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# BMJ Open

## Uptake of COVID-19 vaccines and associated factors among adults in Uganda: a cross-sectional survey

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1 **Uptake of COVID-19 vaccines and associated factors among adults in**  
2 **Uganda: a cross-sectional survey**

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## 22 Abstract

23 **Objective** The Coronavirus Disease (COVID-19) pandemic remains one of the most significant  
24 public health challenges ever faced globally. Vaccines are key to ending the pandemic as well as  
25 minimize its consequences. This study assessed the uptake of COVID-19 vaccines and  
26 associated factors among adults in Uganda.

27 **Design, setting and participants** We conducted a cross-sectional mobile phone survey among  
28 1173 adults across the four regions of Uganda.

29 **Main outcome variable** Participants reported their uptake of COVID-19 vaccines.

30 **Results** Overall, 49.7% had received COVID-19 vaccines with 19.2% having obtained a full  
31 dose and 30.5% an incomplete dose. Among the unvaccinated, 91.0% indicated intention to  
32 vaccinate. Major reasons for vaccine uptake were protection of self from COVID-19 (86.8%)  
33 and a high perceived risk of getting the virus (19.6%). On the other hand, non-uptake was related  
34 to vaccine unavailability (42.4%), lack of time (24.1%), and perceived safety (12.5%) and  
35 effectiveness concerns (6.9%). The factors associated with receiving the COVID-19 vaccines  
36 were older age ( $\geq 65$  years) (APR = 1.32 (95% CI: 1.08 – 1.61), secondary (APR = 1.36 (95%  
37 CI: 1.12 – 1.65), or tertiary education (APR = 1.62 (95% CI: 1.31 – 2.00), and health workers as  
38 a source of information on COVID-19 (APR = 1.26 (95% CI: 1.10 – 1.45). Also, those who  
39 reported a medium-income (APR = 1.24 (1.02 – 1.52) and those resident in Northern (APR =  
40 1.55, 95%CI 1.18 – 2.02) and Central regions (APR = 1.48, 95%CI 1.16 – 1.89) had a higher  
41 uptake of COVID-19 vaccines.

42 **Conclusions** Uptake of COVID-19 vaccines was moderate in this sample and was associated  
43 with older age, secondary and tertiary education, medium-income, region of residence, and

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3 44 health workers as a source of COVID-19 information. Efforts are needed to increase access to  
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5 45 vaccines and should utilize health workers as champions to enhance uptake.  
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10 47 **Wordcount: 3250**  
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15 49 **Keywords:** associated factors, COVID-19, intention, uptake, Uganda, vaccines, willingness  
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## 19 51 **STRENGTHS AND LIMITATIONS OF THIS STUDY**

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23 52 • This study had a high response rate with over 94% of the participants consenting to  
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25 53 participate in the phone survey.  
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28 54 • Results from the backchecking with the same individuals showed high consistency with the  
29  
30 55 survey results.  
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32 56 • Being a mobile phone survey, the study participants were not representative of the population  
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34 57 as only those with a mobile phone could participate.  
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37 58 • Reporting of vaccination status could have been subject to social desirability bias, which we  
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39 59 minimized by reminding participants that the study was only for research purposes.  
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## 67 INTRODUCTION

68 The Coronavirus disease of 2019 (COVID-19) has resulted in significant morbidity and mortality  
69 globally and negatively disrupted multiple socio-economic sectors. As of 31<sup>st</sup> March 2022, over  
70 488 million confirmed cases and 6.1 million deaths had been registered globally <sup>1</sup>. In Africa,  
71 more than 11 million confirmed COVID-19 cases and 251,953 deaths were reported since the  
72 onset of the epidemic. Within the same period, Uganda recorded 163,905 cumulative COVID-19  
73 cases and 3,596 confirmed deaths <sup>1</sup>. In response and under the advice of the World Health  
74 Organization, many countries at the beginning of the pandemic implemented non-pharmaceutical  
75 interventions (NPIs) that restricted movement such as lockdowns and curfews. Several  
76 governments both globally and in Africa also closed schools, places of worship, recreation  
77 centres, and public places. Governments also promoted regular hand and respiratory hygiene,  
78 wearing of facemasks, ensuring physical and social distancing, and working from home <sup>2</sup>. These  
79 public health and social measures significantly impacted the delivery of routine health care  
80 services, caused job losses, disrupted education and formal and informal trade, and increased  
81 gender-based violence and mental health disorders <sup>3-5</sup>.

82 Vaccines as key pharmaceutical interventions to contain COVID-19 were adopted almost one  
83 year into the pandemic globally. Uganda recorded its first confirmed case of COVID-19 on 21<sup>st</sup>  
84 March 2020 and received its first batch of COVID-19 vaccines one-year later in March 2021. At  
85 the start, vaccination targeted high-risk groups including health workers, teachers, security  
86 personnel, persons older than 50 years, and those with co-morbidities. Starting August 2021  
87 when the country received more doses of vaccines, vaccination was opened up to all Ugandans  
88 aged 18 years and above. Vaccines were largely available through designated health facilities,  
89 outreaches and mobile vaccination service points. The Ministry of Health (MoH) ran media

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3 90 campaigns to mobilise communities for COVID-19 vaccination working hand in hand with local  
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5 91 government structures. High vaccination coverage was critical for containment of the pandemic,  
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7 92 re-opening of the economy and reversal of the negative socio-economic impacts of the NPIs.  
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9 93 However, the opening up of eligibility for vaccination was marred with negative information and  
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11 94 fears of vaccine hesitancy. In order to develop critical strategies to achieve high vaccination  
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13 95 coverage, there is need for an in-depth understanding of factors influencing the uptake of  
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15 96 COVID-19 vaccination. This study, therefore, sought to gather and analyse data to determine the  
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17 97 uptake of COVID-19 vaccines and associated factors among adults in Uganda.  
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## 22 98 **METHODS**

### 23 24 25 99 **Study setting**

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28 100 This study was conducted in Uganda located in Eastern Africa. The country has 136 districts  
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30 101 distributed in four administrative regions (Northern, Eastern, Central, and Western) which were  
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32 102 all involved in the study. As of 2020, Uganda had an estimated population of approximately 41.8  
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34 103 million people <sup>6</sup>. Having registered its first confirmed case of COVID-19 in March 2020, the  
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36 104 country had by November 2021 experienced two waves of the disease. The first wave of the  
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38 105 pandemic occurred from August 2020 to February 2021 of various non-Delta variants while the  
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40 106 second wave happened from May to October 2021 fueled by the Delta variant <sup>1 7</sup>.  
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### 45 107 **Study design and population**

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48 108 This was a cross-sectional mobile phone survey conducted in November 2021 among a  
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50 109 nationally constituted sample of adults. The study enrolled persons aged  $\geq 18$  years sampled from  
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52 110 the country's four administrative regions: Central, Eastern, Northern and Western. We excluded  
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54 111 persons who said they were ill and unable to participate in the interview.  
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## 112 **Sample size estimation**

113 To enable tracking changes in adherence to NPIs following the introduction of vaccines, we used  
114 a previous sample of study respondents from an earlier survey <sup>8</sup> whose data were collected in  
115 March 2021 <sup>8</sup>. The sample size for the previous survey was determined using the Leslie Kish  
116 formula for cross-sectional studies <sup>9</sup> considering the following assumptions: Two-sided Z  
117 statistic corresponding to a 95% confidence interval (1.96), NPI adherence level of 50% since no  
118 other study had been conducted to show the composite level of adherence, a precision of 5% and  
119 a design effect of 2.5 <sup>8</sup>. Considering a non-response rate of 10%, the total sample size estimate  
120 was 1056 people.

## 121 **Sampling strategy**

122 We used the sample from an earlier survey <sup>8</sup>, which was constituted following quota sampling.  
123 Quotas were set on age, gender and location proportionate to national COVID-19 case  
124 distribution statistics as of February 2021 <sup>10</sup>. With quotas in place, a simple randomly selected  
125 (SRS) sample was obtained among the eligible population using a database of phone contacts of  
126 previous survey respondents provided by a registered research firm. In cases of replacement of  
127 previous participants due to unavailability or refusal to participate, a similar case distribution was  
128 followed during sampling of new contacts.

## 129 **Data collection**

130 Data were collected using a structured survey questionnaire, with mostly closed-ended questions,  
131 informed by a review of published literature <sup>8 11 12</sup>. The questionnaire was pretested among 20  
132 people from the four regions of Uganda and relevant adjustments were made. The questionnaire  
133 was translated into nine major local languages spoken in Uganda, namely: *Ateso, Luganda,*

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3 134 *Lugbara, Lugisu, Luo, Lusoga, Ngakarimojong, Runyankole-Rukiga and Runyoro-Rutooro.* A  
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5 135 separate group of translators validated the questionnaire translations and any discrepancies were  
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7 136 addressed. The final survey instrument in each language was programmed in SurveyCTO  
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9 137 software, incorporating appropriate routing, conditional logic, and other controls and uploaded  
10  
11 138 on hand-held mobile tablets. Bench testing of the survey questionnaire was conducted, and  
12  
13 139 adjustments made before actual data collection. Trained research assistants with a minimum of a  
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15 140 Diploma in a health-related field, fluent in the survey languages and with experience in mobile  
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17 141 surveys conducted the interviews. Research assistants made phone calls from a designated place  
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19 142 in Kampala to the respondents from whom they sought verbal informed consent after explaining  
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21 143 to them what the study entailed and entered data into the tablets. Respondents who preferred to  
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23 144 defer the phone interviews due to busy schedules or other reasons received follow-up phone calls  
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25 145 based on agreed-upon appointment times. Daily checks of the survey data were conducted to  
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27 146 monitor quality and intervene early and appropriately, as well as ensure adherence to established  
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29 147 quotas. A team of supervisors oversaw the work of the research assistants ensuring that questions  
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31 148 were asked appropriately, and respondents were interviewed in the language they were most  
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33 149 comfortable with. At the end of the interview period, we conducted back checking of 10% of  
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35 150 respondents to ascertain the quality of collected data.  
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### 43 **Data management and analysis strategy**

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45 152 During data collection, each research assistant examined, edited, and cleaned their data daily  
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47 153 before uploading it to the server. Data were encrypted and anonymized on the server and later  
48  
49 154 downloaded and exported to Stata 15.0 for further cleaning. Data analysis was conducted in  
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51 155 Rstudio Version 1.4.1106 (RStudio, PBC). Descriptive statistics have been provided in the form  
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53 156 of means (standard deviation) for continuous variables while categorical variables have been  
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3 157 expressed as frequencies and percentages. Socioeconomic status was generated as an additive  
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5 158 index from 6 variables on household ownership of television, computer, sofa set, refrigerator,  
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8 159 and cassette/CD/DVD player, and access to electricity. The socio-economic status index was  
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10 160 then divided into tertiles. The dependent variable was self-reported uptake of COVID-19  
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12 161 vaccines, which constituted those who reported receiving at least one dose of any World Health  
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14 162 Organization (WHO) approved COVID-19 vaccines. We also determined the intention to uptake  
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16 163 COVID-19 vaccines by asking unvaccinated respondents if they intended to receive the vaccine.  
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19 164 The independent variables included socio-demographic characteristics (age, gender, employment  
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21 165 status, education and occupation, place of residence (urban vs. rural, region) and source of  
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23 166 information on COVID-19. To determine the factors associated with vaccination uptake, we ran  
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25 167 multivariable modified Poisson regressions with robust error variance and presented prevalence  
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27 168 ratios and corresponding 95% confidence intervals. Only variables with a p-value  $\leq 0.2$  at  
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29 169 bivariate levels were included in the final model.  
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### 34 170 **Patient and public involvement**

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37 171 No patients or members of the public were involved in the study design, setting the research  
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39 172 questions, interpretation or writing up of results, or reporting of the research.  
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178 **RESULTS**179 **Sociodemographic characteristics of participants**

180 Of the 1,249 respondents reached, a total of 1,173 (94%) participants completed the survey. The  
 181 mean age of respondents was 39.7 years (SD  $\pm$ 14.2) and majority 717 (61.1%) were males. Half  
 182 606 (51.7%) of the study participants were from the Central region, 548 (46.8%) had an urban  
 183 residence and 548 (46.7%) belonged to the lowest socioeconomic tertile. Nearly four in ten  
 184 (39%) respondents had only primary or no formal education (Table 1).

185 **Table 1: Sociodemographic characteristics of participants**

Characteristic	Number of participants (N = 1,173)	Percentage (%) <sup>1</sup>
<b>Sex</b>		
Male	717	61.1
Female	456	38.9
<b>Age group (years), Mean age (SD)</b>	39.7 ( $\pm$ 14.2)	
18 – 35	553	47.1
36 – 55	439	37.4
56 - 64	92	7.8
65+	89	7.6
<b>Region of residence</b>		
North	182	15.5
East	211	18
Central	606	51.7
West	174	14.8
<b>Residence</b>		
Urban	548	46.8
Rural	417	35.6
Semi-urban	207	17.7
Not stated	1	
<b>Earnings per month (\$)</b>		
< 14	256	25.6
14 – 29	226	22.6
30 – 57	196	19.6
58 – 143	229	22.9
> 143	93	9.3

Characteristic	Number of participants (N = 1,173)	Percentage (%) <sup>1</sup>
Not stated	173	
<b>Education level</b>		
None or Incomplete Primary	265	23.2
Primary (completed)	180	15.7
Secondary	431	37.7
Tertiary	268	23.4
Not stated	27	
<b>Socio-economic index</b>		
Low	548	46.7
Middle	435	37.1
Higher	190	16.2
<b>Religion</b>		
Catholic	384	33.3
Anglican	372	32.3
Born Again (Pentecostal)	147	12.8
Muslim	226	19.6
Other religions	24	2.1
Not stated	20	
<b>Current Occupation</b>		
Unemployed	193	17.1
Employed	182	16.1
Self employed	355	31.4
Casual laborer	67	5.9
Farmer	334	29.5
Not stated	42	
<b>Current household size, Mean (SD)</b>	5.6 (3.5)	
5 or fewer	653	55.7
6 – 10	430	36.7
More than 10	90	7.7

<sup>1</sup> Percentages calculated do not include respondents who did not record responses (e.g. "Not stated" in the tables)

## Uptake of COVID-19 vaccines and intention to vaccinate

Among all respondents, 225 (19.2%) reported receiving a full dose of the vaccine and 357 (30.5%) an incomplete dose. Slightly above sixty per cent of the respondents 367 (63.2%) reportedly experienced side effects following vaccination mostly fever 147 (40.1%), fatigue 115

193 (31.3%) and headache 101 (27.5%). Among those who had not received a vaccine, 537 (91.8%)  
 194 reported intention to vaccinate (  
 195 Table 2).

196

197 **Table 2: Vaccination uptake and intention to vaccinate among participants**

Variable	Count	Percentage (%) <sup>1</sup>
<b>Vaccination uptake</b>	<b>(n = 582)</b>	
Full dose (two shots)	225	19.2
Incomplete dose	357	30.5
No vaccination	590	50.3
<b>Experienced any side effects after first dose</b>		
No	214	36.8
Yes	367	63.2
<b>Side effects reported</b>	<b>(n = 367)</b>	
Fever	147	40.1
Fatigue	115	31.3
Headache	101	27.5
Muscle soreness /pain	95	25.9
Injection site reaction	88	24.0
Others <sup>2</sup>	38	10.4
<b>Vaccination intention (among unvaccinated)</b>	<b>n = 590</b>	
Intend to vaccinate	537	91.0
Did not intend to vaccinate	48	8.1
Did not know	5	0.8

198 <sup>1</sup> Percentages calculated do not include respondents who did not record responses e.g. "Not stated" in the tables

199 <sup>2</sup> Allergic reaction, cough, body pain, dizziness, arrhythmias, body weakness, paralysis for a few days,  
 200 erectile dysfunction for a few days

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6 203 **Reasons for vaccine uptake/ non-uptake and intention/un intention to vaccinate**

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9 204 The reasons for COVID-19 vaccine uptake and intention to vaccinate were similar with both  
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11 205 categories of respondents mostly reporting the need to obtain protection from COVID-19 and  
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13 206 having a high perceived risk of getting the virus. Over 40% of respondents who had not been  
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15 207 vaccinated attributed it to vaccine unavailability 250 (42.4%) and below a quarter of respondents  
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17 208 to not having time 142 (24.1%). The reasons for lack of intention to vaccinate were mainly  
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19 209 related to safety 24 (50.0%) and effectiveness concerns 17 (35.4%) which were similarly  
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21 210 reported for non-uptake of vaccines (  
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244 **Table 3: Reasons for (non) uptake of COVID-19 vaccines and intention to vaccinate**  
245 **(multiple response)**

Reasons	Uptake of vaccines n = 582 (%)	Intention to vaccinate n = 537 (%)
To protect self from COVID-19	505 (86.8%)	458 (85.3%)
High perceived risk of getting COVID-19	114 (19.6)	90 (16.8%)
Prioritized due to health (comorbidities)	95 (16.3)	34 (6.3%)
Recommendation from health workers	81 (13.9)	38 (7.1)
Prioritized due to occupation	74 (12.7)	-
Travel purposes	44 (7.6)	45 (8.4%)



Job requirement	-	82 (15.3%)
Others	21 (3.6) <sup>1</sup>	20 (3.8) <sup>2</sup>
<b>Reasons</b>	<b>Non uptake of vaccines n = 590 (%)</b>	<b>No intention to vaccinate n = 48 (%)</b>
Vaccines are unavailable	250 (42.4)	1 (2.1)
Don't have time	142 (24.1)	2 (4.2)
Safety concerns	74 (12.5)	24 (50.0)
Doubt vaccine effectiveness	41 (6.9)	17 (35.4)
Not among eligible group	30 (5.1)	4 (8.3)
Transport costs	24 (4.1)	Not reported
Don't know where to access the vaccines from	20 (3.4)	Not reported
Do not fear COVID-19/ trust immunity	10 (1.7)	1 (2.1)
Others	82 (14.0) <sup>3</sup>	7 (14.6) <sup>4</sup>

246 <sup>1</sup> Requirement for school attendance, being exemplary, following MOH guidelines, boosting  
247 immunity, to access services, among the eligible group.

248 <sup>2</sup> Access to health services, government mandate, pressure from peers, to be exemplary,  
249 requirement for school attendance.

250 <sup>3</sup> Pregnant, breastfeeding, waiting for another vaccine type, lack identification documents, long  
251 queues, currently sick, recently recovered from COVID-19.

252 <sup>4</sup> Religious beliefs, do not believe COVID-19, HIV positive and fear side effects, underlying  
253 Hepatitis B infection, Body already weak, Lack of identification documents.

254

### 255 **Willingness to vaccinate for different vaccine types**

256 All respondents were asked if they would receive the different types of COVID-19 vaccines if  
257 offered at that point and were free of charge. Only 316 (26.9%) reported that they would take  
258 any vaccine regardless of the type and 488 (41.6%) indicated a willingness to take at least one  
259 type of the vaccine. The most preferred COVID-19 vaccines types were Johnson and Johnson  
260 436 (37.4%) and AstraZeneca 405 (34.7%) (Figure 1).

261

262 **Figure 1 Willingness for COVID-19 vaccination for different vaccine types**

263  
264 **Factors associated with uptake of COVID-19 vaccines**

265 At the multivariable analysis level, participants aged  $\geq 65$  years had a 32% higher likelihood to  
266 have been vaccinated compared to those aged 18-35 years (Adjusted PR = 1.32, 95% CI 1.08 –  
267 1.61,  $p = 0.008$ ). Participants from the Northern (adjusted PR = 1.55, 95% CI 1.18 – 2.02,  $p =$   
268 0.002) and Central regions (adjusted PR = 1.48, 95% CI 1.16 – 1.89,  $p = 0.002$ ) respectively had  
269 a 55% and 48% higher likelihood to have received the vaccine compared to those from the  
270 Western region. Participants with secondary (adjusted PR = 1.36, 95% CI 1.12 – 1.65,  $p = 0.002$ )  
271 or tertiary education (Adjusted PR = 1.62, 95% CI 1.31 – 2.00,  $p < 0.001$ ) were more likely to  
272 have received the COVID-19 vaccine compared to those with incomplete primary/no formal  
273 education. Respondents whose monthly income was between \$30 and \$57 (APR = 1.24 (1.02 –  
274 1.52),  $p = 0.029$ ) had a higher uptake of COVID-19 vaccines than those who earned  $< \$14$ .  
275 Having health workers as a source of information on COVID-19 was associated with higher  
276 uptake of COVID-19 vaccines in Uganda (adjusted PR = 1.26, 95%CI 1.10 – 1.45,  $p = 0.001$ )  
277 (Table 4).

278 **Table 4: Factors associated with COVID-19 vaccine uptake among adults**

Variables / Characteristics	Self-reported uptake of COVID-19 vaccine		Unadjusted PR (95% CI) <sup>1</sup>	p-value	Adjusted PR (95% CI) <sup>2</sup>	p-value
	No (%)	Yes (%)				
<b>Age in years</b>						
18 – 35	296 (53.5)	257 (46.5)	1		1	
36 – 55	213 (48.6)	225 (51.4)	1.11 (0.97 – 1.26)	0.124	1.09 (0.95 – 1.25)	0.244
56 – 64	44 (47.8)	48 (52.2)	1.12 (0.91 – 1.39)	0.292	1.17 (0.92 – 1.48)	0.193
65+	37 (41.6)	52 (58.4)	1.26 (1.03 -1.53)	<b>0.023</b>	1.32 (1.08 – 1.61)	<b>0.008</b>
<b>Region of residence</b>						

Variables / Characteristics	Self-reported uptake of COVID-19 vaccine		Unadjusted PR (95% CI) <sup>1</sup>	p-value	Adjusted PR (95% CI) <sup>2</sup>	p-value
	No (%)	Yes (%)				
Western	115 (66.5)	58 (33.5)	1		1	
Northern	74 (40.7)	108 (59.3)	1.77 (1.39 – 2.25)	<b>&lt;0.001</b>	1.55 (1.18 - 2.02)	<b>0.002</b>
Eastern	112 (53.1)	99 (46.9)	1.40 (1.09 – 1.80)	<b>0.010</b>	1.29 (0.99 - 1.69)	0.064
Central	289 (47.7)	317 (52.3)	1.56 (1.25– 1.95)	<b>0.001</b>	1.48 (1.16 - 1.89)	<b>0.002</b>
<b>Residence</b>						
Urban	270 (49.4)	277 (50.6)			1	
Rural	206 (49.4)	211 (50.6)	0.99 (0.88 – 1.13)	0.990	1.11 (0.97 – 1.28)	0.137
Semi-urban	114 (55.1)	93 (44.9)	0.89 (0.75 – 1.05)	0.173	0.92 (0.75 – 1.11)	0.373
<b>Gender</b>						
Male	351 (49.0)	366 (51.0)	1		1	
Female	239 (52.5)	216 (47.5)	0.93 (0.82 – 1.05)	0.237	1.00 (0.87 – 1.14)	0.973
<b>Wealth index</b>						
Low	290 (53.0)	257 (47.0)	1		1	
Middle	217 (49.9)	218 (50.1)	1.07 (0.94 – 1.21)	0.328	1.06 (0.91 – 1.24)	0.442
High	83 (43.7)	107 (56.3)	1.20 (1.03 – 1.40)	<b>0.021</b>	1.03 (0.83 – 1.28)	0.758
<b>Current Occupation</b>						
Unemployed	91 (47.2)	102 (52.8)	1		1	
Employed	76 (41.8)	106 (58.2)	1.10 (0.92 – 1.32)	0.294	1.03 (0.84 – 1.27)	0.763
Self employed	196 (55.2)	159 (44.8)	0.85 (0.71 – 1.01)	0.066	0.84 (0.68 – 1.02)	0.078
Casual laborer	45 (67.2)	22 (32.8)	0.62 (0.43 – 0.90)	<b>0.011</b>	0.73 (0.48 – 1.11)	0.146
Farmer	164 (49.1)	170 (50.9)	0.96 (0.81 – 1.14)	0.664	0.99 (0.82 – 1.19)	0.931
<b>Education level</b>						
No formal education / incomplete primary	161 (60.8)	104 (39.2)	1		1	

Variables / Characteristics	Self-reported uptake of COVID-19 vaccine		Unadjusted PR (95% CI) <sup>1</sup>	p-value	Adjusted PR (95% CI) <sup>2</sup>	p-value
	No (%)	Yes (%)				
Complete primary	109 (60.6)	71 (39.4)	1.01 (0.79 - 1.27)	0.966	1.00 (0.78 - 1.28)	0.998
Secondary education	207 (48.0)	224 (52.0)	1.32 (1.11 - 1.58)	<b>0.002</b>	1.36 (1.12 - 1.65)	<b>0.002</b>
Tertiary	98 (36.6)	170 (63.4)	1.62 (1.36 - 1.93)	<b>&lt; 0.001</b>	1.62 (1.31 - 2.00)	<b>&lt; 0.001</b>
Household size (mean)	5.41	5.99	1.02 (1.01 - 1.03)	<b>&lt; 0.001</b>	1.02 (1.00 - 1.03)	0.071
Monthly income (\$)						
< 14	144 (56.2)	112 (43.8)	1		1	
14 - 29	117 (51.8)	109 (48.2)	1.10 (0.91 - 1.34)	0.324	1.08 (0.89 - 1.32)	0.423
30 - 57	86 (43.9)	110 (56.1)	1.28 (1.07 - 1.55)	<b>0.009</b>	1.24 (1.02 - 1.52)	<b>0.029</b>
58 - 143	114 (49.8)	115 (50.2)	1.15 (0.95 - 1.39)	0.154	0.98 (0.79 - 1.22)	0.876
> 143	36 (38.7)	57 (61.3)	1.40 (1.13 - 1.73)	<b>0.002</b>	1.16 (0.91 - 1.49)	0.219
Health workers as source of information on COVID-19 <sup>3</sup>						
No	245 (57.9)	178 (42.1)	1		1	
Yes	345 (46.1)	404 (53.9)	1.28 (1.13 - 1.45)	<b>&lt; 0.001</b>	1.26 (1.10 - 1.45)	<b>0.001</b>

279 <sup>1</sup> Bivariate analysis

280 <sup>2</sup> Multivariable analysis

281 <sup>3</sup> Other sources of information included family members, friends/peers, Radio, Television, community  
 282 members and social media among others which were dichotomized and included in the analysis but were  
 283 not significant

284

## 285 DISCUSSION

286 This study examined the uptake of COVID-19 vaccines and associated factors among adults  
 287 aged 18 years and above in Uganda. Among the study participants, about one in five (19.2%)  
 288 reported receiving a full dose of the COVID-19 vaccine while 30.5% had received an incomplete  
 289 dose. Over 90% of those who were unvaccinated reported the intention to be vaccinated. The  
 290 major reasons for vaccine uptake and intention to vaccinate were protection of self from COVID-

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3 291 19 and a high perceived risk of getting the virus while reasons for vaccine non-uptake were  
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5 292 vaccine unavailability, the lack of time to go get vaccinated, and safety and effectiveness  
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8 293 concerns. The factors that were associated with receiving the COVID-19 vaccine were older age  
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10 294 (65 years and above), having secondary education and above, having a moderate income, and  
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12 295 reporting health workers as a source of information on COVID-19. Being a resident of Northern  
13  
14 296 and Central Uganda was also associated with a high likelihood of receiving the vaccine.

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16  
17 297 Uptake of COVID-19 vaccines in this sample of respondents was higher for both full and  
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19 298 incomplete doses than the vaccinated proportion of the population as of November 2021 when  
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21 299 this study was conducted. Ministry of Health data of 8<sup>th</sup> November 2021 indicated that 55.8%  
22  
23 300 and 16.8% of the priority groups and 12.2% and 3.7% of the adult population had received their  
24  
25 301 first and second doses of the vaccine respectively <sup>13</sup>. The higher-than-baseline vaccination  
26  
27 302 coverage could be attributed to the use of mobile phones for the survey and thus the relatively  
28  
29 303 urbanized study sample whose access to vaccines was higher than those in rural areas. Moreover,  
30  
31 304 a high proportion of participants were from the Central region, which was most impacted by  
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33 305 COVID-19, and their experiences could have influenced vaccine uptake. In addition, intention to  
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35 306 vaccinate was very high at over 90%; higher than the combined “definite intention” of 57.8%  
36  
37 307 and “probable intention” of 26.2% from the March survey round <sup>8</sup>. In a November 2021 survey  
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39 308 among 23,000 respondents from 19 African Union members states including Uganda, (78%) of  
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41 309 respondents had either been vaccinated or were likely to get vaccinated <sup>14</sup>. The second COVID-  
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43 310 19 wave fueled by the Delta variant that was experienced in Uganda from June to September  
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45 311 2021 and led to at least 2,800 deaths compared to the less than 300 recorded at the end of the  
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47 312 first wave <sup>1 15</sup> could also have contributed to the high uptake of the vaccine and intention-to-  
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49 313 vaccinate. In addition, there was concern about potential vaccine mandates including anticipation  
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3 314 that the unvaccinated would be denied health and social services which could also have increased  
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5 315 the intention to vaccinate.  
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8 316 The major reasons for vaccine uptake and intention to vaccinate were protection of self from  
9  
10 317 COVID-19 and a high perceived risk of getting the virus, similar to previous research <sup>11</sup>. This is  
11  
12 318 also an indication of the respondents' appreciation of the role of vaccines in preventing morbidity  
13  
14 319 and saving lives. Those unvaccinated attributed it to vaccine unavailability and the lack of time.  
15  
16 320 The survey in 19 African countries concluded that low vaccine uptake was mostly due to  
17  
18 321 unpredictable supply of vaccines and logistical hurdles than reluctance or refusal to get  
19  
20 322 vaccinated <sup>14</sup>. To bridge the willingness-intention-uptake gap in Uganda, the Ministry of Health  
21  
22 323 should increase access and availability of COVID-19 vaccines. Evidence shows that strategies  
23  
24 324 that take vaccines closer to the communities are likely to mitigate time and transport-related  
25  
26 325 barriers and increase vaccine uptake <sup>16 17</sup>. This could be achieved by increasing the number of  
27  
28 326 health facilities offering the vaccines, conducting more vaccination outreaches, or setting up  
29  
30 327 mobile vaccine points. The World Health Organization guidance has also emphasized the  
31  
32 328 importance of location and time in COVID-19 vaccine uptake <sup>18</sup>. On the other hand, the study  
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34 329 reported that safety and effectiveness concerns hindered vaccine uptake and intention to  
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36 330 vaccinate similar to previous research <sup>8 11 19-22</sup>. Of note as well was the observed high prevalence  
37  
38 331 (63%) of self-reported vaccine side effects which could go a long way in reinforcing safety  
39  
40 332 concerns among the population. Vaccine adverse events should be monitored closely, and  
41  
42 333 appropriate information, education and communication material developed including information  
43  
44 334 on expected side effects to counter their potential effect on the uptake of vaccination by the  
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46 335 unvaccinated. Accurate, consistent and transparent communication and dialogue about  
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48 336 uncertainty, risks and anticipated benefits can go a long way in building confidence and trust in  
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3 337 the COVID-19 vaccines and create motivation for vaccination <sup>18 22</sup>. This could also bridge  
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5 338 observed gaps in vaccine preference to prevent this from being a barrier to vaccination. The  
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8 339 Johnson and Johnson vaccine being a single shot had a higher preference among respondents due  
9  
10 340 to the perceived inconvenience and unpredictability of obtaining a second vaccine dose.

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12  
13 341 It was not surprising that those aged 65 years and above had a higher vaccination uptake as these  
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15 342 were part of the prioritized group for COVID-19 vaccination in the country. Education status  
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17 343 also predicted vaccination status similar to previous research on COVID-19 vaccine acceptability  
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19 344 <sup>23-26</sup>. However, further efforts are required to ensure the dissemination of accurate and simple  
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21 345 COVID-19 vaccination messages to those of lower education levels including translating  
22  
23 346 information in the local languages so that this group is not left behind. A moderate income was  
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25 347 associated with higher vaccine uptake; however, this relationship was not sustained with  
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27 348 increasing income levels. The regional differences observed in the uptake of COVID-19 vaccines  
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29 349 may have been due to differences in vaccine access and availability, especially for Central region  
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31 350 which was most hit by the pandemic and was prioritized early during vaccine rollout. From  
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33 351 previous research, income levels and locations have been reported as predictors of COVID-19  
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35 352 vaccine acceptability <sup>26 27</sup>.

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38 353 One major finding from our work was that respondents whose source of information on COVID-  
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41 354 19 was health workers had a higher likelihood for COVID-19 vaccination. This positions health  
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43 355 workers as a key resource in increasing vaccination uptake, and thus they should be furnished  
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45 356 with sufficient and accurate information and supported with effective communication tools to  
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47 357 influence their clients at facility and community level. Previous studies report that health worker  
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49 358 advice on vaccination was most trusted <sup>11 21</sup>. Health workers can lead health education and  
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51 359 awareness programs on COVID-19 and use their platforms at health facility and community  
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3 360 level to influence the masses to uptake COVID-19 vaccines. However, vaccine uptake among  
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5 361 health workers themselves was low at the time even when they were prioritized for vaccination  
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7 362 from the start of the campaigns in Uganda and elsewhere. In a March 2021 survey in Uganda,  
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9 363 just after the launch of the COVID-19 vaccination exercise, a vaccine acceptability rate of 37.3%  
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11 364 and hesitancy of 30.7% were reported among medical students<sup>12</sup>. In a June to August 2021  
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13 365 online survey, acceptance or willingness to uptake the COVID-19 vaccine stood at over 97% and  
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15 366 65.3% of eye healthcare workers had received a COVID-19 vaccine shot influenced by high  
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17 367 perceived susceptibility and benefits<sup>28</sup>. An in-depth study among health workers reported the  
18  
19 368 lack of trust in the vaccine, fear of side effects, not feeling at risk, lack of sufficient information  
20  
21 369 about vaccines, health systems challenges and religious beliefs as barriers to COVID-19  
22  
23 370 vaccination<sup>29</sup>. When health workers are vaccinated, they are more likely to recommend the same  
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25 371 to their clients<sup>30</sup>. Therefore, appropriate interventions should be instituted to effectively deal  
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27 372 with vaccine hesitancy among health workers and have them as champions for COVID-19  
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29 373 vaccination.  
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### 36 374 **Study limitations and strengths**

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39 375 Being a mobile phone survey, the study participants were not representative of the population  
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41 376 and only those with a mobile phone could participate, contributing to selection bias. However  
42  
43 377 mobile phone coverage in Uganda has increased over the years; according to the Uganda  
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45 378 National Household Survey 2020, 74.0% of Ugandans own mobile phones<sup>31</sup>. There was also  
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47 379 potential for social desirability bias, especially regarding reporting vaccination status which we  
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49 380 minimized by reminding participants that the study was only for research purposes. Also, as a  
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51 381 cross-sectional survey, the direction of associations observed is not clear. On the other hand, our  
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53 382 study had a high response rate with over 94% of the participants consenting to participate.  
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3 383 Results from the backchecking with the same individuals also showed high consistency with the  
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5 384 survey results. Our study provides insights into COVID-19 vaccination uptake and intention to  
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8 385 vaccinate which can facilitate the development of context-relevant strategies to increase  
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10 386 vaccinations.

## 11 12 13 387 14 15 388 **CONCLUSIONS**

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18 389 Half of the study respondents were vaccinated against COVID-19, which was associated with  
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20 390 older age, higher education level, moderate income, region of residence and reporting health  
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22 391 workers as the source of COVID-19 information. Among the unvaccinated, over 90% expressed  
23  
24 392 intention to vaccinate. Efforts are needed to increase access to vaccines and utilize health  
25  
26 393 workers as a key resource in sharing information and champions to influence the masses which  
27  
28 394 should positively impact uptake of COVID-19 vaccines.

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## 39 40 41 399 42 43 400 **Author Contributions**

44  
45  
46 401 RN, NC, SNK, AN, WS, LLT and RKW conceptualized and designed the study. RN, NC, SNK,  
47  
48 402 AN, IW, SKiz supported the data collection. RN, NC, SNK, AN, STW, IW, SKiz, SKiw, WS,  
49  
50 403 LLT and RKW contributed to analysis and interpretation of findings. RN, NC, STW wrote the  
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3 404 first draft of the manuscript. SNK, AN, IW, SKiz, SKiw, WS, LLT and RKW critically reviewed  
4  
5 405 the draft manuscript. All authors read and approved the final manuscript.  
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### 24 413 **Competing interests**

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28 414 None declared.  
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### 36 418 **Patient and public involvement**

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39 419 Patients and/or the public were not involved in the design, or conduct, or reporting, or  
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41 420 dissemination plans of this research.  
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### 46 422 **Consent for publication**

47  
48  
49 423 Not applicable  
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53 424

### 54 425 **Ethics approval and consent to participate**

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3 426 Ethical approval to conduct the survey was sought from the Makerere University School of  
4  
5 427 Public Health Higher Degrees Research and Ethics Committee (protocol SPH-2021-150) and the  
6  
7 428 study was registered by the Uganda National Council of Science and Technology (HS1742ES).  
8  
9  
10 429 Verbal consent was provided before participation in the survey. Personally identifiable  
11  
12 430 information including name of respondent, their phone number and the household head name  
13  
14 431 were encrypted with passwords on the SurveyCTO server and drives and was only accessible to  
15  
16 432 the investigator(s). All phones and tablets used for data collection were password-protected to  
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18 433 protect respondent data.  
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#### 23 24 435 **Data availability statement**

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27 436 The data are available from the corresponding author on reasonable request.  
28  
29  
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#### 31 32 438 33 439 34 439 35 36 440 **REFERENCES**

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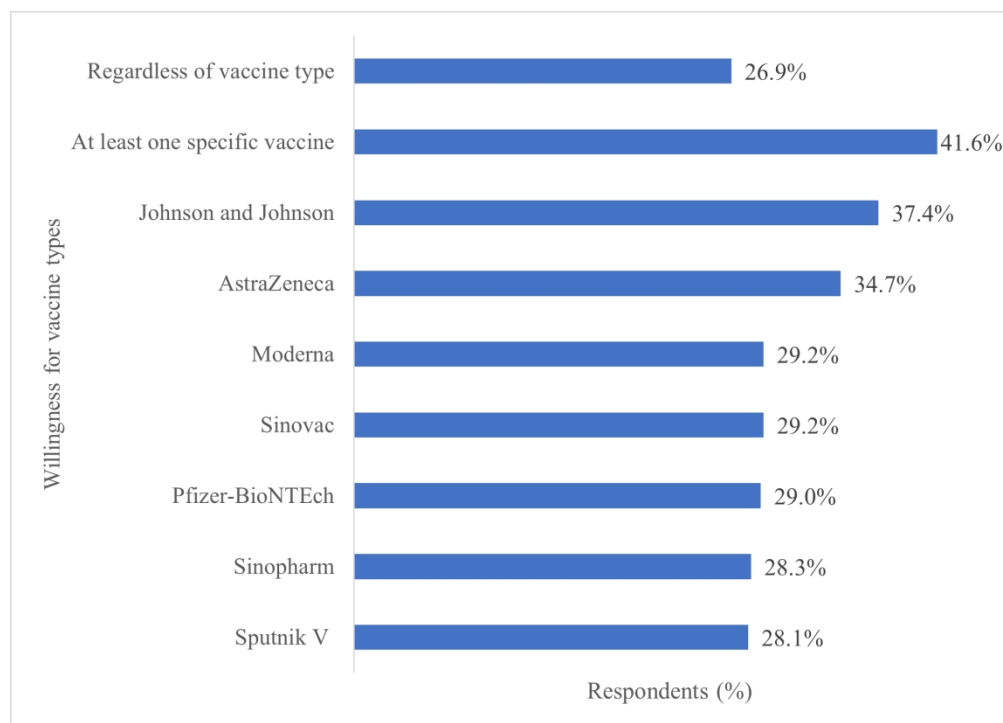
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For peer review only



Willingness for COVID-19 vaccination for different vaccine types

408x294mm (130 x 130 DPI)



STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	1
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4,5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	6,20
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7,8
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7,8
		(b) Describe any methods used to examine subgroups and interactions	7,8
		(c) Explain how missing data were addressed	7,8
		(d) If applicable, describe analytical methods taking account of sampling strategy	Not applicable
		(e) Describe any sensitivity analyses	Not applicable
<b>Results</b>			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	Not necessary
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9

		(b) Indicate number of participants with missing data for each variable of interest	9-16
Outcome data	15*	Report numbers of outcome events or summary measures	9-16
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-16
		(b) Report category boundaries when continuous variables were categorized	9-16
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not relevant
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	None
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	17
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	20,21
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17-21
Generalisability	21	Discuss the generalisability (external validity) of the study results	20,21
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	22

\*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## Uptake of COVID-19 vaccines and associated factors among adults in Uganda: a cross-sectional survey

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1 **Uptake of COVID-19 vaccines and associated factors among adults in**  
2 **Uganda: a cross-sectional survey**

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4 Irene Wanyana<sup>4</sup>, Susan Kizito<sup>1</sup>, Suzanne Kiwanuka<sup>5</sup>, William Sambisa<sup>6</sup>, Lily L. Tsai<sup>2</sup>, Rhoda K.  
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## 22 Abstract

23 **Objective** The Coronavirus Disease (COVID-19) pandemic remains one of the most significant  
24 public health challenges ever faced globally. Vaccines are key to ending the pandemic as well as  
25 minimize its consequences. This study determined the uptake of COVID-19 vaccines and  
26 associated factors among adults in Uganda.

27 **Design, setting and participants** We conducted a cross-sectional mobile phone survey among  
28 adults in Uganda.

29 **Main outcome variable** Participants reported their uptake of COVID-19 vaccines.

30 **Results** Of the participants contacted, 94% (1173) completed the survey. Overall, 49.7% had  
31 received COVID-19 vaccines with 19.2% having obtained a full dose and 30.5% an incomplete  
32 dose. Among the unvaccinated, 91.0% indicated intention to vaccinate. Major reasons for  
33 vaccine uptake were protection of self from COVID-19 (86.8%) and a high perceived risk of  
34 getting the virus (19.6%). On the other hand, non-uptake was related to vaccine unavailability  
35 (42.4%), lack of time (24.1%), and perceived safety (12.5%) and effectiveness concerns (6.9%).  
36 The factors associated with receiving COVID-19 vaccines were older age ( $\geq 65$  years) (APR =  
37 1.32 (95% CI: 1.08 – 1.61), secondary (APR = 1.36 (95% CI: 1.12 – 1.65), or tertiary education  
38 (APR = 1.62 (95% CI: 1.31 – 2.00), and health workers as a source of information on COVID-19  
39 (APR = 1.26 (95% CI: 1.10 – 1.45). Also, reporting a medium-income (APR = 1.24 (1.02 – 1.52)  
40 and residence in Northern (APR = 1.55, 95% CI 1.18 – 2.02) and Central regions (APR = 1.48,  
41 95% CI 1.16 – 1.89) were associated with vaccine uptake.

42 **Conclusions** Uptake of COVID-19 vaccines was moderate in this sample and was associated  
43 with older age, secondary and tertiary education, medium-income, region of residence, and

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3 44 health workers as a source of COVID-19 information. Efforts are needed to increase access to  
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5 45 vaccines and should utilize health workers as champions to enhance uptake.  
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10 47 **Wordcount: 3300**  
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15 49 **Keywords:** associated factors, COVID-19, intention, uptake, Uganda, vaccines, willingness  
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## 19 20 21 51 **STRENGTHS AND LIMITATIONS OF THIS STUDY**

- 22  
23 52 • This study had a high response rate with over 94% of the participants consenting to  
24  
25 53 participate in the phone survey.  
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27  
28 54 • Results from the backchecking with the same individuals showed high consistency with the  
29  
30 55 survey results.  
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32 56 • Being a mobile phone survey, the study participants were not representative of the population  
33  
34 57 as only those with a mobile phone could participate.  
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37 58 • Reporting of vaccination status could have been subject to social desirability bias, which we  
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39 59 minimized by reminding participants that the study was only for research purposes.  
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## 67 INTRODUCTION

68 The Coronavirus disease of 2019 (COVID-19) has resulted in significant morbidity and mortality  
69 globally and negatively disrupted multiple socio-economic sectors. As of 31<sup>st</sup> March 2022, over  
70 488 million confirmed cases and 6.1 million deaths had been registered globally [1]. In Africa,  
71 more than 11 million confirmed COVID-19 cases and 251,953 deaths were reported since the  
72 onset of the epidemic. Within the same period, Uganda recorded 163,905 cumulative COVID-19  
73 cases and 3,596 confirmed deaths [1]. In response and under the advice of the World Health  
74 Organization, many countries at the beginning of the pandemic implemented non-pharmaceutical  
75 interventions (NPIs) that restricted movement such as lockdowns and curfews. Several  
76 governments both globally and in Africa also closed schools, places of worship, recreation  
77 centres, and public places. Governments also promoted regular hand and respiratory hygiene,  
78 wearing of facemasks, ensuring physical and social distancing, and working from home [2].  
79 These public health and social measures significantly impacted the delivery of routine health  
80 care services, caused job losses, disrupted education and formal and informal trade, and  
81 increased gender-based violence and mental health disorders [3-5].

82 Vaccines as key pharmaceutical interventions to contain COVID-19 were adopted almost one  
83 year into the pandemic globally. Uganda recorded its first confirmed case of COVID-19 on 21<sup>st</sup>  
84 March 2020 and received its first batch of COVID-19 vaccines one-year later in March 2021. At  
85 the start, vaccination targeted high-risk groups including health workers, teachers, security  
86 personnel, persons older than 50 years, and those with co-morbidities. Starting August 2021  
87 when the country received more doses of vaccines, vaccination was opened up to all Ugandans  
88 aged 18 years and above. Vaccines were largely available through designated health facilities,  
89 outreaches and mobile vaccination service points. The Ministry of Health (MoH) ran media

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3 90 campaigns to mobilise communities for COVID-19 vaccination working hand in hand with local  
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5 91 government structures. High vaccination coverage was critical for containment of the pandemic,  
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7 92 re-opening of the economy and reversal of the negative socio-economic impacts of the NPIs.  
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10 93 However, the opening up of eligibility for vaccination was marred with negative information and  
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12 94 fears of vaccine hesitancy. In order to develop critical strategies to achieve high vaccination  
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14 95 coverage, there is need for an in-depth understanding of factors influencing the uptake of  
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16 96 COVID-19 vaccination. This study, therefore, sought to gather and analyse data to determine the  
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18 97 uptake of COVID-19 vaccines and associated factors among adults in Uganda.  
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## 22 98 **METHODS**

### 23 24 25 99 **Study setting**

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28 100 This study was conducted in Uganda located in Eastern Africa. The country has 136 districts  
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30 101 distributed in four administrative regions (Northern, Eastern, Central, and Western) which were  
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32 102 all involved in the study. As of 2020, Uganda had an estimated population of approximately 41.8  
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34 103 million people [6]. Having registered its first confirmed case of COVID-19 in March 2020, the  
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36 104 country had by November 2021 experienced two waves of the disease. The first wave of the  
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38 105 pandemic occurred from August 2020 to February 2021 of various non-Delta variants while the  
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40 106 second wave happened from May to October 2021 fueled by the Delta variant [1, 7].  
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### 45 107 **Study design and population**

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48 108 This was a cross-sectional mobile phone survey conducted in November 2021 among a  
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50 109 nationally constituted sample of adults. The study enrolled persons aged  $\geq 18$  years sampled from  
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52 110 the country's four administrative regions: Central, Eastern, Northern and Western. We excluded  
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54 111 persons who said they were ill and unable to participate in the interview.  
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## 112 **Sample size estimation**

113 To enable tracking changes in adherence to NPIs following the introduction of vaccines, we used  
114 a previous sample of study respondents from an earlier survey [8] whose data were collected in  
115 March 2021 [8]. The sample size for the previous survey was determined using the Leslie Kish  
116 formula for cross-sectional studies [9] considering the following assumptions: Two-sided Z  
117 statistic corresponding to a 95% confidence interval (1.96), NPI adherence level of 50% since no  
118 other study had been conducted to show the composite level of adherence, a precision of 5% and  
119 a design effect of 2.5 [8]. Considering a non-response rate of 10%, the total sample size estimate  
120 was 1056 people.

## 121 **Sampling strategy**

122 We used the sample from an earlier survey [8], which was constituted following quota sampling.  
123 Quotas were set on age, sex, and location proportionate to national COVID-19 case distribution  
124 statistics as of February 2021 [10]. The distribution of cases at the time was as follows: age: 18–  
125 35 years (51%), 36–55 years (37%), 56–65 years (8%), 65+ years (4%); sex: male (60%) and  
126 female (40%); and region: Central (55%) and 15% for each of Eastern, Western, and Northern  
127 regions. With quotas in place, a simple randomly selected (SRS) sample was obtained among the  
128 eligible population using a database of phone contacts provided by a registered research firm. In  
129 cases of replacement of previous participants due to unavailability or refusal to participate, a  
130 similar case distribution was followed during sampling of new contacts.

## 131 **Data collection**

132 Data were collected using a structured survey questionnaire (supplementary file 01), with mostly  
133 closed-ended questions, informed by a review of published literature [8, 11, 12]. The

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3 134 questionnaire was pretested among 20 people from the four regions of Uganda and relevant  
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5 135 adjustments were made. The questionnaire was translated into nine major local languages spoken  
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7 136 in Uganda, namely: *Ateso, Luganda, Lugbara, Lugisu, Luo, Lusoga, Ngakarimojong,*  
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9 137 *Runyankole-Rukiga* and *Runyoro-Rutooro*. An independent group of translators validated the  
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11 138 questionnaire translations and any discrepancies were addressed. The final survey instrument in  
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13 139 each language was programmed in SurveyCTO software, incorporating appropriate routing,  
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15 140 conditional logic, and other controls and uploaded on hand-held mobile tablets. Bench testing of  
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17 141 the survey questionnaire was conducted, and adjustments made before actual data collection.  
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19 142 Trained research assistants with a minimum of a Diploma in a health-related field, fluent in the  
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21 143 survey languages and with experience in mobile surveys conducted the interviews. Research  
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23 144 assistants made phone calls from a designated place in Kampala to the respondents from whom  
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25 145 they sought verbal informed consent after explaining to them what the study entailed and entered  
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27 146 data into the tablets. The average interview time was 26 minutes. Respondents who preferred to  
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29 147 defer the phone interviews due to busy schedules or other reasons received follow-up phone calls  
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31 148 based on agreed-upon appointment times. Daily checks of the survey data were conducted to  
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33 149 monitor quality and intervene early and appropriately, as well as ensure adherence to established  
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35 150 quotas. A team of supervisors oversaw the work of the research assistants ensuring that questions  
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37 151 were asked appropriately, and respondents were interviewed in the language they were most  
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39 152 comfortable with. At the end of the interview period, we conducted back checking of 10% of  
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41 153 respondents to ascertain the quality of collected data.  
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#### 154 **Data management and analysis strategy**

155 During data collection, each research assistant examined, edited, and cleaned their data daily  
156 before uploading it to the server. Data were encrypted and anonymized on the server and later

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3 157 downloaded and exported to Stata 15.0 for further cleaning. Data analysis was conducted in  
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5 158 Rstudio Version 1.4.1106 (RStudio, PBC). Descriptive statistics have been provided in the form  
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8 159 of means (standard deviation) for continuous variables while categorical variables have been  
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10 160 expressed as frequencies and percentages. Socioeconomic status was generated as an additive  
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12 161 index from 6 variables on household ownership of television, computer, sofa set, refrigerator,  
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14 162 and cassette/CD/DVD player, and access to electricity. The socio-economic status index was  
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16 163 then divided into tertiles. The dependent variable was self-reported uptake of COVID-19  
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18 164 vaccines, which constituted those who reported receiving at least one dose of any World Health  
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20 165 Organization (WHO) approved COVID-19 vaccines. We also determined the intention to uptake  
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22 166 COVID-19 vaccines by asking unvaccinated respondents if they intended to receive the vaccine.  
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24 167 The independent variables included socio-demographic characteristics (age, gender, employment  
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26 168 status, education and occupation, place of residence (urban vs. rural, region) and source of  
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28 169 information on COVID-19. To determine the factors associated with vaccination uptake, we ran  
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30 170 multivariable modified Poisson regressions with robust error variance and presented prevalence  
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32 171 ratios and corresponding 95% confidence intervals. Only variables with a p-value  $\leq 0.2$  at  
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34 172 bivariate levels were included in the final model.  
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### 41 173 **Patient and public involvement**

42  
43 174 No patients or members of the public were involved in the study design, setting the research  
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45 175 questions, interpretation or writing up of results, or reporting of the research.  
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179 **RESULTS**180 **Sociodemographic characteristics of participants**

181 Of the 1,249 respondents reached, a total of 1,173 (94%) participants completed the survey. The  
 182 mean age of respondents was 39.7 years (SD  $\pm$ 14.2) and majority 717 (61.1%) were males. Half  
 183 606 (51.7%) of the study participants were from the Central region, 548 (46.8%) had an urban  
 184 residence and 548 (46.7%) belonged to the lowest socioeconomic tertile. Nearly four in ten  
 185 (39%) respondents had only primary or no formal education (Table 1).

186 **Table 1: Sociodemographic characteristics of participants**

Characteristic	Number of participants (N = 1,173)	Percentage (%) <sup>1</sup>
<b>Sex</b>		
Male	717	61.1
Female	456	38.9
<b>Age group (years), Mean age (SD)</b>	39.7 ( $\pm$ 14.2)	
18 – 35	553	47.1
36 – 55	439	37.4
56 - 64	92	7.8
65+	89	7.6
<b>Region of residence</b>		
North	182	15.5
East	211	18
Central	606	51.7
West	174	14.8
<b>Residence</b>		
Urban	548	46.8
Rural	417	35.6
Semi-urban	207	17.7
Not stated	1	
<b>Earnings per month (\$)</b>		
< 14	256	25.6
14 – 29	226	22.6
30 – 57	196	19.6
58 – 143	229	22.9
> 143	93	9.3

Characteristic	Number of participants (N = 1,173)	Percentage (%) <sup>1</sup>
Not stated	173	
<b>Education level</b>		
None or Incomplete Primary	265	23.2
Primary (completed)	180	15.7
Secondary	431	37.7
Tertiary	268	23.4
Not stated	27	
<b>Socio-economic index</b>		
Low	548	46.7
Middle	435	37.1
Higher	190	16.2
<b>Religion</b>		
Catholic	384	33.3
Anglican	372	32.3
Born Again (Pentecostal)	147	12.8
Muslim	226	19.6
Other religions	24	2.1
Not stated	20	
<b>Current Occupation</b>		
Unemployed	193	17.1
Employed	182	16.1
Self employed	355	31.4
Casual laborer	67	5.9
Farmer	334	29.5
Not stated	42	
<b>Current household size, Mean (SD)</b>	5.6 (3.5)	
5 or fewer	653	55.7
6 – 10	430	36.7
More than 10	90	7.7

<sup>1</sup> Percentages calculated do not include respondents who did not record responses (e.g. "Not stated" in the tables)

## Uptake of COVID-19 vaccines and intention to vaccinate

Among all respondents, 225 (19.2%) reported receiving a full dose of the vaccine and 357 (30.5%) an incomplete dose. Slightly above sixty per cent of the respondents 367 (63.2%) reportedly experienced side effects following vaccination mostly fever 147 (40.1%), fatigue 115

194 (31.3%) and headache 101 (27.5%). Among those who had not received a vaccine, 537 (91.8%)  
 195 reported intention to vaccinate (  
 196 Table 2).

197

198 **Table 2: Vaccination uptake and intention to vaccinate among participants**

Variable	Count	Percentage (%) <sup>1</sup>
<b>Vaccination uptake</b>	<b>(n = 582)</b>	
Full dose (two shots)	225	19.2
Incomplete dose	357	30.5
No vaccination	590	50.3
<b>Experienced any side effects after first dose</b>		
No	214	36.8
Yes	367	63.2
<b>Side effects reported</b>	<b>(n = 367)</b>	
Fever	147	40.1
Fatigue	115	31.3
Headache	101	27.5
Muscle soreness /pain	95	25.9
Injection site reaction	88	24.0
Others <sup>2</sup>	38	10.4
<b>Vaccination intention (among unvaccinated)</b>	<b>n = 590</b>	
Intend to vaccinate	537	91.0
Did not intend to vaccinate	48	8.1
Did not know	5	0.8

199 <sup>1</sup> Percentages calculated do not include respondents who did not record responses e.g. "Not stated" in the tables

200 <sup>2</sup> Allergic reaction, cough, body pain, dizziness, arrhythmias, body weakness, paralysis for a few days,  
 201 erectile dysfunction for a few days



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6 204 **Reasons for vaccine uptake/ non-uptake and intention/un intention to vaccinate**  
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9 205 The reasons for COVID-19 vaccine uptake and intention to vaccinate were similar with both  
10  
11 206 categories of respondents mostly reporting the need to obtain protection from COVID-19 and  
12  
13 207 having a high perceived risk of getting the virus. Over 40% of respondents who had not been  
14  
15 208 vaccinated attributed it to vaccine unavailability 250 (42.4%) and below a quarter of respondents  
16  
17 209 to not having time 142 (24.1%). The reasons for lack of intention to vaccinate were mainly  
18  
19 210 related to safety 24 (50.0%) and effectiveness concerns 17 (35.4%) which were similarly  
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21 211 reported for non-uptake of vaccines (  
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245 **Table 3: Reasons for (non) uptake of COVID-19 vaccines and intention to vaccinate**  
246 **(multiple response)**

Reasons	Uptake of vaccines n = 582 (%)	Intention to vaccinate n = 537 (%)
To protect self from COVID-19	505 (86.8%)	458 (85.3%)
High perceived risk of getting COVID-19	114 (19.6)	90 (16.8%)
Prioritized due to health (comorbidities)	95 (16.3)	34 (6.3%)
Recommendation from health workers	81 (13.9)	38 (7.1)
Prioritized due to occupation	74 (12.7)	-
Travel purposes	44 (7.6)	45 (8.4%)

Job requirement	-	82 (15.3%)
Others	21 (3.6) <sup>1</sup>	20 (3.8) <sup>2</sup>
<b>Reasons</b>	<b>Non uptake of vaccines n = 590 (%)</b>	<b>No intention to vaccinate n = 48 (%)</b>
Vaccines are unavailable	250 (42.4)	1 (2.1)
Don't have time	142 (24.1)	2 (4.2)
Safety concerns	74 (12.5)	24 (50.0)
Doubt vaccine effectiveness	41 (6.9)	17 (35.4)
Not among eligible group	30 (5.1)	4 (8.3)
Transport costs	24 (4.1)	Not reported
Don't know where to access the vaccines from	20 (3.4)	Not reported
Do not fear COVID-19/ trust immunity	10 (1.7)	1 (2.1)
Others	82 (14.0) <sup>3</sup>	7 (14.6) <sup>4</sup>

<sup>1</sup> Requirement for school attendance, being exemplary, following MOH guidelines, boosting immunity, to access services, among the eligible group.

<sup>2</sup> Access to health services, government mandate, pressure from peers, to be exemplary, requirement for school attendance.

<sup>3</sup> Pregnant, breastfeeding, waiting for another vaccine type, lack identification documents, long queues, currently sick, recently recovered from COVID-19.

<sup>4</sup> Religious beliefs, do not believe COVID-19, HIV positive and fear side effects, underlying Hepatitis B infection, Body already weak, Lack of identification documents.

### 256 Willingness to vaccinate for different vaccine types

257 All respondents were asked if they would receive the different types of COVID-19 vaccines if  
258 offered at that point and were free of charge. Only 316 (26.9%) reported that they would take  
259 any vaccine regardless of the type and 488 (41.6%) indicated a willingness to take at least one  
260 type of the vaccine. The most preferred COVID-19 vaccine types were Johnson and Johnson 436  
261 (37.4%) and AstraZeneca 405 (34.7%) (Figure 1).

262 **Figure 1 Willingness for COVID-19 vaccination for different vaccine types**

263

264 **Factors associated with uptake of COVID-19 vaccines**

265 At the multivariable analysis level, participants aged  $\geq 65$  years had a 32% higher likelihood to  
 266 have been vaccinated compared to those aged 18-35 years (Adjusted PR = 1.32, 95% CI 1.08 –  
 267 1.61,  $p = 0.008$ ). Participants from the Northern (adjusted PR = 1.55, 95% CI 1.18 – 2.02,  $p =$   
 268 0.002) and Central regions (adjusted PR = 1.48, 95% CI 1.16 – 1.89,  $p = 0.002$ ) respectively had  
 269 a 55% and 48% higher likelihood to have received the vaccine compared to those from the  
 270 Western region. Participants with secondary (adjusted PR = 1.36, 95% CI 1.12 – 1.65,  $p = 0.002$ )  
 271 or tertiary education (Adjusted PR = 1.62, 95% CI 1.31 – 2.00,  $p < 0.001$ ) were more likely to  
 272 have received the COVID-19 vaccine compared to those with incomplete primary/no formal  
 273 education. Respondents whose monthly income was between \$30 and \$57 (APR = 1.24 (1.02 –  
 274 1.52),  $p = 0.029$ ) had a higher uptake of COVID-19 vaccines than those who earned  $< \$14$ .  
 275 Having health workers as a source of information on COVID-19 was associated with higher  
 276 uptake of COVID-19 vaccines in Uganda (adjusted PR = 1.26, 95%CI 1.10 – 1.45,  $p = 0.001$ )  
 277 (Table 4).

278 **Table 4: Factors associated with COVID-19 vaccine uptake among adults**

Variables / Characteristics	Self-reported uptake of COVID-19 vaccine		Unadjusted PR (95% CI) <sup>1</sup>	p-value	Adjusted PR (95% CI) <sup>2</sup>	p-value
	No (%)	Yes (%)				
<b>Age in years</b>						
18 – 35	296 (53.5)	257 (46.5)	1		1	
36 – 55	213 (48.6)	225 (51.4)	1.11 (0.97 – 1.26)	0.124	1.09 (0.95 – 1.25)	0.244
56 – 64	44 (47.8)	48 (52.2)	1.12 (0.91 – 1.39)	0.292	1.17 (0.92 – 1.48)	0.193
65+	37 (41.6)	52 (58.4)	1.26 (1.03 -1.53)	<b>0.023</b>	1.32 (1.08 – 1.61)	<b>0.008</b>

Variables / Characteristics	Self-reported uptake of COVID-19 vaccine		Unadjusted PR (95% CI) <sup>1</sup>	p-value	Adjusted PR (95% CI) <sup>2</sup>	p-value
	No (%)	Yes (%)				
<b>Region of residence</b>						
Western	115 (66.5)	58 (33.5)	1		1	
Northern	74 (40.7)	108 (59.3)	1.77 (1.39 – 2.25)	<b>&lt;0.001</b>	1.55 (1.18 - 2.02)	<b>0.002</b>
Eastern	112 (53.1)	99 (46.9)	1.40 (1.09 – 1.80)	<b>0.010</b>	1.29 (0.99 - 1.69)	0.064
Central	289 (47.7)	317 (52.3)	1.56 (1.25– 1.95)	<b>0.001</b>	1.48 (1.16 - 1.89)	<b>0.002</b>
<b>Residence</b>						
Urban	270 (49.4)	277 (50.6)			1	
Rural	206 (49.4)	211 (50.6)	0.99 (0.88 – 1.13)	0.990	1.11 (0.97 – 1.28)	0.137
Semi-urban	114 (55.1)	93 (44.9)	0.89 (0.75 – 1.05)	0.173	0.92 (0.75 – 1.11)	0.373
<b>Gender</b>						
Male	351 (49.0)	366 (51.0)	1		1	
Female	239 (52.5)	216 (47.5)	0.93 (0.82 – 1.05)	0.237	1.00 (0.87 – 1.14)	0.973
<b>Wealth index</b>						
Low	290 (53.0)	257 (47.0)	1		1	
Middle	217 (49.9)	218 (50.1)	1.07 (0.94 – 1.21)	0.328	1.06 (0.91 – 1.24)	0.442
High	83 (43.7)	107 (56.3)	1.20 (1.03 – 1.40)	<b>0.021</b>	1.03 (0.83 – 1.28)	0.758
<b>Current Occupation</b>						
Unemployed	91 (47.2)	102 (52.8)	1		1	
Employed	76 (41.8)	106 (58.2)	1.10 (0.92 – 1.32)	0.294	1.03 (0.84 – 1.27)	0.763
Self employed	196 (55.2)	159 (44.8)	0.85 (0.71 – 1.01)	0.066	0.84 (0.68 – 1.02)	0.078
Casual laborer	45 (67.2)	22 (32.8)	0.62 (0.43 – 0.90)	<b>0.011</b>	0.73 (0.48 – 1.11)	0.146
Farmer	164 (49.1)	170 (50.9)	0.96 (0.81 – 1.14)	0.664	0.99 (0.82 – 1.19)	0.931
<b>Education level</b>						
No formal education /	161 (60.8)	104 (39.2)	1		1	

Variables / Characteristics	Self-reported uptake of COVID-19 vaccine		Unadjusted PR (95% CI) <sup>1</sup>	p-value	Adjusted PR (95% CI) <sup>2</sup>	p-value
	No (%)	Yes (%)				
incomplete primary						
Complete primary	109 (60.6)	71 (39.4)	1.01 (0.79 - 1.27)	0.966	1.00 (0.78 - 1.28)	0.998
Secondary education	207 (48.0)	224 (52.0)	1.32 (1.11 - 1.58)	<b>0.002</b>	1.36 (1.12 - 1.65)	<b>0.002</b>
Tertiary	98 (36.6)	170 (63.4)	1.62 (1.36 - 1.93)	<b>&lt; 0.001</b>	1.62 (1.31 - 2.00)	<b>&lt; 0.001</b>
<b>Household size (mean)</b>	5.41	5.99	1.02 (1.01 - 1.03)	<b>&lt; 0.001</b>	1.02 (1.00 - 1.03)	0.071
<b>Monthly income (\$)</b>						
< 14	144 (56.2)	112 (43.8)	1		1	
14 - 29	117 (51.8)	109 (48.2)	1.10 (0.91 - 1.34)	0.324	1.08 (0.89 - 1.32)	0.423
30 - 57	86 (43.9)	110 (56.1)	1.28 (1.07 - 1.55)	<b>0.009</b>	1.24 (1.02 - 1.52)	<b>0.029</b>
58 - 143	114 (49.8)	115 (50.2)	1.15 (0.95 - 1.39)	0.154	0.98 (0.79 - 1.22)	0.876
> 143	36 (38.7)	57 (61.3)	1.40 (1.13 - 1.73)	<b>0.002</b>	1.16 (0.91 - 1.49)	0.219
<b>Health workers as source of information on COVID-19<sup>3</sup></b>						
No	245 (57.9)	178 (42.1)	1		1	
Yes	345 (46.1)	404 (53.9)	1.28 (1.13 - 1.45)	<b>&lt; 0.001</b>	1.26 (1.10 - 1.45)	<b>0.001</b>

279 <sup>1</sup> Bivariate analysis

280 <sup>2</sup> Multivariable analysis

281 <sup>3</sup> Other sources of information included family members, friends/peers, Radio, Television, community  
 282 members and social media among others which were dichotomized and included in the analysis but were  
 283 not significant

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## 285 DISCUSSION

286 This study examined the uptake of COVID-19 vaccines and associated factors among adults  
 287 aged 18 years and above in Uganda. Among the study participants, about one in five (19.2%)  
 288 reported receiving a full dose of the COVID-19 vaccine while 30.5% had received an incomplete  
 289 dose. Over 90% of those who were unvaccinated reported the intention to be vaccinated. The

290 major reasons for vaccine uptake and intention to vaccinate were protection of self from COVID-  
291 19 and a high perceived risk of getting the virus while reasons for vaccine non-uptake were  
292 vaccine unavailability, the lack of time to go get vaccinated, and safety and effectiveness  
293 concerns. The factors that were associated with receiving the COVID-19 vaccine were older age  
294 (65 years and above), having secondary education and above, having a moderate income, and  
295 reporting health workers as a source of information on COVID-19. Being a resident of Northern  
296 and Central Uganda was also associated with a high likelihood of receiving the vaccine.

297 Uptake of COVID-19 vaccines in this sample of respondents was higher for both full and  
298 incomplete doses than the vaccinated proportion of the population as of November 2021 when  
299 this study was conducted. Ministry of Health data of 8<sup>th</sup> November 2021 indicated that 55.8%  
300 and 16.8% of the priority groups and 12.2% and 3.7% of the adult population had received their  
301 first and second doses of the vaccine respectively [13]. The higher-than-baseline vaccination  
302 coverage could be attributed to the use of mobile phones for the survey and thus the relatively  
303 urbanized study sample whose access to vaccines was higher than those in rural areas. Moreover,  
304 a high proportion of participants were from the Central region, which was most impacted by  
305 COVID-19, and their experiences could have influenced vaccine uptake. In addition, intention to  
306 vaccinate was very high at over 90%; higher than the combined “definite intention” of 57.8%  
307 and “probable intention” of 26.2% from the March survey round [8]. In a November 2021 survey  
308 among 23,000 respondents from 19 African Union members states including Uganda, (78%) of  
309 respondents had either been vaccinated or were likely to get vaccinated [14]. The second  
310 COVID-19 wave fueled by the Delta variant that was experienced in Uganda from June to  
311 September 2021 and led to at least 2,800 deaths compared to the less than 300 recorded at the  
312 end of the first wave [1, 15] could also have contributed to the high uptake of the vaccine and

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3 313 intention-to-vaccinate. In addition, there was concern about potential vaccine mandates including  
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5 314 anticipation that the unvaccinated would be denied health and social services which could also  
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8 315 have increased the intention to vaccinate.  
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11 316 The major reasons for vaccine uptake and intention to vaccinate were protection of self from  
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13 317 COVID-19 and a high perceived risk of getting the virus, similar to previous research [11]. This  
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15 318 is also an indication of the respondents' appreciation of the role of vaccines in preventing  
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17 319 morbidity and saving lives. Those unvaccinated attributed it to vaccine unavailability and the  
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19 320 lack of time. The survey in 19 African countries concluded that low vaccine uptake was mostly  
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21 321 due to unpredictable supply of vaccines and logistical hurdles than reluctance or refusal to get  
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23 322 vaccinated [14]. Earlier surveys in Uganda conducted in 2020 had also shown a high acceptance  
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25 323 of COVID-19 vaccines of over 85% [11, 16]. To bridge the willingness-intention-uptake gap in  
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27 324 Uganda, the Ministry of Health should increase access and availability of COVID-19 vaccines.  
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29 325 Evidence shows that strategies that take vaccines closer to the communities are likely to mitigate  
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31 326 time and transport-related barriers and increase vaccine uptake [17, 18]. This could be achieved  
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33 327 by increasing the number of health facilities offering the vaccines, conducting more vaccination  
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35 328 outreaches, or setting up mobile vaccine points. The World Health Organization guidance has  
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37 329 also emphasized the importance of location and time in COVID-19 vaccine uptake [19]. On the  
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39 330 other hand, the study reported that safety and effectiveness concerns hindered vaccine uptake and  
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41 331 intention to vaccinate similar to previous research [8, 11, 20-23]. Of note as well was the  
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43 332 observed high prevalence (63%) of self-reported vaccine side effects which could go a long way  
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45 333 in reinforcing safety concerns among the population. Vaccine adverse events should be  
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47 334 monitored closely, and appropriate information, education and communication material  
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49 335 developed including information on expected side effects to counter their potential effect on the  
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3 336 uptake of vaccination by the unvaccinated. Accurate, consistent and transparent communication  
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5 337 and dialogue about uncertainty, risks and anticipated benefits can go a long way in building  
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7 338 confidence and trust in the COVID-19 vaccines and create motivation for vaccination [19, 23].  
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10 339 This could also bridge observed gaps in vaccine preference to prevent this from being a barrier to  
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12 340 vaccination. The Johnson and Johnson vaccine being a single shot had a higher preference  
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14 341 among respondents due to the perceived inconvenience and unpredictability of obtaining a  
15  
16 342 second vaccine dose.

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20 343 It was not surprising that those aged 65 years and above had a higher vaccination uptake as these  
21  
22 344 were part of the prioritized group for COVID-19 vaccination in the country. Education status  
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24 345 also predicted vaccination status similar to previous research on COVID-19 vaccine acceptability  
25  
26 346 [24-27]. However, further efforts are required to ensure the dissemination of accurate and simple  
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28 347 COVID-19 vaccination messages to those of lower education levels including translating  
29  
30 348 information in the local languages so that this group is not left behind. A moderate income was  
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32 349 associated with higher vaccine uptake; however, this relationship was not sustained with  
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34 350 increasing income levels. The regional differences observed in the uptake of COVID-19 vaccines  
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36 351 may have been due to differences in vaccine access and availability, especially for Central region  
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38 352 which was most hit by the pandemic and was prioritized early during vaccine rollout. From  
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40 353 previous research, income levels and locations have been reported as predictors of COVID-19  
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42 354 vaccine acceptability [27, 28].

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45 355 One major finding from our work was that respondents whose source of information on COVID-  
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47 356 19 was health workers had a higher likelihood for COVID-19 vaccination. This positions health  
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49 357 workers as a key resource in increasing vaccination uptake, and thus they should be furnished  
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51 358 with sufficient and accurate information and supported with effective communication tools to  
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3 359 influence their clients at facility and community level. Previous studies report that health worker  
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5 360 advice on vaccination was most trusted [11, 22]. Health workers can lead health education and  
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7 361 awareness programs on COVID-19 and use their platforms at health facility and community  
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9 362 level to influence the masses to uptake COVID-19 vaccines. However, vaccine uptake among  
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11 363 health workers themselves was low at the time even when they were prioritized for vaccination  
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13 364 from the start of the campaigns in Uganda and elsewhere. In a March 2021 survey in Uganda,  
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15 365 just after the launch of the COVID-19 vaccination exercise, a vaccine acceptability rate of 37.3%  
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17 366 and hesitancy of 30.7% were reported among medical students [12]. In a June to August 2021  
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19 367 online survey, acceptance or willingness to uptake the COVID-19 vaccine stood at over 97% and  
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21 368 65.3% of eye healthcare workers had received a COVID-19 vaccine shot influenced by high  
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23 369 perceived susceptibility and benefits [29]. An in-depth study among health workers reported the  
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25 370 lack of trust in the vaccine, fear of side effects, not feeling at risk, lack of sufficient information  
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27 371 about vaccines, health systems challenges and religious beliefs as barriers to COVID-19  
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29 372 vaccination [30]. When health workers are vaccinated, they are more likely to recommend the  
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31 373 same to their clients [31]. Therefore, appropriate interventions should be instituted to effectively  
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33 374 deal with vaccine hesitancy among health workers and have them as champions for COVID-19  
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35 375 vaccination.  
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### 378 **Study limitations and strengths**

379 Being a mobile phone survey, the study participants were not representative of the population  
380 and only those with a mobile phone could participate, contributing to selection bias. However

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3 381 mobile phone coverage in Uganda has increased over the years; according to the Uganda  
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5 382 National Household Survey 2020, 74.0% of Ugandans own mobile phones [32]. There was also  
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8 383 potential for social desirability bias, especially regarding reporting vaccination status which we  
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10 384 minimized by reminding participants that the study was only for research purposes. Also, as a  
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12 385 cross-sectional survey, the direction of associations observed is not clear. On the other hand, our  
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14 386 study had a high response rate with over 94% of the participants consenting to participate. The  
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16 387 high response rate could be attributed to following up previous survey participants, flexibility in  
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18 388 conducting interviews at convenient times, as well as the time compensation (phone credit of 1.5  
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20 389 US dollars) provided. Results from the backchecking with the same individuals also showed high  
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22 390 consistency with the survey results. Our study provides insights into COVID-19 vaccination  
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24 391 uptake and intention to vaccinate which can facilitate the development of context-relevant  
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26 392 strategies to increase vaccinations.  
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## 34 394 **CONCLUSIONS**

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37 395 Half of the study respondents were vaccinated against COVID-19, which was associated with  
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39 396 older age, higher education level, moderate income, region of residence and reporting health  
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41 397 workers as the source of COVID-19 information. Among the unvaccinated, over 90% expressed  
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43 398 intention to vaccinate. Efforts are needed to increase access to vaccines and utilize health  
44  
45 399 workers as a key resource in sharing information and champions to influence the masses which  
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47 400 should positively impact uptake of COVID-19 vaccines.  
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11  
12  
13 407 RN, NC, SNK, AN, WS, LLT and RKW conceptualized and designed the study. RN, NC, SNK,  
14  
15 408 AN, IW, SKiz supported the data collection. RN, NC, SNK, AN, STW, IW, SKiz, SKiw, WS,  
16  
17 409 LLT and RKW contributed to analysis and interpretation of findings. RN, NC, STW wrote the  
18  
19 410 first draft of the manuscript. SNK, AN, IW, SKiz, SKiw, WS, LLT and RKW critically reviewed  
20  
21 411 the draft manuscript. All authors read and approved the final manuscript.  
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26 412

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33 416 the authors and do not necessarily reflect the views, opinions, or policies of the Bill and Melinda  
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35 417 Gates Foundation.  
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### 41 419 **Competing interests**

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45 420 None declared.  
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### 48 421 **Consent for publication**

49  
50 422 Not applicable  
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### 424 **Ethics approval and consent to participate**

425 Ethical approval to conduct the survey was sought from the Makerere University School of  
426 Public Health Higher Degrees Research and Ethics Committee (protocol SPH-2021-150) and the  
427 study was registered by the Uganda National Council of Science and Technology (HS1742ES).  
428 Verbal consent was provided before participation in the survey. Personally identifiable  
429 information including name of respondent, their phone number and the household head name  
430 were encrypted with passwords on the SurveyCTO server and drives and was only accessible to  
431 the investigator(s). All phones and tablets used for data collection were password-protected to  
432 protect respondent data.

### 433 **Data availability statement**

434 The data are available from the corresponding author on reasonable request.

### 436 **Supplementary files**

437 Supplementary file 01: Study questionnaire

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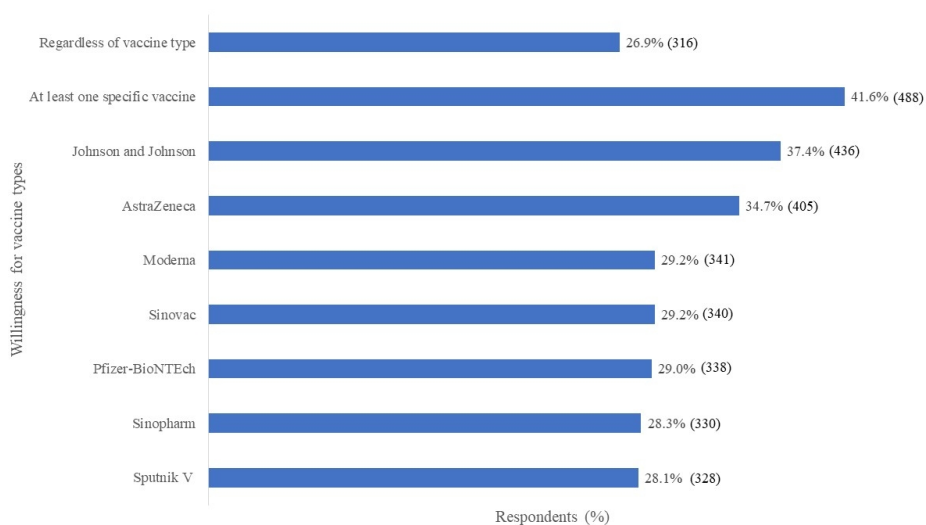
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Willingness for COVID-19 vaccination for different vaccine types

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## Uptake of COVID-19 vaccines and associated factors among adults in Uganda: a cross-sectional survey

Question	Answer	
MAKERERE SCHOOL OF PUBLIC HEALTH AND MIT GOV/LAB MOBILE SURVEY QUESTIONNAIRE		
Phone number used for interview		
Did the call go through?	1	Yes
	0	No
	-97	DO NOT READ: Refused
Was this the respondent previously interviewed?	1	Yes
	0	No
	-97	DO NOT READ: Refused
[Insert Consent Text]		
Do you voluntarily agree to participate in this survey?	1	Yes
	0	No
	-97	DO NOT READ: Refused
Explain:		
A7. What is your name?		
A8. What is your age?		
A9. What region do you live in?	1	North
	2	East
	3	Central
	4	West
	-97	DO NOT READ: Refused
A10. What district do you live in?	[Insert filtered list of districts]	
A11. Do you live in an urban, rural, or semi-urban area?	1	Urban
	2	Rural
	3	Semi-urban
	-99	DO NOT READ: Don't know
A12. Gender of respondent	1	Female
	0	Male
Next, I am going to ask some questions on your awareness and intention to take the COVID-19 vaccine.		
E1. As an adult, have you received a vaccine other than the COVID-19 vaccines? (Hepatitis B, Yellow fever, tetanus)	1	Yes
	0	No
	-97	DO NOT READ: Refused
E2. Have you ever been asked to get a vaccine and declined?	1	Yes
	0	No
	-97	DO NOT READ: Refused

Question	Answer	
E3. What COVID-19 vaccines have you heard of? <i>Do not read options aloud. Select all that apply.</i>	1	AstraZeneca
	2	Pfizer-BioNTech
	3	Moderna
	4	Johnson and Johnson
	5	Sinopharm
	6	Sinovac
	7	Sputnik V
	-96	Other (Specify)
	8	Has heard of COVID-19 vaccine but does not know any names
0	None, has not heard of any COVID-19 vaccine	
-99	DO NOT READ: Don't Know	
-97	DO NOT READ: Refused	
Other, specify:		
E4. Have you received the COVID-19 vaccine? <i>Read all options aloud</i>	1	Yes, full dose
	2	Yes, incomplete dose
	0	No
	-97	DO NOT READ: Refused
E5. Which vaccine did you receive? <i>Do not read options aloud. Select all that apply.</i>	1	AstraZeneca
	2	Pfizer-BioNTech
	3	Moderna
	4	Johnson and Johnson
	5	Sinopharm
	6	Sinovac
	7	Sputnik V
	-96	Other (Specify)
	8	Has heard of COVID-19 vaccine but does not know any names
0	None, has not heard of any COVID-19 vaccine	
-99	DO NOT READ: Don't Know	
-97	DO NOT READ: Refused	
Other, specify:		

Question	Answer	
E6. Why did you receive the COVID-19 vaccine? <i>Do not read options aloud. Select all that apply.</i>	1	To protect self / others from COVID-19
	2	High perceived risk of getting COVID-19
	3	Travel purposes
	4	Recommendation from health workers
	5	Prioritized due to occupation
	6	Prioritized due to health
	-96	Other (Specify)
	-99	DO NOT READ: Don't Know
	-97	DO NOT READ: Refused
Other, specify:		
E7. Did you experience any side effects within 7 days following the first dose?	1	Yes
	0	No
	-97	DO NOT READ: Refused
E8. Which side effects did you experience following the first dose? <i>Do not read options aloud. Select all that apply.</i>	1	Fever
	2	Fatigue
	3	Headache
	4	Muscle soreness/pain (myalgia)
	5	Allergic reaction
	6	Injection site reaction
	-96	Other (Specify)
	-97	DO NOT READ: Refused
Other, specify:		
E9. Did you experience any side effects within 7 days following the second dose?	1	Yes
	0	No
	-97	DO NOT READ: Refused
E10. Which side effects did you experience following the second dose? <i>Do not read options aloud. Select all that apply.</i>	1	Fever
	2	Fatigue
	3	Headache
	4	Muscle soreness/pain (myalgia)
	5	Allergic reaction
	6	Injection site reaction
	-96	Other (Specify)
	-97	DO NOT READ: Refused
Other, specify:		

Question	Answer	
1 2 3 E11. Why haven't you ever received the COVID-19 vaccine? 4 <i>Do not read options aloud. Select all that apply.</i> 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28	1	Safety concerns / fear of adverse events
	2	Doubt vaccine effectiveness
	3	Do not fear COVID-19 / trust immunity
	4	Don't know where to access vaccine from
	5	Religious beliefs
	6	COVID-19 is a hoax / politics
	7	Not among eligible group
	8	Not having time
	9	Transport costs
	10	Cost of vaccine
	11	Vaccines are unavailable
	-96	Other (Specify)
	-99	DO NOT READ: Don't know
	-97	DO NOT READ: Refused
Other, specify:		
29 30 E12. Do you intend to receive the COVID-19 vaccine if it is available? 31 32 33	1	Yes
	0	No
	-97	DO NOT READ: Refused
34 E13. Why do you intend to receive the COVID-19 vaccine? 35 <i>Do not read options aloud. Select all that apply.</i> 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52	1	To protect self / others from COVID-19
	2	High perceived risk of getting COVID-19
	3	Travel purposes
	4	Recommendation from health workers
	5	Prioritized due to occupation
	6	Prioritized due to health
	-96	Other (Specify)
	-99	DO NOT READ: Don't Know
	-97	DO NOT READ: Refused
Other, specify:		
53 E14. Why don't you intend to receive the COVID-19 vaccine? 54 <i>Do not read options aloud. Select all that apply.</i> 55 56 57 58	1	Safety concerns / fear of adverse events
	2	Doubt vaccine effectiveness

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Question	Answer	
	3	Do not fear COVID-19 / trust immunity
	4	Don't know where to access vaccine from
	5	Religious beliefs
	6	COVID-19 is a hoax / politics
	7	Not among eligible group
	8	Not having time
	9	Transport costs
	10	Cost of vaccine
	11	Vaccines are unavailable
	-96	Other (Specify)
	-99	DO NOT READ: Don't know
	-97	DO NOT READ: Refused
Other, specify:		
E15. Has anyone in your household received their COVID-19 vaccine?	1	Yes, specify
	0	No
	-99	DO NOT READ: Don't Know
	-97	DO NOT READ: Refused
E16. In your household, who has received their COVID-19 vaccine? <i>Do not read options aloud. Select all that apply.</i>	1	Parents
	2	Children
	3	Grandparents
	4	Grandchildren
	5	Siblings
	6	Cousins
	7	Aunts and Uncles
	8	Spouse
	-96	Other (Specify)
	-97	DO NOT READ: Refused
Other, specify:		
E17. Do you know anyone personally in your community who has received their COVID-19 vaccine?	1	Yes, specify
	0	No
	-99	DO NOT READ: Don't Know
	-97	DO NOT READ: Refused

Question	Answer	
E18. Among those you know personally in your community, who has received their COVID-19 vaccine? <i>Do not read options aloud. Select all that apply.</i>	1	Traditional leaders
	2	Religious leaders
	3	Colleagues
	4	Personal friends
	5	Neighbors
	-96	Other (Specify)
	-97	DO NOT READ: Refused
Other, specify:		
Next, I am going to ask some questions about COVIDEX.		
E19. Have you ever heard of COVIDEX before?	1	Yes
	0	No
	-97	DO NOT READ: Refused
E20. Has anyone in your household ever bought or used COVIDEX?	1	Yes
	0	No
	-99	DO NOT READ: Don't Know
	-97	DO NOT READ: Refused
E21. Personally, how much trust do you have in COVIDEX? <i>Read all options aloud</i>	1	Trust it a great deal
	2	Tend to trust it
	3	Tend to distrust it
	4	Distrust it greatly
	-99	DO NOT READ: Not sure or don't know
	-97	DO NOT READ: Refused
Next, I am going to ask some more questions on COVID-19 vaccines.		
(Randomize order of F2)		
F2. If you were offered the COVID-19 <b>AstraZeneca</b> vaccine right now free of cost, would you take the vaccine? <i>Read all options aloud</i>	1	Yes
	0	No
	-95	Have not heard of
	-97	DO NOT READ: Refused
F2. If you were offered the COVID-19 <b>Pfizer-BioNTech</b> vaccine right now free of cost, would you take the vaccine? <i>Read all options aloud</i>	1	Yes
	0	No
	-95	Have not heard of
	-97	DO NOT READ: Refused
F2. If you were offered the COVID-19 <b>Moderna</b> vaccine right now free of cost, would you take the vaccine? <i>Read all options aloud</i>	1	Yes
	0	No
	-95	Have not heard of
	-97	DO NOT READ: Refused
F2. If you were offered the COVID-19 <b>Johnson and Johnson</b> vaccine right now free of cost, would you take the vaccine? <i>Read all options aloud</i>	1	Yes
	0	No
	-95	Have not heard of
	-97	DO NOT READ: Refused

Question	Answer	
1 2 3 F2. If you were offered the COVID-19 <b>Sinopharm</b> vaccine right now free of cost, would you 4 take the vaccine? 5 <i>Read all options aloud</i> 6 7	1	Yes
	0	No
	-95	Have not heard of
	-97	DO NOT READ: Refused
8 F2. If you were offered the COVID-19 <b>Sinovac</b> vaccine right now free of cost, would you take 9 the vaccine? 10 <i>Read all options aloud</i> 11 12	1	Yes
	0	No
	-95	Have not heard of
	-97	DO NOT READ: Refused
13 F2. If you were offered the COVID-19 <b>Sputnik V</b> vaccine right now free of cost, would you take 14 the vaccine? 15 <i>Read all options aloud</i> 16 17	1	Yes
	0	No
	-95	Have not heard of
	-97	DO NOT READ: Refused
18 F3. Why would you choose these vaccines? 19 20 21 22 23 24 25 26 27 28 29	1	More effective
	2	Less adverse events
	3	Used in Western countries
	4	Trust in source
	-96	Other (Specify)
	-99	DO NOT READ: Don't Know
	-97	DO NOT READ: Refused
30 Other, specify 31		
32 F4. If you needed information on vaccines, who in your community would you talk to for 33 advice? 34		
35 F5. What are your sources of information on COVID-19? 36 <i>Do not read options aloud. Select all that apply.</i> 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58	1	Family members
	2	Friends/peers
	3	Health worker
	4	Phone (messages and calls)
	5	Radio
	6	Television
	7	Church/Mosque
	8	Community member/village health team member
	9	Local leader
	10	Social media (Facebook, WhatsApp, Twitter)
	11	Internet
	-96	Other (Specify)
	-99	DO NOT READ: Don't Know
	-97	DO NOT READ: Refused



Question	Answer	
Other, specify		
F6. Which three sources of information do you trust the most? <i>Do not read options aloud. Select all that apply.</i>	1	Family members
	2	Friends/peers
	3	Health worker
	4	Phone (messages and calls)
	5	Radio
	6	Television
	7	Church/Mosque
	8	Community member/village health team member
	9	Local leader
	10	Social media (Facebook, WhatsApp, Twitter)
	11	Internet
	-96	Other (Specify)
	-99	DO NOT READ: Don't Know
	-97	DO NOT READ: Refused
Other, specify		
F7. Have you ever been tested at a health facility or laboratory and found to have COVID-19?	1	Yes
	0	No
	-97	DO NOT READ: Refused
F8. Was this COVID infection before or after you received the full dose of the vaccine?	1	Before
	2	After
	3	Both
	-97	DO NOT READ: Refused
B1. What is your highest level of education?	1	No school
	2	Some primary
	3	Complete primary
	4	Secondary - ordinary
	5	Secondary - advanced
	6	Tertiary
	-96	Other (Specify)
	-97	DO NOT READ: Refused
Other, specify		
B2. What is your religion?	1	Catholic
	2	Anglican
	3	Born Again/Pentecostal
	4	Muslim
	-96	Other (Specify)
	-97	DO NOT READ: Refused

Question	Answer	
Other, specify		
B3. On average, how much money do you earn per month? <i>In Ugandan Shillings</i>	1	under 50,000
	2	50,001 - 100,000
	3	100,001 - 200,000
	4	200,001 - 500,000
	5	500-001 - 1,000,000
	6	1,000,001 and above
B4. Does your household have a <b>television</b> ?	-97	DO NOT READ: Refused
	1	Yes
	0	No
	-99	DO NOT READ: Don't Know
B4. Does your household have <b>electricity</b> ?	-97	DO NOT READ: Refused
	1	Yes
	0	No
	-99	DO NOT READ: Don't Know
B4. Does your household have a <b>computer</b> ?	-97	DO NOT READ: Refused
	1	Yes
	0	No
	-99	DO NOT READ: Don't Know
B4. Does your household have a <b>sofa set</b> ?	-97	DO NOT READ: Refused
	1	Yes
	0	No
	-99	DO NOT READ: Don't Know
B4. Does your household have a <b>refrigerator</b> ?	-97	DO NOT READ: Refused
	1	Yes
	0	No
	-99	DO NOT READ: Don't Know
B5. Does anyone in your household own a <b>cassette/CD/DVD player</b> ?	-97	DO NOT READ: Refused
	1	Yes
	0	No
	-99	DO NOT READ: Don't Know

1 B6A. What is your current occupation? 2 <i>Read all options aloud</i> 3 4 5 6 7 8 9 10 11	1	Unemployed/retiree/housewife
	2	Employed
	3	Self-employed
	4	Casual laborer
	5	Farmer
	-	Other (Specify)
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-	DO NOT READ: Refused	
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12	Other, specify:	
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14	B7A. How many people stay in your home, currently?	
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For peer review only

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STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	1
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4,5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	6,20
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7,8
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7,8
		(b) Describe any methods used to examine subgroups and interactions	7,8
		(c) Explain how missing data were addressed	7,8
		(d) If applicable, describe analytical methods taking account of sampling strategy	Not applicable
		(e) Describe any sensitivity analyses	Not applicable
<b>Results</b>			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	9
		(c) Consider use of a flow diagram	Not necessary
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9

		(b) Indicate number of participants with missing data for each variable of interest	9-16
Outcome data	15*	Report numbers of outcome events or summary measures	9-16
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-16
		(b) Report category boundaries when continuous variables were categorized	9-16
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not relevant
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	None
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	17
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	20,21
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17-21
Generalisability	21	Discuss the generalisability (external validity) of the study results	20,21
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	22

\*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).