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Prevalence and Factors Associated with Covid-19 Infection and Mortality Among Frontline Healthcare Workers in Kaduna State

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Abstract

This study in Kaduna State, Nigeria, examined the prevalence, and factors as associated with COVID-19 infection and mortality among frontline healthcare workers (HCWs) in a descriptive, cross-sectional study, where data of HCWs from secondary source, Surveillance Outbreak Response Management and Analysis System (SORMAS), was exported to Microsoft excel and evaluated using SPSS version 26 to provide a snapshot of the vaccine uptake among HCWs in Kaduna state. The study population were all healthcare workers in Kaduna State, Nigeria that were tested for COVID-19 from the onset of the pandemic in Kaduna to 29th August 2022. The consents of all persons were obtained prior to testing data upload to the electronic platform of SORMAS. Prevalence of COVID-19 infection was notably higher pre-vaccination (12%) but dropped to 5.9% post-vaccination, showcasing the vaccine's effectiveness in reducing HCW infections. However, COVID-19-related mortality rates remained relatively consistent, irrespective of vaccination status. Demographics played a role in infection risk. Female HCWs, urban dwellers, and those with higher education levels faced elevated infection risks. Additionally, close contacts with probable COVID-19 cases increased infection likelihood. Concerning mortality, males experienced more COVID-19-related deaths, but no significant links were found with age, residential area, or contact history. Symptoms significantly associated with COVID-19 infection included fever, abdominal pain, cough, sore throat, loss of taste, and loss of smell. The prevalence of COVID-19 infection among the HCWs was higher before the COVID-19 vaccination was introduced (12%) compared to after the vaccine was introduced in Kaduna State. These findings offer valuable insights into the pandemic's impact on frontline workers in Nigeria's Kaduna State.

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Introduction

COVID-19 has impacted almost every country and territory in the world. Globally, the rate of infection among HCWs continue to rise along with the number of infections among the general population. It has also impacted the economic and social wellbeing of individuals and communities globally [1]. The Healthcare workers (HCW) are in the frontline of supporting the response to control the pandemic. They are not only at great risk of contracting this infection, but also undergoing mental and psychological distress, long working hours, fatigue, occupational stigma, and physical violence. [2, 4] has led to a continuous rise in the HCW infection rate before the availability of COVID-19 vaccines [5]. HCWs are always in contact with patients and/or their blood or body fluids, this occupational exposure to blood and body fluids is a serious concern and presents a major risk for the transmission of infectious diseases [6]. This exposes them to the likelihood of getting infected or even transmitting the infection to the patients and other family and community members [7].

Healthcare workers make up more than 1.4 million of the COVID-19 infections worldwide, and they also account for at least 10% of all fatalities. The African Regional Office of the World Health Organization (WHO) in Brazzaville stated that approximately 110,072 healthcare workers (HCW) in Africa were infected with coronavirus, with about 10% of them succumbing to the infection. Global estimates of COVID-19 deaths based on the WHO's surveillance database for COVID-19 which aggregated countries' reported numbers of infections and deaths between 1 January 2020 to 16 May 2021, a period mostly preceding the introduction of a vaccine, revealed that only 6643 deaths occurred among HCWs out of the 3.45 million worldwide. Nonetheless, mixed analytical approaches involving indirect age and sex standardization produced an estimate ranging between 80 000 to 180 000 deaths globally with a central population-based estimate of 115 500 deaths, out of a global healthcare workforce of 135 million people. The analysis assumed that HCWs have the same level of exposure to infection and deaths as that of the general population in every country. The number of deaths among HCWs was estimated by applying the crude mortality rate from each country to the estimated number of HCWs in each country as obtained from the International Labour Organization's database on labour statistics. Even so, both estimates are affected by the under-reporting of COVID-19 deaths which was common in the WHO's African. The majority of infected HCWs are female in Italy and other nations [8].

Even though the virus has continued to mutate, the COVID-19 vaccines serve as a first line of defense and are still quite effective in lowering serious morbidity and mortality. Worldwide, more than 11.3 billion doses of the COVID-19 vaccine have been given, resulting in 58 percent of the population receiving their first shot. However, just 11% of people in low-income countries are immunized, compared to 73% of people in high-income nations [9].

Concerns about the pandemic's larger impact on HCWs, as well as their critical position at the forefront of the response, were recognized by the World Health Assembly's Seventy-third Session in November 2020, when it declared 2021 to be the International Year of Health and Care Workers (WHA730) [5, 10]. Soon after, the World Health Organization (WHO) began a global campaign in support of the International Year. The campaign's goals include an emphasis on preventing harm to HCWs, stressing on the importance of HCWs being vaccinated against COVID-19, demands for the measurement of all

COVID-19-related infections and deaths among HCWs, and emphasizes the necessity for global governance to agree on a worldwide response. It stressed the importance of global governance agreeing on a compact that preserves the duty of care paradigm. National authorities may only implement appropriate policy measures and responses to lower the risks of infection and death for HCWs by tracking the number of vaccines delivered, infections and fatalities rates particularly among professions with emphasis on the HCWs [5].

It is quite necessary to guarantee the safety of health-care workers (HCWs) while providing the ongoing patient care and ensure they do not spread the virus, hence infection and fatality rates in these groups should be assessed. This study seeks to find out the prevalence and factors associated with COVID-19 infection and mortality among frontline healthcare workers in Kaduna State, Nigeria.

Methods

Site of Study

This study was conducted in Kaduna State, located in the North-West geo-political zone of Nigeria. The state is bordered by Zamfara, Niger, Katsina, Kano, Bauchi, Nasarawa, and Plateau States and the Federal Capital Territory. Its entire land area is 46, 020 square kilometers and it is located between the Latitude: 10° 31' 35.08" N and the Longitude: 7° 26' 19.64" E. Kaduna State is now the 12th largest state in Nigeria by land area. By 2022, Nigeria's third-most populous state is anticipated to have 9,735,051 inhabitants. The population is dispersed over 255 wards and 23 LGAs [11].

The healthcare system in Kaduna State is pluralistic, combining the public and private sectors as well as modern and traditional practices. The state government is in charge of secondary level care, while the LGAs are in charge of PHC services. There are a total of 1983 health institutions in the state, according to information acquired from the Department of Planning, Research, and Statistics of Kaduna State Ministry of Health (KSMoH). The government owns around 85.8% (1702) of the state's healthcare institutions, while private businesses hold about 34.2% (678) of them. Primary healthcare (PHC) facilities make up the highest percentage of institutions (52% for government-owned facilities (1024) and 34.2% for privately-owned facilities (678) correspondingly. The health facilities are further classified based on the standard of care provided. Only 7 government-owned facilities (or 0.4% of all healthcare facilities) provide tertiary care, but 6.2% of government-owned hospitals (or 125) and 7.6% of privately-owned hospitals (or 149) provide secondary care. Knowing the Kaduna state healthcare system through and out is essential for developing healthcare treatments and programs that work.

This study aims to determine the prevalence, factors and predictors associated with COVID-19 infection and mortality among frontline healthcare workers in Kaduna State.

Study Design and Data Collection

This descriptive, cross-sectional study utilized data from secondary source; Surveillance Outbreak Response Management and Analysis System (SORMAS), The data was exported to Microsoft excel and evaluated to provide a snapshot of the infection rate and vaccine uptake among HCWs in Kaduna state. The study population were all healthcare workers in Kaduna State, Nigeria that were tested for COVID-19 from the onset of the pandemic in Kaduna on 27th March 2020 to 29th August 2022. The consent of each participant was obtained before being tested for COVID-19 and details uploaded to the electronic platform of SORMAS.

The electronic data capture platform of SORMAS captures variables such as the biodata of the individuals being tested including occupation and educational level, Epidemiological week, the vaccination status and dates of vaccination as evidence on the vaccination card and on the EMID platform, unique verifiers, presumptive symptoms, history of contacts and travels, comorbidities, pregnancy status for females, disease for which the person is being tested for, the state/LGA/ward/health facility where the sample is being collected and tested including the geocoordinates, dates of specimen collection, outcome of the results with date, contact tracing information conducted etc.

In Nigeria, the Nigeria Centre for Disease Control (NCDC) manage Disease surveillance and response while the National Primary Healthcare Development Agency (NPHCDA) manages vaccinations. Both are agencies of the Federal Ministry of Health (FMoH). The NCDC domiciled all electronic data for disease surveillance and control on the SORMAS. The SORMAS contains patient level data details from when a patient is suspected, to when tested, management provided and follow up, laboratory investigations conducted with results and the contact investigations carried out. It was piloted with COVID-19 and later scaled up to capture all diseases.

Data Analysis

The data analysis was performed using SPSS Statistics version 26. The results were presented through various means, including tables, graphs, and charts. For categorical variables, the data was summarized using frequencies and percentages, while for continuous variables, mean ± Standard deviation were computed.

Test of associations were performed with the Chi-square, T-tests and Fisher' tests standard deviation was employed to assess data dispersion. Binary logistic regression was done to identify the factors that predict COVID-19 infection and mortality among the study participants. The level of significance was set at $\alpha = 0.05$.

Ethical Consideration

Ethical clearance was obtained from the Kaduna State Ministry of Health Research Ethics committee (HREC). The informed oral consent of all persons to be tested were obtained before specimen collection and data collection and upload to SORMAS Server.

Results

The ages of study participants ranged between 15 and 115 years, with a mean of 38.38 ± 10.5 years. The dominant age group was the 31–40-year age group, which constituted 35% of the study subjects. About two-thirds of the study participants, 5630 (60.2%), were females, and the majority, 6673 (70.3%), lived in urban areas [Table 1].

Table 1. Sociodemographic Characteristics of the Study Participants

Variables	Frequency (n = 8095)	Proportion (%)
Age		
≤ 20	152	1.6
21-30	2293	24.5
31-40	3317	35.5
41-50	2151	23.0
51-60	1316	14.1
> 60	126	1.3
Gender		
Male	3725	39.8
Female	5630	60.2
Educational status		
None	10	0.1
Primary	65	0.7
Secondary	690	7.4

Tertiary	8415	90.0
Others	175	1.9
Residencial area		
Urban	6673	71.3
Rural	2682	28.7
Mean age	**Mean ± Standard Deviation-** 38.38 ± 10.50 years	

The prevalence of COVID-19 infection was higher before the COVID-19 vaccination was introduced (12%) compared to the prevalence after the vaccine was introduced (5.9%), and the difference was statistically significant (χ^2 = 41.446, p < 0.001). [Figure 1]. COVID-19 vaccination started in Kaduna state on the 26th of March 2021.

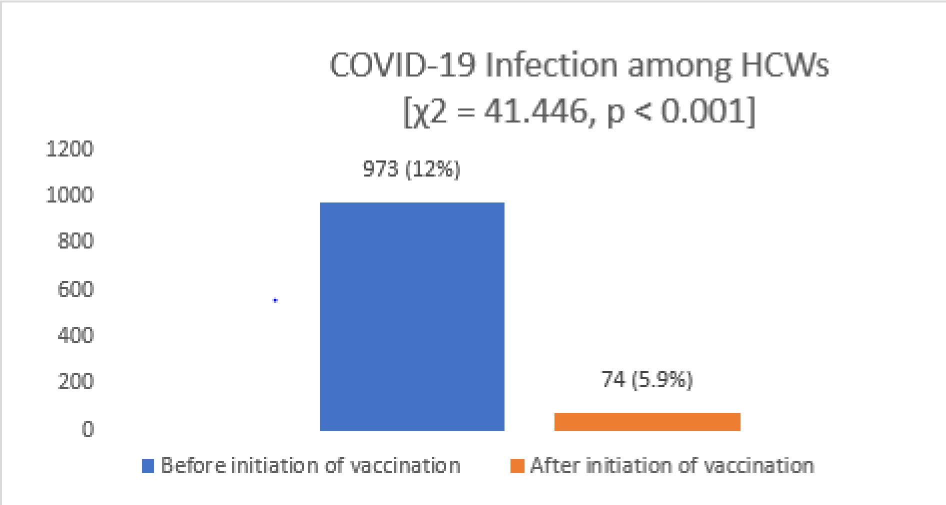

Figure 1. Prevalence of COVID-19 Infection among HCWs in Kaduna State Before and After Initiation of COVID-19 Vaccine (March 2020 to February 2022)

The prevalence of COVID-19 mortality was similar among healthcare workers in Kaduna state before (0.1%) and after (0.2%) the initiation of COVID-19 vaccination. However, the difference was not statistically significant (χ^2 = 0.008, p = 0.929) [Figure 2].

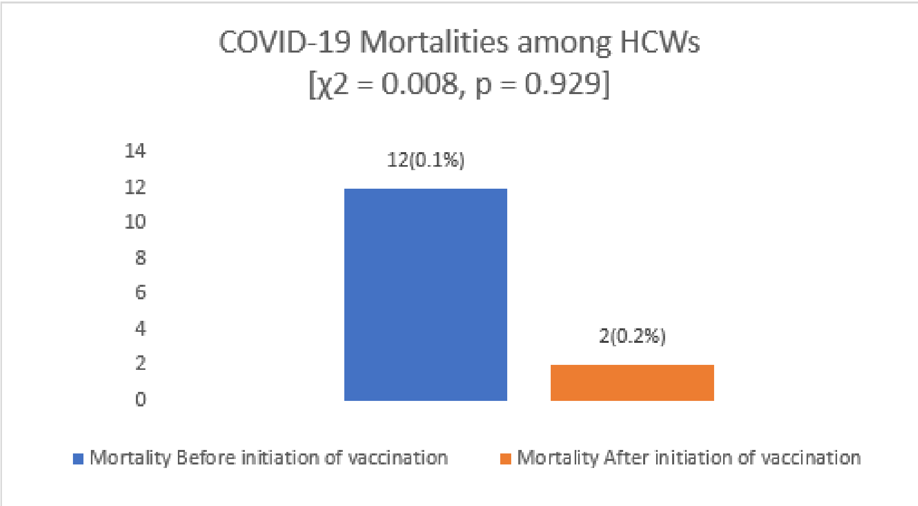

Figure 2. Prevalence of COVID-19 Related Mortality among HCWs in Kaduna State Before and After Initiation of COVID-19 Vaccine (March 2020 to February 2022)

Almost all the study subjects, 9238 (98.7%), had no history of traveling to a COVID-19 endemic state or country, and about a third of them, 2233 (23.9%), had a history of direct contact with a probable case of COVID-19 [Table 2].

Table 2. Travel and Contact History of Study Participants

Variables	Frequency (n = 8095)	Proportion (%)
Travel history		
Yes	91	1.0
No	9238	98.7
Unknown	26	1.9
History of direct contact with a probable case		
Yes	2233	23.9
No	6071	64.9
Unknown	1051	11.2

Headache and fever were the commonest symptoms presented by the study participants, as they were presented by 676 (7.2%) and 663 (7.1%) of the participants, respectively. More than 5% (522, 5.6%) reported a cough, 495 (5.3%) reported a runny nose, and 117 (1.3%) reported a loss of smell [Table 3].

Table 3. Presenting Symptoms of the Study Participants

Symptom	Frequency (n = 8095)	Proportion (%)
Fever	663	7.1
Headache	676	7.2
Abdominal pain	61	0.7
Vomiting	38	0.4
Diarrhea	55	0.6
Joint pain	94	1.0
Cough	522	5.6
Dyspnea	51	0.5
Sore throat	254	2.7
Loss of taste	117	1.3
Loss of smell	101	1.1
Runny nose	495	5.3
Fatigue	205	2.2
Chest pain	56	0.6

Females had a significantly higher proportion of COVID-19 infection (57.3%) than males (42.7%), (χ^2 = 4.067, p = 0.004). Participants that lived in urban areas were more likely to have COVID-19 infection than those from rural areas (75% vs 25%) and the difference between them was statistically significant (χ^2 = 7.661, p = 0.006). The educational status of participants and history of direct contact with a probable COVID-19 case were also statistically significantly associated with COVID-19 infection (χ^2 = 15.741, p = 0.003 and χ^2 = 45.556, p < 0.001) [Table 4].

Table 4. Factors Associated with COVID-19 Infection among HCWs in Kaduna State

Variables	COVID-19 case classification		Test statistic/p-value
	Confirmed cases (n = 1047) n (%)	Non cases (n = 8308) n (%)	
Age			
≤ 20	14 (1.3)	138 (1.7)	-
21-30	243 (23.2)	2050 (24.7)	-
31-40	367 (35.1)	2950 (35.5)	χ^2 = 7.036
41-50	246 (23.5)	1905 (22.8)	p = 0.218
51-60	155 (14.8)	1161 (14.0)	-
> 60	22 (2.1)	104 (1.3)	-
Gender			
Male	447 (42.7)	3278 (39.5)	χ^2 = 4.067
Female	600 (57.3)	5030 (60.5)	**p = 0.044**
Educational status			
None	1 (0.1)	9 (0.1)	-
Primary	8 (0.8)	57 (0.7)	χ^2 = 15.741
Secondary	48 (4.6)	642 (7.7)	**p = 0.003**
Tertiary	976 (93.2)	7439 (89.5)	-
Others	14 (1.3)	161 (1.9)	-
Residential area			
Urban	785 (75.0)	5888 (70.9)	χ^2 = 7.661
Rural	262 (25.0)	2420 (29.1)	**p = 0.006**
Direct contact with a probable case			
Yes	332 (31.7)	1901 (22.9)	χ^2 = 45.556
No	587 (56.1)	5484 (66.0)	**p < 0.001**
Unknown	128 (12.2)	923 (11.1)	-
Travel history			
Yes	13 (1.2)	78 (0.9)	χ^2 = 0.889
No	1031 (98.2)	8207 (98.8)	p = 0.641
Unknown	3 (0.3)	23 (0.3)	-
χ^2 = Pearson's Chi square test			

Gender was the only factor associated with COVID-19 mortality among the study participants. Males had a higher proportion of mortality than females (71.4% vs 28.6%) and the difference was statistically significant (χ^2 = 4.846, p = 0.016). However, age, place of residence, and direct contact with a probable case of COVID-19 were all not significantly associated with COVID-19 related mortality (p > 0.005) [Table 5].

Table 5. Factors Associated with COVID-19 Related Mortality Among HCWs in Kaduna State

Variables	Outcome of cases		Test statistic/ p-value
	Recovered (n = 9341) n (%)	Died (n = 14) n (%)	
Age			
≤ 20	152 (1.6)	0	-
21-30	2290 (24.5)	3 (21.4)	-

31-40	3311 (35.4)	6 (42.9)	FE = 4.098
41-50	2148 (23.0)	3 (21.4)	p = 0.496
51-60	1315 (14.1)	1 (7.1)	-
> 60	125 (1.3)	1 (7.1)	-
Gender			
Male	3715 (39.8)	10 (71.4)	χ^2 = 5.846
Female	5629 (60.2)	4 (28.6)	**p = 0.016**
Educational status			
None	10 (100)	0	-
Primary	65 (100)	0	FE = 3.568
Secondary	690 (100)	0	p = 0.739
Tertiary	8401 (99.8)	14 (100)	-
Others	175 (100)	0	-
Residencial area			
Urban	6660 (71.3)	13 (92.9)	FE = 3.177
Rural	2681 (28.7)	1 (7.1)	p = 0.082
Direct contact with a probable case			
Yes	2231 (23.9)	2 (14.3)	FE = 3.809
No	6063 (64.9)	8 (57.1)	p = 0.129
Unknown	1047 (11.2)	4 (28.6)	-
Travel history			
Yes	91 (1.0)	0	FE = 1.933
No	9224 (98.7)	14 (100)	p = 1.000
Unknown	26 (100)	0	-
χ^2 = Pearson's Chi square test, **FE** = Fisher's Exact test			

Fever was found to be significantly associated with COVID-19 infection. About one-fifth (20.1%) of participants that presented with fever were confirmed to have COVID-19 infection, as against 10.5% of those that did not present with fever (χ^2 = 56.465, p < 0.001). More than one-third of participants that complained of abdominal pain were confirmed with the disease when compared to 11% of those that did not complain of abdominal pain, and the difference was statistically significant (χ^2 = 56.465, p < 0.001). Similarly, chest pain, cough, difficulty in breathing, runny nose, and loss of smell were all significantly associated with COVID-19 infection (p < 0.05). [Table 6]

Table 6. Relationship between Participants' Presenting Symptoms and Covid-19 Infection

Variables	COVID-19 case classification		Test statistic/ p-value
	Confirmed cases (n = 1047) n (%)	**Non cases (n = 8308) n (%)**	
Fever			
Yes	133 (20.1)	530 (79.9)	χ^2 = 56.465
No	914 (10.5)	7778 (89.5)	**p < 0.001**
Abdominal pain			
Yes	22 (36.1)	39 (63.9)	χ^2 = 38.220
No	1025 (11.0)	8269 (89.0)	**p < 0.001**

Vomiting			
Yes	7 (18.4)	31 (81.6)	$\chi^2 = 2.006$
No	1040 (11.2)	8277 (88.8)	p = 0.157
Diarrhea			
Yes	14 (25.5)	41 (74.5)	$\chi^2 = 11.323$
No	1033 (11.1)	8267 (88.9)	**p = 0.001**
Chest pain			
Yes	14 (25.0)	42 (75.0)	$\chi^2 = 10.807$
No	1033 (11.1)	8266 (88.9)	**p = 0.001**
Joint pain			
Yes	18 (19.1)	76 (80.9)	$\chi^2 = 6.049$
No	1029 (11.1)	8232 (88.9)	**p = 0.014**
Cough			
Yes	118 (22.6)	404 (77.4)	$\chi^2 = 72.458$
No	929 (10.5)	7904 (89.5)	**p < 0.001**
Difficulty in breathing			
Yes	13 (25.5)	38 (74.5)	$\chi^2 = 10.548$
No	1034 (11.1)	8270 (88.9)	**p = 0.001**
Runny nose			
Yes	93 (18.8)	402 (81.2)	$\chi^2 = 30.341$
No	954 (10.8)	7906 (89.2)	**p < 0.001**
Sore throat			
Yes	77 (30.3)	177 (69.7)	$\chi^2 = 96.061$
No	970 (10.7)	8131 (89.3)	**p < 0.001**
Loss of taste			
Yes	43 (36.8)	74 (63.2)	$\chi^2 = 77.880$
No	1004 (10.9)	8234 (89.1)	**p < 0.001**
Loss of smell			
Yes	46 (45.5)	55 (54.5)	$\chi^2 = 121.228$
No	1001 (10.8)	8253 (89.2)	**p < 0.001**
χ^2 = Pearson's Chi square test			

None of the assessed symptoms were found to be statistically significantly associated with COVID-19 mortality among the study participants ($p > 0.05$). Even though three (0.5%) of the participants that presented with fever died, only 0.1% of those that did not present with fever died of the disease; however, this difference was not statistically significant (Fisher's Exact test, p = 0.072).

Table 7. Relationship between Participants' Presenting Symptoms and COVID-19 Mortality

Variables	**Outcome of cases**		**Test statistic/ p-value**
	Recovered (n = 1047) n (%)	**Died (n = 8308) n (%)**	
Fever			
Yes	660 (99.5)	3 (0.5)	Fisher's Exact
No	8681 (99.9)	11 (0.1)	p = 0.072
Abdominal pain			
Yes	61 (100)	0	Fisher's Exact
No	9280 (99.8)	14 (0.2)	p = 1.000
Vomiting			
Yes	38 (100)	0	Fisher's Exact
No	9303 (99.8)	14 (0.2)	p = 1.000
Diarrhea			
Yes	55 (100)	0	Fisher's Exact
No	9286 (99.8)	14 (0.2)	p = 1.000
Chest pain			
Yes	55 (98.2)	1 (1.8)	Fisher's Exact
No	9286 (99.9)	13 (0.1)	p = 0.081
Joint pain			
Yes	94 (100)	0	Fisher's Exact
No	9247 (99.8)	14 (0.2)	p = 1.000
Cough			
Yes	521 (99.8)	1 (0.2)	Fisher's Exact
No	8820 (99.9)	13 (0.1)	p = 0.553
Difficulty in breathing			
Yes	50 (98.0)	1 (02.0)	FE = 7.381
No	9291 (99.9)	13 (0.1)	p = 0.074
Runny nose			
Yes	495 (100)	0	Fisher's Exact
No	8846 (99.8)	14 (0.2)	p = 1.000
Sore throat			
Yes	254 (100)	0	FE = 1.129
No	9087 (99.8)	14 (0.2)	p = 1.000
Loss of taste			
Yes	117 (100)	0	Fisher's Exact
No	9224 (99.8)	14 (0.2)	p = 1.000
Loss of smell			
Yes	101 (100)	0	Fisher's Exact
No	9240 (99.8)	14 (0.2)	p = 1.000

Table 8. Binary Logistic Regression for Predictors of COVID-19 Infection among Healthcare Workers in Kaduna State

Variables	aOR	95% CI		p value
		lower	Upper	
Gender (Males vs Females*)	0.723	0.419	1.247	p = 0.243
Residential area (Urban vs rural*)	0.432	0.167	1.118	p = 0.084
Direct contact with probable case (Yes, vs No*)	0.539	0.106	2.744	p = 0.457
Vaccination status (Unvaccinated vs vaccinated)	1.126	0.579	2.191	p = 0.727
Abdominal pain (Yes vs No*)	19.53	1.652	23.888	**p = 0.018**
Cough (Yes vs No*)	5.11	2.400	10.861	**p < 0.001**
Chest pain (Yes vs No*)	1.58	0.450	5.581	p = 0.474
Difficulty in breathing (Yes vs No*)	9.07	0.421	19.670	p = 0.159
Sore throat (Yes vs No*)	2.60	1.078	6.285	**p = 0.033**
Loss of taste (Yes, vs No*)	1.66	0.014	1.878	p = 0.391
Loss of smell (Yes vs No*)	3.06	0.754	12.408	p = 0.118
aOR = Adjusted Odds Ratio **CI** = Confidence Interval *** = Reference** group				

Discussion

The finding of this study shows a low prevalence of COVID-19 infection among HCWs when compared with the general population, just like the findings of similar studies conducted in Qatar, the US, and global [12-16] that corroborated the low prevalence of COVID-19 infection among HCWs. This study further showed a statistically significant finding that the prevalence of COVID-19 infection was twice as much higher during the pre-vaccination period compared to that of the post-vaccination period (χ^2 = 41.446, **p < 0.001).** However, it is in contrast to other reports which showed a rise in the prevalence of SARS-CoV-2 infection among HCWs in the period following the introduction of COVID-19 vaccines compared to the pre-vaccination period attributed partly to the decrease in vaccine effectiveness to emerging variants of SARS-CoV-2 [17] Other attributable factors have to do with the significant increase in the incidence of COVID-19 around the world leading to issue of mental and psychological disturbances from long working hours resulting in lowered resilience, burnout, low quality of life (QoL) among HCWs, experiences of depressive and anxiety symptoms, with females, physicians, and less experienced Healthcare workers showing elevated levels of symptomology [18-24], The prevalence of COVID-19 infection among HCWs following the introduction of vaccines was low and comparable to a global estimate [25] This decline may be attributed to the success of the COVID-19 vaccination programme buttressing the effectiveness of the vaccine against infection with SAR-CoV-2 and probably combined with the improvement in the IPC measures adopted by HCWs across the state [26, 27].

With respect to COVID-19 mortality among HCWs, this study revealed a low prevalence of 0.1% during the pre-vaccination period and an insignificant increase in prevalence to 0.2% between the pre-vaccination and post-vaccination periods which is not statistically significant (χ^2 = 0.008, p = 0.929). This increase in mortality despite decreased infection rates might have arisen because of the emergence of more virulent strains of SARS-CoV-2 such as the delta variant for whom the protective effects of the available vaccines were decreased [26]. Nonetheless, the prevalence of mortality recorded in this study was comparable to studies in the US [15] and Qatar [14] and Nigeria [28].

Furthermore, as found by other researchers, [16] a higher prevalence of COVID-19 infection was noted among females, and this could be attributable to the fact that the proportion of female HCWs in the study population is much higher than that of males. Conversely, other reports have either a higher risk of COVID-19 infection among males, [29] or a gender difference in COVID-19 infection risk [8, 12].

Additionally, the finding that urban dwelling and tertiary education increased the risk of infection was in line with a previous study [29]. The high population density in urban areas often accompanied by overcrowding of public spaces and predominance of jobs requiring repeated physical proximity and face-to-face interactions [30], may be responsible for the higher risk of COVID-19 infection observed among urban dwellers in this study.

Similarly, the study found a 0.5 chance significant increase in the likelihood of developing COVID-19 infection when there is a history of contact with a probable case (χ^2 = 45.556, $p < 0.001$) as reported in the literature by. [12] Surprisingly, contrary to the widely held belief that individuals with higher educational attainment have better health outcomes, [31] this study found out that tertiary education holders were at a higher risk of COVID-19 infection than those with lower educational background. The skewed distribution of more educated HCWs in the urban settings with more likelihood of working in settings with high volumes of out-patient work load and in-patient admissions where there is an ease of COVID-19 infection, contact tracing, follow-up and ascertainment of infection status than their less-educated counterparts who are more likely to practice in rural and peri-urban settings where a full range of COVID-19 management services may be lacking may account for the finding above.

The higher risk of COVID-19 mortality noted among the males in this study is consistent with previous studies, [8, 28, 29] which illustrated that that females have higher numbers of T-cells, hence have an increased capacity to mount humoral immune responses [32]. Conversely, a similar study in Indonesia. [33], didn't find any gender difference in COVID-19 mortalities among HCWs probably because, unlike in our study, there was nearly an equal distribution of males and females among the study participants.

The binary logistic regression on table 8 shows that abdominal pain ($p = 0.008$), cough ($p < 0.001$), and sore throat ($p = 0.033$) were significant predictors of COVID-19 infection. Participants that were presented with complaints of abdominal pain were 19.5 times more likely to be confirmed with COVI-19 infection than those that did not present with abdominal pain (aOR: 19.53, 95% CI: 1.652–23.888, $p = 0.018$). Similarly, participants who reported coughing were 5 times more likely to have a COVID-19 infection than those who did not (aOR: 5.11, 95% CI: 2.400–10.861, p 0.001). Even though participants that were not vaccinated were 1.13 times more likely to develop COVID-19 infection than those that were vaccinated, this was not statistically significant (aOR: 1.26, 95% CI: 0.570-2.191, $p = 0.727$).

Conclusion

This study investigated COVID-19 infection and mortality rates among HCWs before and after COVID-19 vaccination. It found a significant decrease in infection rates post-vaccination, low mortality rates, and identified factors like gender, education, and abdominal, chest pain, cough, difficulty in breathing, runny nose, and loss of smell were all significantly associated with COVID-19 infection while, abdominal pain, cough and vaccination status as predictors.

Recommendations

The study underscores the importance of prioritizing COVID-19 vaccination HCWs and ensure a continuous supply of infection prevention and control (IPC) materials like face masks, gloves, hand sanitizers disposable gowns etc.

Healthcare practitioners and policy makers should implement interventions to create a healthy workplace environment, address concerns related to vaccine hesitancy among HCWs, prevent burnout among HCWs during and after the COVID-19 pandemic, promote coping strategies and innovative approaches to encourage healthcare practice and make digital mental health support interventions or workplace mental health support teams readily accessible to protect the mental wellbeing of healthcare workers with emphasis on the HCWs within identified risk groups.

Conflict of Interest

The authors declare no conflict of interest in this work.

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