Determinants of knowledge, attitudes, and practices of front-line health workers during the first wave of COVID-19 in Africa: a multi-center online cross-sectional study

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Research Article

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Abstract

Background: During its first wave of COVID-19 infection in sub-Saharan Africa, there was insufficient understanding of the pandemic among front-line health care professionals that has led to a misidentification, and mistreatment of affected patients, with a potential risk of contracting and spreading the disease. This study was carried out to determine the Knowledge, attitude, and practices (KAP) of front-line health workers (HWs) towards COVID-19 in Africa and their related factors.

Methods: This was a multi-centers online cross-sectional study conducted over a 3-months study-period using a google survey link among front lines HWs involved in the COVID-19 response in 26 African countries. Chi-square test & logistic regression were used in the bivariate and multivariate analysis respectively to assess determinants of KAP. Statistical analysis was done using STATA version 16; all tests were two-sided with 95% confidence interval.

Results: Five hundred and seventeen (517, 96.3%) consented to participate in this study from 26 African countries; 289 (55.9%) were male and 228 (44.1%) female. Overall, 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). Additionally, knowledge increased with increasing HWs' education level (p=0.011).

Attitude and practice were both influenced by HWs country of workplace (p=0.05 & p< 0.0001 respectively) and their cadre (p = 0.025 & p < 0.0001 respectively).

Conclusions: Majority of the front-line 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 and level of education.

Introduction

The emergence of Corona virus disease (COVID-19) in 2019 from Wuhan-China, and its exponential transmission to all countries in the World, including the fifty-two countries of Africa, present a delicate situation for low-resource countries. This current pandemic has shaken the entire World [1-4, 5, 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 E. et al., found that 300,000 HWs from thirty-seven countries had already gotten COVID-19. In addition to the high

number of infections, over 115,000 of HWs have already lost their lives around the World as of 22th October 22, 2021. Of the thirty-seven countries surveyed, the United States had the highest coronavirus infections among HWs with 114,500 infections (9). Mexico followed with a reported 78,200 infections while France and Italy had 30,000 and 29,000 coronavirus infections, respectively(9). 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 [9].

As of 16th October 2021, over 242,801,421 cases and 4,929,826 deaths have been reported globally (2.96 %). The USA is the most affected, with over 50% of cases and 60% of deaths reported in this region(10). 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 [10]. 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 cases; and similarly, an overall increase in the case number has been reported in Namibia and Nigeria in term of 55% and 19% respectively [11,12]. 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 [13].

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, 14]. 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 [15]. 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 [14, 16]. Several studies reported that age and education level were significantly associated with good Practice and Knowledge towards COVID-19 [16-18]. 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 front-line HWs' KAP and possible risk factors help to improve the safety of both the HWs and the general population. This study aimed to assess the KAP of the front-line 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 2020 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.

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 [16, 23-26] 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 of 7 questions on socio-demographic characteristics of the participants. The second section included 12 questions regarding the Knowledge of HWs on COVID-19 using two points scale. Each incorrect response weighed 0 point and 1 for correct responses. A HW who got sixty percent or more of the responses correct was categorized as having a good knowledge while the one who got less than sixty percent correct responses was categorized as having poor knowledge. The third section had 5 questions assessing attitude of HWs in a Likert scale of agreement format [16, 25]. A HW who got sixty percent or more of the responses correct was categorized as having a good attitude while the one who got less the sixty percent, poor attitude. The fourth section included 5 questions regarding the practices of COVID-19. The responses were: always, occasional, never, and neutral each weighing 3, 2, and 1 point respectively for a given practice. Again, a cut of score of sixty percent 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.

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 [16, 25]. 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 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 percent confidence level. Results reported in crude and adjusted Odds 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 were guaranteed.

Results

Socio-demographic characteristic of study participants: A total of five hundred and thirty-seven (537) Health workers from 26 African countries responded to the survey. Five hundred and seventeen (517, 96.3%) consented to participate in the study. 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 2 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%) where 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).

Determinants of Knowledge of COVID-19 among healthcare givers: Generally, statistically significant determinants of knowledge of COVID-19 infection and prevention measures in the multivariate analysis 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 care-givers 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: As shown in Table 6, 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 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 6). 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 8 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 9, 10, and 11 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. Five hundred and thirty-seven (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. 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, 12]. 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 [27]. 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 [27]. 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 [27], but higher than findings reported in Uganda and Ethiopia with 21% and 35% respectively [16, 28].

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 [29]. 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 [16]. 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 [26]. 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 and colleagues [30]. Good knowledge about COVID-19 is correlated with having a higher educational status because of 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 [16, 27, 35, 36].This study showed that 89% of 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 (15). This result is higher than the findings reported in Uganda and Ethiopia in term of 21% and 65.7% respectively [8, 14, 25, 29]. 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 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 [32-34]. 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 6). 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 surveys [15, 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 6). 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 participants had good practices regarding COVID-19. This finding has revealed a good practice among African HWs. This result corroborates with previous studies [29]. 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 differe 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 protective equipment (PPE), and high workload were factors of COVID-19 prevention [29].

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 [27, 29, 30]. 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 [29, 31].

Limitation of the study: This study collected data from 26 countries in Africa. This means that our study findings could be truly representative of the KAP of HWs from across Africa. However, we acknowledge that some countries' responses were fewer than others, which could have affected the study findings. As the area of study was bigger and financial constraint, we didn't find adequate sample size to include in our study which could help us to assess better knowledge, attitude and practices of African frontline HWs. Then, the study assessed knowledge and attitude and practice, 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.

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 bench-marking 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.

List Of Abbreviations

OR: Odds ratio; CI: Confidence interval; HW: Health worker; KAP: Knowledge-Attitude-Practice.

Declarations

Ethics approval, consent to participate and for publication: 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, DRCongo). (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.

Competing interests: Authors declare no competing interests.

Availability of data and materials: 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.

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Author contributions: LKK conceived and designed the study and wrote the first draft of the manuscript. LKK, HML, ESB, ZMS, DKM, BMK, SKN, FKS, MMV, LMK, AKK, YALT, BMV, undertook the data collection and coordinated of the activities in different countries; LMK and RNI did the statistical analysis. KS, HML and LKK discussed the findings. LKK, HML, RNI, BMK, AKN, FK, LMK. ESB, FK, TKK did the manuscript correction, critical review of the final manuscript and LKK and SR did the supervision of the work. All authors contributed in intellectual content and approved of the final manuscript. All authors have read and agreed to the final manuscript.

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Tables

Table 1: Distribution of frontlines COVID-19 HWs by country of workplace.

Country	Frequency (n)	Percentage (%)
Algeria	57	11.0
Benin	14	2.7
Burkina Faso	2	.4
Burundi	8	1.5
Cameroon	1	0.2
Chad	1	0.2
Congo Brazzaville	3	0.6
DRC	248	48.0
Egypt	9	1.7
Ethiopia	1	0.2
Gabon	1	0.2
Ghana	37	7.2
Guinea	2	0.4
Ivory Coast	3	0.6
Kenya	10	1.9
Libya	4	0.8
Malawi	1	0.2
Mali	1	0.2
Morocco	2	0.4
Niger	3	0.6
Nigeria	3	0.6
Rwanda	5	1.0
Senegal	25	4.8
South Africa	11	2.1
Tanzania	5	1.0
Uganda	60	11.6

Table 2: Socio-demographic characteristics of frontlines COVID-19 HWs

Socio-demographic characteristic	Frequency: n (%)
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 HWs	
Allied HW (others)	66 (12.8)
Nurses	154 (29.8)
Doctors	297 (57.4)
Education level of HWs	
Certificate	15 (2.9)
Diploma	54 (10.4)
Degree/Bachelors	333 (64.4)
Masters	81 (15.7)
Others	22 (4.3)
Marital status of HWs	
Single	218 (42.2)
Married	299 (57.8)
Religion of HWs	
Muslim	82 (15.9)
Christians	396 (76.6)
Jehovah’s witness	16 (3.1)
Others	23 (4.4)

Table 3: Bivariate analysis showing determinants of Knowledge towards COVID-19 infections & prevention. *- *p value from chi-square analysis.*

	Knowledge category		
Variables	Poor: n (%)	Good: n (%)	p-value*
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)	

Table 4: Multivariate analysis showing determinants of Knowledge for COVID-19 infections & preventions. [b] *only variables in the bivariate analysis with p < 0.2 were included.*

	Odds for good knowledge			
	Bivariate Logistic regression		Multivariate Logistic regression	
Variables [b]	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

Table 5: Bivariate analysis showing determinants of attitude towards COVID-19 infection and prevention. **p-value from chi-square analysis.*

	Attitude category		
Variables	Bad: n (%)	Good: n (%)	p-value*
Country of workplace			< 0.0001
Algeria	20 (35.1)	37 (64.9)	
DRC	19 (7.7)	229 (92.3)	
Uganda	3 (5.0)	57 (95.0)	
Ghana	0 (0)	37 (100)	
Others	15 (13.0)	100 (87.0)	
Age category			< 0.0001
< 20 years	7 (43.8)	9 (56.2)	
21-30 years	14 (7.8)	166 (92.2)	
31-40 years	15 (9.0)	152 (91.0)	
41-50 years	11 (11.8)	82 (88.2)	
51-60 years	7 (14.9)	40 (85.1)	
Sex category			0.002
Female	36 (15.8)	192 (84.2)	
Male	21 (7.3)	268 (92.7)	
Cadre of HW			0.004
Others (Allied HW)	11 (16.7)	55 (83.3)	
Nurses	25 (16.2)	129 (83.8)	
Doctors	21 (7.1)	276 (92.9)	
Education level			0.001
Certificate	6 (40.0)	9 (60.0)	
Diploma	6 (11.1)	48 (88.9)	
Degree/Graduate	40 (12.0)	293 (88.0)	
Masters	4 (4.9)	77 (95.1)	
Others	1 (2.9)	33 997.1)	
Marital status			0.784
Single	25 (11.5)	193 (88.5)	
Married	32 (10.7)	267 (89.3)	
Religion of HW			< 0.0001
Muslim	19 (23.2)	63 (76.8)	
Christian	29 (7.3)	367 (92.7)	
Jehovah’s witness	4 (25.0)	12 (75.0)	
Others	5 (21.7)	18 (78.3)	

Table 6: Multivariate analysis showing determinants of attitude towards COVID-19 infections & preventions measures. *[a] All HWs had good attitude towards COVID-19 infection and prevention measures [b]. variables in the bivariate analysis with p < 0.2, * p-value from binary logistic regression,*

	Odds for good attitude			
	Bivariate Logistic regression		Multivariate Logistic regression	
Variables [a]	Crude OR	p-value	Adjusted OR	p-value*
Country				**0.052**
Algeria	Reference	-	-	-
DRC	6.52 (3.18 – 13.35)	< 0.0001	3.95 (1.33 – 11.69)	0.013
Uganda	10.27 (2.85 – 37.02)	< 0.0001	4.58 (1.03 – 20.45)	0.046
Ghana [b]	-	-	-	-
Others	3.60 (1.67 – 7.77)	0.001	2.57 (1.02 – 6.47)	0.045
Sex				**0.144**
Female	Reference	-	-	-
Male	2.39 (1.35 – 4.23)	0.003	1.6 90.81 – 3.17)	0.178
Cadre of HW				**0.025**
Others	Reference		-	
Nurses	1.03 (0.48 – 2.24)	0.937	3.61 (1.29 – 10.12)	0.015
Doctors	2.63 (1.20 – 5.76)	0.016	3.60 (1.36 – 9.53)	0.010
Education level				**0.208**
Certificate	Reference	-	-	
Diploma	5.33 (1.40 – 20.31)	0.014	3.08 (0.43 – 22.01)	0.263
Degree/Graduate	4.88 (1.65- 14.45)	0.004	1.80 (0.32 – 9.97)	0.503
Masters	12.83 (3.04 – 54.24)	0.001	4.74 (0.65 – 34.60)	0.125
Others	22.00 (2.34 – 207)	0.007	10.17 (0.71 – 146.09)	0.088
Religion of HWs				**0.541**
Muslims	Reference	-	-	
Christians	3.82 (2.02 – 7.22)	<0.0001	1.38 (0.54 – 3.55)	0.504
Jehovah's Witnesses	0.91 (0.26 – 3.13)	0.875	0.57 (0.14 – 2.31)	0.426
Others	1.09 (0.36 – 3.31)	0.885	0.66 (0.17 – 2.54)	0.544
Age (years)				**0.427**
<21	Reference		-	
21-30	9.22 (3.00 – 28.50)	< 0.0001	3.35 (0.86 – 13.02)	0.081
31-40	7.88 (2.57 – 24.18)	< 0.0001	2.41 (0.63 – 9.24)	0.200
41-50	5.80 (1.80 – 18.70)	0.003	1.79 (0.46 – 7.04)	0.403
51-60	4.44 (1.24 – 15.87)	0.022	1.84 (0.44 – 7.78)	0.408

Table 7: Bivariate analysis showing determinants of HW's Practice of COVID-19 infections measures. * *p values from chi-square analysis.*

	Practice category		
Variables	Bad: frequency (%)	Good: frequency (%)	p-value*
Country of workplace			< 0.0001
Algeria	20 (35.1)	37 (64.9)	
DRC	15 (6.0)	233 (94.0)	
Uganda	1 (1.7)	59 (98.3)	
Ghana	6 (16.2)	31 (83.8)	
Others	8 (7.0)	107 (93.0)	
Age category			0.031
< 20 years	5 (31.3)	11 (68.7)	
21-30 years	18 (10.0)	162 (90.0)	
31-40 years	11 (6.6)	156 (93.4)	
41-50 years	11 (11.8)	82 (88.2)	
51-60 years	5 (10.6)	42 (89.4)	
Sex category			0.075
Female	28 (12.3)	200 (87.7)	
Male	22 (7.6)	267 (92.4)	
Cadre of HW			< 0.0001
Others (Allied HW)	15 (22.7)	51 (77.3)	
Nurses	21 (13.6)	133 (86.4)	
Doctors	14 (4.7)	283 (95.3)	
Education level			0.087
Certificate	3 (20.0)	12 (80.0)	
Diploma	6 (11.1)	48 (88.9)	
Degree/Graduate	37 (11.1)	296 (88.9)	
Masters	2 (2.5)	79 (97.5)	
Others	2 (5.9)	32 (94.1)	
Marital status			0.782
Single	22 (10.1)	196 (89.9)	
Married	28 (9.4)	271 (90.6)	
Religion of HW			
Muslim	16 (19.5)	66 (80.5)	0.009
Christian	30 (7.6)	366 (92.4)	
Jehovah’s witness	1 (6.3)	15 (93.7)	
Others	3 (13.0)	20 87.0)	

Table 8: Multivariate analysis showing determinants of practice towards COVID-19 infections & preventions. [a] *only variables in the bivariate analysis with p < 0.2 were included. * p-value from binary logistic regression.*

	Odds for good practice			
	Bivariate Logistic regression		Multivariate Logistic regression	
Variables [a]	Crude OR	p-value	Adjusted OR	p-value*
Country				**< 0.0001**
Algeria	Reference	-		
DRC	8.40 (3.95 – 17.85)	< 0.0001	19.72 (6.08 – 63.92)	< 0.0001
Uganda	31.90 (4.11 – 247.7)	< 0.0001	55.63 (5.90 – 524.6)	< 0.0001
Ghana	2.79 (1.00 – 7.82)	0.001	6.00 (1.57 – 23.02)	0.009
Others	7.23 (2.94 – 17.80)	0.051	11.60 (3.87 – 34.74)	< 0.0001
Sex				**0.951**
Female	Reference			
Male	1.70 (0.94 – 3.06)	0.077	0.98 (0.473 – 2.02)	0.951
Cadre of HW				**< 0.0001**
Others	Reference			
Nurses	1.86 (0.86 – 3.89)	0.098	4.25 (1.65 – 10.93)	0.003
Doctors	5.95 (2.71 -13.06)	< 0.0001	8.60 (3.22 – 23.00)	< 0.0001
Education level				**0.221**
Certificate	Reference	-		
Diploma	2.00 (0.44 – 9.18)	0.373	2.60 (0.33 – 20.37)	0.363
Degree/Graduate	2.00 (0.54 – 7.42)	0.300	1.40 (0.22 – 8.90)	0.724
Masters	9.88 (1.49 – 65.33)	0.018	6.42 (0.63 – 65.90)	0.118
Others	4.00 (0.59 – 26.97)	0.154	3.76 (0.30 – 47.04)	0.304
Religion of HWs				**0.633**
Muslims	Reference	-		
Christians	2.96 (1.53 – 5.73)	0.001	0.97 (0.36 – 2.64)	0.957
Jehovah's Witnesses	3.64 (0.45 – 29.60)	0.227	2.84 (0.27- 29.96)	0.386
Others	1.62 (0.43 – 6.12)	0.480	2.25 (0.42 – 12.05)	0.342
Age category (years)				**0.742**
<21	Reference			
21-30	4.09 (1.28 – 13.10)	0.003	0.50 (0.11 – 2.16)	0.350
31-40	6.45 (1.90 – 21.86)	0.003	0.77 (0.17 – 3.54)	0.737
41-50	3.39 (1.00 – 11.60)	0.052	0.46 (0.10 – 2.16)	0.324
51-60	3.82 (0.94 – 15.58)	0.062	0.66 (0.12 – 3.54)	0.624

Table 9: Multi-variate logistic regression showing the influence of HW's knowledge on their attitude towards COVID-19 prevention measures: adjusted for socio-demographic factors.

	Odds for good attitude			
	Adjusted odds ratio	95% Confidence interval (CI)		p-value
		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/Bachelors	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

Table 10: Influence of HW's knowledge on their practice of COVID-19 infection and prevention measures (adjusted for confounding socio-demographic factors). * *p-value from binary logistic regression.*

	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/bachelors	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

Table 11: Influence of HW’s attitude on their practice of COVID-19 infection prevention measures; (adjusted for confounding socio-demographic factors). * *p-value from binary logistic regression.*

	Odds for good practice			
	Adjusted odds ratio	95% Confidence interval (CI)		p-value*
		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
HCW 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/bachelors	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

Figures

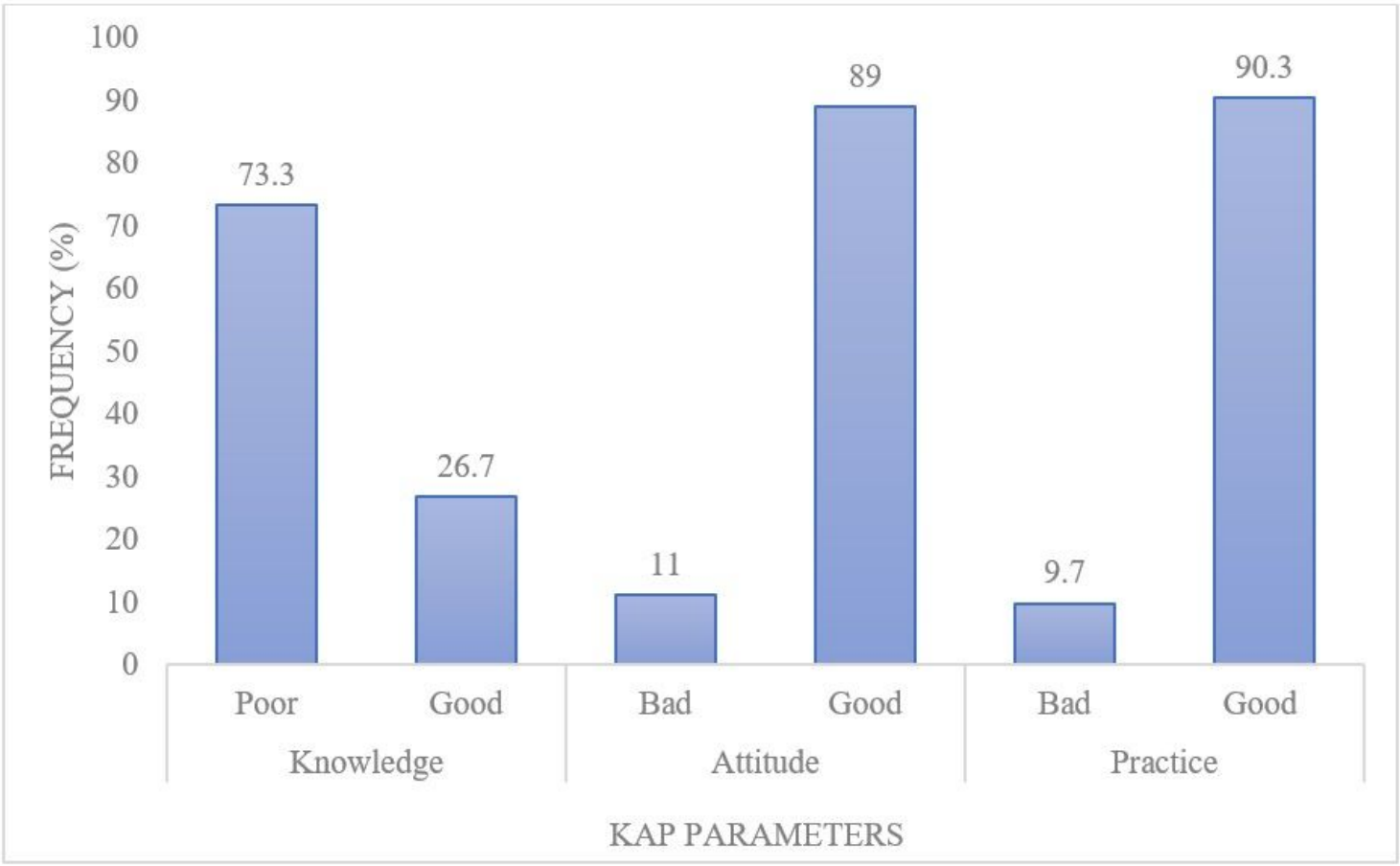

Figure 1

COVID-19 Knowledge, Attitude and Practice distribution among HWs in Africa.