as their highest qualification. Many were medical doctors (35.6%) and a third (37.3%) worked in a tertiary facility (Table 1).

3.1. Knowledge of prevention of COVID-19

Overall knowledge scores ranged from 7 to 12 with a mean and SD of 10.5±1.3. One hundred and ninety-five respondents (83.7%) had good knowledge of COVID-19. All respondents had knowledge on how to prevent COVID-19 (100.0%), ways of getting infected (99.1%), new signs and symptoms of COVID-19, and susceptibility to infection (96.6%). Slightly more than half (58.2%) knew that COVID-19 was a zoonotic infection.

Table 2 summarizes findings for the associations between the independent variables in the study and knowledge about COVID-19. Factors identified as predictive of adequate knowledge about COVID-19 were marital status, professional categorization, and type of health facility where respondents were working at the time of the survey. Compared to

Table 1: Sociodemographic and workplace characteristics of respondents

Characteristic	Frequency (Percentage) N=233
Age in years	
20-29	64 (27.5)
30-39	97 (41.6)
40-49	57 (24.5)
50-59	15 (6.4)
Gender	
Male	154 (66.1)
Female	79 (33.9)
Religion	
Islam	200 (85.8)
Christianity	33 (14.2)
Tribe	
Hausa/Fulani	175 (75.0)
Yoruba	13 (5.6)
Igbo	12 (5.2)
Others	33 (14.2)
Marital Status	
Single	76 (65.7)
Married	153 (32.6)
Divorced	4 (1.7)
Highest Educational Qualification	
Diploma	36 (15.5)
M.B.B.S/Bachelor's degree	117 (50.2)
Master's degree	18 (7.7)
Specialist training	62 (26.6)
Professional Cadre	
Doctor	83 (35.6)
Nurse/Midwife	39 (16.7)
Lab Scientist	19 (8.2)
Pharmacist	11 (4.7)
Physiotherapists	11 (4.7)
CHO/CHEW	22 (9.4)
Others	48 (20.6)
Years of Service	
< 1 year	2 (0.9)
1 to 5 years	93 (39.9)
6 to 10 years	59 (25.3)
> 10 years	79 (33.9)
Type of Facility you Work	
Tertiary	87 (37.3)
Secondary	55 (23.6)
Primary	66 (28.3)
Private	25 (10.7)
Involvement in Direct Patient Care	
Yes	199 (85.4)
No	34 (14.6)

Table 2: Predictors of Knowledge on COVID-19 infection

Variable	Crude OR (95% CI)	*p*-value	Adjusted OR* (95% CI)	*p*-value
Age (in years)				
20-29	Reference	0.63	Reference	0.64
30-39	1.1 (0.4-2.7)		0.5 (0.1-1.6)	
40-49	0.9 (0.3-2.2)		0.4 (0.1-2.1)	
50-59	2.9 (0.3-24.5)		1.5 (0.1-7.2)	
Gender				
Male	Reference	0.45	Reference	0.85
Female	1.3 (0.6-2.8)		1.1 (0.4-3.1)	
Marital status				
Single	Reference	0.3	Reference	0.03
Married	1.2 (0.6-2.5)		1.4 (0.6-3.4)	
Divorced	0.2 (0.1-1.6)		0.1 (0.1-0.5)	
Highest Qualification				
Diploma	Reference	0.01	Reference	0.15
MBBS/Bachelor's degree	3.8 (1.6-9.2)		2.5 (0.9-6.6)	
Master's degree	9.6 (1.1-80.7)		4.2 (0.4-41.4)	
Specialist Training	3.3 (1.2-8.9)		1.1 (0.3-4.0)	
Professional Cadre				
Doctor	Reference	<0.001	Reference	<0.001
Nurse/Midwife	0.4 (0.1-1.2)		0.4 (0.1-1.3)	
Lab Scientist	0.5 (0.1-3.0)		0.6 (0.1-3.9)	
Physiotherapist	0.6 (0.7-6.1)		0.4 (0.1-7.0)	
CHO/CHEW	0.1 (0.1-0.4)		0.2 (0.1-0.6)	
Others	0.1 (0.1-0.4)		0.1 (0.1-0.3)	
Years in service				
<1 year	Reference	0.35	Reference	0.50
1 to 5 years	0.7 (0.3-1.5)		0.7 (0.1-3.7)	
6 to 10 years	1.3 (0.5-3.6)		1.8 (0.3-9.6)	
> 10 years	1.6 (0.5-6.6)		3.2 (0.7- 14.7)	
Type of facility				
Tertiary	Reference	<0.001	Reference	0.04
Secondary	0.3 (0.1-0.8)		0.2 (0.1-0.9)	
Primary	0.2 (0.1-0.5)		0.4 (0.1-1.5)	
Private	0.1 (0.1-0.3)		0.2 (0.1-0.7)	
Involved in direct patient care				
Yes	Reference		Reference	
No	0.9 (0.3-2.4)	0.78	0.5 (0.1-1.8)	0.28

Notes: *Adjusted for all variables in the table. OR = Odds ratio; CI = Confidence Interval

single HCWs, divorced HCWs were 90% less knowledgeable about COVID-19. Although there was a noticeable trend that married HCWs could be more knowledgeable than their single counterparts, the result did not reach statistical significance as shown by the confidence interval that enclosed unity or one. Concerning professional categories, doctors appeared to be the most knowledgeable about

COVID-19 followed by physiotherapists. However, the adjusted odds ratios were not significant for the noted differences in comparing nurses/midwives, lab scientists, and physiotherapists versus doctors. Respondents working in tertiary facilities were most knowledgeable about COVID-19. Age, gender, highest qualification, years in service and involvement in direct patient care was not predictive of COVID-19 knowledge.

3.2. Attitudes towards Prevention and Management of COVID-19

Attitude scores ranged from 5 to 10 with a mean and SD of 8.4±1.2. One hundred and eighty-three respondents (78.9%) had a positive attitude towards the prevention and management of COVID-19. Specifically, all respondents (100.0%) trusted the COVID-19 task force and the media to give them correct information on COVID-19. A higher proportion of respondents believed that HCWs were vulnerable to getting infected with COVID-19 (98.7%) and that it was possible to get COVID-19 in their community (96.6%).

Using Multivariable analysis (Table 3) knowledge of COVID-19, age, gender, religion, highest qualification, professional cadre, and type of facility worked in were independently associated with having a positive attitude towards COVID-19. After adjusting for these variables, there was strong evidence that those who had good knowledge of COVID-19 had an almost 5-fold increase in positive attitude compared to those who had poor knowledge (adjusted (a) OR=4.8, 95% CI: 1.7-10.2; *p*=0.003). Furthermore, the adjusted odds of having a positive attitude among HCWs who were in their fifth decade of life were almost six times as high compared to those in their third decade of life (aOR=5.5, 95% CI: 1.1–29.3; *p*= 0.04). The adjusted odds of having a positive attitude were also higher among females compared to males (aOR=3.0, 95% CI: 1.1-8.3; *p*= 0.04*)*, Christians compared to Muslims (aOR=7.0, 95% CI: 1.3-40.4; *p*=0.03*)*, and in environmental health officers/dental technicians/ health rehabilitators compared to doctors (aOR=6.2, 95% CI: 1.5-26.6; *p*= 0.02).

Similarly, healthcare workers whose highest qualification was a Bachelor's degree or medical

degree (aOR=4.6, 95% CI: 1.3-16.5), those who had Master's degree (aOR: 24.3, 95% 1.7-34.1) and those who had specialty training (aOR=15.4, 95% CI: 3.0-79.8) all had higher adjusted odds of having a positive attitude compared to those who had a diploma (*p*=0.002).

3.3. Practice towards Prevention of COVID-19

An overwhelming majority of the HCWs (77.6%) HCWs had good practice towards the prevention of COVID-19 by employing all three prevention practices. Fifteen (6.5%) of the healthcare workers used face mask alone, 17 (7.3%) washed their hands alone and 20 (8.6%) practiced social distancing alone. Only knowledge remained independently associated with good practice (aOR=7.8, 95% CI: 2.8-12.4; *p*<0.001) after adjusting for age, gender, religion, marital status, highest educational qualification, specialist cadre, type of facility worked in, years in service and involvement in direct patient care.

4. Discussion

We explored the KAP of HCWs regarding COVID-19 in Nigeria. In an evaluation of a diverse group of 233 HCWs; including doctors, nurses, and paramedics; we found evidence to suggest that majority of the HCWs in this study had good aggregated knowledge, attitude, and prevention practices on COVID-19. However, there was a gap in knowledge of the zoonotic origin of the virus and whether or not there is a cure for it.

To our knowledge, this is the first study to assess the KAP of HCWs on COVID-19 in Kano, Nigeria. While it was encouraging that majority of the HCWs had sufficient knowledge on COVID-19 and all of them were aware of how to prevent it, the type of health facility and professional cadre determined their level of knowledge. Specifically, those working in primary, secondary, and private facilities had less knowledge than those working in tertiary facilities while Community Health Officers/Community Health Extension Workers and others (Environmental health officers, dental technicians, etc.) had less knowledge than doctors. Although it is expected that doctors and HCWs at teaching hospitals and isolation centres are the

Table 3: Predictors of attitude towards COVID-19 infection

Variable	Crude OR (95% CI)	p-value	Adjusted OR* (95% CI)	p-value
Knowledge				
Poor Knowledge	Reference		Reference	
Good Knowledge	3.7 (1.8-7.9)	<0.001	4.8 (1.7-10.2)	0.003
Age (in years)				
20-29	Reference	0.16	Reference	0.04
30-39	1.4 (0.7-2.9)		1.5 (0.5-4.8)	
40-49	2.1 (0.9-5.1)		5.5 (1.1-29.3)	
50-59	5.5 (0.7-44.8)		3.3 (0.3-39.4)	
Gender				
Male	Reference	0.01	Reference	0.04
Female	2.7 (1.2-5.9)		3.0 (1.1-8.3)	
Tribe				
Hausa Fulani	Reference	0.72	Reference	0.65
Yoruba	1.6 (0.4-7.5)		1.4 (0.1-6.7)	
Igbo	0.9 (0.2-3.4)		0.1 (0.1-0.7)	
Others	1.6 (0.6-4.5)		1.4 (0.1-2.8)	
Religion				
Islam	Reference		Reference	
Christianity	2.2 (0.6-7.3)	0.21	7.0 (1.3-40.4)	0.03
Marital Status				
Single	Reference	0.23	Reference	0.60
Married	1.8 (0.9-3.4)		1.2 (0.4-3.7)	
Divorced	1.1(0.1-11.6)		0.5 (0.1-8.2)	
Highest Qualification				
Diploma	Reference	0.001	Reference	0.002
MBBS/Bachelor's degree	3.1 (1.4-6.9)		4.6 (1.3-16.5)	
Master's degree	13.6 (1.6-113.4)		24.3 (1.7-34.1)	
Specialist Training	5.3 (2.0-14.3)		15.4 (3.0-79.8)	
Professional Cadre				
Doctor	Reference	<0.001	Reference	0.02
Nurse/Midwife	0.7 (0.3-1.8)		0.9 (0.3-3.0)	
Lab Scientist	0.2 (0.1-0.6)		0.5 (0.1-1.9)	
Physiotherapist	1.7 (0.2-14.6)		6.6 (0.5-18.6)	
Pharmacist	1.7 (0.2-14.6)		2.2 (0.2-22.5)	
CHO/CHEW	0.1 (0.1-0.4)		0.3 (0.1-0.9)	
Others	1.2 (0.4-3.4)		6.2 (1.5-26.6)	
Years in Service				
<1 year	Reference	0.04	Reference	0.10
1 to 5 years	0.4 (0.2-0.8)		0. (0.1-3.7)	
6 to 10 years	0.5 (0.2-1.2)		1.8 (0.3-9.6)	
> 10 years	0.9 (0.4-2.6)		2.5 (0.5- 12.1)	

(Contd...)

Table 3: (*Continued*)

Variable	Crude OR (95% CI)	*p*-value	Adjusted OR* (95% CI)	*p*-value
Type of Facility				
Tertiary	Reference	0.02	Reference	0.03
Secondary	1.8 (0.6-5.6)		0.2 (0.1-0.9)	
Primary	1.3 (0.4-4.8)		0.4 (0.1-1.5)	
Private	10.5 (1.4-79.9)		0.2 (0.1-0.7)	
Involved in Direct Patient Care				
Yes	Reference		Reference	
No	0.5 (0.2-1.4)	0.13	0.7 (0.2-2.8)	0.61

*Adjusted for all the variables in the table. OR = Odds ratio. CI = Confidence Interval

core staff at the frontline of battling the pandemic, this fraction of community health workers who are less knowledgeable would be a weak link and be at increased risk of contracting the disease. At the beginning of the pandemic, a lot of efforts and focus were concentrated at the tertiary level of care which consisted majorly of doctors. Also, doctors and staff of tertiary institutions who are more involved in the care of patients may seek out more information[13] than the other cadre of staff. This may partly explain why the staffs at the secondary, primary level of care and private health facilities with their complimentary staff were less knowledgeable on COVID-19.

Most respondents had a positive attitude towards COVID-19 which was associated with knowledge on COVID-19, an array of socio-demographic characteristics, professional qualifications, and type of health facility. The reasons why older (40-49 vs 20-29 years), female and Christian respondents had a better attitude than their counterparts are not very clear and may need to be explored in subsequent studies. Some studies noted that attitude towards COVID-19 was not associated with socio-demographic and job characteristics.[13, 18] In this study, HCWs with higher or specialty training had a better attitude and this maybe because they were likely to have sought more information on COVID-19 or may have been directly involved in the care of patients or both. Adequate knowledge on a subject has been noted as a prerequisite for good attitude and practice,[13, 19] as knowledge was also the only predictor of good practice in this study. The role of disseminating correct, appropriate, and timely information particularly during emergencies

is crucial in building capacity and improving the performance of HCWs.

The finding on COVID-19 knowledge in our study (83.7%) is comparable to findings from the Nigerian general populace (83.8%)[20] and the US (80.0%)[21]; but lower than what was reported among HCWs in China (89%)[12]and Pakistan (93.2%)[13]The level of knowledge, however, was higher than what was reported among HCWs in Uganda (69.0%),[14]and university students and staff in Pakistan (50.2%).[18] The proportion of HCWs (78.9%) with a positive attitude to COVID-19 in this study is higher than was reported in the general populace in Pakistan (65.4%),[18] but not comparable to that observed among HCWs in Uganda (21.0%).[14]

Practice in this study (77.6%) is lower than was noted among HCWs in China (89.7%),[12] Pakistan (88.7%),[13] although higher than was reported among respondents in the university community in Pakistan(36.5%).[18] Respondents' personal and environmental characteristics as well as the fact that these studies were conducted at different timings during the pandemic may explain the differences in levels of KAP observed.

While the current findings are encouraging that HCWs are knowledgeable, have good attitude and prevention practices towards COVID-19, more emphasis with information dissemination should be directed at the lower levels of care (secondary, primary, and private) and their health personnel. It is noteworthy that the risk of infection may still be high and largely dependent on the availability of Personal Protective Equipment (PPE), appropriate

donning and doffing techniques, HCWs behaviour in observing precautionary measures and in managing emergencies, work overload, stress, and degree of occupational exposure. These have been noted to influence the risk of getting infected.[22] Notably, the majority of our respondents reported elevated vulnerability and risk of getting infected at work and in their communities. This may either promote fear or drive adherence to preventive practices.

This study has limitations. The study has a limited sample size and may not necessarily reflect the true proportion of HCWs' disposition on COVID-19. A reasonable attempt was made at reaching out to a larger group of HCWs but with limited success due to prevailing social constraints from the pandemic. The study has highlighted an appreciation of a fair KAP among HCWs and how job qualifications may impact on their practice of infection control. Consequently, it allows resources to be dedicated to planning continuing professional development programs and creating an enabling environment for HCWs to provide quality care using effective PPE. Our findings would be useful in the context of HCWs practicing in Nigeria and other countries with similar socio-economic circumstances.

5. Conclusion and Global Health Implications

The study has highlighted an appreciation of a fair KAP among HCWs and how job qualifications may impact on their practice of infection control. Consequently, it allows resources to be dedicated to planning continuing professional development programs and creating an enabling environment for HCWs to provide quality care using effective PPE. Our findings would be useful in the context of HCWs practicing in Nigeria and other countries with similar socio-economic circumstances.

Compliance With Ethical Standards

Key Messages

► Although the majority of healthcare workers (HCWs) exhibited sufficient knowledge about COVID-19 infection, there is a knowledge gap between HCWs in tertiary hospitals versus those in primary, secondary and private facilities.

► While the current findings are encouraging that HCWs are knowledgeable, have positive attitude and good prevention practices towards COVID-19, more emphasis on information dissemination should be directed at the lower levels of care (secondary, primary, and private) and their health personnel.

► The findings in this study could be used to launch future campaigns to enhance COVID-19 vaccination uptake among HCWs, who are particularly at-risk of contracting and disseminating COVID-19 infections.

References

1. Velavan TP, Meyer CG. The COVID-19 Epidemic. Trop Med Int Health. 2020;25(3):278-80

2. Chen H, Guo J, Wang C, Luo F, Yu X, Zhang W, et al. Clinical characteristics and intrauterine vertical transmission potential of COVID-19 infection in nine pregnant women: a retrospective review of medical records. *The Lancet.* 2020;395(10226):809-15

3. Lai C-C, Shih T-P, Ko W-C, Tang H-J, Hsueh P-R. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): The epidemic and the challenges. *Int J Antimicrob Agents.* 2020:105924

4. Liu Y, Gayle AA, Wilder-Smith A, Rocklov J. The reproductive number of COVID-19 is higher compared to SARS coronavirus. *Journal of Travel Medicine.* 2020 Feb 13;27(2)

5. World Health Organization. Coronavirus disease 2019 (COVID-19) Situation Report- 133. 2020. Available on https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200601-covid-19-sitrep-133.pdf?sfvrsn=9a56f2ac_4. Accessed June 20, 2020.

6. Mackay IM, Arden KE. MERS coronavirus: diagnostics, epidemiology and transmission. *Virol J.* 2015;12(222)

7. Desta M, Ayenew T, Sitotaw N, Tegegne N, Dires M, Getie M. Knowledge, practice and associated factors of infection prevention among healthcare workers in Debre Markos referral hospital, Northwest Ethiopia. *BMC Health Serv Res.* 2018;18(1):1-10

8. Sahiledengle B, Gebresilassie A, Getahun T, Hiko D. Infection Prevention Practices and Associated Factors among Healthcare Workers in Governmental Healthcare Facilities in Addis Ababa. *Ethiop J Health Sci.* 2018;28(2):177-86

9. Gilbert M, Pullano G, Pinotti F, Valdano E, Poletto C, Boëlle P-Y, et al. Preparedness and vulnerability of African countries against importations of COVID-19: a modelling study. *The Lancet.* 2020;14(395(10227)):871-77

10. 812 health workers infected with Covid-19- FG [Internet]. BUSINESSDAY. 2020 [cited 2nd June 2020]. Available from: https://businessday.ng/coronavirus/article/812-health-workers-infected-with-covid-19-fg/. Accessed June 2, 2020.

11. Evirgen O, Savas N, Koksaldi Motor V, Onlen Y, Yengil E. An evaluation of knowledge, attitudes, and behaviors of employees of a university hospital in an H1N1 influenza pandemic. *Journal of Infection in Developing Countries.* 2014 May 14;8(5):561-9

12. Zhou M TF, Wang Y, Nie H, Zhang L, You G, Zhang M. Knowledge, attitude and practice regarding COVID-19 among health care workers in Henan, China. *Journal of Hospital Infection.* 2020 1st June 2020;105(2):183-87

13. Saqlain M MM, Rehman Su, Gulzar A, Naz S, Ahmed Z, Tahir AH, M. M. Knowledge, attitude, practice and perceived barriers among healthcare professionals regarding COVID-19: A Cross-sectional survey from Pakistan. *Journal of Hospital Infection.* 2020 July 2020;105(3):419-23

14. Olum R CG, Wekha G, Nassozi DR, Bongomin F. Coronavirus Disease-2019: Knowledge, Attitude, and Practices of Health Care Workers at Makerere University Teaching Hospitals, Uganda. *Frontiers in Public Health.* 2020 April 2020;8:1-9

15. Ejeh FE, Saidu AS, Owoicho S, Maurice NA, Jauro S, Madukaji L, et al. Knowledge, attitude, and practice among healthcare workers towards COVID-19 outbreak in Nigeria. *Heliyon.* 2020;6(11):e05557-e

16. The Maternal, Newborn and Child Health Programme (MNCH2). Kano State Statistical Data [Internet]. Available from: https://www.mnch2.com/kano-state/. Accessed june 12, 2020.

17. Kaliyaperumal K. Guideline for conducting a knowledge, attitude and practice (KAP) study. *AECS Illumination.* 2004;4(1):7-9

18. Salman M, Mustafa ZUI, Asif N, Zaidi HA, Haider AZ, Hussain K, Shehzadi N, et al.. Knowledge, attitude and preventive practices related to COVID-19: a cross-sectional study in two Pakistani university populations [Internet]. *Drugs Ther Perspect.* 2020;(**36**), 319–325. https://doi.org/10.1007/s40267-020-00737-7.

19. McEachan R TN, Harrison R, Lawton R, Gardner 2, Conner M et al. Meta-Analysis of the Reasoned Action Approach (RAA) to Understanding Health Behaviors. *Ann Behav Med.* 2016;50(4):592-612.

20. Olapegba PO, Steven KI, Samso KO, Oguntayo R, Joshua C, Gandi J, et al. Survey data of COVID-19-related Knowledge, Risk Perceptions and Precautionary Behavior among Nigerians. [Internet]. *Data in Brief.* 2020; 105685. Available from: https://doi.org/10.1016/j.dib.2020.105685.

21. Clements JM. Knowledge and behaviors toward COVID-19 among US residents during the early days of the pandemic: Coss-Sectional Online Questionnaire. [Internet]. *JMIR Public Health Surveill.* 2020. 6(2):e19161

22. Kumar J KM, Siddiqui A A, et al.. Knowledge, Attitude, and Practices of Healthcare Workers Regarding the Use of Face Mask to Limit the Spread of the New Coronavirus Disease (COVID-19). *Cureus.* 2020;122(4):e7737