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Post-pandemic SARS-CoV-2 Antigen Detection and Clinical Patterns among Patients in a Tertiary Hospital in North Central Nigeria

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ABSTRACT

Background: The emergence of the Coronavirus Disease 2019 (COVID-19) pandemic has posed a major public health challenge globally. Early diagnosis of infectious diseases such as COVID-19 is essential in limiting the spread and associated complications. Also, understanding the local disease dynamics, including its risk factors and clinical patterns, is critical for guiding preventive and control measures.

Objective: This study aimed to detect SARS-CoV-2 antigen in nasopharyngeal swabs from patients and to determine the associated risk factors and clinical patterns of infection among patients attending the Federal Medical Centre (FMC), Keffi, Nasarawa State, Nigeria.

Methods: A cross-sectional study was conducted between March and July 2023, recruiting 400 patients who presented with symptoms suggestive of COVID-19. Nasopharyngeal swab samples were collected and analyzed for SARS-CoV-2 antigen using the STANDARD Q COVID-19 Ag Test (SD BIOSENSOR, Inc, Korea) rapid test kit following the manufacturer's instructions. Socio-demographic and clinical data, including age, sex, and symptoms, were collected using a questionnaire after consent was obtained. Results were analyzed using SPSS Version 25.0 (IBM Corp., USA). Descriptive statistics, Chi-square test and Fisher's exact test were used to summarise and determine the association between categorical variables with a significance level of $P < 0.05$.

Results: Out of the 400 patients tested, 4 (1.0%) (95% CL: 0.3% - 1.97%) were positive. There was no statistically significant difference with gender ($P > 0.05$). However, a borderline significant association with infection status ($P = 0.05$) was observed for age, with higher prevalence in older age groups, suggesting vulnerability. Cough ($P < 0.05$), loss of smell ($P < 0.05$), and nasal congestion ($P < 0.05$) were significant. No significant association was observed for fever, loss of taste, or shortness of breath, occupation and hand hygiene ($P > 0.05$). Additionally, SARS-CoV-2 antigen positivity was significantly associated with lack of vaccination and the use of a facemask ($P < 0.05$).

Conclusion: The outcome of this study suggests a reduction in the number of COVID-19 infection cases among patients in the study area. Age was identified

as a significant risk factor. Though the RDT method used and sample size may limit categorical conclusions, the RDT facilitates rapid detection, which is cost-effective and timely. It serves as an alternative for mass testing and public health surveillance.

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INTRODUCTION

Coronavirus disease 2019 (COVID-19) is an infectious respiratory illness caused by the novel coronavirus Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) (World Health Organization [WHO], 2020). It was first identified in December 2019 in Wuhan, Hubei province, China, and rapidly escalated into a global pandemic (Chauhan, 2020). On March 11, 2020, the World Health Organization officially declared COVID-19 a pandemic due to its widespread transmission and public health impact (WHO, 2020). Globally, the COVID-19 pandemic has resulted in over 770 million confirmed cases and more than 6.9 million deaths as of August 2025 (WHO, 2025). As of mid-2025, Africa accounted for approximately 2% of global COVID-19 cases and 4% of deaths, though experts caution that under-testing and under-reporting may have masked the full extent of transmission (Africa CDC, 2024). As of 2023, Nigeria has reported over 440,139 confirmed cases and 3,156 deaths, though actual figures are likely higher due to limited testing and reporting infrastructure (Diamreyan *et al*., 2024).

SARS-CoV-2 primarily spreads through respiratory droplets produced when an infected person talks, coughs, sneezes, or breathes (Rahman *et al*., 2021). These droplets can infect individuals in proximity, typically within 1–2 meters (Karia *et al*., 2020). Airborne transmission is also possible, particularly in enclosed, poorly ventilated spaces where aerosols containing the virus can remain suspended for extended periods (CDC, 2021). Additionally, contact transmission via contaminated surfaces (fomites) is considered less common but possible when individuals touch contaminated surfaces and then touch their nose, mouth, or eyes (Morawska *et al*., 2020).

SARS-CoV-2 has continued to evolve, resulting in the emergence of multiple Variants of Concern (VOCs). These variants differ in their transmissibility, disease severity, and potential to evade immunity (Zabidi *et al*., 2023). Notable variants include: Alpha (B.1.1.7) detected in the UK; Beta (B.1.351) South Africa; Gamma (P.1) Brazil; Delta (B.1.617.2) India; Omicron (B.1.1.529) reported in late 2021, characterized by a high number of mutations and increased ability to evade prior immunity and vaccine protection (WHO, 2021; Bostanghadiri *et al*., 2023; Sarkar & Madabhavi, 2024).

The clinical presentation of COVID-19 ranges from asymptomatic or mild flu-like symptoms to severe pneumonia, acute respiratory distress syndrome (ARDS), multi-organ failure, and death (Huang *et al*., 2020). Generally, several factors are responsible for the severity and mortality of COVID-19 disease. From different studies, it has been found that patients with comorbidities had a higher chance of experiencing disease severity and death (Laguna-Goya *et al*., 2020; Zhang *et al*, 2020).

Polymerase chain reaction (PCR) and other molecular detection methods are not accessible or available for routine use; these methods may not be effective as a routine monitoring tool aimed at containing the spread of infectious viral diseases (Mina *et al*., 2020).

Rapid Antigen diagnostic test kits (RDTs), on the other hand, meet all these criteria and represent an alternative diagnostic technique, though they are less sensitive compared to the molecular methods (Dinnes, 2021). This is very important, especially in low-resource settings such as in Nigeria (Omonkhua *et al*., 2024).

Most studies in Nigeria focus on the performance of COVID-19 RDTs and the molecular detection using PCR, leading to a paucity of data regarding the prevalence of COVID-19 using the RDT method. Amid the declaration by the World Health Organization in March 2025 that the disease is no longer a pandemic status, the current study aimed to detect the presence of SARS-CoV-2 antigen among patients attending various clinics in the Federal Medical Centre, Keffi, Nasarawa State, Nigeria, identify associated risk factors, clinical patterns and evaluate the role of rapid diagnostic testing in early detection of this highly infectious disease.

MATERIALS AND METHODS

Study Location

The Federal Medical Centre Keffi is a tertiary referral health facility that provides specialized healthcare services to patients within Nasarawa State and neighboring states (Oluwale, 2025). It is situated in Keffi town, approximately 69.5km from Abuja, the Federal Capital Territory of Nigeria, and 124km from Lafia, the capital of Nasarawa State. Keffi is located at a latitude of 8° 49' 24" N of the equator and longitude 7° 52' 35" E and is situated at an altitude of 850m above sea level (Akwa *et al*., 2007).

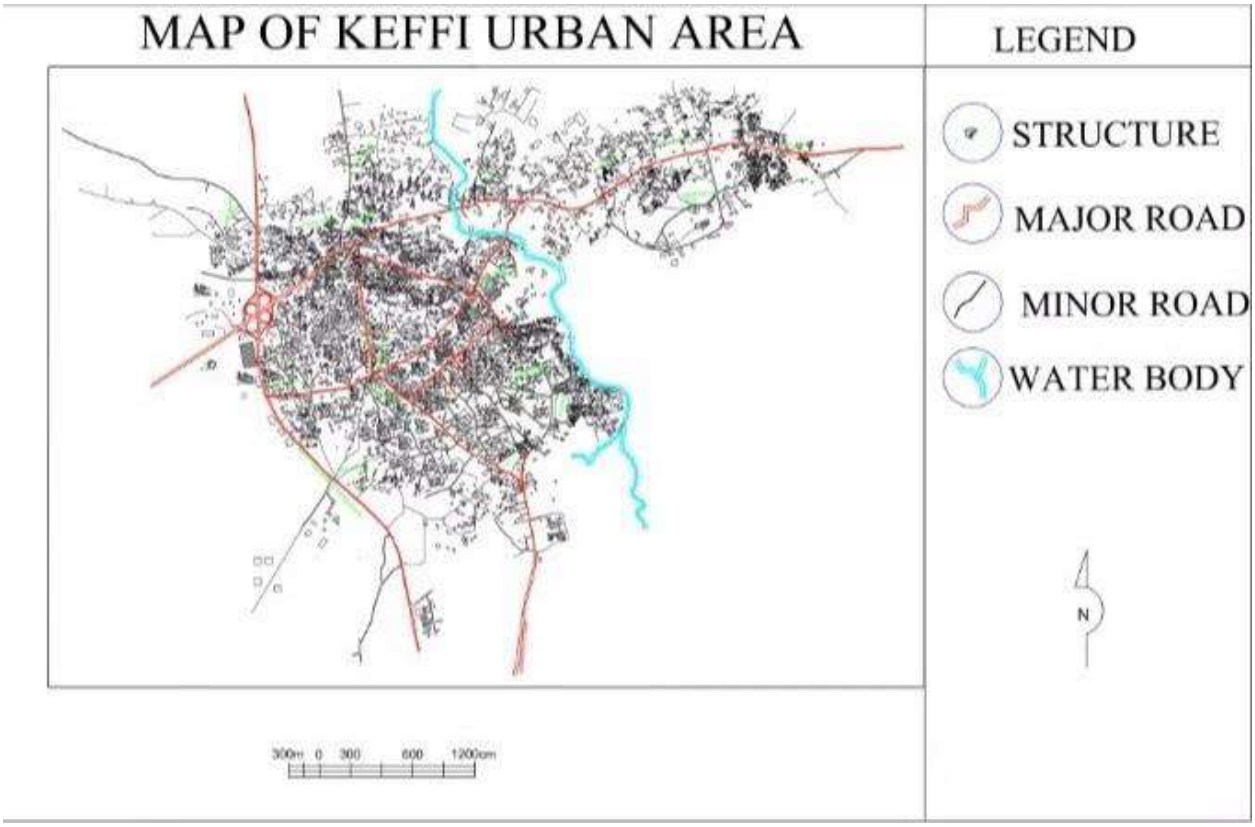

Figure 1. Map of Keffi Metropolis (Augustine (n.d.)

Study Design and Participants

The study adopted a cross-sectional design, recruiting 400 patients attending clinics at the Federal Medical Centre Keffi, who presented with COVID-19 symptoms as described by the World Health Organisation. Following consent, nasopharyngeal swabs were collected. The study was undertaken after obtaining approval from the Institutional Ethics Committee. Patient demographic data, like age, sex, and history of illness, were obtained using a questionnaire.

Inclusion and Exclusion Criteria

The study included all symptomatic individuals who elected to undergo COVID-19 testing. Asymptomatic patients and those who didn't give consent were excluded from the study.

Sample Size Determination

A SARS-CoV-2 antigen rapid diagnostic test positivity rate of 15% based on previous findings by Kolude *et al*. (2022), at 95% confidence level, and 5% precision was used to estimate a minimum of 216 samples with the aid of the formula described by Charan & Biswas (2013) as follows;

$N = Z^2pq/ d^2$

Where, N = Sample size Z = Statistics for a level of 95% confidence interval = 1.96

P = prevalence rate of rotavirus infection from previous studies = 15% (Kolude *et al*., 2022).

d = level of significance (allowable error) = 5% or 0.05 q = 1-p

Thus, $N= (1.96)^2 \times 0.15 \times (1-0.15)$

$(0.05)^2$

$= 3.8416 \times 0.15 \times 0.85/0.0025$

$= 195.9 \approx 196$

N = 196

However, the actual sample size is equal to the calculated sample size + 10% Attrition rate. But 10% Attrition rate = 19.6

Therefore, actual sample size = 196 + 19.6 ≈ 216

N = 216

Although the minimum sample size calculated was 216, 400 participants were recruited to improve the accuracy of the results.

Ethical Considerations

Ethical approval for this research was obtained from the Health Research Ethics Committee, Federal Medical Centre Keffi, with certificate number FMC/KF/HREC/02631/24.

Specimen Collection and Transport

Specimens were collected following the test kit manufacturer's instructions by gently inserting the sterile polyester flocked swabs into the participant's nostril, parallel to the palate, for a few seconds, then rotating 3-4 times. The swab was withdrawn carefully and placed in the extraction buffer. It was removed while squeezing the sides of the tube to extract the liquid. Then the tube was capped. The samples were appropriately labeled, triple-packed, and then delivered to the lab while maintaining a good cold chain.

Testing for SARS-CoV-2 Antigen

The test kit was brought to room temperature, and testing was commenced immediately after opening the test device pouch. The test device was removed and placed on a flat surface. Three drops of the extracted specimen were applied to the specimen well of the test device. The test results were read within 30 minutes and interpreted according to the manufacturer's instructions.

Statistical Analysis

The results were analysed using SPSS Version 25.0 (IBM Corp., USA). Descriptive statistics, Chi-square test and Fisher's exact test were used to determine the association between categorical variables with a significance level of $P < 0.05$.

RESULTS

Basic Demographics of Participants

Of the 400 participants, 51% were aged 21-41 years, and 5.8% were aged 61-80. There were more females (58.8%) than males (28.8%). The majority were students 26.5% while 5% were self-employed, as summarised in Figure 2.

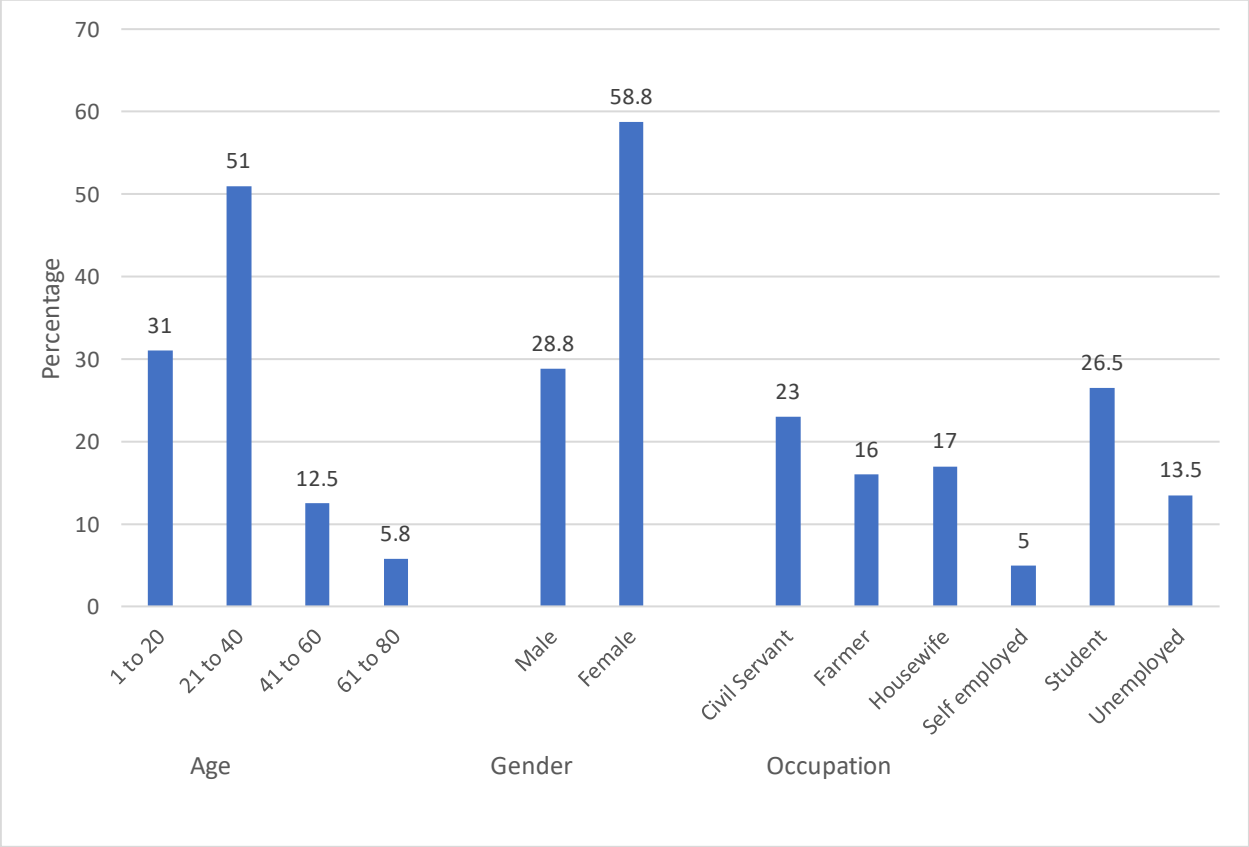

Figure 2. Basic demographics of the participants

Clinical Symptoms and Vaccination History of the Participants

Coughing was the predominant symptom (40%) observed in this study, followed by nasal congestion (26.5%), while the least was loss of smell (5%). Furthermore, 87% reported that they had received the complete dose of the SARS-COV-2 vaccine (Figure 3).

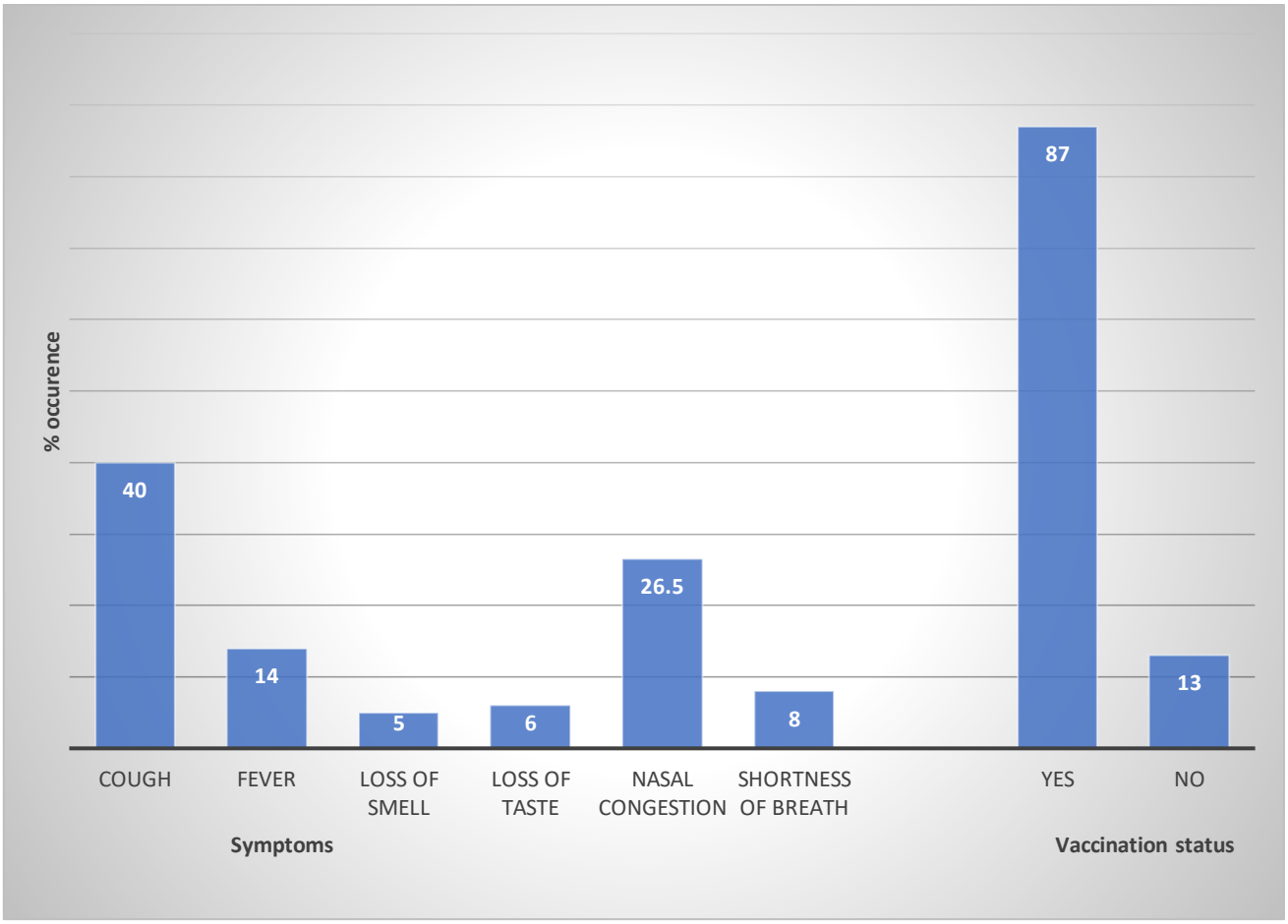

Figure 3. Clinical Symptoms and Vaccination History of the Participants

Multivariate Analysis of SARS-CoV-2 Positivity by Demographic and Clinical Characteristics

Out of the 400 participants included in the current study, 4 (1.0%) tested positive. Positivity was higher among males (1.74%) compared to females (0.44%), although this difference was not statistically significant ($P > 0.05$).

Age-specific analysis showed that positivity increased with age; the highest proportion was recorded in the 61–80 age group (8.33%), although the greatest number of positive cases was recorded in the 41–60 age group (2/82; 2.44%). No cases were observed among participants aged 1–20 years. This association was statistically significant ($P < 0.05$).

Symptomatology was significantly associated with test positivity. All positive cases presented with cough (2.48%) vs. (0%) in those without cough ($P < 0.05$), loss of smell (21.05%) vs. (0%) ($P < 0.05$), and nasal congestion (3.77%) vs. (0%) ($P < 0.05$). In contrast, fever, loss of taste, and shortness of breath were not significantly associated with positivity ($P > 0.05$), respectively.

There was a strong association between vaccination status and infection. None of the vaccinated participants tested positive (0.0%), whereas all positive cases occurred among unvaccinated individuals (7.69%), a difference that was highly statistically significant ($P < 0.05$). All of these are summarised in Table 1.

Table 1. Multivariate Analysis of SARS-CoV-2 Positivity by Demographic and Clinical Characteristics

Variable	Category	Total (n)	Positive (n)	Negative (n)	% Positive	p-value
Gender	Male	172	3	169	1.74	
	Female	228	1	227	0.44	0.31
Age	1–20	65	0	65	0.00	
	21–40	241	1	240	0.41	
	41–60	82	2	80	2.44	
	61–80	12	1	11	8.33	0.05
Symptoms	Cough	161	4	157	2.48	0.026
	Fever	57	0	57	0.00	0.58
	Loss of smell	19	4	15	21.05	<0.001
	Loss of taste	25	0	25	0.00	0.49

	Nasal congestion	106	4	102	3.77	0.003
	Shortness of breath	32	0	32	0.00	0.42
Vaccination	Yes	348	0	348	0.00	
	No	52	4	48	7.69	<0.001

The Association Between Risk Factors and COVID-19 Infection

Selected risk factors and COVID-19 infection among the 400 participants were assessed for associations. Age showed a statistically significant association with infection ($P < 0.05$), with the highest positivity observed among individuals aged 41–60 years (4.0%) and 61–80 years (4.3%), while no cases were recorded among those aged 1–20 years.

Gender was not significantly associated with infection ($P > 0.05$), although males had a higher proportion of positive cases (2.6%) compared to females (0.4%). Similarly, no significant association was observed between occupation and COVID-19 infection ($P > 0.05$), despite civil servants recording the highest number of cases.

The use of facemasks was strongly associated with COVID-19 infection ($P < 0.05$), as participants who did not use facemasks had a markedly higher positivity rate (8.3%) compared with (0.3%) for non-use. In contrast, there was no significant association regarding handwashing practices ($P > 0.05$).

Table 2. Association Between Risk Factors and COVID-19 Infection

Variable	Category	Total (n)	Positive (n)	Negative (n)	% Positive	p-value
Age (years)	1–20	123	0	123	0.0	0.031
	21–40	204	1	203	0.5	
	41–60	50	2	48	4.0	
	61–80	23	1	22	4.3	
Gender	Male	115	3	112	2.6	0.053
	Female	235	1	234	0.4	
Occupation	Civil servant	93	3	90	3.2	0.218
	Farmer	62	0	62	0.0	
	Housewife	66	0	66	0.0	
	Self-employed	19	0	19	0.0	
	Student	106	1	105	0.9	
	Unemployed	54	0	54	0.0	
Facemask use	Yes	364	1	363	0.3	<0.001
	No	36	3	33	8.3	
Hand washing	Yes	287	2	285	0.7	0.335
	No	113	2	111	1.8	

DISCUSSION

This study was carried out to detect SARS-CoV-2 antigen and associated risk factors of the infection among patients attending the Federal Medical Centre (FMC), Keffi, Nasarawa State, Nigeria. Of the 400 nasopharyngeal swab samples collected, only 4 (1%) were found to be positive. This could indicate a relatively low burden of COVID-19 infection among individuals presenting with COVID-19-like symptoms at the facility during the study period. Our findings are comparable to reports from other tertiary health institutions in Nigeria, such as a study by Awopolagha *et al*. (2024) assessing the effectiveness and precision of four rapid diagnostic kits for detecting SARS-CoV-2 in Rivers State, Nigeria, where 3% of the population were positive. In a similar study carried out in the Republic of Congo, Demboux Lyelet *et al*. (2025) reported a slightly higher prevalence of 5%, though their study focused on qR–PCR for detection. Additionally, Meltzer *et al*. (2023) reported a prevalence of 6.5% in Israel, while Turcato *et al*. (2021) in Italy reported a prevalence of 9.3%. Conversely, a much higher prevalence of 26.6% was reported by Filgueiras *et al*. (2022) in Brazil. The relatively low prevalence in our study is expected, given that at the time of study, COVID-19 infection was no longer an emergency, as mass vaccinations have improved disease outcomes (Sarker *et al*., 2023).

In the current study, there were more female participants than males. However, there was a higher infection rate among males 1.74% than females 0.44 %, though not statistically significant ($P > 0.05$). Similarly, Ammar *et al*. (2024) observed that more females (76.12%) participated in their study compared to males (23.85%). This contrasts with a report by Awopolagha *et al*. (2024) that documented higher infection rates among females, despite males being 8.9 times greater than females.

The age distribution of cases showed that the 41–60-year age group was the most affected (2.44%). This is consistent with reports from Nigeria (Awopolagha *et al*., 2024) indicating that young and middle-aged adults form the majority of infections. This age

group is typically the most socially and economically active, with higher mobility and contact rates, which facilitate viral transmission (Uchenna *et al*., 2024). Although older adults are at higher risk of severe disease, the relatively lower infection rate among them in this study may reflect reduced healthcare attendance and social interaction. Similar observation has been reported previously by Obi *et al*. (2021) and Yazdi-Feyzabadi *et al*. (2025). Occupation was not found to be significantly associated with COVID-19 infection, although civil servants recorded the highest number of positive cases (3.2%). This could be attributed to workplace exposure commonly experienced among civil servants. Similar findings have been reported, where occupational categories were not consistently associated with SARS-CoV-2 positivity (Utulu *et al*., 2022; Beale *et al*., 2023).

In contrast, the use of facemasks showed a strong statistically significant association with COVID-19 infection in this study ($P < 0.05$). This finding supports the established role of facemasks as an effective non-pharmaceutical intervention for reducing respiratory virus transmission. Similar observations were reported in southeastern Nigeria, where facemask usage was significantly associated with reduced transmission risk and improved community protection against COVID-19 (Chukwuocha *et al*., 2022; Utulu *et al*., 2022). Furthermore, studies among healthcare workers in Nigeria demonstrated that proper facemask utilization and adherence to infection prevention measures contributed to lower transmission risk within healthcare and community settings (Ogunsola *et al*., 2023; Orji *et al*., 2023). Comparable findings have also been documented across Africa (Aloui-Zarrouk *et al*., 2020; Arikpo *et al*., 2025). Although handwashing remains an important preventive measure against infectious diseases, no statistically significant association was observed between handwashing practices and COVID-19 infection in the present study. This finding may reflect inconsistent compliance, improper hand hygiene techniques, recall bias among respondents, or the dominant role of airborne transmission in SARS-CoV-2 spread. Similar findings have been reported in several studies within and outside Nigeria, where good knowledge of hand hygiene did not necessarily translate into effective practice or measurable reduction in infection rates (Fisher *et al*., 2020; Perra, 2021; Enabulele & Mobolaji, 2022; Orji *et al*., 2023).

This suggests that contextual factors such as occupational exposure, caregiving roles, and healthcare-seeking behaviors may influence the observed patterns. This finding emphasizes the need for gender-sensitive public health interventions and awareness campaigns in the study area.

Among presenting symptoms, cough, loss of smell, and nasal congestion were significantly associated with SARS-CoV-2 positivity, aligning with the classical presentation of the disease. Similar significant associations have been reported by Elimian *et al*. (2021) and Omonkhua *et al*. (2024) in Nigeria. Additionally, Chen *et al*. (2023) in the United States and Kiani *et al*. (2024) in the Netherlands reported similar symptoms. Smith *et al*. (2020), however, focused on loss of smell and the complete loss of taste as the chief symptoms among COVID-19-positive military men. Interestingly, the presence of other mild or nonspecific symptoms in both positive and negative individuals highlights the challenge of relying solely on symptom-based screening for case detection. These findings reinforce the importance of laboratory confirmation in clinical diagnosis and surveillance.

Overall, the findings of this study reinforce the importance of adherence to facemask use as a critical public health intervention against COVID-19 transmission.

LIMITATION AND STRENGTHS

The duration of this study (3 months) is too short to make definitive conclusions. Thus, longer studies are needed to provide better epidemiological data. Also, vaccination cards were not sighted; we relied on patients' responses regarding their COVID-19 vaccination status. The study population consisted only of symptomatic patients attending FMC Keffi, limiting the generalizability of the results to the wider community.

However, this study provides important data that could inform the design of early diagnosis protocols and patient management.

CONCLUSION AND RECOMMENDATIONS

The study demonstrated a 1% prevalence of COVID-19 infection among patients attending FMC Keffi clinics, with males, the 41–60 years age group, not being vaccinated against the virus, and the presence of cough being identified as a significant risk factor. Though the RDT method used and sample size may limit categorical conclusions, the RDT facilitates rapid detection, which is cost-effective and timely. It serves as an alternative for mass testing and public health surveillance. To mitigate infection risk, the Federal Medical Centre, Keffi, and similar institutions should continue enforcing infection-prevention protocols, encourage routine testing for symptomatic patients, and promote vaccination uptake. Public health authorities should also design targeted awareness programmes focusing on vulnerable populations. Further studies are recommended to explore the roles of comorbidities, vaccination, and behavioural factors in SARS-CoV-2 transmission dynamics within the study area.

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