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Retrospective study of COVID-19 outcomes among healthcare workers in Rivers State, Nigeria

Chidinma Eze-Emiri ,[1,2] Foster Patrick,[1,2] Ezinne Igwe,[3] Golden Owhonda[2]

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[1]Department of Epidemiology, School of Public Health, University of Port Harcourt, Choba, Rivers State, Nigeria
[2]Department of Public Health & Disease Control, Rivers State Ministry of Health, Port Harcourt, Nigeria
[3]University of Wollongong Faculty of Science Medicine and Health, Wollongong, New South Wales, Australia

Correspondence to
Dr Golden Owhonda;
goldenowhonda@yahoo.com

ABSTRACT

Objective To determine the illness severity and mortality among COVID-19-infected healthcare workers (HCWs).

Design A retrospective cohort study using population-level data. Secondary analysis was conducted on collated data from the Public Health Emergency Operations Centre (PHEOC) at the State Ministry of Health, Rivers State, Nigeria. Data were gathered from the COVID-19 patient database of the PHEOC on demographics, place of work, illness severity and outcome.

Participants The cohort included all documented HCWs with confirmed COVID-19 infection (diagnosed by PCR).

Primary and secondary outcome measures Illness severity defined as 'hospitalisation required' and treatment outcome labelled as 'alive' or 'dead' were the outcomes of interest.

Results The mean age was 43 years and 50.5% of the cohort were female. Of the 301 HCWs infected, 187 patients were symptomatic with 32 requiring hospitalisation. Seven infected HCWs died of their COVID-19 infection, resulting in a case fatality ratio (CFR) of 2.3%. Population proportions for age groups, case presentation and mortality, would be significantly greater than those seen in the study population. Health professionals made up 79.7% (240) of the study cohort, with 68.8% (165) of them working at the teaching hospitals; the association between HCWs and health facilities they worked in, was significant. Symptomatic cases were more inclined to progress to severe illness ($\chi^2_{(1)} = 15.219,\ \alpha = < 0.0001$; adjusted OR (aOR) 10.658, 95% CI 2.494 to 45.552); patients also had greater odds of dying from COVID-19 ($\chi^2_{(5)} = 13.7,\ \alpha = 0.003$; aOR 1.079, 95% CI 1.02 to 1.141) per year increase in age adjusted for sex, case class and illness severity.

Conclusions Frontl-ine HCWs are at an increased risk of exposure to COVID-19 infections. In Nigeria, there is a higher risk of experiencing severe illness if symptomatic while infected with COVID-19. Preventive strategies, proper education and awareness must be put in place to protect HCWs.

Objective To determine the illness severity and mortality among COVID-19-infected HCWs.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The use of population registry data enabled the representation of the population, giving a snapshot of the burden of COVID-19 on health workers in the study region.
⇒ It also limited bias due to selection and recall.
⇒ The use of secondary data also implied that some variables that would have better informed the study were not available.
⇒ The reliance on reported infections and deaths made it impossible to estimate how many cases were missed by non-reporting.

INTRODUCTION

Healthcare workers (HCWs) have a higher risk of encountering infectious agents due to their work environments. With the COVID-19 pandemic, front-line HCWs face a higher risk of infection and mortality as well as being the drivers of community-level infection. Recent evidence shows that compared with individuals in the general community, front-line HCWs have a 12-fold risk of testing positive for COVID-19, with a higher risk observed for workers with inadequate access to personal protective equipment (PPE).[1] In addition to increased exposure to COVID-19 in the pandemic, Wang *et al*[2] found that poor sleep quality and higher working pressure can increase the risk of nosocomial SARS-CoV-2 infection among HCWs. Hence, it is possible to extrapolate these results to the Nigerian healthcare setting; the density of the health workforce (1.95–1000 persons) in the country,[3] in an addition to an estimated doctor-to-patient ratio of 1:2753[4] is reportedly 'still very low' to effectively deliver essential health services.[3]

SARS-CoV-2 appears to have tropism for diverse tissues, this underscores the difficulty in predicting the severity of COVID-19. Nevertheless, factors, such as age, comorbidities, immune response, radiographic findings, laboratory markers and indicators of organ dysfunction, might predict worse outcomes independently or collectively.[5] It was suggested that age, gender and the number of comorbidities showed a good

Table 1 Demographics and characteristics of COVID-19 among healthcare workers (n=301)

Variable	N (%)	z-test (95% CI) p value
Sex		
Male	149 (49.5)	−0.17 (−0.12 to 0.10) $H_a \neq 0$: 0.862
Female	152 (50.5)	
Age	43±11.7*	
20–29	25 (8.3)	†7.61 (0.38 to 0.60) $H_a \neq 0$: 0.000; $H_a>0$: 0.000
30–39	118 (39.2)	
40–49	81 (26.9)	
50–59	44 (14.6)	
60–69	23 (7.6)	
>70	10 (3.3)	
‡Case presentation		
Symptomatic	187 (62.1)	4.08 (0.13 to 0.35) $H_a \neq 0$: 0.000; $H_a>0$: 0.000
Asymptomatic	114 (37.9)	
‡Illness severity (requiring hospitalisation)		
Yes	32 (10.6)	−10.75 (−0.90 to 0.68) $H_a \neq 0$: 0.000; $H_a<0$: 0.000
No	269 (89.4)	
Contact with probable case		
Yes	108 (35.9)	
No	156 (51.8)	
Non-response/incomplete data	37 (12.3)	
Knowledge of suspected exposure		
Yes	101 (33.6)	
No	157 (52.3)	
Non-response/incomplete data	47 (15.7)	
Exposure		
Church	12 (4)	
Home	12 (4)	
Social event	26 (8.7)	
Workplace	51 (17)	
Ootcome		
Recovered	294 (97.7)	9.94 (0.43 to 1.06) $H_a \neq 0$: 0.000; $H_a>0$: 0.000
Dead	7 (2.3)	

*Mean±SD, case fatality ratio=2.33%.
†Difference in proportion between 20–49 years and ≥50 years.
‡At the time of testing.

predictive ability of whether confirmed patients would develop severe disease,[6] and evidence showed that advanced age, male sex, current smoking status, preexisting comorbidities (especially chronic kidney, respiratory and cardiocerebrovascular diseases) were important predictors associated with mortality.[7 8]

The estimated mortality rate among HCWs attributed to COVID-19 has increased progressively.[9] In May 2020, the total number of reported HCW deaths from 67 countries was 1413. Consequently, it suggests that for every 100 HCWs that got infected, one died—the deaths were also 0.5% of the total number of 270 426 COVID-19 deaths worldwide.[10] In addition, a survey of 37 countries estimated median death of 0.05 HCWs per 100 000 population. A report from the Pan American Health Organization in collaboration with the WHO stated that approximately 570 000 HCWs got infected with COVID-19 with above 2500 dying from the virus across the American region alone.[11] The WHO also estimated that between 80 000 and 180 000 HCWs died of COVID-19 in the period between January 2020 and May 2021, converging to a medium scenario of 115 500 deaths; although HCWs mortality in the African region was estimated at 2003, it was also acknowledged that several uncertainties and limitations surrounded the measurement of the death toll of HCWs due to COVID-19.[12]

A subnational study highlighting the burden of COVID-19 among HCWs is paramount to understanding the effect of the pandemic on the healthcare workforce in Nigeria. The study's aim was to determine the illness severity and mortality among COVID-19 infected HCWs in Rivers State, Nigeria.

METHOD

Study location

The study was conducted in Rivers State, located in the South-South geopolitical zone of Nigeria.

Study design and population

The study was a retrospective cohort study using existing population-level records data. The cohort included only HCWs with confirmed COVID-19 infection that were reported to the Public Health Emergency Operations Centre (PHEOC). The HCWs were categorised using the WHO and International Labour Organization International Standard Classification of Occupations.[13] There were five categories based on their roles in patient management and healthcare services:

- Health professionals—medical doctors, nurses, dentists, pharmacists and health safety professionals.
- Health associate professional—all technologists and assistants in health professions, CHWs.
- Personal care workers—healthcare and home-based care workers.
- Health management and support personnel—administrative and management staff, trade workers, social workers and life science professionals.
- Other health service providers—armed forces staff, interns and hospital volunteers.

Furthermore, the health facilities were classified based on services rendered. Hospital classification by services: Teaching hospitals—offering tertiary health services; General hospitals—offering secondary health services; Community hospitals—offering primary and community-based care; specialised outpatient clinics—rendering specialty outpatient services like dentistry, radiology and diagnostic services; Corporate/occupational health clinics—ffering general and occupational health services, restricted to employees only and Health-allied organisations.

Data source

Secondary data were collated from the COVID-19 case investigation form dataset at the PHEOC data centre,

Rivers State Ministry of Health. The data sources included reports from public and private-owned health facilities, containment centres, offshore platforms and other health-allied facilities. The duration of data extraction was from 24 March 2020 to 30 November 2021. The dataset characterised demographics, pre-existing comorbidities, symptoms, facility managed, patient status, treatment outcome and dates of related events, without personal identifiers. Hence, this secondary analysis waived the required individual informed consent. Patient information was retrieved from the dataset based on the occupation of interest—HCW and their respective designation—alongside demographic data on age, sex, place of work defined as 'health facility', hospitalisation required', and case presentation, knowledge of exposure, place of exposure and treatment outcome labelled as 'recovered' or 'dead'.

Based on the National Interim Guidelines for Clinical Management of COVID-19 (Nigeria Centre for Disease Control, 2020), all patients requiring hospitalisation at the time of testing were classified as severely ill, and it was the definition for illness severity; case presentation at the time of testing was also categorised as 'symptomatic' or 'asymptomatic'.

Data analysis

Data were analysed using Stata Statistical Software: Release V.12.[14] Descriptive statistics were used to report on the cohort characteristics. Means and SDs were reported for continuous variables and proportions for categorical variables, qualitative responses and subgroup analysis of variables. A test of proportions was conducted for both risk factors and outcome proportions. Univariate analysis of categorical variables was conducted by using (χ^2) and Fischer's exact test where appropriate. A two-tailed p<0.05 was statistically significant. Multivariate logistic regression was used to evaluate risk factors of illness severity and mortality among HCWss with COVID-19. The aOR with a 95% CI was used to report the measure of association between the following: illness severity and risk factors—age, sex and case presentation; mortality and risk factors –age, sex, illness severity and case presentation.

Patient and public involvement

It was not possible to involve patients or the public in the design, conduct, reporting or dissemination plans of our research as the study used secondary data without personal identifiers.

RESULTS

Patient characteristics

Data on 301 HCWs infected with COVID-19 were identified and extracted into a spreadsheet. The demographic and clinical characteristics of the patients are found in table 1. The mean age was 43 years and 50.5% of the cohort were female. Of the 301 HCWs, 187 patients were symptomatic with 10% (32) of the study cohort requiring hospitalisation—a measure of illness severity. A total of 108 HCWs were in contact with known probable cases, and 101 persons knew the place of exposure. From the available data, 7 (26.4%) infected HCWs died of their COVID-19 infection, resulting in a CFR of 2.3%. A test of proportion revealed a significant difference in proportions for age groups, case presentation, illness severity and outcome. Statistics showed that population proportions for illness severity would be significantly lower than seen in the study population, while they would be significantly greater for age groups, case presentation and mortality.

The distribution of HCWs by the WHO classification[13] and health facilities were cross-tabulated in table 2 to determine association. Health professionals made up 79.7% (240) of the study cohort, with 68.8% (165) of them working at the teaching hospitals. The teaching hospitals are also the two major government own tertiary facilities in the state; HCWs in these facilities made up 66.1% (199) of the study population. A significant association was portrayed between HCWs and the health facilities they worked in.

Table 3 is a cross-tabulation of HCWs by risk factors and outcomes. Health professionals aged 30–49 years were the most affected subgroup, making up 53.2% of the study population; they also made up 80.7% (151/187) of all symptomatic cases. All mortality cases were also health

Table 2 Contingency table of healthcare workers by health facility

Healthcare workers	Health facility classification, n (%)						
	Teaching hospitals	General service hospitals	Health allied organisations	Corporate health clinics	Community hospitals	Outpatient clinics	Total
Health professionals	165 (54.8)	32 (10.6)	9 (3.0)	17 (5.7)	15 (5.0)	2 (0.7)	240 (79.7)
Health associate professionals	11 (3.7)	0 (0.0)	3 (1.0)	3 (1.0)	1 (0.3)	1 (0.3)	19 (6.3)
Personal care workers	12 (4.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (0.7)	0 (0.0)	14 (4.7)
Health management and support personnel	10 (3.3)	4 (1.3)	10 (3.3)	2 (0.7)	0 (0.0)	0 (0.0)	26 (8.7)
Other health service providers	1 (0.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.3)
Missing values	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.3)	0 (0.0)	0 (0.0)	1 (0.3)
Total	199 (66.1)	36 (12.0)	22 (7.3)	23 (7.6)	18 (6.0)	3 (1.0)	301 (100%)

χ^2 (25) = 72.9883 , α = 0.000)

Table 3 Contingency table of healthcare workers by risk factors and outcomes

Healthcare workers	Risk factors, n (%)								Outcomes, n (%)					
	Age						Sex		Symptomatic		Illness severity		Mortality	
	20–29	30–39	40–49	50–59	60–69	>70	Female	Male	No	Yes	No	Yes	Alive	Dead
Health professionals	21 (7.0)	99 (32.9)	61 (20.3)	33 (11.0)	18 (6.0)	8 (2.7)	125 (41.5)	115 (38.2)	89 (29.6)	151 (50.2)	215 (71.4)	25 (8.3)	233 (77.4)	7 (2.3)
Health associate professionals	1 (0.3)	10 (3.3)	5 (1.7)	2 (0.7)	1 (0.3)	0 (0.0)	6 (2.0)	13 (4.3)	7 (2.3)	12 (4.0)	17 (5.7)	2 (0.7)	19 (6.3)	0 (0.0)
Personal care workers	1 (0.3)	2 (0.7)	5 (1.7)	2 (0.7)	3 (1.0)	1 (0.3)	9 (3.0)	5 (1.7)	4 (1.3)	10 (3.3)	13 (4.3)	1 (0.3)	14 (4.7)	0 (0.0)
Health management and support personnel	2 (0.7)	7 (2.3)	9 (3.0)	7 (2.3)	0 (0.0)	1 (0.3)	11 (3.7)	15 (5.0)	13 (4.3)	13 (4.3)	23 (7.6)	3 (1.0)	26 (8.7)	0 (0.0)
Other health service providers	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.3)	0 (0.0)	1 (0.3)	0 (0.0)	0 (0.0)	1 (0.3)	0 (0.0)	1 (0.3)	1 (0.3)	0 (0.0)
Missing value*	0 (0.0)	0 (0.0)	1 (0.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.3)	1 (0.3)	0 (0.0)	1 (0.3)	0 (0.0)	1 (0.3)	0 (0.0)
Total	25 (8.3)	118 (39.2)	81 (26.9)	44 (14.6)	23 (7.6)	10 (3.0)	152 (50.5)	149 (49.5)	114 (37.9)	187 (62.1)	269 (89.4)	32 (10.6)	294 (97.7)	7 (2.3)
χ^2	χ^2 (20) = 27.8331						χ^2 (4) = 5.7015		χ^2 (4) = 2.8223		χ^2 (4) = 8.5943		χ^2 (4) = 1.7918	
α	0.113						0.223		0.5888		0.072		0.774	
Fishers exact							0.204		0.6360		0.264		1.000	

*Not included in analysis.

professionals. The association between HCWs and either risk factors, or outcomes were not significant.

The cross-tabulation of health facilities by risk factors and outcomes showed that health workers aged 30–49 years were also the most dominant in the teaching hospitals, and they made up 44.2% of the total HCWs. The majority of symptomatic patients—73.2%, persons who required hospitalisation for testing—87.5%, and six out of the seven mortality cases were also staff of the teaching hospitals. Age and case presentation were significantly associated with the health facilities and are shown in table 4.

Table 5 shows a subgroup analysis conducted on the health professionals infected—doctors (71.7%), nurses (27.3%), others (1%); and teaching hospitals by ownership: public (78.6%), private (21.4%).

Predictors of illness severity and mortality among HCWs

The outcome proportions by risk factors were reported in tables 6 and 7. The effects of age, sex and case class on illness severity were evaluated using both univariate (table 6) and multivariate logistic regression (table 7), respectively. Symptomatic cases were more likely to advance to severe illness ($\chi^2(1) = 15.219$, $\alpha = < 0.0001$; aOR 10.658, 95% CI 2.494 to 45.552). The overall model was statistically significant ($\chi^2(8) = 19.112$, $\alpha < 0.0001$); it explained 12.5% (Nagelkerke R^2) of the variance in illness severity, and correctly classified 89.4% of cases.

Predictors of mortality assessed included age, sex, case class and illness severity. The logistic regression model was statistically significant, $\chi^{2,}(9) = 16.965$, $\alpha = 0.049$. The model explained 27.6% (Nagelkerke R^2) of the variance in mortality and correctly classified 97.7% of cases. Age ($\chi^2(1) = 19.24$, $\alpha = 0.002$; aOR 1.079, 95% CI 1.02 to 1.141 per year increase) was identified as a risk factor for mortality among HCWs with COVID-19 patients.

DISCUSSION

Using comprehensive data on COVID-19 infections in HCWs in Rivers State Nigeria, this study showed a mortality proportion of 2.3% in the study cohort of 301 participants. Health professionals and HCWs in the teaching hospitals made up a majority of the study population, and HCWs between 30 and 49 years were the most affected. It was also noted that the most probable source of infection was the workplace, followed by a social event. Ten per cent of the study cohort experienced severe illness, the result agrees with available evidence from a meta-analysis that reported a 9.9% incidence of severe disease in HCWs.[15] Age and gender are predictors with established association with COVID-19 mortality. Age is a crucial risk factor in the epidemiology of COVID-19; our study found an association between age and mortality; prior studies revealed patients above 65 years are at a greater risk of both disease severity and mortality from infection with SARS-CoV2.[16 17] Consistent with research findings, mortality was higher in male patients

Table 4 Contingency table of healthcare facilities by risk factors and outcomes

Health facility	Risk factors, n (%)								Outcomes, n (%)					
	Age						Sex		Symptomatic		Illness severity		Mortality	
	20–29	30–39	40–49	50–59	60–69	>70	Female	Male	No	Yes	No	Yes	Alive	Dead
Teaching hospitals	14 (4.7)	79 (26.3)	54 (17.9)	34 (11.3)	14 (4.7)	4 (1.3)	101 (33.6)	98 (32.6)	62 (20.6)	137 (45.5)	171 (56.8)	28 (9.3)	193 (64.1)	6 (2.0)
General service hospitals	7 (2.3)	9 (3.0)	10 (3.3)	4 (1.3)	4 (1.3)	2 (0.7)	21 (7.0)	15 (5.0)	20 (6.6)	16 (5.3)	32 (10.6)	4 (1.3)	35 (11.6)	1 (0.3)
Health allied organisations	1 (0.3)	8 (2.7)	3 (1.0)	6 (2.0)	2 (0.7)	2 (0.7)	7 (2.3)	15 (5.0)	11 (3.7)	11 (3.7)	22 (7.3)	0 (0.0)	22 (7.3)	0 (0.0)
Corporate health clinics	2 (0.7)	13 (4.3)	7 (2.3)	0 (0.0)	1 (0.3)	0 (0.0)	8 (2.7)	15 (5.0)	14 (4.7)	9 (3.0)	23 (7.6)	0 (0.0)	23 (7.6)	0 (0.0)
Community hospitals	1 (0.3)	6 (2.0)	7 (2.3)	0 (0.0)	2 (0.7)	2 (0.7)	13 (4.3)	5 (1.7)	6 (2.0)	12 (4.0)	18 (6.0)	0 (0.0)	18 (6.0)	0 (0.0)
Outpatient clinics	0 (0.0)	3 (1.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (0.7)	1 (0.3)	1 (0.3)	2 (0.7)	3 (1.0)	0 (0.0)	3 (1.0)	0 (0.0)
Total	25 (8.3)	118 (39.2)	81 (26.9)	44 (14.6)	23 (7.6)	10 (3.0)	152 (50.5)	149 (49.5)	114 (37.9)	187 (62.1)	269 (89.4)	32 (10.6)	294 (97.7)	7 (2.3)
χ^2	χ^2 (30) = 37.7053						χ^2 (5) = 9.9447		χ^2 (5) = 15.3283		χ^2 (5) = 10.3373		χ^2 (5) = 2.0203	
α	0.049						0.077		0.009		0.066		0.846	
Fishers exact							0.067		0.007		0.068		1.000	

Table 5 Subgroup analysis

Health professionals	240 (100)
Doctors	172 (71.7)
Nurses	63 (26.3)
Hospitals by ownership	276 (100)
Public	217 (78.6)
Private	59 (21.4)

in our study[18 19]; although no significant association was deduced in the cohort evaluated. Also, infection among HCWs was typically asymptomatic at the time of testing, with 89.4% not requiring hospitalisation, this might be due to the active tracing and testing of contacts of positive cases in the State; however, more research is required to determine whether these findings are attributable to the healthy worker bias. The results were similar to conclusions from a study that observed less severe manifestations of COVID-19 infection in medical professionals.[20] Our results also showed a significant association between symptomatic cases and illness severity; prior evidence found an association between prolonged SARS-CoV-2 RNA shedding and the interval between illness onset and treatment,[21] and may be indicative of a high viral load in these persons.

The proportion of mortality in the study cohort was higher, compared with available evidence of 0.5%.[22] The difference in mortality is perhaps attributable to the geographical location of studies conducted and may be suggestive of better working conditions and workforce. Studies on COVID-19-related mortality have mostly been conducted in developed regions (Asia, Europe and the USA), and showed lower mortality compared with the current study conducted in Nigeria developing country. Health professionals being the most infected subgroup aligns with various evidence,[12] as they are mostly involved in patient-facing roles. A difference in our study though was most infections were seen in doctors as against nurses in other studies; the doctors were the front-line responders for COVID-19 response in the state, and that may be the reason for this observation. Other plausible explanations are that all exposures were not in the workplace, and there was an indication that HCWs were infected to a greater extent in the community than in the workplace[23]; thoughts are also to be given to the adherence to infection prevention and control (IPC) protocol among the HCWs, and their willingness to work during the COVID-19 pandemic.[24 25]

A random selection of studies using HCWs as study participants conducted in the study region depicts a workforce majorly aged under 50[26–29]; although no association can be inferred, it is suggestive of a mostly younger age distribution of HCWs and was indicated in our results. Also indicated, were persons aged above 70, still in service. Although the constitutional retirement age ranges between 60 and 70 years from civil service depending on

Table 6 Contingency table of outcomes by risk factors

Outcome	Risk factors, n (%)											
	Age						Sex		Symptomatic		Illness Severity	
	20–29	30–39	40–49	50–59	60–69	>70	Female	Male	No	Yes	No	Yes
Illness severity, n=32	3 (9.4)	13 (40.6)	4 (12.5)	6 (18.8)	5 (15.6)	1 (3.1)	16 (50)	16 (50)	2 (6.3)	30 (93.8)	–	–
χ^2	χ^2 (5) = 6.2195						χ^2 (1) = 0.0036		χ^2 (1) = 15.2187		–	
α	0.285						0.952		0.000		–	
Fishers exact	0.199						1.000		0.000		–	
Mortality, n=7	0 (0.0)	1 (14.3)	0 (0.0)	2 (28.6)	3 (42.9)	1 (14.3)	1 (14.3)	6 (85.7)	2 (28.6)	5 (71.4)	6 (85.7)	1 (14.3)
χ^2	χ^2 (1) = 19.240						χ^2 (1) = 3.7596		χ^2 (1) = 0.2636		χ^2 (1) = 0.1007	
α	0.002						0.053		0.608		0.754	
Fishers exact	0.003						0.065		0.713		0.549	

Table 7 Multivariate analysis of risk factors for COVID-19 outcomes

Outcome	Risk factors	aOR	95% CI	P value
Illness severity	Age	0.98	0.455 to 2.111	0.959
	Sex*	1.003	0.971 to 1.036	0.859
	Case class†	10.658	2.494 to 45.552	0.001
Classification table –89.4% correctly classified, constant=–4.139				
Mortality	Age	1.079	1.02 to 1.141	0.008
	Sex*	4.274	0.486 to 37.582	0.190
	Case class†	1.166	0.198 to 6.869	0.865
	Illness severity‡	1.305	0.130 to 13.123	0.821

*Female
†Asymptomatic
‡No

the profession (70 years for the medical professional), the Civil Service Commission offers contract appointments to pensioners. Due to several challenges, evidence showed that Nigerians generally have a poor attitude towards retirement; with a preference to continue working privately in some capacity, after retirement from the civil service.[30–32]

The use of routinely collected data is beneficial in this scenario as the data were readily available and could be representative of the study population, following the integrated testing and reporting approach used in data collection. The completeness of the data also minimises the effects of selection bias due to non-response and lost to follow-up. The independent mode of prospective data collection reduces recall bias on exposure.[33] This study gives a snapshot into the impact of COVID-19 on the healthcare workforce of Rivers State and serves as a model for a more holistic research.

The existent significant challenge in giving an accurate report on deaths due to COVID-19, let alone those among HCWs for several reasons, was acknowledged by the WHO.[12] As applicable to our setting, reports were for deaths with a confirmed COVID-19 test; hence, untested individuals and persons who died outside a hospital facility would not have been included in the death counts. The reliance on reported infections and deaths implies that there is a probability of missing unreported cases and mild cases of COVID-19. Some reasons for non-reporting may include: the fear of stigmatisation from colleagues,[34] and poor health-seeking behaviour among this cohort—the practice of self-medication and reluctance to obtain medical care.[35 36] The health-seeking behaviour of the HCWs in Nigeria and poor reporting of COVID-19 infection cases within this cohort is to be considered. There is evidence that the practice of self-medication and reluctance to obtain medical care is high among doctors and nurses in Nigeria[35–39]; therein lies the possibility of non-reporting of mild cases. This behavourial pattern emphasises the need for more awareness and education on these issues within this group of healthcare professionals. These are limitations to this study. The viral load of SARS-CoV-2

and comorbidities are useful markers for assessing disease severity and prognosis[21]; the availability of information on these variables would have better informed the study. Data on the interval between illness onset and treatment onset would have given a more concise inference of disease severity also.

HCWs are the most important human resource for hospitals; the workplace-related mortality in HCWs not only compromises the workforce in healthcare settings but also affects the mental health of colleagues.[40 41] A CFR of 2.33% though comparable with global statistics for HCWs[10] is higher than both the CFR of the study area—Rivers state (0.98%) and Nigeria (1.23%).[42] There is a need for re-evaluation of compliance to the COVID-19 IPC protocol, the adequacy of PPE and working conditions in place for HCWs in Rivers State; because, exposure to numerous infected individuals, may demonstrate that HCWs, if infected, could be characterised by higher viral load, thereby, associated with worse clinical outcomes.[21] The results from the study also further emphasise the need to protect HCWs; ensure they are knowledgeable in both IPC, and that the healthcare space is safe against nosocomial infections. The density of HCWs in the state and country at large is also a point of concern; although it is estimated that 74 543 doctors and 301 579 nurses are registered in Nigeria, the Medical and Dental Council Of Nigeria stated that only about 59% of the doctors and 35% of nurses are in active service. Nigeria has also suffered a mass exodus of HCWs over the years; in 2020 during the height of COVID-19, it was reported that 7256 Nigerian nurses migrated from Nigeria.[43–45] Better working conditions for health workers need to be advocated, to regulate the export of human capital.

To our knowledge, this research is the foremost study representing a relatively comprehensive analysis of COVID-19-related mortality and disease severity in HCWs from available state records in Rivers State. As an emerging research area in the current pandemic, there are other factors worth considering. For example, the effect of time of hospitalisation on disease severity and mortality, and viral load count. As a secondary analysis, we were unable to analyse this variable. Future studies to investigate this variable is essential. The impact of nosocomial versus community transmission is also a vital area of research. A national study is required to extrapolate the findings from this study to the nation, as surveillance of the impact of COVID-19 by occupation and industry will benefit not only HCWs but all workers in the nation.

CONCLUSION

In conclusion, front-line HCWs are at an increased risk of exposure to COVID-19 infections. In Nigeria, there is the possibility of a higher risk of experiencing a severe disease if symptomatic while infected. It is imperative that preventive strategies are established and implemented, alongside proper education, and awareness to protect HCWs.

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ORCID iD

Chidinma Eze-Emiri http://orcid.org/0000-0002-6423-3175

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