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Original Article

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Perceived preparedness to respond to the COVID-19 pandemic: a study with healthcare workers in Ghana

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ABSTRACT

Background: Healthcare workers' (HCWs) preparedness to respond to pandemics is critical to containing disease spread. Low- and middle-income countries, however, experience barriers to preparedness due to limited resources. In Ghana, a country with a constrained healthcare system, we examined HCWs' perceived preparedness to respond to coronavirus disease 2019 (COVID-19) and associated factors.
Methods: The 472 HCWs completed questions in a cross-sectional self-administered online survey. Perceived preparedness was assessed using a 15-question scale (Cronbach alpha = 0.91) and summative scores were created (range = 0–45). Higher scores meant greater perceived preparedness, with scores ≥ 30 considered prepared. We used linear regression with robust standard errors to examine associations between perceived preparedness and potential predictors.
Results: About 27.8% of HCWs felt prepared to respond to COVID-19. The average perceived preparedness score was 24 (standard deviation = 8.9). In multivariate analysis, factors associated with higher perceived preparedness were: training (β = 3.35, 95% confidence interval [CI], 2.01–4.69); having adequate personal protective equipment (PPE; β = 2.27, 95% CI, 0.26, 4.29), an isolation ward (β = 2.74, 95% CI, 1.15, 4.33), and protocols for screening (β = 2.76, 95% CI, 0.95, 4.58); and good perceived communication from management (β = 5.37, 95% CI, 4.03, 7.90). When added to the model, perceived knowledge decreased the effect of training by 28.0%, although training remained significant, suggesting a partial mediating role. Perceived knowledge was associated with a 6-point increase in perceived preparedness score (β = 6.04, 95% CI, 4.19, 7.90).
Conclusion: HCWs reported low perceived preparedness to respond to COVID-19. Training, clear protocols, PPE availability, isolation wards, and communication play an important role in increasing preparedness. Government and other stakeholders must institute interventions to increase HCWs' preparedness to respond to the ongoing pandemic and prepare for future pandemics.

Keywords: COVID-19; Preparedness; Healthcare workers; Ghana

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Conflict of Interest
The authors declare that they have no competing interests.

Author Contributions
Conceptualization: Afulani PA; Data curation: Afulani PA, Gyamerah AO, Aborigo R, Nutor JJ, Malechi H, Laar A, Sterling M, Awoonor-Williams JK; Formal analysis: Afulani PA; Writing - original draft: Afulani PA, Gyamerah AO; Writing - review & editing: Afulani PA, Gyamerah AO, Aborigo R, Nutor JJ, Malechi H, Laar A, Sterling M, Awoonor-Williams JK.

INTRODUCTION

In the aftermath of the Ebola and Zika outbreaks, a 2017 World Bank study reported that countries across the world were inadequately prepared to respond to pandemics, despite the increasing frequency and diversity of outbreaks over the past three decades.[1] Despite warnings and subsequent efforts to strengthen global pandemic preparedness, many countries remain underprepared to respond to the novel coronavirus disease of 2019 (COVID-19) pandemic due to limited resources, underinvestment, and competing priorities.[1]

As of July 24th, 2020, there were 15.3 million COVID-19 cases and 630,000 deaths globally.[2] In all countries, health systems have struggled to procure adequate personal protective equipment (PPE) for healthcare workers (HCWs), testing kits, and hospital beds. Emerging empirical studies report that HCWs have inadequate protocols, knowledge, PPE, and other preparedness indicators to respond to COVID-19.[3-6]

Epidemics and pandemics are often unpredictable by nature. Thus, along with mitigation and suppression strategies, health systems, and in particular, preparedness of HCWs (i.e., physicians, nurses/midwives, and allied health workers), to respond to pandemics are critical to containing disease spread.[7-10] Previous studies on epidemics, such as with other severe acute respiratory syndrome and Ebola, have found that preparedness of HCWs are not only essential to effectively containing epidemics, but also in ensuring that they are not pulled from addressing other illnesses that may lead to preventable deaths.[8,11,12] Additionally, inadequate HCW preparedness to respond to an outbreak contributes to workers leaving their positions due to fear of infection and community distrust of government and HCWs, while preparedness has been associated with increased team spirit.[12-15]

Unfortunately, low-resource countries, like Ghana, experience multilevel barriers to preparedness due to limited resources and weak healthcare infrastructure. Across Africa, weak health systems caused by debt, poor governance and economic instability have made the continent underprepared to contain the spread of COVID-19.[16,17] For instance, in a 2016 study, African countries reported the lowest scores for preparedness indicators and only two-thirds of countries had a national health emergency preparedness and response plan.[1] Additionally, a World Health Organization (WHO) COVID-19 readiness study found that about nine intensive care unit beds are available per one million people across the continent.[18] Ghana in particular scored 52% on the International Health Regulations core capacity for emergency preparedness and rate the lowest score for its system for sending and receiving medical countermeasures and health personnel during a public health emergency.[19] Due to challenges like these, the United Nations (UN) has warned of the possible loss of 300,000 to 3.3 million lives in Africa due to COVID-19.[16]

As of July 24th, 2020, Ghana had 30,000 COVID-19 cases and 153 deaths, making it the country with the third highest number of cases in Africa and 54th globally.[20] Healthcare providers have been disproportionately affected by the virus, with over 2,000 cases.[21] With less than one hospital bed and 0.2 physicians per 1,000 people,[16,18] the country's constrained health system presents challenges to slowing the spread of the epidemic and in maintaining an overburdened healthcare infrastructure. Yet, few studies have examined HCWs' preparedness to respond to epidemics in Ghana and none on a pandemic of this scale. Previous studies that assessed HCWs' preparedness to respond to the Ebola outbreak found that providers did not feel adequately prepared or trained to respond to Ebola, and

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reported challenges such as inadequate staff and PPE, and delayed reporting of cases.[22-25] To understand the multilevel barriers to containing the spread of COVID-19 in Ghana, we examined HCWs' perceived preparedness to respond to the pandemic and the associated contributors, including potential mediating factors.

METHODS

Context

Healthcare delivery in Ghana is based on a 3-tier system: 1) the primary level, which is delivered by community-based health planning and services compounds, maternity homes, health centers, and district hospitals; 2) the secondary level, implemented by regional hospitals; and 3) the tertiary level, which is run by specialists at the teaching hospitals. Ninety-three percent of facilities in Ghana are Primary Health Care facilities. There are an estimated 1.8 medical doctors and 42 nurses and midwives per 10,000 population in the country.[26,27] The Ghana Health Service is tasked with establishing effective mechanisms for disease surveillance, prevention, and control nationally and is currently leading the country's COVID-19 response.[28] Since the detection of Ghana's first case on March 12th, 2020, several strategies have been adopted to control the epidemic. Key among them is the "3 Ts approach"—Testing, Tracing, and Treatment. Consequently, more symptomatic cases are being reported resulting in overburdened treatment sites. The exponential increase in cases has led the WHO to declare Ghana as one of the countries with an accelerated increase in the number of COVID-19 cases. HCW deaths due to COVID-19 have sparked threats of strike actions by nurses and doctors in Ghana, raising issues related to the health system and HCW preparedness to contain the virus at all levels of the health system.[21,29,30]

Sample and data collection

The data are from a cross-sectional study conducted with HCWs in Ghana between April 17th to May 31st, 2020. All HCWs (i.e., nurses, physicians, and allied health workers) in Ghana were eligible to participate. A convenience sampling approach was used to recruit HCWs virtually through advertising on social media platforms (WhatsApp, Facebook, and direct messaging), and invited to complete a self-administered online survey through a link in the ad. No incentives were provided, and respondents had the option of skipping questions they did not want to respond to. The sample size is 472 providers who completed all the questions relevant for this analysis. The survey included questions on demographics, perceived preparedness, as well as other questions relevant to the pandemic response described in the measures section. Providers consented to the study by completing the survey.

Ethical statement

This study received ethical approval from the University of California, San Francisco (#20-30656) and the Navrongo Health Research Centre (#NHRCIRB374).

Measures

Dependent variable

The outcome variable in this analysis is perceived preparedness, which was assessed using 15 questions (**Supplementary Table 1**) that captured various aspects of preparedness including personal/self, facility/institutional, and mental/psychological preparedness for prevention, diagnoses, management, and education regarding COVID-19. Each question had the following response options: 0 = not prepared at all, 1 = a little prepared, 2 = prepared, 3 = very prepared, 4 = I don't know about this, and 5 = not applicable to my role. These questions were developed by our research team after thorough review of the WHO and Centers for Disease Control and Prevention COVID-19 preparedness Tools and guidelines for Healthcare Professionals and Facilities, and after soliciting questions from HCWs on what they thought was relevant to include to assess preparedness.[31,32] The questions underwent various revisions and were piloted with 10 HCWs in Ghana. Feedback from the piloting was used to finalize the questions. This process helped ensure the items represented the universe of items relevant to perceived preparedness, resulting in high content validity.[33] The 15 questions were combined to create a summative preparedness score for the analysis.

Independent variables

The key predictor in this analysis was training on COVID-19 based on the question "Have you had any training on how to respond to the COVID-19 crises?" with a binary yes/no response. Other predictors included: perceived availability of PPE ("Does your facility have adequate PPE?"); isolation ward for COVID-19 cases in facility ("Does your facility have a ward for isolating COVID-19 patients?"); clear guidelines ("Have you received guidelines on how to report suspected cases of COVID-19?", "Does your facility have a protocol for screening for potential COVID-19 patients?", and "Does your facility have a protocol for managing confirmed COVID-19 patients?"); communication from management ("How will you describe communication from management of your facility or your in-charge/supervisor regarding the COVID-19 situation in your facility?"); ability to isolate at home without exposing family ("If you have to isolate or quarantine at home because of contact with an infected person, is there a place you can isolate without coming into contact with your family?"); and perceived knowledge ("Do you know what to do if you suspect a patient may have COVID-19", and "Do you know how to manage a confirmed case of COVID-19?"). Provider and facility characteristics are also included as predictors.

Analysis

We examined the distribution of variables using descriptive statistics and assessed the psychometric properties of the perceived preparedness scale. To increase the interpretability of a summative preparedness score, we first recoded the response options to all range from 0 to 3 by recoding 4 (I don't know about this) to 0 (not at all prepared), and 5 (not applicable to my role) to 2 (prepared). We then used the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy to assess whether the variables were suitable for factor analysis. KMO values range between 0 and 1, with small values indicating that overall, the variables have little in common to warrant a factor analysis.[34] We assessed construct validity (whether the items represent the underlying latent structure) using exploratory factor analysis and criterion validity (whether the measure relates to other measures in theoretically predictable ways) using the relationship with the various predictors).[33,35] For reliability, we examined internal consistency using Cronbach alpha and split-half reliability using the correlation between odd and even numbered items and the Guttman lower bound reliability coefficients.[36]

We then created a summative score for preparedness ranging from 0–45, where higher scores meant higher perceived preparedness. We categorized scores less than 15 as "Not at all prepared" (equivalent to > 1 if divided by number of items (15) to set scale to 0 to 3). Scores 15 to 29 (1 to < 2) is considered "somewhat prepared," and 30 or more (≥ 2) as "prepared". However, because the continuous preparedness score was normally distributed, we used the continuous score for the analysis presented. We used linear regressions with robust standard errors in bivariate and multivariate analyses to examine the association between

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perceived preparedness and various predictors. Some questions with more than two response options were recoded to binary variables to avoid very small samples in some categories in the multivariate analysis. We built multivariate models by gradually adding demographic and other independent variables that were significant in bivariate models and testing model fit. Variables that did not improve the models or were strongly correlated with other variables were dropped from the final model. Finally, we examined if the relationship between training and preparedness is mediated by perceived knowledge using the difference of coefficients (c−c′) method. The mediated or indirect effect is the difference between the coefficient in the model without the mediator (total effect: c) and coefficient in the model with the mediator (direct effect: c′); and the proportion mediated is [(c−c′)/c].[37,38] We also examined if the primary association was moderated by type of provider by including interaction terms for training and provider type. We used STATA 15.0 for all analyses.[39]

Sensitivity analysis

We examined residual plots and conducted post-estimation tests to assess violations of regression assumptions. Additionally, due to the significant number of missing observations (n = 166) from people starting and not completing the survey, we compared the characteristics of the analytic sample to the starting sample and ran additional analyses with higher sample sizes by excluding variables that had more missing observations to assess if the main findings changed significantly. The survey included general knowledge questions on COVID-19 (e.g., transmission, prevention, symptoms, risk factors, treatment, etc.) which were used to generate a knowledge score. This variable is not included in the current analysis because of the large number of missing observations on that variable (these were the last set of questions) which significantly reduced the sample size for the analysis (from 472 to 389). Thus, in the sensitivity analysis, we ran the final models with the knowledge scores and imputed for the missing observations. In addition, we ran the final model as a logistic model, using 2 binary preparedness variables comparing those who felt prepared (≥ 30) to the others (not at all or somewhat prepared < 30) and also those with above median preparedness scores (≥ 23) to those with below the median scores.

RESULTS

Descriptive results

The characteristics of respondents are shown in **Table 1**. Of the 472 respondents used for this analysis, 20% were doctors, 63% nurses (inclusive of midwives and medical/physician assistants) and 17% other professionals, including medical laboratory professionals, disease control officers, nutritionists and other allied HCWs. Twenty-six percent worked in teaching hospitals, 59% in other public hospitals, including regional and district hospitals and health centers, and 15% in private facilities. Twenty-three percent were working in the Greater Accra and Ashanti regions (the initial epicenters), another 23% from the Northern region, and the remaining from other regions of the country. The average age of respondents was 34.3 years (standard deviation [SD] = 6.1), with 8.3 years of experience (SD = 5.8). Approximately half of the respondents identified as male and the other half as female.

The KMO values for all the preparedness items were > 0.8, with an average value of 0.88. Factor analysis of the 15 questions yielded two factors with eigenvalues > 1 accounting for 91% of the cumulative variance, with items on personal preparedness loading on the first factor and those on facility preparedness loading on the second factor (**Table 2**). But there was one

Table 1. Univariate distributions of study variables

Variable name	Values
Total	472 (100.0)
Provider type	
Doctor	94 (19.9)
Nurse/related	297 (62.9)
Other	81 (17.2)
Facility type	
Teaching hospital	124 (26.3)
Other government facility	276 (58.5)
Private/mission facility	72 (15.3)
Region	
Greater Accra/Ashanti	107 (22.7)
Northern region	108 (22.9)
Other Northern	105 (22.2)
Other Southern	152 (32.2)
Years of experience	
5 or less years	154 (32.6)
6 to 10 years	193 (40.9)
More than 10 years	125 (26.5)
Ages	
Less than 30	130 (27.8)
30 to 39	260 (55.7)
40 to 73	77 (16.5)
Gender	
Male	238 (50.4)
Female	234 (49.6)
No. of children	
No children	145 (31.4)
1 or 2 children	212 (45.9)
3 to 6 children	105 (22.7)
Marital status	
Single	137 (29.0)
Married	335 (71.0)
Perceived preparedness	
Not at all prepared	74 (15.7)
A little prepared	267 (56.6)
Prepared	131 (27.8)
Training on COVID-19	
No	216 (45.8)
Yes	256 (54.2)
Facility has adequate PPEs	
No	356 (75.4)
Yes	32 (6.8)
I don't know	84 (17.8)
Facility has COVID-19 isolation ward	
No	143 (30.3)
Yes	315 (66.7)
I don't know	14 (3.0)
Guidelines on how to report suspected case	
No	91 (19.3)
Yes	362 (76.7)
I don't know	19 (4.0)
Facility has protocol for screening for COVID-19	
No	75 (15.9)
Yes	378 (80.1)
I don't know	19 (4.0)
Facility has protocol for managing COVID-19	
No	168 (35.6)
Yes	233 (49.4)
I don't know	71 (15.0)

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Table 1. (Continued) Univariate distributions of study variables

Variable name	Values
Communication from management	
Very poor communication	61 (12.9)
Poor communication	152 (32.2)
Good communication	218 (46.2)
Very good communication	41 (8.7)
Ability to isolate at home without exposing family	
No	257 (54.4)
Somewhat	60 (12.7)
Yes	155 (32.8)
Know what to do if COVID-19 suspected	
No	23 (4.9)
Somewhat	134 (28.4)
Yes	315 (66.7)
Know how to manage a confirmed case of COVID-19	
No	162 (34.3)
Somewhat	158 (33.5)
Yes	103 (21.8)
Not applicable to my role	49 (10.4)

Values are presented as number (%).
COVID-19 = coronavirus disease of 2019; PPE = personal protective equipment.

dominant factor (**Fig. 1**) accounting for 74% of the cumulative variance and all 15 items had factor loadings of greater than 0.3 on the first factor for both the unrotated factor and with oblique rotations (**Table 2**). All items had uniqueness of < 0.7. The Guttman lower bound reliability coefficients ranged from 0.84 to 0.94 and Cronbach alpha for the 15 items is 0.91.

The average score for preparedness was 24 (SD = 8.9). Based on the specified cut offs, 27.8% felt prepared, 56.6% somewhat prepared, and 15.7% not at all prepared (**Table 1**). Fifty-four percent had participated in a COVID-19 training and only seven percent reported their facilities had enough PPE. Two-thirds (67%) reported they had an isolation ward for COVID-19 cases in the facility; 76% reported they had guidelines on how to report suspected cases of COVID-19; 80% reported their facility had a protocol for screening for potential COVID-19 patients; and 49% reported they had a protocol for managing confirmed COVID-19 patients. Fifty-five

Table 2. Rotated factor loadings from factor analysis

Perceived preparedness scale items	Two factor structure		Single factor structure
	Factor 1	Factor 2	
1. Ability to assess and triage patients with acute respiratory symptoms	0.49		0.65
2. Ability to diagnose a patient with COVID-19?	0.41		0.58
3. Ability to manage a patient with diagnosed COVID-19	0.47		0.69
4. Ability to accurately put on PPE	0.79		0.71
5. Ability to safely take off PPE	0.80		0.73
6. Ability to implement standard contact precautions	0.71		0.72
7. Ability to implement standard airborne precautions	0.64		0.70
8. Ability to communicate COVID-19 risks to your patient	0.80		0.65
9. Ability to educate the public about COVID-19	0.72		0.59
10. Ability to ration scarce life-saving commodities	0.54		0.59
11. Mentally prepared	0.52		0.60
12. Preparedness of facility to diagnose COVID-19		0.81	0.59
13. Preparedness of facility to manage patients with COVID-19		0.83	0.53
14. Preparedness of facility you to prevent the spread of COVID-19 if you had an infected patient		0.75	0.67
15. Preparedness of facility to prevent spread of COVID-19 if you had an infected health worker		0.73	0.66

Blanks represent loading 0 < 0.3.
COVID-19 = coronavirus disease of 2019; PPE = personal protective equipment.

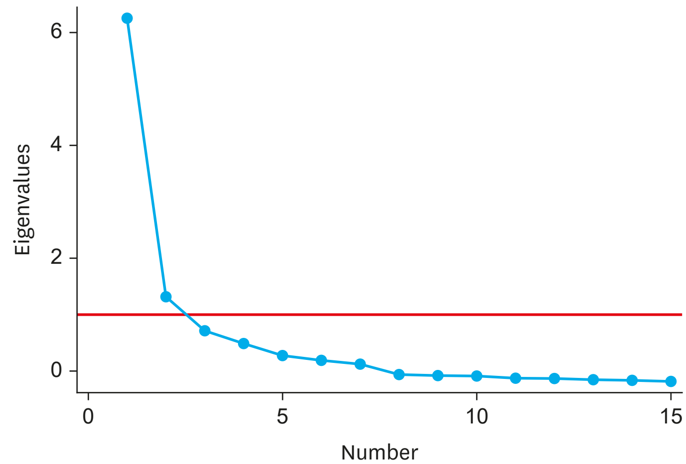

Fig. 1. Scree plot of eigenvalues after factor analysis.

percent perceived communication from management to be good or very good. Only a third (32.8%) were certain of a place to quarantine at home without contact with their family. Two-thirds (66.7%) reported they knew what to do if they suspected a patient may have COVID-19 and only 22% said they know how to manage a confirmed COVID-19 case.

Bivariate results

In the bivariate analysis (**Table 3**), significant factors associated with preparedness were male gender; training on COVID-19; availability of PPE, isolation ward, protocols for diagnoses and management; communication from management; ability to isolate at home without exposing family; and confidence in knowledge of what to do for a suspected case and management of COVID-19. For example, the average preparedness score was about 28 (SD = 7.8) for those who

Table 3. Bivariate distributions

Variable name	Preparedness scores			Prob > F
	No.	Mean ± SD	β (95% CI)	
Total	472	24.0 ± 8.9		
Provider type				0.699
Doctor	94	24.0 ± 8.4	0.00 (0, 0)	
Nurse/related	297	23.8 ± 9.1	−0.12 (−2.19, 1.95)	
Other	81	24.8 ± 8.6	0.82 (−1.83, 3.48)	
Facility type				0.124
Teaching hospital	124	25.1 ± 8.7	0.00 (0, 0)	
Other government facility	276	23.3 ± 9.0	−1.75 (−3.64, 0.13)	
Private/mission facility	72	24.9 ± 8.6	−0.15 (−2.73, 2.43)	
Region				0.027
Greater Accra/Ashanti	107	24.4 ± 7.7	0.00 (0, 0)	
Northern region	108	23.5 ± 9.4	−0.89 (−3.26, 1.48)	
Other Northern	105	22.2 ± 8.9	−2.18 (−4.57, 0.20)	
Other Southern	152	25.5 ± 9.2	1.12 (−1.08, 3.31)	
Years of experience				0.217
5 or less years	154	24.3 ± 9.7	0.00 (0, 0)	
6 to 10 years	193	23.2 ± 8.5	−1.09 (−2.98, 0.80)	
More than 10 years	125	24.9 ± 8.3	0.63 (−1.47, 2.73)	
Ages				0.022
Less than 30	130	24.1 ± 9.5	0.00 (0, 0)	
30 to 39	260	23.3 ± 8.7	−0.89 (−2.75, 0.97)	
40 to 73	77	26.4 ± 8.1	2.27 (−0.22, 4.76)	

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Table 3. (Continued) Bivariate distributions

Variable name	Preparedness scores			Prob > F
	No.	Mean ± SD	β (95% CI)	
Gender				0.004
Male	238	25.2 ± 8.7	0.00 (0, 0)	
Female	234	22.8 ± 8.9	−2.36[b] (−3.96, −0.77)	
No. of children				0.136
No children	145	24.3 ± 9.2	0.00 (0, 0)	
1 or 2 children	212	23.1 ± 8.5	−1.12 (−3.01, 0.77)	
3 to 6 children	105	25.2 ± 9.5	0.95 (−1.30, 3.20)	
Marital status				0.058
Single	137	25.2 ± 8.8	0.00 (0, 0)	
Married	335	23.5 ± 8.9	−1.71 (−3.48, 0.057)	
Training on COVID-19				< 0.001
No	216	20.0 ± 8.4	0.00 (0, 0)	
Yes	256	27.5 ± 7.8	7.52[c] (6.06, 8.99)	
Facility has adequate PPEs				< 0.001
No	356	23.4 ± 8.7	0.00 (0, 0)	
Yes	32	31.1 ± 7.0	7.66[c] (4.50, 10.8)	
I don't know	84	24.0 ± 9.2	0.62 (−1.46, 2.69)	
Facility has COVID-19 isolation ward				< 0.001
No	143	20.3 ± 8.2	0.00 (0, 0)	
Yes	315	26.2 ± 8.4	5.86[c] (4.21, 7.51)	
I don't know	14	14.2 ± 7.4	−6.09[b] (−10.7, −1.51)	
Guidelines on how to report suspected case				< 0.001
No	91	18.3 ± 8.4	0.00 (0, 0)	
Yes	362	25.7 ± 8.3	7.49[c] (5.57, 9.42)	
I don't know	19	19.2 ± 8.2	0.91 (−3.24, 5.05)	
Facility has protocol for screening for COVID-19				< 0.001
No	75	18.6 ± 8.1	0.00 (0, 0)	
Yes	378	25.5 ± 8.5	6.92[c] (4.83, 9.01)	
I don't know	19	16.5 ± 8.9	−2.05 (−6.29, 2.20)	
Facility has protocol for managing COVID-19				< 0.001
No	168	20.9 ± 8.0	0.00 (0, 0)	
Yes	233	26.7 ± 8.5	5.78[c] (4.09, 7.47)	
I don't know	71	22.7 ± 9.5	1.83 (−0.54, 4.19)	
Communication from management				< 0.001
Very poor communication	61	17.7 ± 8.0	0.00 (0, 0)	
Poor communication	152	20.5 ± 8.0	2.81[a] (0.49, 5.14)	
Good communication	218	26.8 ± 7.8	9.11[c] (6.89, 11.3)	
Very good communication	41	32.2 ± 6.9	14.5[c] (11.4, 17.6)	
Ability to isolate at home without exposing family				< 0.001
No	257	23.0 ± 9.0	0.00 (0, 0)	
Somewhat	60	22.3 ± 7.9	−0.66 (−3.13, 1.80)	
Yes	155	26.4 ± 8.7	3.46[c] (1.72, 5.21)	
Know what to do if COVID-19 suspected				< 0.001
No	23	14.7 ± 7.8	0.00 (0, 0)	
Somewhat	134	19.2 ± 7.4	4.59[a] (1.05, 8.12)	
Yes	315	26.8 ± 8.2	12.1[c] (8.72, 15.5)	
Know how to manage a confirmed case of COVID-19				< 0.001
No	162	18.9 ± 7.9	0.00 (0, 0)	
Somewhat	158	24.2 ± 8.0	5.33[c] (3.61, 7.04)	
Yes	103	30.4 ± 7.4	11.5[c] (9.54, 13.4)	
Not applicable to my role	49	27.1 ± 7.5	8.21[c] (5.71, 10.7)	

COVID-19 = coronavirus disease of 2019; PPE = personal protective equipment; SD = standard deviation; CI = confidence interval.
[a]$P < 0.05$; [b]$P < 0.01$; [c]$P < 0.001$.

received training compared to 20 (SD = 8.4) for those who had no training; and 31 (SD = 7.0) for those who reported their facility had adequate PPE compared to 23 (SD = 8.7) for those who reported they did not have enough PPE.

Table 4. Multivariable linear regression of potential predictors on perceived preparedness

Variable name	Model 1	Model 2	Model 3
	β (95% CI)	β (95% CI)	β (95% CI)
Had COVID-19 training	7.47[c] (5.94, 9.01)	4.64[c] (3.27, 6.01)	3.35[c] (2.01, 4.69)
Provider type			
Doctor	0 (0, 0)	0 (0, 0)	0 (0, 0)
Nurse/related	2.85[b] (0.71, 4.99)	3.70[c] (1.87, 5.53)	3.48[c] (1.76, 5.21)
Other	2.96[a] (0.48, 5.44)	2.48[a] (0.33, 4.64)	2.26[a] (0.077, 4.44)
Region			
Teaching hospital	0 (0, 0)	0 (0, 0)	0 (0, 0)
Other government facility	−3.15[b] (−5.32, −0.99)	−2.03 (−4.07, 0.0064)	−1.75 (−3.65, 0.16)
Private/mission facility	−2.93[a] (5.67, −0.20)	−2.87[a] (−5.30, −0.44)	−2.71[a] (−5.01, −0.41)
Region			
Greater Accra/Ashanti	0 (0, 0)	0 (0, 0)	0 (0, 0)
Northern region	−3.48[b] (−5.94, −1.01)	−2.69[a] (−4.87, −0.52)	−2.29[a] (−4.41, −0.17)
Other Northern	−4.09[b] (−6.56, −1.62)	−3.53[b] (−5.71, −1.36)	−2.69[a] (−4.83, −0.55)
Other Southern	−1.5 (−3.75, 0.75)	−1.96 (−3.94, 0.016)	−1.97[a] (−3.92, −0.024)
Years of experience			
5 or less years	0 (0, 0)	0 (0, 0)	0 (0, 0)
6 to 10 years	−0.66 (−2.38, 1.06)	−0.95 (−2.45, 0.55)	−0.9 (−2.32, 0.53)
More than 10 years	0.8 (−1.15, 2.75)	0.24 (−1.47, 1.95)	0.16 (−1.50, 1.82)
Female	−1.46 (−2.99, 0.076)	−1.88[b] (−3.24, −0.53)	−1.43[a] (−2.71, −0.15)
PPEs Adequate		2.14[a] (0.064, 4.21)	2.27[a] (0.26, 4.29)
Have Isolation ward		3.53[c] (1.94, 5.12)	2.74[c] (1.15, 4.33)
Protocol for screening for COVID-19		2.98[b] (1.17, 4.79)	2.76[b] (0.95, 4.58)
Good communication from management		6.01[c] (4.67, 7.34)	5.37[c] (4.03, 6.72)
Place to isolate at home		1.27 (−0.12, 2.67)	1.06 (−0.30, 2.41)
Know how to manage COVID-19 case			
Somewhat			2.84[c] (1.27, 4.42)
Yes			6.04[c] (4.19, 7.90)
Not applicable to my role			4.19[c] (2.07, 6.31)
Constant	22.9[c] (20.3, 25.6)	15.1[c] (12.1, 18.1)	13.7[c] (10.8, 16.6)
No.	472	472	472
Adjusted R-squared	0.223	0.427	0.477

COVID-19 = coronavirus disease of 2019; PPE = personal protective equipment; CI = confidence interval.
[a]$P < 0.05$; [b]$P < 0.01$; [c]$P < 0.001$.

Multivariate analysis

In the multivariate analysis (**Table 4**), including only the demographic models (model 1), training was associated with a 7-point higher score in preparedness (β = 7.47, 95% CI, 5.94, 9.01, $P < 0.001$), and decreased to about 5 points (β = 4.64, 95% CI, 3.27, 6.01; $P < 0.001$) with the addition of availability of PPE, isolation ward, and protocols for diagnoses and management; perceived communication from management; and ability to self-isolate at home to the model (model 2). When knowledge of how to manage a COVID-19 patient was added to the model (model 3), the training effect decreased to about 3 points (β = 3.35, 95% CI, 2.01, 4.69; $P < 0.001$). This was a 28% decrease (4.64−3.35)/4.64 × 100) and the total effect of training was still significant (**Table 5**), suggesting the effect of training is partially mediated by perceived knowledge. Perceived knowledge of how to manage a COVID-19 patient is associated with a 6-point higher perceived preparedness score compared to not knowing what to do (β = 6.04, 95% CI, 4.19, 7.90; $P < 0.001$). In the final model (model 3), having adequate PPE (β = 2.27, 95% CI, 0.26, 4.29; $P < 0.05$), an isolation ward (β = 2.74, 95% CI, 1.15, 4.33; $P < 0.001$), protocols for screening (β = 2.76, 95% CI, 0.95, 4.58; $P < 0.01$), and good perceived communication from management (β = 5.37, 95% CI, 4.03, 7.90; $P < 0.001$) were associated with higher perceived preparedness.

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Table 5. Mediation of COVID-19 training effect by perceived knowledge

Effect type	Preparedness score
	β (95% CI)
Total effect (c: from model 2 in **Table 4**)	4.64[a] (3.33, 5.94)
Direct effect (c′: from model 3 in **Table 4**)	3.35[a] (2.01, 4.68)
Mediated (indirect) effect: c−c′	1.29[a] (0.73, 1.85)
% of total effect mediated: [(c−c′)/c] × 100	27.80
No.	472

COVID-19 = coronavirus disease of 2019.
[a]$P < 0.001$.

Other predictors in the final model were provider and facility type, region, and gender. Nurses and other non-physician providers had higher preparedness scores than doctors. But, the interaction between provider type and training was not significant, suggesting the relationship between training and preparedness does not differ between providers. Also, HCWs in private facilities had lower preparedness scores than those in teaching hospitals, but there was no significant difference between providers in teaching hospitals and other government facilities. In addition, HCWs in all the other regions had lower preparedness scores than providers in Greater Accra and Ashanti region, which were the initial and current epicenters; and female HCWs had lower perceived preparedness than males.

Sensitivity results

The variance inflation factor (VIF) of all items in the final model were less than 2, with a mean VIF of 1.27, indicating no collinearity. The Durbin-Watson statistic was 1.48, suggesting no autocorrelation of the residuals.[40] The analytic sample did not differ substantially from the total sample on key variables, except that there were more providers from teaching hospitals in the analytic sample (26%) compared to the total sample (15%). Also, the results obtained in the various sensitivity analyses (**Supplementary Table 2**) did not differ substantially from the results presented. The average knowledge score was 53 (SD = 4.19) out of 66 for the 392 providers who responded to the knowledge questions. But knowledge scores were not associated with perceived preparedness (using the continuous knowledge variable, as well as a categorical variable and imputing for the missing observations). Other findings were consistent in their significance, direction, and magnitude of the associations. Providers who had participated in COVID-19 related training had over 2 times higher odds of being prepared compared to those who had no training.

DISCUSSION

Our study presents evidence on perceived preparedness to respond to the COVID-19 pandemic among HCWs in Ghana. Based on a perceived preparedness for COVID-19 scale, we found that most HCWs do not feel prepared to respond to the pandemic. Low perceived preparedness was associated with lack of training, PPE, COVID-19 protocols, and isolation wards as well as poor communication from management. The effect of training was partially mediated by perceived knowledge of COVID-19. This study is one of the few studies to empirically examine providers' perceived preparedness for COVID-19, and the first to use the perceived preparedness scale, which was developed and validated by our study team. The association of perceived preparedness with various factors in theoretically predictable ways also provides evidence of criterion validity. The scale, thus, has good psychometric properties with potential utility for replication in other settings.

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Our findings are consistent with what we expected given that all the predictors are critical to preventing the spread of COVID-19 and for management and containment. They are also consistent with findings from the few emerging studies on provider preparedness to respond to COVID-19 elsewhere. For example, a study in Palestine found that the vast majority of HCWs did not have access to masks and other PPE and only 11.6% felt prepared to respond to the epidemic.[3] Another study in Jordan found that about half of medical doctors surveyed had access to an institutional COVID-19 protocol and a minority had PPE.[4] As in our study, the doctors who reported having an institutional protocol for dealing with COVID-19 cases and those who reported sustained availability of PPE had higher preparedness scores than their references. Also, as in prior studies, males had higher perceived preparedness scores than females.[4] Another study on maternal and newborn health professionals found that only one-third of respondents received COVID-19 training.[6] Moreover, similar to our finding that 49% of HCWs reported receiving a protocol for COVID-19 care provision, only half of the providers in low-middle income countries received updated care provision guidelines compared to 82% of those in high income countries.[6]

The finding that the effect of training on preparedness is partially accounted for by perceived knowledge to manage cases is likely because perceived knowledge increases self-efficacy. However, general knowledge scores were not associated with preparedness in the sensitivity analysis, which is potentially due to the nature of the knowledge questions, the high knowledge scores in the sample, and the extent of missingness on that variable. Studies in China and Vietnam also found that HCWs surveyed had good knowledge about COVID-19 transmission, signs, symptoms, and prevention.[41,42] Studies in Pakistan and the United Arab Emirates, however, found that a majority of HCWs surveyed had poor knowledge of COVID-19.[5,43] The relatively high knowledge among HCWs in Ghana might be due to increasing understanding of COVID-19 as more is learnt about the disease.

The UN estimates that up to 3.3 million people in Africa could die of COVID-19 if containment measures are not prioritized.[16] With fragmented health systems that were already constrained before the advent of COVID-19, low- and middle-income countries, such as Ghana, must act differently to avoid such a calamity. HCWs are central to containment efforts and the results of our study suggest that most of them do not feel prepared to respond to the pandemic. Ghana has received support from the International Monetary Fund and the World Bank, and other sources to help with containment efforts.[44,45] Given the high number of COVID-19 cases among HCWs, prioritizing the use of these funds to make providers more prepared to effectively respond to COVID-19 cases is key to the country's containment efforts. Preparedness efforts should include the provision of adequate PPE, training on protocols for screening, diagnoses and management of cases, providing clear care guidelines, and open communication across all levels. The approach should be comprehensive and inclusive of HCWs in the private sector, since current efforts largely focus on only geographic hotspots and government facilities.

A key limitation of this study is the sampling approach. Specifically, the use of an online survey with recruitment via social media may have accounted for the relatively young sample. Thus, this sampling limitation and volunteer sample limits the generalizability of the findings to all HCWs in Ghana. Nonetheless, given that the country was on partial lock-down during the study period, an online survey was the best option available. A second limitation is social desirability bias from the self-reported data—providers may want to project a greater sense of preparedness than they actually have. The use of composite scores from several questions helps address this limitation. Finally, because this was a cross-sectional study, associations described are not causal. Despite these limitations, our study is the first to assess HCWs' perceived preparedness for COVID-19 in Africa and among the few studies on the topic globally, and reports findings that can help inform the pandemic response in Africa and globally. In addition, we developed and validated the first scale for examining HCWs perceived preparedness for responding to the pandemic. The scale has high content validity and the psychometric analysis showed it has high construct and criterion validity and reliability. It therefore has potential utility in other settings and could allow comparisons across settings.

In conclusion, we found that HCWs had low perceived preparedness to respond to COVID-19. HCWs who had undergone training had significantly higher perceived preparedness than those who had not received training, and this was partly because they felt more knowledgeable about what to do if they had a COVID-19 case. In addition, communication from management, having COVID-19 protocols, isolation wards, and adequate PPEs, play an important role in increasing preparedness. Given the devastating implications of low preparedness in response to the pandemic in Africa as warned by the UN, it is critical for the government of Ghana and other stakeholders within the health system to intervene to increase HCWs' preparedness to respond to the rapidly growing epidemic in the country, with attention to factors associated with low perceived preparedness. Despite the importance of HCW and health systems preparedness to containing the COVID-19 pandemic, relatively few studies have examined this dimension of the pandemic response. To address this gap, more research is needed to evaluate perceived and actual preparedness of HCWs in other settings to inform the global response to the pandemic. Such research would also provide a baseline of HCW preparedness that can be tracked over time to further address the barriers in the health systems faced by providers globally. Furthermore, research is needed on the impact of inadequate preparedness on the psychological and physical wellbeing of HCWs, COVID-19 prevalence among HCWs, quality of care, and patient outcomes. The assessment tool developed for the current study to measure perceived preparedness to respond to COVID-19 could facilitate some of this research.

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SUPPLEMENTARY MATERIALS

Supplementary Table 1

Distribution of responses to individual preparedness questions

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Supplementary Table 2

Additional multivariable regression of potential predictors on preparedness

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