# COVID-19 Vaccination Uptake and Its Effect on Morbidity and Mortality among Frontline Healthcare Workers in Kaduna State, Nigeria

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## Abstract

*The COVID-19 pandemic has placed tremendous burdens on healthcare workers (HCWs), accounting for over 1.4 million HCW infections and 10% of global fatalities. HCWs faced elevated infection risk, psychological distress, long working hours, fatigue, stigma, and violence. While vaccines are pivotal in reducing severe illness, HCW vaccine hesitancy, given their role as advocates, jeopardizes vaccination coverage global goals and healthcare systems. Addressing this vaccine uptake is imperative through education, transparent communication, and support to safeguard HCWs' safety and pandemic containment. This study assessed COVID-19 vaccination uptake among frontline HCWs in Kaduna State, Nigeria, and its impact on morbidity and mortality. Utilizing a descriptive cross-sectional approach, we analyzed secondary data from the Surveillance Outbreak Response Management and Analysis System (SORMAS). The study encompassed HCWs in Kaduna State, excluding pregnant and lactating individuals, following national guidelines. Among 8095 HCWs tested for COVID-19, most were aged 31-40 years (35%), female (60.2%), and urban residents (70.3%). COVID-19 vaccination uptake was low at 17.4%, with 82.6% unvaccinated. COVID-19 infection was significantly associated with vaccination (p = 0.039). Although unvaccinated participants exhibited a higher mortality rate (60%) than vaccinated ones (40%), this difference was not statistically significant (p = 0.209). In conclusion, this study unveiled insufficient vaccination uptake among HCWs, potentially impeding pandemic response. While vaccination seemed to positively impact disease outcomes, it didn't*

*significantly affect the infection risk. Addressing HCW vaccine hesitancy remains critical for achieving immunization goals and ensuring healthcare system safety.*

## Introduction

The Corona Virus Disease (COVID-19) pandemic was a serious health challenge that infected millions of individuals and killed hundreds of thousands, affected people's and communities' economic and social well-being, disrupted livelihoods, affected trade, increased the fiscal deficit and monetary burden, increased the risk of macroeconomic instability, decreased migration and remittances, decreased income from travel and tourism, and led to a decline in micro, small, and medium-sized industries and informal businesses [1, 2].

The world is yet to recover from the devastating impact of this dreaded pandemic. HCWs were on the frontlines of supporting the response to control the pandemic; therefore, they were not only at great risk of contracting this infection but also passed through psychological distress, long working hours, fatigue, occupational stigma, and physical violence [3, 4] This led to a rise in the HCW infection rate before the availability of COVID-19 vaccines [5] The introduction of various vaccines with varying levels of efficacy brought the promising hope of bringing the spread to a halt, and since the frontline HCWs were highly vulnerable, they were prioritized among the first eligible beneficiaries of these vaccines [6-8].

Corona virus (COVID-19) is an infectious disease caused by a virus in the family Coronaries. These viruses cause mild to severe respiratory illnesses ranging from the common cold to severe acute respiratory syndrome (SARS-CoV) and Middle East respiratory syndrome (MERS-CoV) [9, 10] The viral infection was first reported to World Health Organization (WHO) on December 31, 2020, in a group of patients with unknown pneumonia in Huanan, South China Seafood Market Wuhan,

Hubei Province, China [11]. The precise zoonotic (animal) origin of the 2019 nCoV is still uncertain. The virus has been identified in environmental samples from a live animal market in Wuhan, and some human cases have been epidemiologically linked to this market [12, 13] The virus is zoonotic and is believed to have been transmitted from civet cats, bats, and raccoon dogs to humans. Human-to-human transmission has also been documented [11]. The species of COVID-19 isolated in humans was identified as a novel coronavirus and designated as 2019-nCoV [14]. After genomic sequencing, it was genetically related to the coronavirus outbreak responsible for the SARS outbreak of 2003; therefore, the virus was named severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) by the International Committee for Taxonomy of Viruses [10, 15].

Vaccines are a game-changing tool in the fight against the pandemic, preventing people from getting seriously ill or dying from COVID-19 [16] Several safe and effective vaccines are being manufactured globally. As of January 14, 2022, there were 333 vaccine candidates in development, of which 139 had entered the clinical phase. In total, 330 vaccine candidates are in various stages of development, with 102 in clinical research, including 30 in Phase I trials, 30 in Phase I–II trials, 25 in Phase III trials, and 8 in Phase IV development [9, 17, 18]. Prior knowledge of the structure and functions of other coronaviruses (MERS-CoV and SARS-CoV) helped to expedite the process of COVID-19 vaccine production, and the vaccines are widely credited for their role in reducing the spread, severity, and death caused by COVID-19 [19]. The vaccine is meant to be used in addition to other preventive measures that include avoiding overcrowded places, maintaining social distancing, regular handwashing with

soap and water for at least twenty seconds, wearing a mask in public, staying at home, ensuring good ventilation in closed spaces, managing potential exposure durations, practicing good respiratory hygiene, and avoiding the touching of mucosal areas such as the eyes, nose, or mouth with unwashed hands [20]. HCWs are exposed to 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 [21]. This exposes them to the likelihood of getting infected or even transmitting the infection to the patients and other family and community members [22].

COVID-19 has impacted almost every country and territory in the world. Globally, the rate of infection among HCWs rose along with the number of infections among the general population. As of May 15, 2022, over 521 million cases of COVID-19, including 6,266,324 deaths, have been documented by WHO worldwide, with Europe and America being the continents worst hit by the pandemic, recording 218,268,130 and 154,826,856 cases, respectively, with over two (2) million deaths from each of the continents. Africa was least affected, recording only 8,901,606 cases and 172,094 deaths. The United States of America (USA) alone accounted for 16% of all global cases, followed by India, Brazil, France, Germany, and the United Kingdom, which all recorded more than twenty million (20,000,000) cases each. In terms of deaths, the USA had the highest mortality rate of 992,289. Brazil and India also recorded more than half a million deaths each, followed by the Russian Federation, Mexico, and Peru, with deaths ranging from two hundred thousand (200,000) to four hundred thousand (400,000). Nigeria recorded over 250,000 cases and over 3,000 deaths.

Healthcare workers accounted for more than 1.4 million of the COVID-19 infections worldwide, and they also accounted for at least 10% of all fatalities. The African Regional Office of the WHO in Brazzaville stated that approximately 110,072 HCW in Africa were infected with coronavirus, with about 10% of them succumbing to the infection. 570,000 healthcare workers were infected with COVID-19, according to the WHO Pan American Regional Office in Washington, DC, and 2500 of them died as a result. HCW infections in America and Europe were 475,565 and 186,824, respectively, while 2586 and 288 deaths were also reported [23].

The epidemic also revealed the weaknesses in our healthcare systems. The number of coronavirus cases overwhelmed the health systems all around the world, and even the most developed and well-prepared nations struggled. Millions of people, including healthcare workers, did not have access to an uninterrupted supply of materials for infection prevention and control or other vital life-saving equipment like test kits, face masks, and respirators in the most vulnerable nations. The lockdown and long hours at work exposed the HCWs to psychological effects, burnout, and post-traumatic stress disorder (PTSD), extreme fear and uncertainty, negative societal behaviors motivated by fear, and distorted perceptions of risk, including distress reactions, insomnia, rage, and extreme fear of illness even in those not exposed, as well as other health risk behaviors such as increased use of tobacco, alcohol, and other drugs [24]. 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. To stop and recover from the pandemic, the WHO set a global goal in 2021 of immunizing 70% of the population worldwide. Only 52 countries have reached that goal, while 69 more have not yet reached the interim goal of 40% coverage, with 21 of them having not even reached 10% coverage. Significant coverage disparities for the COVID-19 vaccination, especially in nations with low coverage rates, pose a risk to a sustained economic recovery and the achievement of herd immunity. 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. Africa's aim is to vaccinate at least 20% of the population by providing up to 600 million doses by the end of 2021, prioritizing HCW and other vulnerable groups. Vaccination coverage in Africa ranges from 0.13 per 100 population in Burundi to 224 per 100 population in the Seychelles, with a continent average of 38 per 100 population.[25] 50,619,238 doses have been given since the vaccination programme began in Nigeria on March 5th, 2021, with 28,340,766 people receiving at least one dose of the vaccine and 20,986,761 people receiving all two to three doses. The coverage for Nigeria is 25 vaccine recipients for every 100 people who are eligible [26]. Healthcare workers (HCWs) are prone to vaccine hesitancy, which is a global public health issue that could jeopardies immunization goals [6]. HCWs are important vaccine advocates, and their hesitation could result in unvaccinated HCWs working with patients who could endanger them, other HCWs, and the healthcare system [6]. Prior to the COVID-19 pandemic, HCWs had vaccine hesitation that was primarily focused on the influenza vaccine. HCWs' knowledge of and perception of personal danger from illnesses may have an impact on their vaccine reluctance. Studies have also documented the poor knowledge of HCWs about respiratory diseases like tuberculosis [27]. Measles, tetanus, and hepatitis B vaccines, among others, are frequently better absorbed by HCWs than by the public. HCWs may not, however, always consider the hazards to their patients when determining whether to get vaccinated [6]. Infodemics, vaccination efficacy and safety worries, and medical skepticism all contribute to vaccine hesitation [28]. They also must have access to immunizations and treatments. Distrust in the medical community is widespread, ingrained, and probably justified. Skepticism about the intentions of vaccine manufacturers and public health officials was also fueled by inequities in the distribution of vaccines around the world, especially among immigrants concerned about friends and family members in nations with insufficient vaccine supply [28]. Understanding the root causes and effects of vaccine reluctance is essential to finding solutions [29]. The hesitation to get vaccinated may be impacted by things like complacency, convenience, confidence, and shared responsibility. Understanding the causes of vaccine reluctance, eliminating misinformation, and fostering faith in vaccines and medical professionals are all important components of combating vaccine hesitancy [29]. Achieving vaccination goals also depends on ensuring vaccine equity because some black or African American and Hispanic or Latino people are less likely to receive the COVID-19 vaccine due to barriers like vaccine access and medical mistrust. Efforts to maintain sufficient levels of current vaccination must consider the needs of all communities to guarantee fair and just access to COVID-19 vaccination [29, 30].

Several COVID-19 vaccines have been approved for use worldwide. As of May 16, 2022, about 11.8 billion vaccine doses had been delivered. In comparison to the general population, HCWs had a risk of infection that was more than three times higher. When the World Health Assembly's Seventy-third Session declared 2021 to be the International Year of the HCWs in November 2020. It acknowledged worries about the pandemic's wider effects on HCWs as well as their crucial role at the forefront of the response [31]. Soon after, the WHO began a global campaign in support of the International Year [32]. The campaign's goals include an emphasis on preventing harm to HCWs, stressing the importance of HCWs being vaccinated against COVID-19, demanding the measurement of all COVID-19-related infections and deaths among HCWs, and emphasizing 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 fatality rates, particularly among professions, with an emphasis on HCWs. It is critical to guarantee the safety of health-care workers (HCWs) not only to provide ongoing patient care but also to ensure that they do not become sources of spread. This study aims to assess the uptake of the COVID-19 vaccination and its effect on morbidity and mortality among frontline healthcare workers in Kaduna State, Nigeria.

## Methods

**Geographical Location**: Kaduna State is situated in the North-West geopolitical zone of Nigeria. It shares borders with several other Nigerian states and the Federal Capital Territory [31].

**Land Area**: The State covers an area of 46,020 square kilometers, making it the 12th largest State in Nigeria by land area [33].

**Climate and Geography**: Kaduna State features Sudan Savannah vegetation with distinct wet and dry seasons. It experiences average maximum and minimum temperatures of 15.1 and 35.18 degrees Celsius, respectively. The annual rainfall is approximately 1,524 millimeters, with a humidity level of 56.64% [33].

**Population**: As of 2022, Kaduna State had an estimated population of 9,735,051 people, distributed across 255 wards and 23 Local Government Areas (LGAs). The State serves as a major commercial and transportation hub for northern Nigeria [33].

**Healthcare System**: The healthcare system in Kaduna State is pluralistic, involving both public and private sectors, as well as modern and traditional practices. The government is responsible for secondary-level care, while Primary Healthcare (PHC) services are managed by LGAs. There are a total of 1,983 health institutions in the State, primarily owned by the government (85.8%) and private entities (34.2%).

**Sample Size:** The review targeted the total population of HCWs in the State that were tested for COVID-19 at any time within the review period of this study and those HCWs that had received the COVID-19 vaccination.

**Study Context**: This study assessed the uptake of COVID-19 vaccines by HCWs following the vaccine introduction. It is a descriptive, cross-sectional study where data from a secondary source; the Surveillance Outbreak Response Management and Analysis System (SORMAS), from the onset on the pandemic to 29th August 2022 was exported and evaluated to provide a snapshot of the vaccine uptake. The study population were healthcare workers in Kaduna State, Nigeria, excluding pregnant and lactating mothers who, as of the time of the study, were not eligible for the COVID-19 vaccination according to the national guidelines.

**Data Sources and Analysis**: The Nigeria Centre for Disease Control (NCDC) manages disease surveillance and response, while the National Primary Healthcare Development Agency (NPHCDA) manages vaccinations. The NCDC domiciled all electronic data for disease surveillance and response on the SORMAS. The SORMAS contains patient-level data details, from when a patient is suspected to when tested, treatment provided and follow-up, laboratory investigations conducted with results, and contact investigations carried out. This study exported data from SORMAS and reviewed it. The Electronic Management of Immunization Data (EMID) platform had incomplete data due to technical issues so daily call-in data were relied upon. Data analysis was performed using SPSS version 25, and results were presented through tables, graphs, and charts.

## Results

Sociodemographic characteristics of the study participants

**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 |
| **Residential Area** | | |
| Urban | 6673 | 71.3 |
| Rural | 2682 | 28.7 |
| **Mean Age** | **Mean ± Standard Deviation** | - |
| | 38.38 ± 10.50 years | - |

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]. The trend of COVID-19 infection among HCWs in Kaduna State Nigeria.
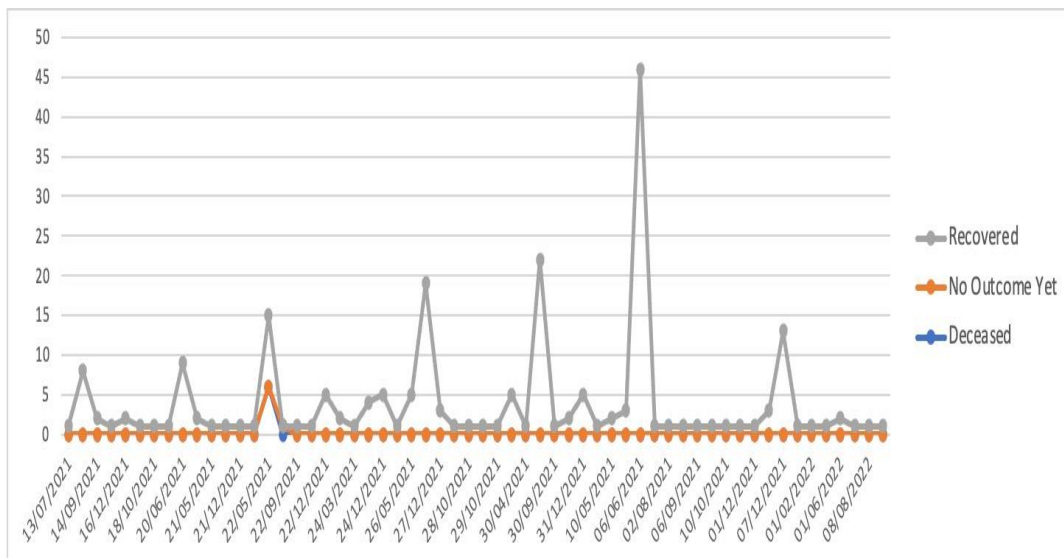


**Figure 1.** The Trend of COVID-19 Infection amongst HCW in KADUNA STATE Nigeria

The figure 1 shows the trend of COVID-19 infection among HCWs in Kaduna State Nigeria. The various spikes represent periods where active screening is conducted targeting HCWs in the various health facilities in the state as part of efforts by the government to interrupt the transmission of the disease among HCWs.

The figure 2 shows the COVID-19 vaccination uptake among healthcare workers in Kaduna state.
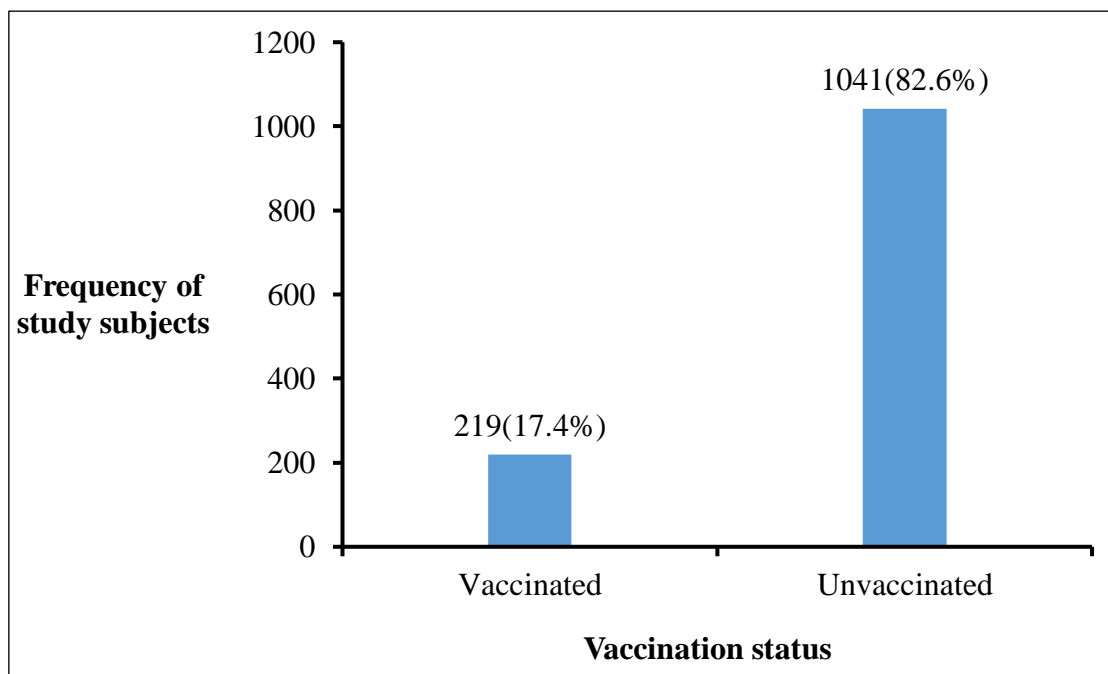


**Figure 2.** Vaccination status of HCWs in Kaduna state from March 2021 to February 2022

The uptake of COVID-19 vaccination among healthcare workers in Kaduna state was 17.4%. Only 219 (17.4%) of the study participants received the COVID-19 vaccination, while majority of them, 1041 (82.6%), were not vaccinated for COVID-19 [Figure 1].

Effect of COVID-19 vaccination on infection and mortality among HCWs in Kaduna state

**Table 2.** Effect of COVID-19 Vaccination on Development of COVID-19 Infection among HCWs in Kaduna State

| Variables | COVID-19 case classification | | Test statistic | OR | 95% CI | |
|---|---|---|---|---|---|---|
| | Cases (n = 74) | Non cases (n = 1186) | | | Lower | Upper |
| | n (%) | n (%) | p-value | | | |
| COVID-19 Vaccination status | | | | | | |
| Vaccinated | 20 (26.0) | 199 (16.8) | $\chi^2 = 4.265$ | 1.74 | 1.023 | 2.962 |
| Unvaccinated | 57 (74.0) | 987 (83.2) | **p = 0.039** | | | |
| $\chi^2$ = Pearson's Chi square test, **OR** = Odds Ratio, **CI** = Confidence interval | | | | | | |

COVID-19 infection seen to have a statistically significant association with COVID-19 vaccination ($\chi^2$ = 4.265, p = 0.039). About 74% of participants with COVID-19 infection were unvaccinated. However, among uninfected population, a larger proportion of them (83.2%) were also not vaccinated for COVID-19 (OR = 1.74, 95% CI = 1.023-2.962).

**Table 3.** Effect of COVID-19 Vaccination on COVID-19 Related Mortality among HCWs in Kaduna State

| Variables | Outcome of cases | | Test statistic | OR | 95% CI | |
|---|---|---|---|---|---|---|
| | Recovered (n = 1258) | Died (n = 5) | | | Lower | Upper |
| | n (%) | n (%) | p-value | | | |
| **COVID-19 Vaccination status** | | | | | | |
| Vaccinated | 217 (17.2) | 2 (40.0) | Fisher's Exact | 0.313 | 0.052 | 1.882 |
| Unvaccinated | 1041 (82.8) | 3 (60.0) | p = 0.209 | | | |
| $\chi^2$ = test, **OR** = Odds Ratio, **CI** = Confidence interval | | | | | | |

A large proportion (82.8%) of HCWs who recovered from the illness were unvaccinated and although participants that were not vaccinated had a higher proportion of mortality (60%) than those that were vaccinated (40%), the difference was not statistically significant (Fisher's Exact test, p = 0.209).

## Discussion

The health and safety of the health workforce are critical for an effective COVID-19 pandemic response. This study assessed the uptake of the COVID-19 vaccination and its effect on the development of COVID-19 infection and mortality among frontline healthcare workers in Kaduna State, north-western Nigeria. This study found a considerably low COVID-19 vaccine uptake among frontline HCWs in Kaduna State, like the findings of a previous study on vaccine hesitancy amongst HCWs in Kaduna State by A.K. Koledade et al., 2022, and in Nigeria by Agha et al., 2021. The low COVID-19 vaccine uptake observed in this study may be attributable to variations in the demographic characteristics and educational backgrounds of the participants. Only a few of the respondents were males, aged $\geq 40$ years, and with a postgraduate qualification, which, according to Agha et al., 2021, and Nomhwange et al., 2022, are the characteristics reported to be associated with a higher likelihood of accepting the vaccine. Low uptake of COVID-19 vaccines among frontline HCWs may negatively impact the pandemic response since the unprotected frontline HCWs will pose a risk to family members, colleagues, and clients, who will most likely also reject the vaccines. A major limitation, however, was the incompleteness of data uploads on the SORMAS and EMID platforms.

In a study conducted by Koladade et al. in Kaduna state, a total of 351 respondents, predominantly falling within the age groups of 20-39 (53.3%) and mostly male (55.3%), were examined to understand the reasons behind low COVID-19 vaccine uptake among healthcare workers (HCWs). Only 47.9% of the respondents expressed a willingness to accept the COVID-19 vaccine. The primary reasons for vaccine hesitancy among HCWs were as follows; Fear of side effects: A significant proportion (50.0%) cited concerns about potential adverse effects of the vaccine. Lack of trust in the source: Nearly half (47.4%) expressed a lack of trust in the source of the vaccine. Concerns about mRNA components: A substantial number (39.5%) were apprehensive about the mRNA components of the vaccine. The study also identified two factors associated with vaccine hesitancy: Gender: The odds of vaccine hesitancy were lower among males, with an adjusted odds ratio (AOR) of 0.43 (confidence interval [CI] 0.25-0.72), indicating that females were more likely to be hesitant. Cadre: HCWs in certain job cadres were less likely to express vaccine hesitancy, with an AOR of 0.37 (CI 0.14-0.94), implying that individuals in specific roles were less hesitant compared to others. These findings shed light on the challenges faced in promoting COVID-19 vaccination among healthcare workers in Kaduna state. Addressing vaccine hesitancy, particularly among females and specific job cadres, will be crucial for achieving higher

vaccine acceptance rates and ensuring the safety of both HCWs and the broader community. Strategies to build trust in the vaccine source, provide education about vaccine safety, and address concerns about side effects and mRNA components should be considered in public health interventions.

Another important finding of this study is the low prevalence of COVID-19 infection among HCWs with or without vaccination. The vaccinated group had a seemingly better outcome of lower mortality but was not statistically significant ($\chi^2 = 0.008$, p = 0.929). This might be attributed to a very small sample of only five mortalities. Nonetheless, the finding was comparable to previous studies in the US. Qatar [34] and Nigeria [35].

Furthermore, similar to other studies [36], 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. Previous studies have always reported a higher risk of COVID-19 infection among males among the general population [37-39].

Evidence suggests that individuals of any age who have underlying medical issues are more likely to contract COVID-19, become unwell, need hospitalization, and die. As a person's number of underlying medical disorders rises, so does their risk of developing severe COVID-19. Because of this, vaccination is highly recommended for them. For those with co-morbidities, COVID-19 vaccinations have been demonstrated to be both safe and effective. As a result, having one or more underlying medical issues should be a further justification for choosing vaccination over delaying it [40-42].

## Conclusion

This study looked at the uptake of the COVID-19 vaccine and the effect of the vaccine on infection and mortality among frontline HCWs in Kaduna State, Nigeria. The study showed low vaccination uptake among HCWs, which could negatively impact the overall pandemic response. The study also shows that while vaccination might have some positive effects on disease outcomes, it does not seem to have any effect on the risk of getting infected.

Further studies would be required to conduct qualitative research to complement this quantitative data to explore healthcare workers' attitudes, beliefs, experiences, and determinants regarding COVID-19 vaccination and hesitancy. This can provide valuable insights into vaccine acceptance and hesitancy. Also, to replicate this work among the general population and with a larger sample size, to assess the effect of vaccination on the disease outcome.

Interventions to increase vaccine uptake among healthcare workers and intensified public education on COVID-19 vaccination uptake would be required.

## Conflict of Interest

The authors declare no conflict of interest in this work.

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