






RESEARCH ARTICLE

Assessing COVID-19 vaccine roll-out in Uganda: a case study of uptake and associated factors among health care workers and older people [version 1; peer review: awaiting peer review]

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V1 First published: 20 Mar 2024, 7:5
<https://doi.org/10.12688/openresafrika.14719.1>
Latest published: 20 Mar 2024, 7:5
<https://doi.org/10.12688/openresafrika.14719.1>

Open Peer Review

Approval Status AWAITING PEER REVIEW

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Abstract

Introduction

We conducted a survey to investigate the uptake of COVID-19 vaccination among healthcare workers (HCWs) and older persons (≥ 50 years) in Uganda, groups at particular risk of infection and severe disease outcomes respectively.

Methods

The survey was conducted between May and August 2021, during the early phase of COVID-19 vaccine roll-out. All HCWs at Entebbe and Kisubi hospitals, Wakiso district (urban/peri-urban) and Villa Maria hospital, Kalungu district (rural), and non-healthcare worker (non-HCW) individuals enrolled in an ongoing older persons' cohort study in Wakiso district, completed an interviewer-administered questionnaire on socio-demographics, pre-existing medical conditions, attitudes regarding COVID-19 vaccines, and vaccination uptake. Logistic

regression was performed to investigate factors associated with uptake.

Findings

A total of 746 individuals, 597 HCWs and 149 non-HCW older persons, participated. Majority were aged ≤ 50 years (71.6%), female (63.1%), and had secondary school/other higher-level education (77.8%). COVID-19 uptake was 63.7%, overall; 95.2%, Entebbe Hospital; 75.4%, Kisubi Hospital; 49.5%, Villa Maria Hospital; and 20.8%, non-HCW. Among HCWs, health facility [Entebbe hospital (aOR 18.9, 95% CI 8.9-40.2), Kisubi hospital (aOR 5.2, 95% CI 3.0-9.0) all compared with Villa Maria], age >50 years (aOR 3.1, 95% CI 1.2-8.4) and positive attitude towards COVID-19 vaccines (aOR 5.0, 95% CI 2.1-11.8) were associated with high uptake, while female sex (aOR 0.5, 95% CI 0.3-0.9) was associated with low uptake. Among non-HCW older persons, absence of chronic infectious disease (aOR 4.3, 95% CI 1.1-16.3) good attitude towards COVID-19 vaccines (aOR 29.2, 95% CI 4.1-208.8) were associated with high uptake, while advanced age 70-79 years (aOR 0.1, 95% CI 0.01-0.97) was associated with low uptake.

Conclusion

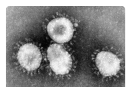
COVID-19 vaccine uptake was lowest among rural-based HCWs and non-HCW older persons. Vaccination campaigns during a pandemic need to foster positive attitudes towards vaccines and employ strategies specifically designed to improve vaccine uptake among disadvantaged populations.

Keywords

COVID-19, Vaccine uptake, older persons, Health-care workers, Uganda



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Competing interests: No competing interests were disclosed.

Grant information: This work was funded through the Makerere University-Uganda Virus Research Institute Centre of Excellence for Infection and Immunity Research and Training (MUII). MUII was supported through the DELTAS Africa Initiative (Grant no. DEL-15-004). The DELTAS Africa Initiative was an independent funding scheme of the African Academy of Sciences (AAS), Alliance for Accelerating Excellence in Science in Africa (AESA) and supported by the New Partnership for Africa's Development Planning and Coordinating Agency (NEPAD Agency) with funding from the Wellcome Trust and the UK Government. The views expressed in this publication are those of the authors and not necessarily those of AAS, NEPAD Agency, Wellcome Trust or the UK government. The work was conducted at the MRC/UVRI and LSHTM Uganda Research Unit which is jointly funded by the UK Medical Research Council (MRC) part of UK Research and Innovation (UKRI) and the UK Foreign, Commonwealth and Development Office (FCDO) under the MRC/FCDO Concordat agreement and is also part of the EDCTP2 programme supported by the European Union.

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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How to cite this article: Bahemuka UM, Abaasa A, Asaba R *et al.* **Assessing COVID-19 vaccine roll-out in Uganda: a case study of uptake and associated factors among health care workers and older people [version 1; peer review: awaiting peer review]** Open Research Africa 2024, 7:5 <https://doi.org/10.12688/openresafrica.14719.1>

First published: 20 Mar 2024, 7:5 <https://doi.org/10.12688/openresafrica.14719.1>

Introduction

The COVID-19 pandemic caused a significant impact on global health. Within 24 months of the COVID-19 outbreak, there had been over 759 million confirmed cases of COVID-19 and nearly 6.9 million reported COVID-19 deaths globally¹. Health care workers (HCWs) around the world were considered one of the populations at risk of both infection and severe outcomes from COVID-19 disease due to the nature of their work^{2,3}. Likewise, other vulnerable populations including people with co-morbidities such as diabetes mellitus⁴ and older people⁵, were considered populations at risk of suffering severe disease when exposed to COVID-19. Over the years, vaccines have been described as a significant tool to control several types of infectious diseases⁶. Similarly, vaccines were identified as a critical intervention for the COVID-19 disease. Vaccination of HCWs against COVID-19 not only protects them from severe disease, but, also has been found to protect members of their households⁷. In Uganda the vaccination roll-out by the Ministry of health of AstraZeneca vaccine (ChAdOx1 nCoV-19) was launched on 10th March 2021, with a focus on at-risk populations including frontline workers such as Health care workers and armed forces, individuals with co-morbidities, and older people (50+ years)⁸. Vaccination uptake monitoring is critical to assess the effectiveness of the vaccine together with other non-pharmaceutical interventions⁹. Lack of clarity on the safety and fear of side effects, were some of the critical factors associated with COVID-19 vaccine hesitancy in Africa¹⁰. Some studies such as that by Biswas *et al.*, found a high prevalence of COVID-19 vaccine hesitancy in HCWs globally, and recommended communication and education strategies along with COVID-19 vaccination mandates to increase vaccination uptake in this population¹¹. However, other studies reported high willingness of COVID-19 vaccination among HCWs in these hospitals¹². Additionally in a study by Ndejjo *et al.* older age has been associated with moderate COVID-19 vaccine uptake among adults in Uganda¹³. Relatively little is known about the uptake of COVID-19 vaccines and associated factors among groups that are most vulnerable to COVID-19 in Uganda. The aim of this study was to determine the uptake of COVID-19 vaccines and associated factors among HCWs and older persons in Uganda in order to inform strategies for increasing vaccination coverage in these populations.

Methods

Study design, setting, and context

This was a cross sectional study conducted among HCWs at three hospitals i.e., Entebbe Regional Referral Hospital (ERRH), Our Lady of Consolata Kisubi Hospital (KH), Villa Maria Hospital (VMH), and individuals aged 50 years and above who are participants in an existing cohort study (non-HCW older persons) – the “Well-being of Older People Study (WOPS)”¹⁴ in Wakiso district, Uganda. ERRH is a 200-bed public hospital located in the central business district of Entebbe municipality, in Wakiso District, approximately 44km from Kampala, Uganda’s capital. The hospital was one of two major COVID-19 treatment centres in Uganda¹⁵. KH is a 110-bed private-not-for-profit (PNFP) hospital located in Kisubi, Wakiso district. The hospital is located approximately 28km from

Kampala and 16km from Entebbe. VMH is a 100-bed PNFP hospital located in Villa Maria, Kalungu District, about 100km Southwest of Kampala and 15km from Masaka city.

Study participants comprised all willing HCWs at Entebbe, Kisubi, and Villa Maria Hospitals and individuals aged 50 years and above who are participants in an existing cohort study, named “Well-being of Older People Study (WOPS)”¹⁴ based at the MRC/UVRI and LSHTM Uganda Research Unit’s in Wakiso and Kalungu districts.

The study was conducted from 24th May 2021 through 12th August 2021, a period that coincided with the 2nd wave (April–June 2021) of the COVID-19 pandemic in Uganda¹⁶, and which was characterised by partial lockdown restrictions. The first COVID-19 vaccination campaign had been launched on 10th March 2021 and targeted HCWs and other priority groups including teachers, persons older than 50 years, persons aged 18–50 years with underlying health conditions, and security personnel⁸.

Identification and recruitment of participants

HCWs. The study team sought and obtained administrative approval from each of the three hospitals to conduct the study among their staff. All hospital staff members were invited to a general meeting at which they received information and asked questions about the study. Thereafter, HCWs were invited to one-on-one sessions with a member of the study team to receive more detailed information about the study. In order not to disrupt work, the hospital administration created rotas for staff to attend these sessions. HCWs that were willing to participate in the study agreed to meet the study team members in designated places for consenting and completion of study procedures. Those meeting the inclusion criteria were consecutively recruited into the study.

Non-HCW older persons. Planning meetings were held with the WOPS cohort study project leader to confirm numbers of and obtain a random list of older persons to be invited for participation in the study. Individuals included on the list were contacted by phone or home visit, given information about the study, and invited to participate in the study if interested.

Enrolment visit and study procedures. A member of the study team provided detailed study information using the informed consent document, obtained written informed consent, assigned a study number, and consecutively administered a study questionnaire. Data collected included socio-demographics, medical history including pre-existing conditions (cardiovascular disease, diabetes, obesity, asthma, tuberculosis, HIV), beliefs and attitudes about COVID-19 illness; history of vaccination for self and children; sources of information about COVID-19 vaccination; knowledge and attitudes about, intention to receive, and actual receipt of COVID-19 vaccine. Approximately 30 minutes were required to complete the questionnaire.

Data collection and transmission. Data were captured electronically using encrypted tablets linked to REDCap software

database. Data from the tablet computers was synced once daily over a secure connection to the study database. The study database was hosted on a user rights and access-restricted secure server at the MRC/UVRI and LSHTM Uganda Research Unit in Entebbe.

Scoring of knowledge and attitudes. Knowledge about COVID-19 vaccines was assessed using 8 questions on availability of effective vaccines, eligibility for vaccination, effectiveness of and perceived risk of vaccines. Each question was assigned a score of 0 if the response was incorrect or 'I don't know', or 1 if the response was correct (True or False). Hence the possible minimum and maximum scores were 0 and 8 respectively. A participant's score was calculated as the number of correctly answered questions divided by 8 expressed as percentage. We used Bloom's cut-off point, to categorize a participant's knowledge as good, if the score was $\geq 80\%$ (≥ 7 points) and insufficient if the score was $< 80\%$ ¹⁷.

Attitudes towards COVID-19 vaccines were assessed using 8 Likert-item questions. The responses were 'agree', 'not sure', and 'disagree' each weighing 2, 1, 0 points, respectively. Hence the possible minimum and maximum scores were 0 and 16 respectively. For each participant, their total score was divided by 16 and their attitude level categorized, using Bloom's cut-off point, as positive, if the percentage score was $\geq 80\%$ (≥ 13 points) and poor if the score was $< 80\%$ ¹⁷.

Sample size consideration. No formal sample size estimation was done. We planned to include all consenting HCWs at the participating health facilities and all reachable WOPS.

Statistical analysis. Data were extracted from REDCap database and exported to Stata 15 (StataCorp, College Station, TX USA) for cleaning and analysis. We summarised participants' variables using counts and percentages stratified by the study site/population and compared the distribution of HCWs characteristics between the three hospitals using chi-squared tests. We estimated the uptake of COVID-19 vaccine as number receiving vaccination divided by the total number of the enrolled participants expressed as a percentage, first for HCWs and secondly for older persons. We further compared HCWs and older persons' characteristics between those who took up the COVID-19 vaccine and those who did not using chi-squared tests. Simple logistic regression models were fitted to determine factors associated with COVID-19 vaccine uptake stratified by HCWs and older persons. After bivariable analyses, a multivariable logit model was fitted including only those factors that were statistically significantly associated with COVID-19 vaccine uptake at bivariable analysis considering a Likelihood Ratio test p-value of less than 0.2. In the multivariable model, factors were removed from the model using a backward elimination algorithm retaining any factors, that did not make the fit of the model significantly worse at the 5% level on a likelihood ratios test.

Ethical considerations. Before any of the study procedures, written informed consent was obtained from the participants at

the hospitals and in the community (for WOPS participants) by trained research assistants while maintaining privacy. The protocol, informed consent document and its translated versions were submitted to and approved by Uganda Virus Research Institute (UVRI) Research Ethics Committee (Reference: GC/127/21/03/813), 25-Mar-2021; Uganda National Council for Science and Technology (UNCST) (Reference: SS767ES), 27-Apr-2021, and LSHTM Research Ethics Committee (Reference 25997), 4-May-2021. Each participant was reimbursed a total of thirty thousand Uganda shillings (approximately 8 USD) for their time. Study procedures were performed in accordance to UNCST national guidelines for conduct of research during the COVID-19 pandemic¹⁸.

Results

Screening and enrolment

A total 746 individuals [597 of the registered 650 HCWs (80%) and 149 of the 150 (99%) invited WOPS study participants] were screened and enrolled in the study between May and August 2021. Overall, most HCWs were aged ≤ 50 years (89.1%), female (61.6%), and had secondary school/other higher-level education (89.8%). The mean age was higher in Entebbe hospital 37.4 (SD=11.5) compared with Kisubi 31.9 (SD=20.7) and Villa Maria 34.2 (SD=13.2), $p < 0.001$. Table 1 compares participants characteristics among the three hospitals. Entebbe and Kisubi hospitals has more participants with diploma or degree education, 30.5% each compared with Villa Maria, 16.8% $p = 0.006$. Entebbe hospital had a lower proportion of single ever married participants 34.3% compared with Kisubi 45.3% and Villa Maria 45.7%, $p = 0.038$.

Uptake of COVID-19 Vaccine

Overall COVID-19 vaccination uptake was 74.4% (95.2%, Entebbe Hospital; 75.4%, Kisubi Hospital; 49.5%, Villa Maria Hospital) among HCWs and 20.8% among non-HCW older persons.

Factors associated with COVID-19 vaccine uptake among health care workers

Factors associated with high uptake of COVID-19 vaccine among HCWs were being staff of Entebbe (aOR 18.9, 95% CI 8.9-40.2) or Kisubi (aOR 5.2, 95% CI 3.0-9.0) hospitals, age > 50 years (aOR 3.1, 95% CI 1.2-8.4), having a good attitude towards COVID-19 vaccines (aOR 4.98, 95% CI 2.11-11.79). Female HCWs were less likely to have received COVID-19 vaccine (aOR: 0.5; 95% CI: 0.3-0.9) compared to their male counterparts (Table 2).

Factors associated with COVID-19 vaccine uptake non-health care worker older people

Most non-HCW older people were aged ≥ 60 years (85.2%), female (69.1%), had no formal education or only primary education (70.5%), and were single (previously married) (67.8%). Factors associated with high uptake of COVID-19 vaccine among non-HCW older people were having a good attitude towards COVID-19 vaccines (aOR 7.04, 95% CI (1.65-30.09) and being a stay home parent (aOR 11.29, 95% CI 2.47-51.61), Table 3.

Table 1. Socio-demographic characteristics of healthcare workers at three hospitals in Uganda (N=597).

Characteristic	All	Villa Maria hospital	Kisubi hospital	Entebbe hospital	P-value
	N (%)	n (%)	n (%)	n (%)	
All	597 (100)	184 (30.8)	203 (34.0)	210 (35.2)	
Sex					0.747
Male	229 (38.4)	74 (40.2)	74 (36.5)	81 (38.6)	
Female	368 (61.6)	110 (59.8)	129 (63.5)	129 (61.4)	
Age group (years)					<0.001
18–24	122 (20.4)	46 (25.0)	52 (25.6)	24 (11.4)	
25–34	244 (40.9)	74 (40.2)	94 (46.3)	76 (36.2)	
35–50	166 (27.8)	41 (22.3)	49 (24.2)	76 (36.2)	
51+	65 (10.9)	23 (12.5)	8 (3.9)	34 (16.2)	
Occupation					0.423
Doctor/clinical officer	40 (6.7)	15 (8.2)	9 (4.4)	16 (7.6)	
Nurse/midwife	256 (42.9)	74 (40.2)	88 (43.3)	94 (44.8)	
Other medical	93 (15.6)	24 (13.0)	33 (16.3)	36 (17.1)	
Other non-medical	208 (34.8)	71 (38.6)	73 (36.0)	64 (30.5)	
Education					0.006
None/primary	61 (10.2)	22 (12.0)	17 (8.4)	22 (10.5)	
Secondary	83 (13.9)	22 (12.0)	35 (17.2)	26 (12.4)	
Technical/professional	296 (49.6)	109 (59.2)	89 (43.9)	98 (46.6)	
University (diploma/degree)	157 (26.3)	31 (16.8)	62 (30.5)	64 (30.5)	
Marital status					0.038
Single (never married)	248 (41.5)	84 (45.7)	92 (45.3)	72 (34.3)	
Married (cohabiting)	297 (49.8)	83 (45.1)	100 (49.3)	114 (54.3)	
Single (ever married*)	52 (8.7)	17 (9.2)	11 (5.4)	24 (11.4)	
Religion					0.044
Christian	572 (95.8)	181 (98.4)	195 (96.1)	196 (93.3)	
Muslim	25 (4.2)	3 (1.6)	8 (3.9)	14 (6.7)	
Number of people in household [‡]					
Children (<18 years)	476 (79.7)	149 (81.0)	164 (80.8)	163 (77.6)	0.639
Adults (18–49)	585 (98.0)	181 (98.4)	202 (99.5)	202 (96.2)	0.051
Older (>50 years)	341 (57.1)	109 (59.2)	124 (61.1)	108 (51.4)	0.110

*Single (ever married)=separated/divorced/widowed, [‡] proportions based on total responses

Discussion

Our study found a moderately high uptake (74.4%) of the COVID-19 vaccine among HCWs at three hospitals in Uganda.

This finding is similar to that reported in a study by Farar *et al*, in which the overall COVID-19 vaccine uptake was 78.6%¹⁹. However, vaccine uptake varied by health facility, with the

Table 2. COVID-19 vaccine uptake and associated factors among healthcare workers at three hospitals in Uganda (N=597).

Characteristic	Received COVID-19 vaccine		uOR (95% CI)	LRT p-value	aOR (95% CI)	LRT p-value
	No (%)	Yes (%)				
Overall	153 (25.6)	444 (74.4)				
Occupation						
Doctor/clinical officer	8 (20.0)	32 (80.0)	1.00	0.013	1.00	0.001
Nurse/midwife	51 (19.9)	205 (80.1)	1.01 (0.44-2.31)		1.31 (0.45-3.79)	
Other medical	26 (28.0)	67 (72.0)	0.64 (0.26-1.58)		0.53 (0.17-1.64)	
Other non-medical	68 (32.7)	140 (67.3)	0.51 (0.23-1.18)		0.50 (0.17-1.49)	
Hospital						
Villa Maria	93 (50.5)	91 (49.5)	1.00	<0.001	1.00	<0.001
Kisubi	50 (24.6)	153 (75.4)	3.13 (2.03-4.81)		5.22 (3.03-8.99)	
Entebbe	10 (4.8)	200 (95.2)	20.44 (10.17-41.07)		18.86 (8.86-40.15)	
Sex						
Male	54 (23.6)	175 (76.4)	1.00	0.364	1.00	0.023
Female	99 (26.9)	269 (73.1)	0.84 (0.57-1.23)		0.53 (0.32-0.87)	
Age group						
18-24	41 (33.6)	81 (66.4)	1.00	0.006	1.00	0.003
25-34	70 (28.7)	174 (71.3)	1.26 (0.79-2.01)		1.13 (0.64-2.01)	
35-50	31 (18.7)	135 (81.3)	2.21 (1.28-3.79)		1.85 (0.92-3.73)	
51+	11 (16.9)	54 (83.1)	2.48 (1.17-5.26)		3.11 (1.15-8.39)	
Education						
None/primary	23 (37.7)	38 (62.3)	1.00	0.113		
Secondary	23 (27.7)	60 (72.3)	1.58 (0.78-3.20)			
Technical/professional	73 (24.7)	223 (75.3)	1.85 (1.03-3.31)			
University (diploma/degree)	34 (21.7)	123 (78.3)	2.19 (1.15-4.16)			
Marital status						
Single (never married)	70 (28.2)	178 (71.8)	1.00	0.330		
Married (cohabiting)	73 (24.6)	224 (75.4)	1.21 (0.82-1.77)			
Single (ever married*)	10 (19.2)	42 (80.8)	1.65 (0.79-3.47)			
Religion						
Christian	145 (25.3)	427 (74.7)	1.00	0.466		
Muslim	8 (32.0)	17 (68.0)	0.72 (0.31-1.71)			
Number of people in household						
Children (<18 years)	125 (26.3)	351 (73.7)	0.85 (0.53-1.35) ^y	0.479		
Adults (18-49)	151 (25.8)	434 (74.2)	0.57 (0.13-2.65) ^y	0.452		
Older (>50 years)	82 (24.0)	259 (76.0)	1.21 (0.84-1.75) ^y	0.308		
Chronic infectious disease (TB, HIV or HBV)						
Yes	9 (25.0)	27 (75.0)	1.00	0.929		
No	144 (25.7)	417 (74.3)	0.97 (0.44-2.10)			

Characteristic	Received COVID-19 vaccine		uOR (95% CI)	LRT p-value	aOR (95% CI)	LRT p-value
	No (%)	Yes (%)				
Other chronic conditions [‡]						
Yes	12 (31.6)	26 (68.4)	1.00	0.395		
No	141 (25.2)	418 (74.8)	1.37 (0.67-2.78)			
Receipt of medicines that can affect the immune system (e.g., steroids)						
Yes	5 (23.8)	16 (76.2)	1.00	0.845		
No	148 (25.7)	428 (74.3)	0.90 (0.33-2.51)			
Know someone that died of COVID-19						
Yes	100 (23.5)	326 (76.5)	1.00	0.060	1.00	0.496
No	53 (31.0)	118 (69.0)	0.68 (0.46-1.01)		1.14 (0.66-1.97)	
Believes COVID-19 risk is exaggerated						
Yes	43 (27.9)	111 (72.1)	1.00	0.452		
No	110 (24.8)	333 (75.2)	1.17 (0.78-1.77)			
Worried about acquisition of COVID-19						
Yes	144 (27.5)	379 (72.5)	1.00	0.002	1.00	0.019
No	9 (12.2)	65 (87.8)	2.74 (1.33-5.65)		3.84 (1.51-9.78)	
Believes has/had COVID-19						
Definitely	17 (34.7)	32 (65.3)	1.00	0.073	1.00	0.010
Probably	26 (32.9)	53 (67.1)	1.08 (0.51-2.30)		1.85 (0.72-4.79)	
Probably not	110 (23.4)	359 (76.6)	1.73 (0.93-3.24)		3.60 (1.56-8.31)	
Knows someone that had COVID						
Yes	129 (24.6)	396 (75.4)	1.00	0.119	1.00	0.260
No	24 (33.3)	48 (66.7)	0.65 (0.38-1.11)		0.70 (0.34-1.42)	
Source of information about COVID-19 vaccination						
Medical	72 (20.0)	288 (80.0)	1.00	0.001	1.00	0.278
Media	18 (36.7)	31 (63.3)	0.43 (0.23-0.82)		0.43 (0.20-0.95)	
Other	63 (33.5)	125 (66.5)	0.50 (0.33-0.74)		0.77 (0.46-1.27)	
COVID-19 vaccine knowledge score ¹						
Low	30 (27.3)	80 (72.7)	1.00	0.184	1.00	0.537
Moderate	99 (27.3)	264 (72.7)	1.00 (0.62-1.61)		0.97 (0.53-1.76)	
High	24 (19.4)	100 (80.6)	1.56 (0.85-2.88)		1.03 (0.48-2.22)	
Attitude towards COVID-19 vaccines ²						
Poor	15 (41.7)	21 (58.3)	1.00	<0.001	1.00	<0.001
Fair	67 (38.1)	109 (61.9)	1.16 (0.56-2.41)		1.57 (0.67-3.69)	
Good	71 (18.4)	314 (81.6)	3.16 (1.55-6.43)		4.98 (2.11-11.79)	

LRT-Likelihood Ratio Test; uOR-Unadjusted Odds Ratio; aOR-Adjusted Odds Ratio; CI-Confidence Interval; *Single (ever married)=separated/divorced/widowed; TB- Tuberculosis; HIV- Human immunodeficiency virus; HBV-Hepatitis B virus; ¹Calculated as number of correctly answered questions/total number questions expressed as percentage (Score <50 (Low), 51-79 (Moderate), 80+ (High)); ²Calculated as number of correctly answered questions/total number questions expressed as percentage (score <50 (Low), 51-79 (Fair) and 80+ (Good)), [‡] uOR reference equals to households not having people in shown category

Table 3. COVID-19 vaccine uptake and associated factors among non-healthcare worker older people in Wakiso district, Uganda (N=149).

Characteristic	All	Received COVID-19 vaccine		uOR (95%CI)	LRT p-value	aOR (95%CI)	p-value
		No	Yes				
	N (%) [*]	n (%) [#]	n (%) [#]				
All	149 (100)	118 (79.2)	31 (20.8)				
Sex							
Male	46 (30.9)	36 (78.3)	10 (21.7)	1.00	0.852	1.00	0.852
Female	103 (69.1)	82 (79.6)	21 (20.4)	1.08 (0.46-2.54)		0.92 (0.34-2.49)	
Age group (complete years)							
50-59	22 (14.8)	15 (68.2)	7 (31.8)	1.00	0.409	1.00	0.403
60-69	61 (40.9)	49 (80.3)	12 (19.7)	1.91 (0.64-5.71)		0.38 (0.10-1.42)	
70+	66 (44.3)	54 (81.8)	12 (18.2)	2.10 (0.70-6.27)		0.32 (0.07-1.45)	
Education							
None/primary	105 (70.5)	84 (80.0)	21 (20.0)	1.00	0.710		
Secondary+	44 (29.5)	34 (77.3)	10 (22.7)	0.85 (0.36-1.99)			
Marital status							
Married (cohabiting)	48 (32.2)	37 (77.1)	11 (22.9)	1.00	0.664		
Single (previously married ^f)	101 (67.8)	81 (80.2)	20 (19.8)	1.21 (0.52-2.77)			
Employment status							
Employed	47 (31.5)	39 (83.0)	8 (17.0)	1.00	0.075	1.00	0.014
Unemployed	45 (30.2)	36 (80.0)	9 (20.0)	1.22 (0.42-3.50)		2.86 (0.79-10.28)	
Stay home parent	29 (19.5)	18 (62.1)	11 (37.9)	2.98 (1.02-8.67)		11.29 (2.47-51.61)	
Retired	28 (18.8)	25 (89.3)	3 (10.7)	0.59 (0.14-2.42)		1.59 (0.31-8.21)	
Religion							
Christian	135 (90.6)	109 (80.7)	26 (19.3)	1.00	0.174		
Muslim	14 (9.4)	9 (64.3)	5 (35.7)	0.43 (0.13-1.39)			
Number of people in household							
Children (<18 years)	142 (95.3)	113 (79.6)	29 (20.4)	0.64 (0.12-3.48) ^y	0.618		
Adults (18-49)	136 (91.3)	106 (77.9)	30 (22.1)	3.40 (0.42-27.18) ^y	0.178		
Older (>50 years)	142 (95.3)	113 (79.6)	29 (20.4)	0.64 (0.12-3.48) ^y	0.618		
Chronic Infectious Disease (TB,HIV or HBV)							
Yes		68 (81.9)	15 (18.1)	1.00	0.358		
No		50 (75.8)	16 (24.2)	1.45 (0.66-3.21)			
Other chronic conditions [‡]							
Yes		56 (82.4)	12 (17.6)	1.00	0.382		
No		62 (76.5)	19 (23.5)	1.43 (0.64-3.21)			

Characteristic	All	Received COVID-19 vaccine		uOR (95%CI)	LRT p-value	aOR (95%CI)	p-value
		No	Yes				
	N (%) [*]	n (%) [#]	n (%) [#]				
Receipt of medicines that can affect the immune system (e.g., steroids)							
Yes		32 (76.2)	10 (23.8)	1.00	0.575		
No		86 (80.4)	21 (19.6)	0.78 (0.33-1.84)			
Know someone that died of COVID							
Yes		62 (74.7)	21 (25.3)	1.00	0.125	1.00	0.028
No		56 (84.8)	10 (15.2)	0.53 (0.23-1.22)		0.71 (0.24-2.12)	
Believes COVID-19 risk is exaggerated							
Yes		25 (78.1)	7 (21.9)	1.00	0.867		
No		93 (79.5)	24 (20.5)	0.92 (0.36-2.38)			
Know someone that had COVID							
Yes		82 (78.1)	23 (21.9)	1.00	0.606		
No		36 (81.8)	8 (18.2)	0.79 (0.32-1.94)			
Source of information about COVID vaccination							
Medical		8 (80.0)	2 (20.0)	1.00	0.688		
Media		36 (75.0)	12 (25.0)	1.33 (0.25-7.17)			
Other-non-medical		75 (81.3)	17 (18.7)	0.92 (0.18-4.72)			
COVID vaccine knowledge score ¹							
Low		50 (80.6)	12 (19.4)	1.00	0.308		
Moderate		60 (81.1)	14 (18.9)	0.97 (0.41-2.29)			
High		8 (61.5)	5 (38.5)	2.60 (0.72-9.39)			
Attitude towards COVID vaccines ²							
Low		30 (88.2)	4 (11.8)	1.00	0.001	1.00	0.002
Fair		59 (89.4)	7 (10.6)	0.89 (0.24-3.28)		1.23 (0.31-4.93)	
Good		29 (59.1)	20 (40.8)	5.17 (1.58-16.98)		7.04 (1.65-30.09)	

uOR-Unadjusted Odds Ratio, aOR-Adjusted Odds Ratio, LRT-Likelihood Ratio Test, uOR-Unadjusted Odds Ratio, aOR-Adjusted Odds Ratio, CI-Confidence Interval; ^{*}Column percentage; [#]Row percentage; TB- Tuberculosis; HIV- Human immunodeficiency virus; HBV-Hepatitis B virus; ¹Diabetes mellitus, hypertension, asthma, obesity; ¹calculated as number of correctly answered questions/total number questions expressed as percentage (Score <50 (Low), 51-79 (Moderate), 80+ (High)); ²Calculated as number of correctly answered questions/total number questions expressed as percentage (score <50 (Low), 51-79 (Fair) and 80+ (Good)); ²Single (ever married)=separated/divorced/widowed, ² uOR reference equals to households not having people in shown category

lowest uptake in the rural-based Villa Maria hospital. These findings are similar to the findings from a study by Annalee et al. conducted in Canada where vaccination uptake between HCWs in urban health facilities was compared to that of HCWs in rural areas. The study found discrepancies in vaccination rates between rural-based HCWs compared to urban-based HCWs²⁰. This may also be because of the methods of vaccine distribution with priority being given to those health facilities

that are easy to access. Hence distant health facilities may be more prone to issues of vaccine stock outs and poor distribution mechanisms²¹. In addition, COVID-19 vaccine uptake requires good knowledge of the safety of the vaccine, with the HCWs in the rural health facilities falling short on proper information regarding safety of vaccines and probably depending on other nonstandard forms of information such as social media.

The finding that vaccine uptake was highest at Entebbe hospital may be due to the fact that this hospital was one of the two main COVID-19 treatment centres in the early phase of the pandemic¹⁵ and so the HCWs there might have self-identified as high risk due to the large numbers of COVID-19 patients that were being treated at the hospital.

The finding that older HCWs had higher vaccine uptake is probably because these HCWs self-identified as being at higher risk of exposure to SARS-CoV-2 and adverse COVID-19 outcomes than their younger colleagues on account of their age²².

Female HCWs had lower vaccine uptake compared to their male counterparts a phenomenon that may be related to their gender roles of childbearing and breastfeeding, where they may not want to risk the health of their unborn children and breastfeeding infants. This finding is consistent with that reported in a study by Mazin B et al, where non-uptake of COVID-19 vaccination was more likely in females than males (78.5% vs. 21.5%)²³.

We found extremely low vaccination uptake among non-HCW older persons. This finding is disturbing since this is a population that is extremely vulnerable to COVID-19 disease. Older people tend to be isolated in society which could affect their access to accurate information on vaccines and social networks that could assist them to identify and travel to vaccination sites. The risk of social isolation and its consequences was likely exacerbated by the prolonged COVID-19 lockdown restrictions. Also, older people may avoid attending crowded vaccination centres where they risk competing with younger and more energetic people for scarce vaccine doses²⁴. This was likely a major contributing factor to low vaccine uptake among older persons in our study. This is because the study was conducted during the Delta variant driven second wave of COVID-19 in Uganda, a period of high vaccine demand but limited supply^{25,26}.

Older people with chronic infectious diseases such as HIV had lower vaccine uptake compared to those who did not. This finding may be due to the misconception that COVID-19 vaccines worsen pre-existing chronic health conditions²⁴. The finding that vaccine uptake was lowest in the oldest age group probably suggests that the barriers to vaccination in this population become more difficult to overcome with increasing age.

A good attitude towards COVID-19 vaccines was associated with high uptake of COVID-19 vaccine among HCWs and non-HCW older persons. Previous studies have reported a strong association between positive attitudes to vaccines and COVID-19 vaccine confidence^{27,28}. Positive attitudes towards vaccines have been shown to be a result of having correct information about vaccines' safety and expected side effects²⁷.

A strength of this study is the high response rate of 80% and 99% among HCWs and non-HCW older people respectively. The study is one of the few that assessed vaccine uptake during the initial phase of the COVID-19 vaccine roll-out in Africa. Thus, the results highlight some of the early

challenges to the implementation of the COVID-19 vaccination programmes on the continent. The limitations of the study are, firstly, that its cross-sectional nature does not allow for thorough cause and effect assessment. Secondly, because the study was performed during the early phase of the vaccine roll-out and in the context of limited vaccine supply, it is likely that some of the unvaccinated respondents intended to be vaccinated but had not had the chance yet to do so. Although access to vaccines likely impacted non-HCW older persons as discussed above, it is unlikely to have been a strong barrier for vaccine uptake among HCWs. Thirdly, the study enrolled participants from only two districts and included a small number of non-HCWs. Hence the results may not be widely generalisable to HCWs and older persons in Uganda. Finally, receipt of COVID-19 vaccine was self-reported and may have been subject to social desirability bias.

Conclusions

COVID-19 vaccine uptake was moderately high among HCWs, and extremely low among non-HCW older persons. COVID-19 vaccine programmes should foster positive attitudes towards COVID-19 vaccines by providing accurate vaccine information to target populations. Vaccine delivery strategies should be customised to suit target populations such as the elderly and persons in rural areas that may otherwise find it challenging to access vaccination centres. These strategies could include community-based vaccines delivery approaches as well as health facility-based approaches that target specific populations such persons attending chronic disease clinics.

Data availability

The data underlying this study cannot be openly shared based upon the LSHTM Ethics guidelines outlined in the Confidentiality and Anonymisation of Research Data (LSHTM-SOP-036-02). The research data was collected with a promise to protect participant confidentiality. This is a particular concern, due to the presence of participant-provided information on Covid-19 infection and vaccination that carries some stigma within the community. Although measures have been applied to de-identify data as far as possible, there remains a recognised risk that participants may be re-identified if combined with other public sources. To protect participants, a controlled access approach has been adopted that will allow data to be used for research purposes, with additional processing performed where needed. We will seek to ensure access restrictions are kept to a minimum.

LSHTM Data Compass: Data for: "COVID-19 vaccine roll-out in Uganda: a case study of uptake and associated factors among health care workers and older people". <https://doi.org/10.17037/DATA.00003735>²⁹. The anonymised data can be accessed through the link. The data description, questionnaire and the data codebook too can be accessed through the link shared above.

Acknowledgements

We are grateful to the staff of the collaborating institutions, Entebbe Regional referral, Our Lady of Consolata Kisubi and Villa Maria Hospitals, the older people from the Well-being of Older People Study.

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