Infection and Drug Resistance

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ORIGINAL RESEARCH

Determinants of Knowledge, Attitudes, and Practices of Frontline Health Workers During the First Wave of COVID-19 in Africa: A Multicenter Online Cross-Sectional Study

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Background: During its first wave of COVID-19 infection in sub-Saharan Africa, there was insufficient understanding of the pandemic among frontline health workers. This study was carried out to determine the knowledge, attitude, and practices (KAP) of frontline health workers (HWs) towards COVID-19 in Africa and their related factors.

Methods: This was a multicenter online cross-sectional study conducted between April 2020 and July 2020 using a Google survey link among frontline HWs involved in the COVID-19 response in 26 African countries. Bivariate and multivariate logistic regression were used to analyse the determinants of KAP. Data were analyzed using STATA ver 16; all tests were two-sided with 95% confidence interval.

Results: Five hundred and seventeen participated in this study from 26 African countries; 289 (55.9%) were male and 228 (44.1%) female. Most of HWs, 379 (73.3%) showed poor knowledge about COVID-19 infection and preventive measures. In contrast, majority of them showed good attitude (89%) and practice (90.3%) towards prevention of COVID-19 infections. Knowledge varied among countries; Uganda had the greatest number of HWs with good knowledge (OR: 28.09, p<0.0001) followed by Ghana (OR=10.92, p=0.001) and DRC (OR: 4.59, p=0.015). The cadre of HWs also influenced knowledge; doctors were the most knowledgeable as compared to other cadres (OR: 3.4, p= 0.005). Attitude and practice were both influenced by HWs country of workplace and their cadre (p<0.05).

Conclusion: Majority of the frontline HWs in the African region had an overall good attitude and practice towards COVID-19 infection and practice measures despite relatively poor knowledge. The KAP is influenced by HWs country of workplace, their cadre. The knowledge of HWs in Africa should be increased to concourt with their attitude and practice to reduce the burden of intra-hospital transmission of the COVID-19.

Keywords: knowledge, attitude, practices, COVID-19, frontline health workers, Africa, survey

Received: 9 May 2022
Accepted: 4 August 2022
Published: 18 August 2022

Introduction

The emergence of coronavirus disease (COVID-19) in 2019 from Wuhan, China, and its exponential transmission to all countries in the World, including the 52 countries of Africa, present a delicate situation for low-resource countries. This current pandemic has shaken the entire world.[1–6]

During its first wave, while millions of people worldwide stayed at home to minimize the transmission of the COVID-19, most healthcare workers (HWs) remained at the forefront of the response to this pandemic. They go to clinics and hospitals, exposing themselves to a high risk of COVID-19.[7] In addition to exposure to the pathogen, long hours of work, psychological stress, fatigue, social stigma and physical abuse were some of the additional burdens faced by the HWs.[8] A recent study by Hakan et al found that 300,000 HWs from 37 countries had already gotten COVID-19.[9] In addition to the high number of infections, over 115,000 of HWs have already lost their lives around the World as of October 22, 2021. Of the 37 countries surveyed, the United States had the highest coronavirus infections among HWs with 114,500 infections.[10] Mexico followed with a reported 78,200 infections, while France and Italy had 30,000 and 29,000 coronavirus infections, respectively.[10] While the United States had the highest number of infections, the rate of infections adjusted for the population size was highest in Mexico, Italy, and France.[10]

As of 16October 2021, over 242,801,421 cases and 4,929,826 deaths have been reported globally (2.96%).[11] The USA is the most affected, with over 50% of the cases and 60% of the deaths reported in this region.[12] The United States of America, with over 45 million cases of COVID-19 and over 733,000 deaths, currently constitutes the most infected country in the World.[12] Still, an overall decrease in the number of cases and deaths across the region has been reported by 11% in the last 40 days. Despite the overall decrease of cases in the region, Uganda reported an intensive community transmission in capital Kampala and an increase of over 300% of the cases; and similarly, an overall increase in the case number has been reported in Namibia and Nigeria in terms of 55% and 19%, respectively.[13,14] Despite resource limitations in the African health care system, COVID-19 seems to be contained and under control. Several hypotheses have been fronted; one of them is the relatively younger population in the continent (more than 60% of the population in Africa are below the age of 25). Other factors cited include low travel and outdoor living, expertise in epidemic control from tackling other outbreaks, and cross-immunity from other coronaviruses.[15]

Despite governmental efforts to mobilize HWs to support the health systems, most of those health professionals were not sufficiently educated about preventive measures of this novel disease and were at a high risk of contracting and subsequently spreading the virus to uninfected patients who seek assessment.[6,8] A study among HWs in Henan, China, revealed that over 80% of HWs had sufficient Knowledge of COVID-19 and correct practices regarding COVID-19.[16] In Uganda, a study done at Mulago and Kiruddu Hospitals reported 69% of HWs had good Knowledge, 21% had a positive attitude, and 74% had good practices towards COVID-19.[17] Several studies reported that age and education level were significantly associated with good Practice and Knowledge towards COVID-19.[18–20] During its first wave of COVID-19 infection in sub-Saharan Africa, there was insufficient understanding of the pandemic among frontline health care professionals that has led to a misidentification, and mistreatment of affected patients, with a potential risk of contracting and spreading the disease. There is a paucity of evidence of the current KAP towards COVID-19 in sub-Saharan Africa, despite several WHO materials, up-to-date, and governments' guidelines. Understanding frontline HWs' KAP and possible risk factors help improve the safety of both the HWs and the general population. This study aimed to assess the KAP of the frontline HWs towards COVID-19 during the first wave of the pandemic, and also to identify determinant factors of KAP towards COVID-19 pandemic.

Methods

Study Design, Setting, and Participants

This was a cross-sectional descriptive study using an online structured questionnaire (French and English versions), sent to the frontline HWs in several African countries via emails between April and July 2020. The frontline HWs surveyed included nurses, doctors and other cadres (anesthesia and laboratory personnel) in any level of practice experience and working in any level of African hospital involved in COVID-19 patient care.

Inclusion Criteria

All frontline health workers aged 18 years and above working in hospitals in African countries.

Exclusion Criteria

In this study, those who did not consent, duplicate responses, participants from the pilot study, health workers from departments not involved in care of COVID-19 patients were excluded.

Study Instrument, Variables and Data Collection

The online Google Form link was sent to frontline health care givers via emails, or social media platforms (WhatsApp, Twitter, and Facebook) with a help of a focal lead country person, and reminders were sent 3 times a week for duration of 4 months. Standardized and pre-tested screening tools and adjusted pre-validated questionnaire were used to obtain information on the study variables. Questions and answers about COVID-19 in the webpage of WHO and other previous studies[17,21–24] were adapted to formulate the questionnaire for the interview. A pilot study was carried out on 11 HWs from Benin, Ghana, Malawi and Niger, and adjustment were made based on their opinions relating to the feasibility of the questionnaire, and the final questionnaire was reviewed by the authors accordingly. The final questionnaire had four sections. The first section comprised seven questions on the socio-demographic characteristics of the participants. The second section included 12 questions regarding the knowledge of HWs on COVID-19 using a two-point scale. Each incorrect response weighed 0 point and 1 for correct responses. A HW who got 60% or more of the responses correct was categorized as having a good knowledge, while the one who got less than 60% correct responses was categorized as having poor knowledge. The third section had five questions assessing attitude of HWs in a Likert scale of agreement format.[17,22,25] A HW who got 60% or more of the responses correct was categorized as having a good attitude, while the one who got less the 60%, poor attitude. The fourth section included five questions regarding the practices of COVID-19. The responses were as follows: always, occasional, never, and neutral each weighing 3, 2, and 1 point respectively for a given practice. Again, a cut-off score of 60% or more differentiated good from poor practice. As part of quality assurance, the most active email of each participant was collected to identify duplicate responses. We used the random sampling to recruit the study participants. The flowchart is provided to know how participants were recruited (see Figure 1).

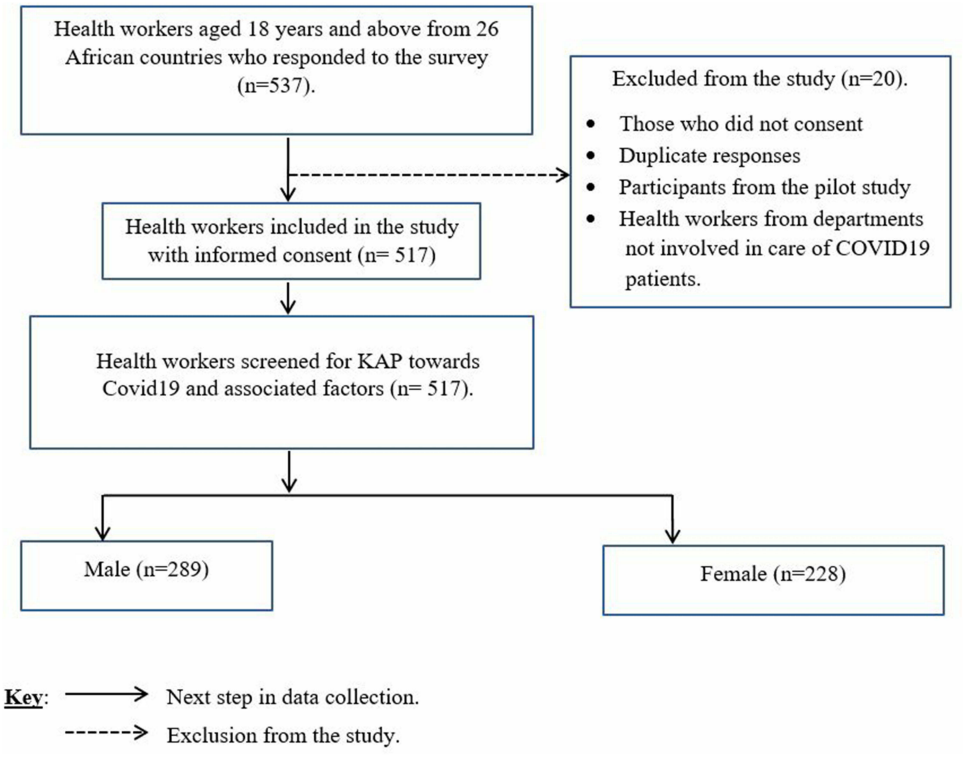

Figure 1 Flowchart showing the recruitment of study participants.
Abbreviations: KAP, knowledge, attitude and practices; n, absolute frequency.

Statistical Analysis

Fully completed questionnaires were extracted from Google Forms and exported to a Microsoft Excel 2016 for cleaning and coding. The cleaned data was exported to STATA version 16 for analyses.[17,22] The means and standard deviations were used to describe continuous data, while the frequencies and proportions described categorical data. Chi-square test of independence was used in the bivariate analysis to identify potential predictors of KAP. All variables in the bivariate analysis with p-value <0.2 were included in the multivariate logistic regression model to assess the determinants of KAP towards COVID-19 African frontline health workers during the first wave of COVID-19 pandemic. All analysis were two-sided with 95% confidence level. Results were reported in crude and adjusted udds ratio.

Ethical Considerations

The protocol has been cleared by the Integrated Multidisciplinary Research Center Ethics committee (IMRCEC) of Adventist University of Lukanga (Campus Wallace, Lukanga, D.R. Congo) (Protocol Number.02/2020), and all participants provided an informed consent, and their anonymity was guaranteed.

Results

Socio-Demographic Characteristic of Study Participants

A total of 537 health workers from 26 African countries responded to the survey. Five hundred and seventeen (96.3%) consented to participate in the study (see Figure 1). Majority of the HWs were from the Democratic republic of Congo; DRC (48%), Uganda (11.6%), Algeria (11.0%), Ghana (7.2%) and 22.24% from the other countries (see Table 1). Table 1 shows the socio-demographic characteristics of the study participants. Of the 517 health care givers, 289 (55.9%) were males and 228 (44.1%) females. Based on HWs' cadre, 297 (57.4%) of the HWs were doctors, 154 (29.8%) nurses and the rest 66 (12.8%) were other cadres (anaesthesia personnel, laboratory technicians, etc). In terms of education level, 64.4% of the HWs were degree holders, the least numbers were for certificate holders (2.9%). Overall, most of the HWs showed poor knowledge about COVID-19 infection and preventive measures (73.3% and 26.7% for poor and good knowledge, respectively). In contrast, majority of them showed good attitude and practice measures towards prevention of COVID-19 infections (89% and 90.3% respectively) (see Figure 2).

Determinants of Knowledge of COVID-19 Among Healthcare Givers

Factors associated with Knowledge of COVID-19 are presented in Table 2 for bivariate analysis. There is an association between Knowledge of COVID-19 and country of workplace, cadre of HW and educational level.

Generally, statistically significant determinants of knowledge of COVID-19 infection and prevention measures in the multivariate analysis (see Table 3) were HWs' country of workplace, their cadre, and education level.

Algeria had the least number of HWs with good knowledge about COVID-19, while Uganda had the greatest number with good knowledge. (OR: 34.09, $p < 0.0001$) followed by Ghana (OR=13.22, $p < 0.0001$). HWs from DRC were also more knowledgeable on COVID-19 than those from Algeria (OR: 4.59, p=0.015). Compared to other cadres of HWs (Allied HWs), doctors were 3.26 times more knowledgeable on COVID-19 infection and preventive measures (OR: 3.26, $p = 0.005$) while nurses were 36% less likely to have good knowledge of COVID-19 infection and prevention measures compared to the allied health caregivers although this difference was not statistically significant (OR=0.64, p=0.383). Except for certificate holders, knowledge of COVID-19 infection and prevention measures increase with increasing level of education from diploma to master's level.

Determinants of Attitudes Towards COVID-19 Among HWs

There was an association between attitudes towards COVID-19 and country of workforce, age, religion of HW ($p < 0.0001$) education level ($p < 0.001$) gender ($p < 0.002$), and cadre ($p < 0.004$) (see Table 4).

As shown in Table 5, differences in HWs' attitudes towards COVID-19 infection and prevention measures were statistically significant among the various countries. All study participants (HWs) from Ghana showed a good attitude towards COVID-19 infection and preventive measures. Algeria had the least number of HWs with a good attitude

Table 1 Socio-Demographic Characteristics of Frontlines COVID-19 Health Workers

Socio-Demographic Characteristics	Frequency: n (%)
Country of residence	
DRC	248 (48.0)
Uganda	60 (11.6)
Algeria	57 (11.0)
Ghana	37 (7.2)
Senegal	25 (4.8)
Others	90 (17.4)
Age category	
<21 years	16 (3.1)
21–30 years	180 (34.8)
31–40 years	167 (32.3)
41–50 years	93 (18.0)
51–60 years	47 (9.1)
Sex	
Male	289 (55.9)
Female	228 (44.1)
Cadre of HW	
Allied HW (others)	66 (12.8)
Nurses	154 (29.8)
Doctors	297 (57.4)
Education level of HW	
Certificate	15 (2.9)
Diploma	54 (10.4)
Degree/Bachelor's	333 (64.4)
Masters	81 (15.7)
Others	22 (4.3)
Marital status of HW	
Single	218 (42.2)
Married	299 (57.8)
Religion of HW	
Muslim	82 (15.9)
Christians	396 (76.6)
Jehovah's witness	16 (3.1)
Others	23 (4.4)

Abbreviations: HW, health workers; DRC, Democratic Republic of Congo.

compared to those from Uganda (OR: 4.58, p= 0.046), DRC (OR: 3.95, p=0.013), and others (OR: 2.57, p=0.045). The cadre of HWs also had a statistically significant positive influence on attitude towards COVID-19 infection and prevention measures. Doctors were 3.6 times more likely to have a positive attitude than allied HWs. Similarly, nurses were also 3.61 times more likely than allied HWs to have a positive attitude towards COVID-19 infection and prevention measures (see Table 5). Positive differences in attitude were also noted among HWs of various age categories, sex, but these differences were not statistically significant.

Determinants of the Practice of COVID-19 Preventive Measures Among HWs in Africa

Table 4 describes the relationships between the practice of COVID-19 preventive measures and country of workplace, cadre and religion of HW ($p < 0.0001$).

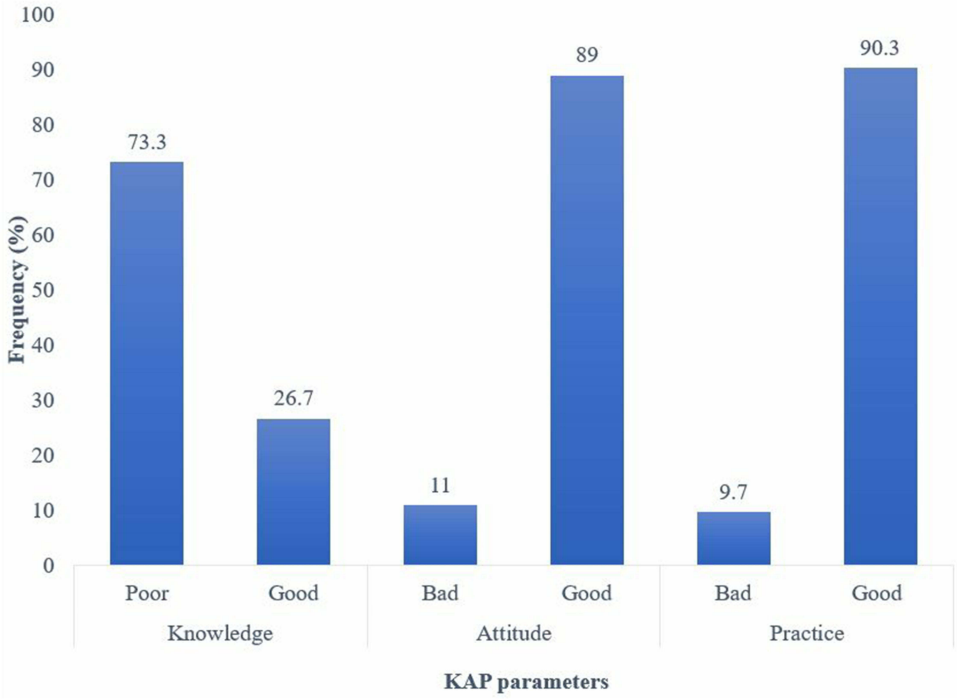

Figure 2 Distribution of knowledge, attitudes and practices (KAP) of COVID-19 preventive measures among healthcare workers in Africa.

Table 5 shows a multivariate logistic regression model for determinants of the practice of COVID-19 preventive measures among HWs in Africa. Overall, statistically significant differences in terms of the practice of COVID-19 preventive measures existed among HWs of the various countries. Algeria had the lowest number of HWs with good practice of COVID-19 infection and prevention measures as compared to Uganda (OR: 55.63, $p < 0.0001$), DRC (OR: 19.72, $p < 0.0001$), Ghana (OR = 6.00, $p = 0.009$) and others (OR: 11.60, $p<0.0001$). Statistically significant differences in the practice of COVID-19 preventive measures also existed among various cadres of HWs in Africa. Both doctors (OR= 8.60, $p < 0.0001$) and nurses (OR: 4.25, $p < 0.003$) showed good practice of COVID-19 preventive measures compared to Allied (other) cadres of HWs. Good practice of COVID-19 preventive measures also varied among HWs of different religions, and education levels, but these differences were not statistically significant.

Relationships Between Knowledge, Attitude, and Practice of COVI-19 Infection and Prevention Among HWs in Africa

Tables 6–8 show, respectively, the influence of knowledge on HWs' attitude, knowledge on practice, and attitude on HWs practice of COVID-19 infection and prevention measures. Adjustments were made for confounding socio-demographic characteristics. Good knowledge of COVID-19 infection and prevention measures had a statistically significant positive impact on HWs attitude (OR: 3.52, $p = 0.037$). Knowledge also positively impacted HW's practice of COVID-19 prevention measures, but this relationship was not statistically significant (OR: 2.21, $p = 0.189$). Similarly, a good attitude had a highly statistically significant positive relationship with good practice of COVID-19 prevention measures (OR: 4.66, $p < 0.0001$).

Discussion

This study aimed to describe and establish the determinants of frontline health workers' Knowledge, attitudes, and practices during the COVID-19 first wave in Africa and their related factors. A total of 537 health workers (HWs) from 26 African countries responded to the survey. The study showed that most HWs had poor knowledge (73.3%) about COVID-19 infection and preventive measures. This could be because COVID-19 is a new infectious disease in Africa.

Table 2 Bivariate Analysis Showing Determinants of Knowledge Towards COVID-19 Infections and Prevention

Variables	Knowledge Category		p-value*
	Poor: n (%)	Good: n (%)	
Country of workplace			<0.0001
Algeria	53 (93.0)	4 (7.0)	
DRC	192 (77.4)	56 (22.6)	
Uganda	17 (28.3)	46 (71.7)	
Ghana	21 (56.8)	16 (43.2)	
Others	96 (83.5)	19 (16.5)	
Age category			0.216
<20 years	15 (93.8)	1 (6.2)	
21–30 years	125 (69.4)	55 (30.6)	
31–40 years	120 (71.9)	47 (28.1)	
41–50 years	70 (75.3)	23 (24.7)	
51–60 years	37 (78.7)	10 (21.3)	
Sex category			0.170
Female	205 (70.9)	84 (29.1)	
Male	174 (76.3)	54 (23.7)	
Cadre of HW			<0.0001
Others (Allied HW)	56 (84.8)	10 (15.2)	
Nurses	141 (91.6)	13 (8.4)	
Doctors	182 (61.3)	115 (38.7)	
Education level			<0.0001
Certificate	13 (86.7)	2 (13.3)	
Diploma	49 (90.7)	5 (9.3)	
Degree/Graduate	249 (74.8)	84 (25.2)	
Masters	46 (56.8)	35 (43.2)	
Others	22 (64.7)	12 (35.3)	
Marital status			0.811
Single	161 (73.9)	57 (26.1)	
Married	218 (72.9)	81 (27.1)	
Religion of HW			0.195
Muslim	66 (80.5)	16 (19.5)	
Christian	282 (71.2)	114 (28.8)	
Jehovah's witness	14 (87.5)	2 (12.5)	
Others	17 (73.9)	6 (26.1)	

Note: *p value from chi-square analysis.
Abbreviations: DRC, Democratic Republic of Congo; HW, health workers.

This poor knowledge would cause rapid spread of the disease, nosocomial contamination, and exposing the lives of several patients.[1] In addition, this misunderstanding would contribute to the spread of the virus to uninfected patients who seek an assessment.[6,7,13] Frontline HWs are directly exposed to SARS-CoV-2 infections. The risk of acquiring COVID-19 is higher among HWs compared to the general population.[26] In addition, this finding highlights the knowledge gap among African HWs and could explain the major barriers to infection control in the African region. Therefore, most HWs had not encountered it in their practice, this agrees with a study done among HWs in Ethiopia on Ebola.[26] However, since Africa has experienced several deadly infectious diseases in the past, most of the HWs demonstrated a good attitude (89%) and (90.3%) practice measures towards preventing COVID-19 infections. This finding agrees with a study conducted in Pakistan which reported a high positive attitude among HWs about COVID-19,[19] but higher than findings reported in Uganda and Ethiopia with 21% and 35%, respectively.[17,26]

Table 3 Multivariate Analysis Showing Determinants of Knowledge for COVID-19 Infections and Preventions

Variables[a]	Odds for Good Knowledge			
	Bivariate Logistic Regression		Multivariate Logistic Regression	
	Crude OR	p-value	Adjusted OR	p-value
Country				<0.0001
Algeria	Reference	-	-	
DRC	3.9 (1.3–11.1)	0.012	4.59 (1.34–15.73)	0.015
Uganda	33.5 (10.5–107.0)	<0.0001	34.09 (9.26–125.48)	<0.0001
Ghana	10.1 (3.0–33.7)	<0.0001	13.22 (3.36–52.00)	<0.0001
Others	2.6 (0.8–8.1)	0.094	2.09 (0.63–6.89)	0.227
Sex				0.331
Female	Reference		-	
Male	1.3 (0.89–1.96)	0.170	0.78 (0.48–1.28)	0.331
Cadre of HW				<0.0001
Others	Reference	-	-	
Nurses	0.5 (0.21–1.25)	0.140	0.64 (0.23–1.75)	0.383
Doctors	3.5 (1.74–7.21)	0.001	3.26 (1.43–7.43)	0.005
Education level				0.011
Certificate	Reference		-	
Diploma	0.7 (0.12–3.82)	0.046	0.17 (0.02–1.33)	0.091
Degree/Graduate	2.2 (0.48–9.92)	0.308	0.50 (0.09–3.68)	0.569
Masters	4.9 (1.05–23.35)	0.044	0.99 (0.15–6.56)	0.991
Others	3.5 (0.68–18.40)	0.132	1.46 (0.20–10.74)	0.712
Religion of HWs				0.885
Muslims	Reference	-		
Christians	1.7 (0.93–3.00)	0.088	0.98 (0.43–2.22)	0.955
Jehovah's Witnesses	0.6 (0.12–2.86)	0.512	0.67 (0.122–3.85)	0.668
Others	1.5 (0.49–4.28)	0.495	1.48 (0.38–5.75)	0.574

Note: [a]Only variables in the bivariate analysis with $p < 0.2$ were included.
Abbreviations: HW, health workers; DRC, Democratic Republic of Congo.

Generally, statistically significant determinants of knowledge of COVID-19 infection and prevention measures in the multivariate analysis were HWs' country of work, their cadre, and education level. This finding differs from the study by Mulusew Andralem where age less than 34 years, rural residence and access to infection prevention (IP) training were determinants of knowledge of HW towards COVID-19 in Ethiopia.[27] This study revealed that Algeria had the least number of HW with good knowledge about COVID-19, while Uganda had the greatest number of HWs with good knowledge. (OR: 34.09, $p < 0.0001$) followed by Ghana (OR=13.22, $p < 0.0001$). HWs from DRC were also more knowledgeable on COVID-19 than those from Algeria (OR: 4.59, p=0.015). Compared to other cadres of HWs (Allied HWs), doctors were 3.26 times more knowledgeable on COVID-19 infection and preventive measures (OR: 3.26, $p = 0.005$) while nurses were 36% less likely to have good knowledge of COVID-19 infection and prevention measures compared to the allied health caregivers although this difference was not statistically significant (OR=0.64, p=0.383). The study also showed that in most countries, doctors were more knowledgeable on COVID-19 compared to other cadres of HWs which showed a similar result with the study by Olum et al.[17] This could be because doctors are always the first to contact patients, which could have prompted them to read more about the novel COVID-19 to better their knowledge for diagnosis and prevention of the disease. This is consistent with other studies whereby clinical HWs were more knowledgeable on COVID-19 than their non-clinical counterparts.[23] Except for certificate holders, knowledge of COVID-19 infection and prevention measures increase with increasing level of education. This finding agrees with the finding of Kassie et al.[28] Good knowledge about COVID-19 is correlated with having a higher educational status because of

Table 4 Analysis Showing Determinants of Attitude Towards COVID-19 Infections and Preventions Measures

Variables	Attitude Category		Bivariate Logistic Regression		Multivariate Logistic Regression	
	Bad: n (%)	Good: n (%)	Crude OR	p-value	Adjusted OR	p-value*
Country						0.052
Algeria	20 (35.1)	37 (64.9)	Reference	-	-	-
DRC	19 (7.7)	229 (92.3)	6.52 (3.18–13.35)	<0.0001	3.95 (1.33–11.69)	0.013
Uganda	3 (5.0)	57 (95.0)	10.27 (2.85–37.02)	<0.0001	4.58 (1.03–20.45)	0.046
Ghana	0 (0)	37 (100)	-	-	-	-
Others	15 (13.0)	100 (87.0)	3.60 (1.67–7.77)	0.001	2.57 (1.02–6.47)	0.045
Age category						0.427
<20 years	7 (43.8)	9 (56.2)	Reference		-	
21–30 years	14 (7.8)	166 (92.2)	9.22 (3.00–28.50)	<0.0001	3.35 (0.86–13.02)	0.081
31–40 years	15 (9.0)	152 (91.0)	7.88 (2.57–24.18)	<0.0001	2.41 (0.63–9.24)	0.200
41–50 years	11 (11.8)	82 (88.2)	5.80 (1.80–18.70)	0.003	1.79 (0.46–7.04)	0.403
51–60 years	7 (14.9)	40 (85.1)	4.44 (1.24–15.87)	0.022	1.84 (0.44–7.78)	0.408
Sex category						0.144
Female	36 (15.8)	192 (84.2)	Reference	-	-	-
Male	21 (7.3)	268 (92.7)	2.39 (1.35–4.23)	0.003	1.6 90.81–3.17)	0.178
Cadre of HW						0.025
Others (Allied HW)	11 (16.7)	55 (83.3)	Reference		-	
Nurses	25 (16.2)	129 (83.8)	1.03 (0.48–2.24)	0.937	-	-
Doctors	21 (7.1)	276 (92.9)	2.63 (1.20–5.76)	0.016	3.60 (1.36–9.53)	0.010
Religion of HW						0.541
Muslim	19 (23.2)	63 (76.8)	Reference	-	-	
Christian	29 (7.3)	367 (92.7)	3.82 (2.02–7.22)	<0.0001	1.38 (0.54–3.55)	0.504
Jehovah's witness	4 (25.0)	12 (75.0)	0.91 (0.26–3.13)	0.875	-	-
Others	5 (21.7)	18 (78.3)	1.09 (0.36–3.31)	0.885	-	-

Note: *p-value from binary logistic regression.
Abbreviations: HW, health workers; DRC, Democratic Republic of Congo.

increased opportunity to access local and international information, mini-round, seminars, lectures, research, conference, and knowledge. These results are different from other studies which reported that the majority of frontline HWs use social media to seek information about COVID-19.[17,26,29,30] This study showed that 89% of the participants had a positive attitude towards COVID-19. This finding agrees with a study conducted in Pakistan which reported a high positive attitude among HWs about COVID-19.[19] This result is higher than the findings reported in Uganda and Ethiopia in terms of 21% and 65.7%, respectively.[17,26] This finding could be explained by the fact that Africa has experienced several deadly infectious diseases in the past, most of the HWs demonstrated a good attitude (89%) and (90.3%) practice measures towards preventing COVID-19 infections. This statement is confirmed by a multivariate positive logistic regression found between attitude and practice in this study. The above finding of positive attitude among African frontline HWs is corroborated with the findings of Bhagavathula et al who revealed that 78% of HWs, had positive attitude about COVID-19.[26]

Interestingly, the factors positively associated with the attitude of frontline HWs towards COVID-19 in Africa were countries of workplace and cadre of HWs. All study participants from Ghana showed good attitude towards COVID-19 preventive measures. This finding corroborates with previous studies.[20,31–39] Algeria had the least number of HW with good attitude compared to those from Uganda (OR: 4.58, p=0.046), DRC (OR: 3.95, p=0.013) and others (OR: 2.57, p=0.045). The cadre of HWs also had a statistically significant positive influence on attitude towards COVID-19 infection and prevention measures. Doctors were 3.6 times more likely to have a positive attitude than allied HWs. Similarly, nurses were also 3.61 times more likely than allied HWs to have a positive attitude towards COVID-19 infection and prevention measures (see Table 4). Positive differences in attitude were also noted among HWs of various age categories, sex, but these differences were not statistically significant. These results are similar with other

Table 5 Analysis Showing Determinants of Practice Towards COVID-19 Infections and Preventions

Variables	Practice Category		Bivariate Logistic Regression		Multivariate Logistic Regression	
	Bad: n (%)	Good: n (%)	Crude OR	p-value	Adjusted OR	p-value*
Country						<0.0001
Algeria	20 (35.1)	37 (64.9)	Reference	-		
DRC	15 (6.0)	233 (94.0)	8.40 (3.95–17.85)	<0.0001	19.72 (6.08–63.92)	<0.0001
Uganda	1 (1.7)	59 (98.3)	31.90 (4.11–247.7)	<0.0001	55.63 (5.90–524.6)	<0.0001
Ghana	6 (16.2)	31 (83.8)	2.79 (1.00–7.82)	0.001	6.00 (1.57–23.02)	0.009
Others	8 (7.0)	107 (93.0)	7.23 (2.94–17.80)	0.051	11.60 (3.87–34.74)	<0.0001
Age category						0.742
<20 years	5 (31.3)	11 (68.7)	Reference			
21–30 years	18 (10.0)	162 (90.0)	4.09 (1.28–13.10)	0.003	0.50 (0.11–2.16)	0.350
31–40 years	11 (6.6)	156 (93.4)	6.45 (1.90–21.86)	0.003	0.77 (0.17–3.54)	0.737
41–50 years	11 (11.8)	82 (88.2)	3.39 (1.00–11.60)	0.052	0.46 (0.10–2.16)	0.324
51–60 years	5 (10.6)	42 (89.4)	3.82 (0.94–15.58)	0.062	0.66 (0.12–3.54)	0.624
Sex category						0.951
Female	28 (12.3)	200 (87.7)	Reference			
Male	22 (7.6)	267 (92.4)	1.70 (0.94–3.06)	0.077	0.98 (0.473–2.02)	0.951
Cadre of HW						<0.0001
Others (Allied HW)	15 (22.7)	51 (77.3)	Reference			
Nurses	21 (13.6)	133 (86.4)	1.86 (0.86–3.89)	0.098	4.25 (1.65–10.93)	0.003
Doctors	14 (4.7)	283 (95.3)	5.95 (2.71 −13.06)	<0.0001	8.60 (3.22–23.00)	<0.0001
Religion of HW			Reference	-		
Muslim	16 (19.5)	66 (80.5)	2.96 (1.53–5.73)	0.001	0.97 (0.36–2.64)	0.957
Christian	30 (7.6)	366 (92.4)	3.64 (0.45–29.60)	0.227	2.84 (0.27–29.96)	0.386
Jehovah's witness	1 (6.3)	15 (93.7)	1.62 (0.43–6.12)	0.480	2.25 (0.42–12.05)	0.342
Others	3 (13.0)	20 87.0)	Reference	-		

Note: *p-value from binary logistic regression.
Abbreviations: HW, health workers; DRC, Democratic Republic of Congo.

surveys.[19,22] The cadre of HWs also had a statistically significant positive influence on attitude towards COVID-19 infection and prevention measures. Doctors were 3.6 times more likely to have a positive attitude than allied HWs. Similarly, nurses were also 3.61 times more likely than allied HWs to have a positive attitude towards COVID-19 infection and prevention measures (see Table 4). Positive differences in attitude were also noted among HWs of various age categories, sex, but these differences were not statistically significant.

In addition, the survey found that 90.3% of the participants had good practices regarding COVID-19. This finding has revealed a good practice among African HWs. This result corroborates with previous studies.[27] Overall, statistically significant differences exist among HWs of the various countries in terms of practice of COVID-19 preventive measures. Algeria had the lowest number of HWs with good practice of COVID-19 infection and prevention measures as compared to Uganda (OR: 55.63, $p < 0.0001$), DRC (OR: 19.72, $p < 0.0001$), Ghana (OR: 6.00, $p = 0.009$) and others (OR: 11.60, $p<0.0001$). Statistically significant differences in practice of COVID-19 preventive measures also existed among various cadres of HWs in Africa. Both doctors (OR: 8.60, $p < 0.0001$) and nurses (OR: 4.25, $p < 0.003$) showed good practice of COVID-19 preventive measures compared to Allied cadres of HWs. Good practice of COVID-19 preventive measures also varied among HWs of different religions, and education levels but these differences were not statistically significant. The results of this could inform policy makers on the practice of African frontline HWs towards SARS-CoV-2 infections. The findings by providing a more precise assessment of the magnitude of good practice among frontline HWs, offer an additional robust knowledge in literature. However, the determinants of practice towards COVID-19 identified in this study differed from those revealed by Mulusew Andualem where rural residence, facility type, access to IP training, presence of IP guidelines, knowledge about COVID-19, having chronic illnesses, lack of personal protective equipment (PPEs), and high workload were factors of COVID-19 prevention.[27]

Table 6 Multi-Variate Logistic Regression Showing the Influence of Health Workers' Knowledge on Their Attitude Towards COVID-19 Prevention Measures: Adjusted for Socio-Demographic Factors

	Odds for Good Attitude			p-value*
	Adjusted Odds Ratio	95% Confidence Interval (CI)		
		Lower Limit	Upper Limit	
Knowledge category				
Bad	Reference	-	-	-
Good	3.52	1.08	11.45	0.037
Age category				
<20 years	Reference	-	-	-
21–30 years	3.67	0.93	14.42	0.063
31–40 years	2.62	0.68	10.13	0.161
41–50 years	1.92	0.49	7.57	0.353
51–60 years	2.01	0.47	8.51	0.345
Sex category				
Female	Reference	-	-	-
Male	1.72	0.86	3.44	0.126
HW category				
Others	Reference	-	-	-
Nurses	3.78	1.34	10.69	0.012
Doctors	3.13	1.17	8.37	0.023
Religion				
Muslims	Reference	-	-	-
Christians	1.41	0.55	3.61	0.472
Jehovah's Witnesses	0.61	0.15	2.50	0.493
Others	0.66	0.17	2.58	0.548
Country				
Algeria	Reference	-	-	-
DRC	3.45	1.16	10.23	0.025
Uganda	2.31	0.48	11.21	0.300
Ghana	-	-	-	1
Others	2.55	1.01	6.44	0.048
Education level				
Certificate	Reference	-	-	-
Diploma	3.62	0.49	26.58	0.206
Degree/Bachelor's	1.84	0.33	10.37	0.492
Masters	4.59	0.61	34.34	0.138
Others	8.96	0.61	131.14	0.109

Note: *p-value from binary logistic regression.
Abbreviations: HW, health workers; DRC, Democratic Republic of Congo.

Correlations among Knowledge, attitude and practice of COVID-19 infection measures showed that good Knowledge of COVID-19 infection and prevention measures impacted HWs attitude and practice on COVID-19 preventive measures. Similar findings were also reported in previous studies.[26–28] This further emphasizes the need to have all HWs handling COVID-19 patients better trained about the disease for better patient health care outcomes and supplied with all the necessary PPEs to ensure that HWs do not get infected with the virus when handling patients.[27,29]

Limitation of the Study

This study collected data from 26 countries in Africa using online platform. This means that our study findings could be truly representative of the KAP of HWs from across Africa. However, we acknowledge that some

Table 7 Influence of HW's Knowledge on Their Practice of COVID-19 Infection and Prevention Measures (Adjusted for Confounding Socio-Demographic Factors)

	Odds for Good Practice			
	p-value*	Adjusted Odds Ratio	95% Confidence Interval (CI)	
Knowledge category	0.189		Lower limit	Upper limit
Bad	Reference			
Good	0.189	2.21	0.68	7.24
Age category	0.766			
<20 years	Reference			
21–30 years	0.373	0.51	0.12	2.24
31–40 years	0.761	0.79	0.17	3.63
41–50 years	0.351	0.48	0.10	2.26
51–60 years	0.680	0.70	013	3.80
Sex category	0.993			
Female	Reference			
Male	0.993	1.00	0.48	2.10
HW category	<0.0001			
Others	Reference			
Nurses	0.003	4.18	1.62	10.74
Doctors	<0.0001	7.51	2.77	20.40
Religion of respondent	0.597			
Muslims	Reference			
Christians	0.997	1.00	0.37	2.72
Jehovah's Witnesses	0.337	3.17	0.30	33.29
Others	0.325	2.32	0.43	12.45
Country	<0.0001			
Algeria	Reference			
DRC	<0.0001	18.12	5.78	59.00
Uganda	0.002	36.16	3.61	362.05
Ghana	0.018	5.24	1.33	21.00
Others	<0.0001	11.57	3.87	34.62
Education level	0.243			
Certificate	Reference			
Diploma	0.334	2.77	0.35	21.78
Degree/Bachelor's	0.725	1.40	0.22	8.92
Masters	0.122	6.33	0.61	65.50
Others	0.410	3.00	0.23	37.58

Note: *p-value from binary logistic regression.
Abbreviations: DRC, Democratic Republic of Congo; HW, health workers.

countries' responses were fewer than others, which could have affected the study findings. As the area of study was bigger and financial constraint, we did not find adequate sample size to include in our study which could help us to assess better knowledge, attitude and practices of African frontline HWs. Moreover, COVID-19 is an emerging infectious disease so information related to knowledge (treatment, symptom, transmission, etc) and prevention is likely to change following each wave of pandemic; however, the study assessed knowledge and attitude and practice in 2020, it may not necessarily reflect the actual attitude, practice and that people comply with. The best way to assess practice could be by daily observation of African frontline HWs. Despite these limitations, our findings provide valuable information about African frontline HWs' KAP regarding COVID-19.

Table 8 Influence of Health Workers' Attitude on Their Practice of COVID-19 Infection Prevention Measures; (Adjusted for Confounding Socio-Demographic Factors)

	Odds for Good Practice			p-value*
	Adjusted Odds Ratio	95% Confidence Interval (CI)		
		Lower Limit	Upper Limit	
Attitude category				
Bad	Reference	-	-	-
Good	4.66	1.98	10.99	<0.0001
Age category				
<21 years	Reference	-	-	-
21–30 years	0.33	0.07	1.57	0.162
31–40 years	057	0.11	2.84	0.488
41–50 years	0.36	0.07	1.86	0.224
51–60 years	0.61	0.10	3.65	0.586
HW category				
Others	Reference	-	-	-
Nurses	3.78	1.36	9.42	0.010
Doctors	7.25	2.65	19.86	<0.0001
Religion				
Muslims	Reference	-	-	-
Christians	0.85	0.30	2.43	0.756
Jehovah's Witnesses	2.83	0.28	28.32	0.376
Others	2.91	0.45	18.56	0.26
Country				
Algeria	Reference	-	-	-
DRC	18.60	5.10	61.26	<0.0001
Uganda	44.25	4.57	428.21	0.001
Ghana	3.86	0.96	15.45	0.056
Others	10.47	3.35	32.75	<0.0001
Sex category				
Female	Reference	-	-	-
Male	0.90	0.43	19.20	0.792
Education level				
Certificate	Reference	-	-	-
Diploma	2.02	0.20	20.32	0553
Degree/Bachelor's	1.09	0.13	9.09	0.939
Masters	4.14	0.32	53.73	0.278
Others	2.45	0.14	42.83	0.74

Note: *p-value from binary logistic regression.
Abbreviations: HW, health workers; DRC, Democratic Republic of Congo.

Strengths of the Study

This multicenter online cross-sectional study had the following strengths: Firstly, a comprehensive search including multiple variables at the time of the KAP of HWs from across Africa. Secondly, this study used an online-based survey method to avoid possible transmission and the questionnaire was designed in English and French, the most spoken national languages in Africa to capture the valuable information about African frontlines HWs'KAP towards COVID-19. Thirdly, the study was conducted using standardized and pre-tested screening tools and adjusted pre-validated questionnaire to obtain information on the study variables.

Conclusions

Majority of the frontline HW in Africa had an overall good attitude and practice towards the COVID-19 infection and prevention measures despite a comparatively poor knowledge about the disease. A good knowledge of COVID-19 infection and prevention measures, however, positively impacted HWs attitude and practice on COVID-19 preventive measures. Determinants of knowledge of COVID-19 infection prevention measures among HWs include, country of workplace, cadre and level of education, while country of workplace and HWs' cadre were the determinants for both attitude and practice. Promoting inter-state benchmarking and experience sharing among African countries in addition to regular refresher trainings for HWs could help to enhance their KAP towards COVID-19 infection and prevention measures.

Abbreviations

CI, confidence interval; DRC, Democratic Republic of the Congo; HW, health worker; KAP, Knowledge-Attitude-Practice; OR, odds ratio; PPE, personal protective equipment.

Data Sharing Statement

The datasets generated during and analyzed during the current study are not publicly available due to legal and ethical reasons but are available from the corresponding author on reasonable request.

Ethics and Consent

Before collecting data, ethical approval has been cleared by the Integrated Multidisciplinary Research Center Ethics committee (IMRCEC) of Adventist University of Lukanga (Campus Wallace, Lukanga, DR Congo; protocol number 02/2020). The study was conducted according to the Declaration of Helsinki and all participants signed a written informed consent. Participants consented for publication.

Acknowledgments

The authors would like to thank all respondents for their voluntary participation and cooperation in this study. LKK is grateful to the Uganda government through the Excellence scholarship program under Ministry of Health Sponsorship in the FY 2020/2021 HML and SKN are thankful to the Else-Kröner-Fresenius-Stiftung, Holger-Poehlmann-Stiftung and the NGO Förderverein Uni Kinshasa e.V., fUNIKIN through the Excellence Scholarship Program "Bourse d'Excellence Bringmann aux Universités Congolaises, BEBUC".

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted, and agree to be accountable for all aspects of the work.

Funding

No funding is to be disclosed.

Disclosure

The authors report no conflicts of interest in relation to this work.

References

1. Rancourt DG. Face masks, lies, damn lies, and public health officials: " A growing body of evidence"; 2020.
2. Paterlini M. On the front lines of coronavirus: the Italian response to covid-19. *BMJ*. 2020;368:1–2. doi:10.1136/bmj.m1065
3. Liu Z, Magal P, Seydi O, Webb G. Understanding unreported cases in the COVID-19 epidemic outbreak in Wuhan, China, and the importance of major public health interventions. *Biology*. 2020;9(3):50.

4. Zhou P, Yang X-L, Wang X-G, et al. A pneumonia outbreak associated with a new coronavirus of probable bat origin. Nature. 2020;579 (7798):270–273. doi:10.1038/s41586-020-2012-7
5. Ayebare R, Waitt P, Okello S, et al. Leveraging investments in Ebola preparedness for COVID-19 in Sub-Saharan Africa. *AAS Open Res*. 2020;3 (May):3. doi:10.12688/aasopenres.13052.1
6. Sirina Keesara MD, Andrea Jonas MD, Kevin Schulman M. Covid-19 and health care's digital revolution. *N Engl J Med*. 2020;382:1–2.
7. Joshi JR. COVSACK: an innovative portable isolated and safe COVID-19 sample collection kiosk with automatic disinfection. *Trans Indian Natl Acad Eng*. 2020;5(2):269–275. doi:10.1007/s41403-020-00139-1
8. Nguyen LH, Drew DA, Graham MS, et al. Risk of COVID-19 among front-line health-care workers and the general community: a prospective cohort study. *Lancet Public Heal*. 2020;5(9):e475–e483. doi:10.1016/S2468-2667(20)30164-X
9. Nearly 300,000 healthcare workers have been infected with Covid-19 worldwide, threatening health systems. [cited October 22, 2021]. Available from: https://www.forbes.com/sites/williamhaseltine/2020/11/17/the-infection-of-hundreds-of-thousands-of-healthcare-workers-worldwide-poses-a-threat-to-national-health-systems/?sh=1e94b38f3499. Accessed August 5, 2022.
10. World Covid-19 tracker: latest cases and deaths by country. [cited October 22, 2021]. Available from: https://edition.cnn.com/interactive/2020/health/coronavirus-maps-and-cases/. Accessed August 5, 2022.
11. Epidemic and pandemic-prone diseases » Outbreaks » COVID-19. Available from http://www.emro.who.int/pandemic-epidemic-diseases/covid-19/covid-19-situation-updates-for-week-40-39-october-2021.html. Accessed August 5, 2022.
12. Ritchie H, Mathieu E, Rodés-Guirao L, et al. Coronavirus Pandemic (COVID-19). Our World Data; 2020 [cited October 22, 2021]. Available from: https://ourworldindata.org/coronavirus. Accessed August 5, 2022.
13. Kimball A, Hatfield KM, Arons M, et al. Asymptomatic and presymptomatic SARS-CoV-2 infections in residents of a long-term care skilled nursing facility. *Morb Mortal Wkly Rep Summ CDC*. 2020;69(13):377–381. doi:10.15585/mmwr.mm6913e1
14. Kapata N, Ihekweazu C, Ntoumi F, et al. Is *Africa* prepared for tackling the COVID-19 (SARS-CoV-2) epidemic. Lessons from past outbreaks, ongoing pan-African public health efforts, and implications for the future. *Int J Infect Dis*. 2020;93(February):233–236. doi:10.1016/j.ijid.2020.02.049
15. Driggin E, Madhavan MV, Bikdeli B, Chuich T, Harm PD. Cardiovascular considerations for patients, health care workers, and health systems during the coronavirus disease 2019 (COVID-19) pandemic. *J Am Coll Cardiol*. 2020;75(January):2352–2371. doi:10.1016/j.jacc.2020.03.031
16. Cecyli C, Ezhilarasan G. Assessment of knowledge, attitude and practices of paramedic health care workers towards Covid-19 pandemic. *Saudi J Nurs Health Care*. 2021;4(8):236–240.
17. Olum R, Chekwech G, Wekha G, Nassozi DR, Bongomin F. Coronavirus disease-2019: knowledge, attitude, and practices of health care workers at makerere university teaching hospitals, Uganda. *Front Public Heal*. 2020;8.
18. Kassie AD, Bifftu BB, Mekonnen HS. Self-medication practice and associated factors among adult household members in Meket district, Northeast Ethiopia, 2017. *BMC Pharmacol Toxicol*. 2018;19(1). doi:10.1186/s40360-018-0205-6
19. Saqlain M, Munir MM, Rehman SU. Knowledge, attitude, practice and perceived barriers among healthcare professionals regarding COVID-19: a Cross-sectional survey from Pakistan. *J Hosp Infect*. 2020;105:419–423.
20. Nkansah C, Serwaa D, Adarkwah LA, et al. Novel coronavirus disease 2019: knowledge, practice and preparedness: a survey of healthcare workers in the offinso-north district, Ghana. *Pan Afr Med J*. 2020;35(Supp 2):1–6.
21. Maina J, Ouma PO, Macharia PM, et al. A spatial database of health facilities managed by the public health sector in sub Saharan Africa. *Sci Data*. 2019;6(1):1–8. doi:10.1038/s41597-019-0142-2
22. Zhong BL, Luo W, Li HM, et al. Knowledge, attitudes, and practices towards COVID-19 among Chinese residents during the rapid rise period of the COVID-19 outbreak: a quick online cross-sectional survey. *Int J Biol Sci*. 2020;16(10):1745–1752. doi:10.7150/ijbs.45221
23. Goni MD, Naing NN, Hasan H, et al. Development and validation of knowledge, attitude and practice questionnaire for prevention of respiratory tract infections among Malaysian Hajj pilgrims. *BMC Public Health*. 2020;20(1):1–10. doi:10.1186/s12889-019-7969-5
24. Huynh G, Nguyen T, Tran V, Vo K, Vo V, Pham L. Knowledge and attitude toward COVID-19 among healthcare workers at District 2 Hospital, Ho Chi Minh City. *Asian Pac J Trop Med*. 2020;13(6):260–265. doi:10.4103/1995-7645.280396
25. Le An P, Huynh G, Nguyen HTN, et al. Assessment of COVID-19 preventive practice and associated factors among educators in Vietnam. *Infect Drug Resist*. 2022;15:183. doi:10.2147/IDR.S350045
26. Abebe TB, Bhagavathula AS, Tefera YG, et al. Healthcare professionals' awareness, knowledge, attitudes, perceptions and beliefs about Ebola at Gondar University Hospital, Northwest Ethiopia: a cross-sectional study. *J Public Health Africa*. 2016;7(2). doi:10.4081/jphia.2016.570
27. Asemahagn MA. Factors determining the knowledge and prevention practice of healthcare workers towards COVID-19 in Amhara region, Ethiopia: a cross-sectional survey. *Trop Med Health*. 2020;48(1):1. doi:10.1186/s41182-020-00254-3
28. Kassie BA, Adane A, Tilahun YT, Kassahun EA, Ayele AS, Belew AK. Knowledge and attitude towards COVID-19 and associated factors among health care providers in Northwest Ethiopia. *PloS One*. 2020;15(8):e0238415. doi:10.1371/journal.pone.0238415
29. le Roux C, Dramowski A. Personal protective equipment (PPE) in a pandemic: approaches to PPE preservation for South African healthcare facilities. *South African Med J*. 2020;110(6):466–468.
30. Control CfD, Prevention. Preparing for COVID-19: long-term care facilities, nursing homes; 2020.
31. Greenhalgh T, Schmid MB, Czypionka T, Bassler D, Gruer L. Face masks for the public during the covid-19 crisis. *BMJ*. 2020;4:369.
32. Bartoszko JJ, Farooqi MAM, Alhazzani W, Loeb M. Medical masks vs N95 respirators for preventing COVID-19 in healthcare workers: a systematic review and meta-analysis of randomized trials. *Influenza Other Respi Viruses*. 2020;14:365–373. doi:10.1111/irv.12745
33. Saqlain M, Munir MM, Rehman S, et al. Knowledge, attitude, practice and perceived barriers among healthcare professionals regarding COVID-19: a Cross-sectional survey from Pakistan. *J Hosp Infect*. 2020;105:419–423. doi:10.1016/j.jhin.2020.05.007
34. Giao H, Han NTN, Van khanh T, Ngan VK, Van Tam V, Le An P. Knowledge and attitude toward COVID-19 among healthcare workers at District 2 Hospital, Ho Chi Minh City. *Asian Pacific J Trop Med*. 2020;13:3–5.
35. Afulani PA, Gyamerah AO, Aborigo R, et al. Perceived preparedness to respond to the COVID-19 pandemic: a study with healthcare workers in Ghana. *medRxiv*. 2020. doi:10.1101/2020.07.10.20151142
36. Essel HB, Tachie-Menson A, Osei M, Yeboah E. Towards the easing of restrictions during an infectious outbreak: a cross-sectional online survey to assess the knowledge, misperceptions, attitudes and behaviour of Ghanaians on the COVID-19 pandemic; 2020.

37. Cai H, Tu B, Ma J, et al. Psychological impact and coping strategies of frontline medical staff in Hunan between January and March 2020 during the outbreak of coronavirus disease 2019 (COVID-19) in Hubei, China. *Med Sci Monitor*. 2020;26:e924171. doi:10.12659/MSM.924171
38. Galbraith N, Boyda D, McFeeters D, Hassan T. The mental health of doctors during the Covid-19 pandemic. *BJPsych Bulletin*. 2020;1–4. doi:10.1192/bjb.2020.141
39. Houghton C, Meskell P, Delaney H, et al. Barriers and facilitators to healthcare workers' adherence with infection prevention and control (IPC) guidelines for respiratory infectious diseases: a rapid qualitative evidence synthesis. *Cochrane Database Syst Rev*. 2020;4:e34.