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COVID-19 vaccination status and associated factors among patients presenting with COVID-19-like symptoms in Uganda

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A B S T R A C T

Introduction: The emergence of new SARS-CoV-2 variants threatens the effectiveness of global vaccination campaigns. This study examines the vaccination status and associated factors among patients presenting with COVID-19-like symptoms at 19 healthcare facilities in Uganda.

Materials and methods: A cross-sectional analysis was conducted using data collected at health facilities to evaluate the effectiveness of COVID-19 vaccines in Uganda from March 2023 to March 2024. Participants were individuals aged 12 years and older with COVID-19-like symptoms who underwent a SARS-CoV-2 qPCR test within 10 days of symptom onset. The study involved obtaining informed consent, collecting medical and vaccination histories (confirmed using vaccination cards and Ministry of Health COVID-19 database), performing physical examinations, administering a questionnaire, and taking oral/nasopharyngeal swabs for SARS-CoV-2 qPCR testing. Vaccination coverage was defined as receiving at least one vaccine dose. Logistic regression was used to identify factors associated with vaccination status.

Results: Among 1398 participants enrolled (55.4 % female), the median age was 30.0 years (IQR: 24.0–41.0). Vaccination coverage, was 66.6 %. Residing in Wakiso district compared to the Capital, Kampala was associated with a higher likelihood of vaccination (adjusted odds ratio [aOR] = 1.4, 95 % CI: 1.0–1.8, $p = 0.021$). Frontline and healthcare workers were more likely to be vaccinated (aOR = 5.0, 95 % CI: 3.6–7.3, $p < 0.001$), as were individuals with a previous COVID-19 diagnosis (aOR = 2.4, 95 % CI: 1.6–3.9, $p < 0.001$).

Conclusions: Our results underscore the need for targeted public health messaging and support to promote vaccination, especially among non-healthcare workers. Addressing these gaps is crucial for maintaining high vaccination coverage and mitigating the impact of new SARS-CoV-2 variants on the population.

1. Introduction

Coronavirus disease 2019 (COVID-19), caused by the novel single-stranded enveloped RNA virus known as SARS-CoV-2, first emerged in late December 2019 in Wuhan province, China, eventually evolving into a global pandemic by March 11, 2020 [1,2]. By March 2024, global confirmed COVID-19 cases had exceeded 774.9 million, resulting in 7.04 million deaths. Within the African region, infection rates surged, reaching 9.58 million confirmed cases and 175,505 deaths by the same date. In Uganda, 172,149 cumulative cases of COVID-19 were reported, resulting in 3632 deaths [3].

In response to the pandemic, vaccination campaigns were launched worldwide to curb transmission, reduce severe illness and fatalities, and achieve herd immunity [4]. Globally, 13.59 billion doses have been administered, with 67 % of the total population completing the initial primary series and only 32 % receiving a booster dose. In Uganda, vaccination efforts saw a total of 26.41 million doses administered but uptake remains lower than anticipated [5], with only 13.1 million (29

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%) having received a complete dose and 765,000 (2 %) having received a booster dose [3]. Despite willingness to be vaccinated, factors such as limited vaccine supplies, long queues at vaccination centres, and myths and misconceptions have been associated with low uptake [6,7]. These challenges may have hindered the achievement of herd immunity and led to breakthrough infections.

Identifying factors associated with vaccination uptake is essential for addressing disparities in vaccine coverage and promoting vaccine acceptance across diverse populations. This analysis aimed to determine factors associated with COVID-19 vaccination status among individuals presenting with COVID-19-like symptoms at health facilities in Uganda. The findings will inform targeted public health interventions and vaccination efforts against COVID-19 and potential other vaccine interventions.

2. Materials and methods

2.1. Study design

This cross-sectional analysis used data collected in a WHO COVID-19 vaccine effectiveness study (main study) from March 2023 to March 2024 in Uganda. The main study was a test-negative case-control (TNCC) study.

2.2. Study population

Patients ≥12 years old who presented with COVID-19-like symptoms, provided informed consent (or assent if under 18 with parent/guardian consent) and had undergone a COVID-19 PCR test within 10 days of symptom onset.

2.3. Study sites

Patients were recruited from 19 hospitals and health centres across 3 locations: Greater Masaka (6 centres) about 10 km Southwest of Kampala the capital of Uganda, Kampala (5 centres, a radius of about 5 km from the city centre) and Wakiso (8 centres, a radius of 20-40 km from the city centre) districts.

2.4. Study procedures

A study nurse approached patients with COVID-19 like symptoms, provided information about the study, answered their questions, and obtained informed consent or assent. The nurse took a brief medical history, measured vital signs (heart rate, respiratory rate, temperature, oxygen saturation), assessed and confirmed eligibility, collected a nasal/oropharyngeal swab, and administered a questionnaire. The questionnaire collected information on social demographics (age, sex, employment, area of residence, smoking status, HIV status), pre-existing chronic health conditions, severity of current illness (mild: no limitation to normal activities; moderate-severe: limitation to normal activities) previous COVID-19 diagnosis, and COVID-19 vaccination status. Vaccination status was confirmed via the Ministry of Health's online portal or a vaccination card.

2.5. Laboratory procedures

Nasal and or oropharyngeal swabs were placed in a viral transport medium and transported to the MRC/UVRI and LSHTM Uganda Research Unit laboratory in Entebbe for SARS-CoV-2 quantitative polymerase chain reaction (qPCR). The qPCR was performed using QuantStudio™ 7 Pro Real-Time PCR System following the Berlin protocol.

2.6. Measurement of outcomes

The main study outcome was COVID-19 vaccination status. Vaccination status was classified into five groups: i) Unvaccinated – never received a COVID-19 vaccine; ii) Partial-first-dose – enrolled 0–13 days after receiving the first dose; iii) Full first dose – enrolled 14 days after the first dose, up to 13 days after the second dose, if second dose was received; iv) Fully vaccinated – enrolled 14 or more days after second dose (or 14 days after a single dose of the Johnson & Johnson vaccine); v) Received a booster dose. Vaccination status in vaccinated participants was confirmed by reviewing the vaccination card, hospital records, and/or the Ministry of Health COVID-19 vaccination database [8].

2.7. Data management and statistical analysis

Data were entered directly into a Research Electronic Data Capture (REDCap) (Westlake, TX, USA) software database via electronic questionnaires using encrypted tablet computers. In instances where direct data entry was not feasible because of intermittent internet connectivity, paper questionnaires were used, and data entry performed on the same day. For this analysis, demographic data, past medical history, past COVID-19 infection, symptoms and severity of the current infection, COVID-19 PCR results, vaccination status, vaccine types and date of vaccination were extracted from REDCap. Statistical analyses were done using R Version 4.2.2. Categorical data were summarised using frequencies and percentages, while continuous data were summarised using medians and interquartile ranges. To assess the relationship between vaccination status and other covariates, a chi-squared test was used. Logistic regression models were used to investigate the odds of receiving ≥1 COVID-19 vaccine doses. The adjusted odds ratio were obtained using a logistic regression model while adjusting for age and sex a priori and other covariates that were significant at 0.2 significance level.

3. Results

3.1. Baseline socio- demographic characteristics and vaccination status

A total of 1483 (55.3 % female) patients with COVID-19 symptoms were screened. Of those screened, 1398 (94.3 %) were enrolled. Reasons for exclusion included having experienced symptoms for more than 10 days (83, 5.6 %) and being <12 years of age (2, 0.1 %). The most frequently reported symptoms were, cough (92.1 %), headache (78.8 %), fever (71.1 %), sore throat (67.4 %), coryza (66.7 %), malaise (62.2 %), and fatigue (61.7 %).

Among those enrolled, the median age was 30.0 years (interquartile range = 24.0–41.0), 775 (55.4 %) were female, 1185 (84.8 %) were < 50 years of age. 196 (14.0 %) reported having a chronic disease (cardiovascular disease, hypertension, diabetes, asthma, tuberculosis, chronic lung disease, cancer, renal disease, and liver disease), while 1333 (95.4 %) reported never smoking. Furthermore, 179 (12.8 %) had previously been diagnosed with COVID-19, and the majority (1165, 83.3 %) reported having a mild current illness, 176 (12.6 %) tested positive for SARS-COV-2 (Table 1).

Of those enrolled, 802 (57.4 %) were fully vaccinated. Of those fully vaccinated, 52 (6.5 %) had received a booster vaccine dose. Regarding the type of vaccine received, 492 (35.2 %) received the AstraZeneca (ChAdOx1) vaccine, 288 (20.6 %) received Pfizer (BNT162b2) vaccine, 103 (7.4 %) received the (Ad26.COV2.5) vaccine, 33 (2.4 %) received the Moderna (mRNA-1273) vaccine, and 15 (1.1 %) received the Sinopharm-Beijing (BBIBP-CorV) vaccine. Out of the 802 that were fully vaccinated, vaccination status was significantly associated with employment ($p < 0.001$), area of residence ($p = 0.002$), smoking status ($p = 0.0014$), HIV status ($p = 0.001$) and previous COVID-19 infection ($p < 0.001$) (Table 1).

Table 1
Baseline characteristics by vaccination status among 1398 patients with COVID-19-like symptoms in Uganda (March 2023–March 2024).

Characteristic	All n (%)	COVID-19 vaccination status			
		Unvaccinated $n = 467$, n (%)	Partial $n = 129$, n (%)	Fully * $n = 802$, n (%)	*p*-value
	1398 (100)	467 (33.4)	129 (9.2)	802 (57.4)	
Age (complete years)					0.131
< 50	1185 (84.8)	400 (85.7)	116 (89.9)	669 (83.4)	
50+	213 (15.2)	67 (14.3)	13 (10.1)	133 (16.6)	
Sex					0.256
Female	775 (55.4)	245(52.5)	71 (55.0)	459 (57.2)	
Male	623 (44.6)	222 (47.5)	58 (45.0)	343 (2.8)	
Employment					< 0.001
Others	1045 (74.7)	427 (91.4)	105 (81.4)	513 (64.0)	
Frontline/health worker	353 (25.3)	40 (8.6)	24 (18.6)	289 (36.0)	
Area of residence					0.002
Kampala	373 (26.7)	141(30.2)	29 (22.5)	203 (25.3)	
Greater Masaka[¶]	347 (24.8)	117 (25.1)	47 (36.4)	183 (22.8)	
Wakiso	678 (48.5)	209 (44.8)	53 (41.1)	416 (51.9)	
Smoking status					0.014
Current/former	65 (4.6)	30 (6.4)	9 (7.0)	26 (3.2)	
Never	1333 (95.4)	437 (93.6)	120 (93.0)	776 (96.8)	
Presence of chronic disease[#]					0.688
No	1202 (86.0)	402 (86.1)	114 (88.4)	686 (85.5)	
Yes	196 (14.0)	65 (13.9)	15 (11.6)	116 (14.5)	
HIV Status					0.001
Negative	1234 (88.3)	402 (86.1)	104 (80.6)	728 (90.8)	
Positive	80 (5.7)	27 (5.8)	10 (7.8)	43 (5.4)	
Unknown	84 (6.0)	38 (8.1)	15 (11.6)	31 (3.9)	
Previous COVID-19 infection					< 0.001
No	1127 (80.6)	415 (88.1)	99 (76.7)	613 (76.4)	
Yes	179 (12.8)	27 (5.8)	17 (13.2)	135 (16.8)	
Unknown	92 (6.6)	25 (5.4)	13 (10.1)	54 (6.7)	
Current disease severity					0.088
Mild	1165 (83.3)	394 (84.4)	115 (89.1)	656 (81.8)	
Moderate - severe	233 (16.7)	73 (15.6)	14 (10.9)	146 (18.2)	
COVID-19 PCR results					0.811
Positive	176 (12.6)	62 (13.3)	17 (13.2)	97 (12.1)	
Negative	1222 (87.4)	405 (86.7)	112 (86.8)	705 (87.9)	
COVID-19 vaccine received					
Unvaccinated	467 (33.4)	467 (100)			
AstraZeneca (ChAdOx1)	492 (35.2)		66 (51.2)	426 (53.1)	
Pfizer (BNT162b2)	288 (20.6)		56 (43.4)	232 (28.9)	
JnJ (Ad26. COV2·S)	103 (7.4)		0 (0.0)	103 (12.8)	
Moderna (mRNA-1273)	33 (2.4)		7 (5.4)	26 (3.2)	
Sinopharm (BBIBP-CorV)	15 (1.1)		0 (0)	15 (1.9)	

N = number; [‖]Other forms of employment included: driver (66), retail worker (199), cleaning and domestic worker (89), public safety worker (37), religious worker (17), construction worker, (52) factory worker (25), teacher (48) and student (207); [#]Hypertension, diabetes, heart/Cardiovascular disease, asthma, tuberculosis, chronic lung disease, cancer, renal disease, liver disease; [¶]Greater Masaka comprises health centres from districts of Kalungu (1), Kyotera (1), Lyantonde (1) and Masaka (4). * Patients who received a single dose for a one-dose vaccine, both doses for a two-dose vaccine, as well as those who received a booster dose. [+] Only participants that received a booster dose among those that were fully vaccinated.

3.2. COVID-19 vaccination and associated factors

A total of 931 (66.6 %) of those enrolled received one or more vaccine doses. In the unadjusted analysis, receiving one or more COVID-19 vaccine doses was significantly associated with residing in Wakiso [OR = 1.4, 95 % CI 1.0–1.8, $p = 0.022$] compared to residing in the Capital, Kampala, and with being a frontline/health worker [OR = 5.4, 95 % CI 3.8–7.8, $p < 0.001$] compared to other occupations. Being a non-smoker [OR = 1.8, 95 % CI 1.1–2.9, $p = 0.027$] compared to a smoker, and having a history of previous COVID-19 diagnosis [OR = 3.3, 95 % CI 2.2–5.1, $p < 0.001$] compared to not having a previous COVID-19 diagnosis were also significantly associated with receiving one or more vaccine doses. In the multivariable analysis, residing in Wakiso [aOR = 1.4, 95 % CI 1.0–1.8, $p = 0.021$], being a frontline/health worker [aOR = 5.0, 95 % CI 3.6–7.3, $p < 0.001$] and having a history of previous COVID-19 diagnosis (aOR = 2.4, 95 % CI 1.6–3.9, $p < 0.001$) remained significantly associated with receipt of one or more COVID-19 vaccine doses (Table 2).

4. Discussion

Overall, the proportion of patients with COVID-19 like symptoms who had received one or more COVID-19 vaccines in the study population was 66.6 %, slightly higher than the national average [3].This could have resulted from the initial widespread vaccination campaigns that were implemented to combat the early phases of the pandemic and relative ease of access to vaccine centers in urbanized districts. Our results show a higher vaccination rate than a 2021 survey across four regions of Uganda, which found that only 49.7 % had received more than

Table 2
Vaccination status and associated factors among 1398 patients with COVID-19-like symptoms in Uganda (March 2023–March 2024).

Variable	N (Column %)	Received ≥ 1 vaccine dose (Row %)	OR (95 % CI)	*p*-value	aOR (95 % CI)[§]	p-value
All	1398 (100)	931 (66.6)	–	–		
Age group (years)						
<50	1185 (84.8)	785 (66.2)	1		1	
≥50	213 (15.2)	146 (68.5)	1.1 (0.8–1.5)	0.512	1.3 (0.9–1.8)	0.176
Sex						
Female	775 (55.4)	530 (68.4)	1		1	
Male	623 (44.6)	401 (64.4)	0.8 (0.7–1.0)	0.113	1.0 (0.8–1.3)	0.992
Area of residence						
Kampala	373 (26.7)	232 (62.2)	1		1	
Greater Masaka[¶]	347 (24.8)	230 (66.3)	1.2 (0.9–1.6)	0.254	1.2 (0.9–1.7)	0.250
Wakiso	678 (48.5)	469 (69.2)	1.4 (1.0–1.8)	0.022	1.4 (1.0–1.8)	0.021
Employment						
Other[‖]	1045 (74.7)	618 (59.1)	1		1	
Frontline/Healthcare worker	353 (25.3)	313 (88.7)	5.4 (3.8–7.8)	< 0.001	5.0 (3.6–7.3)	<0.001
Presence of chronic disease[#]						
No	1202 (86.0)	800 (66.6)	1			
Yes	196 (14.0)	131 (66.8)	1.0 (0.7–1.4)	0.938		
Smoking status						
Current/Former smoker	65 (4.6)	35 (53.8)	1		1	
Never smoked	1333 (95.4)	896 (67.2)	1.8 (1.1–2.9)	0.027	1.5 (0.9–2.6)	0.125
Previous COVID-19 diagnosis						
No	1127 (80.6)	712 (63.2)	1		1	
Yes	179 (12.8)	152 (84.9)	3.3 (2.2–5.1)	< 0.001	2.4 (1.6–3.9)	<0.001
Unknown	92 (6.6)	67 (72.8)	1.6 (1.0–2.6)	0.066	1.7 (1.0–2.7)	0.046
Severity of current illness						
Mild	1165 (83.3)	771 (66.2)	1			
Moderate - Severe	233 (16.7)	160 (68.7)	2.0 (0.8–1.5)	0.462		

N = number; OR = odds ratio; CI: confidence interval; aOR = adjusted odds ratio; [§]Adjusted for age, pregnancy status, employment status, presence of chronic disease, previous COVID-19 diagnosis, and disease severity; [‖]Other forms of employment included: driver (66), retail worker (199), cleaning and domestic worker (89), public safety worker (37), religious worker (17), construction worker, (52) factory worker (25), teacher (48) and student (207); [#]Hypertension, diabetes, heart/Cardiovascular disease, asthma, tuberculosis, chronic lung disease, cancer, renal disease, liver disease; [¶]Greater Masaka comprises health centres from districts of Kalungu (1), Kyotera (1), Lyantonde (1) and Masaka (4).

one dose, and just 19.2 % were fully vaccinated [6]. In contrast, a lower proportion of individuals received booster doses in our study. The low booster uptake may be partly attributed to intermittent vaccine shortages, hindering timely administration [9]. Moreover, the public health campaign for booster doses lacked the intensity of the initial vaccination drive. Combined with misinformation about vaccines, this likely contributed to reduced public awareness and motivation to receive booster shots [10]. Additionally, booster doses were mainly recommended for high-risk groups such as the elderly and healthcare workers, which may have contributed to the lower overall coverage in the general population.

Our findings show that frontline/healthcare workers were approximately five times more likely to have received one or more COVID-19 vaccine doses compared to individuals in other occupations. This may be a consequence of the vaccination campaigns that specifically targeted frontline/healthcare workers when COVID-19 vaccines first became available in Uganda [11]. Moreover, frontline healthcare workers possess greater knowledge about vaccines and easier access to them, along with a heightened perception of the risk of contracting the virus compared to the general population, owing to the nature of their training and work environment [12]. The high vaccination coverage in this population underscores the success of targeted vaccination campaigns.

Individuals who reported a previous diagnosis of COVID-19 were more likely to have been vaccinated than those who did not. This finding is consistent with reports from other studies in which individuals with a self-reported history of COVID-19 infection were more likely to be vaccinated [13] and to accept vaccination [14]. Prior exposure to the virus may serve as a motivating factor for individuals to pursue vaccination as a protective measure against reinfection [15]. Moreover, individuals previously diagnosed with COVID-19 may opt for vaccination to enhance and broaden their natural immunity in line with public health recommendations. Finally, iindividuals previously diagnosed with COVID-19 may have easier access to vaccination due to their familiarity with the healthcare system [16,17].

The higher vaccination uptake observed among participants in Wakiso district may be due to differences in availability of COVID-19 vaccines [6], healthcare infrastructure, and local vaccine awareness and promotion campaigns [18–20]. Wakiso is highly urbanized and has a relatively good healthcare and physical infrastructure compared to other parts of Uganda, factors that correlate with better access to healthcare, including vaccinations [21].

A major limitation of the study is that self-reported information on receipt of COVID-19 vaccines could not be verified for 37.2 % of the participants due to missing vaccination cards or because we could not find participants' information in the Ministry of Health COVID-19 vaccination database. Thus, it is possible that misreporting of COVID-19 vaccination status could have resulted in the overestimation of

COVID-19 vaccination coverage due to social desirability bias. Secondly, our study sample was purposively drawn from individuals with COVID-19-like symptoms seeking care at health facilities, introducing selection bias. Consequently, the results may not be generalizable to the broader population, as they primarily represent those who sought medical attention.

5. Conclusion

The proportion of individuals who had been vaccinated was moderate among patients with COVID-19-like symptoms, but there was a notable gap in booster dose coverage. Targeted public health messaging and support should be directed towards non-healthcare related occupations to encourage vaccination uptake. Additionally, expanding access to vaccines in less urbanized areas through mobile clinics and strengthening public awareness campaigns may be key to achieving broader population coverage.

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Institutional review board statement

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Uganda Virus Research Institute Research Ethics Committee (Ref#- GC/127/952, 22 February 2023) and the Uganda National Council of Science and Technology (Ref#-HS2672ES, 7 March 2023, London School of Hygiene and Tropical Medicine Research Ethics Committee (Ref#-28,824, 16 March 2023). Administrative approvals were obtained from the Uganda Ministry of Health and all participating hospitals/health facilities.

Informed consent statement

Written informed consent and assent were obtained from all study participants before any study procedures were performed.

CRediT authorship contribution statement

Sylvia Kusemererwa: Writing – review & editing, Writing – original draft, Visualization, Supervision, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Violet Ankunda:** Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Formal analysis, Data curation. **Terry A. Ongaria:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Project administration, Methodology, Investigation, Data curation. **Andrew Abaasa:** Writing – review & editing, Visualization, Validation, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Ayoub Kakande:** Writing – review & editing, Visualization, Validation, Software, Project administration. **Deogratius Ssemwanga:** Writing – review & editing, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Geofrey Kimbugwe:** Writing – review & editing, Supervision, Project administration, Funding acquisition, Conceptualization. **Bernadette Nayiga:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Conceptualization. **Henry K. Bosa:** Writing – review & editing, Resources, Funding acquisition. **Alfred Driwale:** Writing – review & editing, Funding acquisition. **Yonas T. Woldemariam:** Writing – review & editing, Funding acquisition. **Annet Kisakye:** Writing – review & editing, Funding acquisition. **James Humphreys:** Writing – review & editing, Methodology. **Archibald K. Worwui:** Writing – review & editing, Methodology, Data curation. **Sandra Cohuet:** Writing – review & editing, Supervision. **Jason M. Mwenda:** Writing – review & editing, Supervision, Funding acquisition. **Alison M. Elliott:** Writing – review & editing, Supervision, Funding acquisition. **Pontiano Kaleebu:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization. **Eugene Ruzagira:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

The data sharing policy and procedures for accessing the data used in this manuscript are available at https://apps.mrcuganda.org/mrcdatavisibility. Researchers interested in accessing this data can follow the detailed processes outlined in the policy. For any clarifications or assistance with data access, the corresponding author can be contacted.

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