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Article

COVID-19 Knowledge, Attitudes and Practices and Vaccine Acceptability in Rural Western Kenya and an Urban Informal Settlement in Nairobi, Kenya, May 2021: A Cross-sectional Survey

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Abstract: An important step towards COVID-19 pandemic control is adequate knowledge and adherence to mitigation measures, including vaccination. We assessed the level of COVID-19 knowledge, attitudes, and practices among residents from an urban informal settlement in the City of Nairobi (Kibera), and a rural community in western Kenya (Asembo). A cross-sectional survey was implemented from April to May 2021 among randomly selected adult residents from a population-based infectious diseases surveillance (PBIDS) cohort in Nairobi and Siaya Counties. Factors associated with the level of COVID-19 KAP, were assessed using multivariable regression methods. COVID-19 vaccine acceptance was 83.6% for the participants from Asembo and 59.8% in Kibera. The reasons cited for vaccine hesitancy in Kibera were safety concerns (34.0%), insufficient information available to decide (18.0%), and a lack of belief in the vaccine (21.0%), while the reasons in Asembo were safety concerns (55.0%), insufficient information to decide (26.0%) and lack of belief in the vaccine (11%). Our study findings suggest the need for continued public education to enhance COVID-19 knowledge, attitudes, and practices to ensure adherence to mitigation measures. Urban informal settlements require targeted messaging to improve vaccine awareness, acceptability, and uptake.

Keywords: Urban; rural; COVID-19; Knowledge; Attitudes; Practices; vaccine acceptability; Vaccine hesitancy; Kenya

1. Introduction

Since the first case of Coronavirus disease 2019 (COVID-19) was confirmed in Kenya on 13th March 2020, the number of cases and deaths has risen steadily. As of 20th April, 2021, more than 140 million cases and 3 million deaths had been reported worldwide, including 152,523 cases and 2,516 deaths in Kenya **[1]**. The elderly and those with underlying medical conditions are at a greater risk of developing severe illness and possible death after infection with COVID-19 **[2]**. To control COVID-19, the Kenyan government introduced such as suspension of international travel, restriction of movements in hotspot areas, closure of all learning institutions, and banning public gatherings **[3]**. The government also encouraged the wearing of face masks in public, frequent hand hygiene practices, and keeping physical distance.

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Just like Kenya, many African countries imposed partial or total lockdowns on peoples' movements and activities, with detrimental impacts on the economies **[4]**. Some countries adopted their own models of mitigating COVID-19 based on country-specific culture and socioeconomic activities **[5]**. The effectiveness of any COVID-19 **mitigation** measures depends on widespread acceptance and uptake by the population **[6]**. There has been increased availability of COVID-19 vaccines since they became available globally in November 2020. Countries initially set a target to vaccinate 60-80% of the population to achieve herd immunity **[7]**. There are concerns that emerging variants of SARS-CoV-2 might push the overall herd immunity threshold to >80% **[8]**. The Kenyan government rolled out vaccination against COVID-19 in March 2021, one year after the first case was confirmed in the country. At the time of the study, only the Astra Zeneca-Oxford COVID-19 vaccine was in use in the country**[9]**. Initially, priority was given to frontline healthcare workers but six months later, this was expanded to include the elderly (≥58 years), those with underlying chronic conditions and other frontline workers, such as teachers and the military **[1,9]**.

An important step towards COVID-19 vaccine acceptance is adequate knowledge of the disease and understanding attitudes towards mitigation measures **[6]**. Population-based surveys implemented in Kenya in early 2021 found high COVID-19 vaccine hesitancy that was associated with the low-risk perception of the disease, difficulty in adhering to government prevention measures, and concerns about vaccine safety and effectiveness **[10,11]**. Other studies in Africa have shown that despite good COVID-19 knowledge and attitudes, there were still a significant level of vaccine hesitancy **[12,13]**. Here, we assessed the level of COVID-19 knowledge, attitudes, and practices (KAP) on acceptance and practice of COVID-19 mitigation measures among urban and rural populations – including estimated vaccine acceptability.

2. Materials and Methods

Study Setting and Design

We conducted a cross-sectional survey from 21st April to 5th May 2021 among residents enrolled in population-based infectious disease surveillance (PBIDS) in Kibera, Nairobi County and Asembo, Siaya County, Kenya [14]. The PBIDS platform was established by Kenya Medical Research Institute - Centre for Global Health Research (KEMRI-CGHR) with support from United States Centers for Disease Control and Prevention (CDC) in 2005 and has been described elsewhere [14]. Briefly, the PBIDS platform aims to assess the burden of cute infectious diseases and evaluate the impact of public health interventions within a 5kms and 1km radius of a designated health facility in Asembo and Kibera, respectively. Kibera is a densely populated informal ban settlement with poor infrastructure and sanitation, unlike Asembo, which has a homogenous, sparsely populated rural area. Community interviewers regularly visit the households to collect demographic and health information using a standardized electronic questionnaire. All PBIDS participants have free access to medical care at the designated health facility at each site. Those presenting with acute respiratory, diarrheal, and/or febrile illness are consented for this systematic surveillance. By the end of June 2021, the Kibera site had 22,312 active participants in 5,163 households, while the Asembo site had 32,149 participants in 16,365 households.

Study population

We generated a sampling frame from the list of all household IDs for active PBIDS households. Using Excel, we then randomly selected a total of about 225 households to yield the desired sample size. All adults (≥18 years) residing in the randomly selected households from the two PBIDS sites, Asembo and Kibera, were eligible to participate. Household members found at home who consented to participate were enrolled, while the study team attempted to reach those not at home by revisiting their household three times.

Data Collection

Data were collected over a period of two weeks using a standardized KAP questionnaire collected on netbooks or tablets. The questions were adopted from previous COVID-19 vaccine surveys carried out by the ministry of health, the population council of Kenya, and Trends and Insights For Africa (TIFA) research [10,15,16]. The questionnaires were administered by a research assistant assisted by a trained fieldworker and the interviews lasted 30-45 minutes. The sociodemographic characteristics collected included age, sex, level of education, occupation, marital status, and religion. Additionally, we collected data on practise of COVID-19 mitigation measures such as handwashing, wearing of face masks, physical distancing and staying at home. We also collected data on COVID-19 vaccine awareness, vaccine acceptability and any reasons for vaccine hesitancy. To assess vaccine acceptability, participants were asked whether they would accept the COVID-19 vaccine if it was offered.

Data analysis

Data were analysed using Stata (16.1, Stata Corp LLC, College Station, TX). Frequencies, proportions, and means were calculated to summarise participants' sociodemographic characteristics and KAP, as well as vaccine awareness and acceptability. Survey data was weighted by ranking on sex and age group to the structure of the PBIDS population. The age groups applied were 18-29, 30-39, 40-49, 50-59, and ≥60 years. Knowledge scores were calculated for each respondent as the proportion of correctly answered questions (see Table 2). Using modified Bloom's cut-off points [17], the knowledge scores were then grouped into two categories: good knowledge scores (answered at least 6 out of the 8 knowledge questions correctly) and poor knowledge scores (answered less than 6 questions correctly). Multivariable logistic models were used to assess the factors associated with participants' level of knowledge on COVID-19. The factors assessed were age groups, sex, occupation, education level, marital status, residence (rural-urban,) and religion. Occupation categories were reported as unemployed, employed formal, employed informal or self-employed. Education level was categorized as "None," "Primary education (incomplete and complete primary)," "Secondary education (incomplete and complete secondary)," and "Post-secondary education." Bivariate logistic regression was used to determine whether age, sex, occupation, and level of education were associated with being worried about contracting COVID-19. For vaccine acceptability, logistic regression was used to identify whether age, sex, occupation, education, COVID-19 knowledge, and risk perception were associated with acceptability. Factors that had a p-value of p-value ≤0.2 in the univariate analysis were considered for inclusion in the multivariable models. In the multivariable analysis, p-values of <0.05 were considered statistically significant. For the logistic regression models, we accounted for clustering by household using lustered sandwich estimator [18,19].

Ethical considerations

Ethical approval for this study was provided by the KEMRI Scientific and Ethical Review Committee in Kenya (KEMRI/SERU/4098) and protocol reliance provided by Washington State University. This project was also reviewed by CDC and conducted consistent with applicable federal law and CDC policy as provided for in the Code of Federal Regulations (45 C.F.R part 46 and 21 C.F.R. part 56). The PBIDS platform is approved by KEMRI Scientifical and Ethical Review Committee in Kenya (#2761), Washington State University reliance agreement and CDC reliance approval (#6775). Written consents were obtained from all study participants. Incentives were not provided to participants, although a bar of soap was given at the end of the study as a token of appreciation.

3. Results

3.1 *Household and Participants' Characteristics*

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Out of 440 eligible persons in Kibera, 398 (90.5%) were enrolled, 40 (9.1%) were unavailable during the study period, and 2 (0.4%) declined consent. In Asembo, 480 participants were eligible, with 458 (95.4%) agreeing to participate, 16 (3.3%) were unavailable, and 6 (1.3%) declining consent. The median age for the Asembo participants was 39.3 (IQR, 28.8 – 56.8) years and 33.0 (IQR, 25.0 – 43.0) years for the Kibera participants. Of those enrolled, 166 (36.2%) and 136 (34.2%) were males in Asembo and Kibera, respectively (Table 1).

Table 1: Socio-demographic characteristics of study participants in Asembo, Siaya County and Kibera, Nairobi County, Kenya

Characteristics	Categories	Asembo, N=458	Kibera, N=398
		n (%)	n (%)
Age in years (y)	18-29 y	127 (27.7)	145 (36.4)
	30-39 y	106 (23.1)	115 (28.9)
	40-49 y	75 (16.4)	81 (20.4)
	50-59 y	57 (12.5)	43(10.8)
	≥60 y	93 (20.3)	14 (3.5)
Sex	Male	166 (36.0)	136 (34.2)
	Female	292 (63.8)	262 (65.8)
Marital status	Married	265 (57.9)	260 (65.7)
	Single	103 (22.5)	111 (28.0)
	Previously married*	90(19.7)	25(5.5)
Education	None	29 (6.3)	5 (1.3)
	Incomplete primary	135 (29.5)	51 (12.8)
	Complete primary	107 (23.4)	113 (28.4)
	Incomplete secondary	95 (20.7)	67 (16.8)
	Complete secondary	60 (13.1)	100 (25.1)
	Post-secondary	32 (7.0)	60 (15.1)
	Missing	0	2(0.5)
Occupation	Unemployed	173 (37.7)	138(34.7)
	Employed formal	17 (3.7)	26 (6.5)
	Employed informal	32 (7.2)	88 (22.1)
	Self-employed	210(45.6)	139 (34.9)
	Missing	26(5.7)	7(1.8)

*** Includes widowed, divorced, and separated participants**

3.2 Knowledge on COVID-19

A total of 441 (96.3%) participants from Asembo and 380 (95.4%) from Kibera correctly answered ≥6 of the 8 knowledge questions (good knowledge score) with 308 (67.2%) respondents in Asembo and 254 (63.8%) in Kibera correctly answering all the knowledge questions. A high proportion of participants n Asembo (449, 97.8%) reported that COVID-19 is real compared to Kibera (370, 91.6%) (p-value=0.001) (Table 2).

Table 2: Frequency of correct responses to the 8 knowledge questions in Asembo, Siaya County and Kibera, Nairobi County, Kenya

Knowledge questions**	Asembo n=458 n (%)	Kibera n=398 n (%)	p-value

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1.	COVID-19 can spread through coughs or sneezes.	441 (96.2)	385(96.5)	0.84
2.	COVID-19 can spread when people are in close contact with each other.	445 (97.5)	386 (86.3)	0.39
3.	COVID-19 can spread by touching a surface or object that has the virus on it and then touching their mouth, nose, or eyes.	431 (95.3)	381 (94.6)	0.67
4.	An asymptomatic person can transmit COVID-19	396 (88.3)	343 (86.0)	0.40
5.	Only adults need to take precautionary measures to prevent the spread of COVID-19.	418 (91.2)	356 (89.3)	0.44
6.	Young people can develop severe illnesses or die from COVID-19.	420 (92.8)	349 (87.2)	0.03*
7.	COVID-19 virus is real.	449 (97.8)	370 (91.6)	0.001*
8.	Avoiding crowded areas prevents transmission of COVID-19.	446 (98.1)	392 (97.4)	0.55

** Statistically significant (p-value <0.05); **Questions adopted from previous KAP surveys* [10,15,16]

On multivariable analysis, age, sex, occupation, and marital status were not significantly associated with good knowledge among the two populations (Table 3). However, those with secondary education in Kibera were more likely to have good knowledge scores compared to those with none (aOR, 4.02; 95% CI, 1.23-13.16).

Table 3: Factors associated with good COVID-19 knowledge scores in Kibera, Nairobi and Asembo, Siaya County, Kenya on multivariable analysis.

Characteristics	**Asembo**		**Kibera**	
Age	**odds ratio (95% CI)**	**p-value**	**odds ratio (95% CI)**	**p-value**
18-29yrs	Ref		Ref	
30-39yrs	1.96 (0.16-23.73)	0.595	1.02 (0.21-4.89)	0.984
40-49yrs	5.79 (0.48-69.53)	0.165	0.86 (0.14-5.41)	0.873
50-59yrs	1.32 (0.12-14.27)	0.820	3.76 (0.22-64.73)	0.361
60+**	1.79 (0.23-14.21)	0.579		
Sex				
Female	Ref		Ref	
Male	0.59 (0.13-2.72)	0.498	0.27 (0.07-1.04)	0.058
Occupation				
Unemployed	Ref		Ref	
Employed	0.98 (0.06-17.42)	0.990	2.31 (0.39-13.62)	0.355

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Self-employed	0.57 (0.13-2.49)	0.455	1.88 (0.37-9.68)	0.447
Education				
None/Primary	Ref		Ref	
Secondary	3.88 (0.52-29.00)	0.186	4.02 (1.23-13.16)*	0.022
Post-secondary	2.19 (0.49-9.78)	0.304	4.01 (0.34-47.82)	0.271
Marital status				
Single	Ref		Ref	
Married	1.89 (0.40-9.07)	0.423	0.61 (0.06-5.73)	0.661
Divorced/separated**			0.48 (0.01-15.89)	0.682
Widowed	0.46 (0.08-2.64)	0.379	0.43 (0.01-13.11)	0.624

** Statistically significant (p-value <0.05)*
*** Missing data because of zero numerators*

The most common sources of COVID-19 information were religious leaders (67.5%), relatives (47.8%) and healthcare workers (40.6%) in Asembo and journalists (69.1%), government authorities (59.8%), scientists (56.8%) in Kibera (Figure 1).

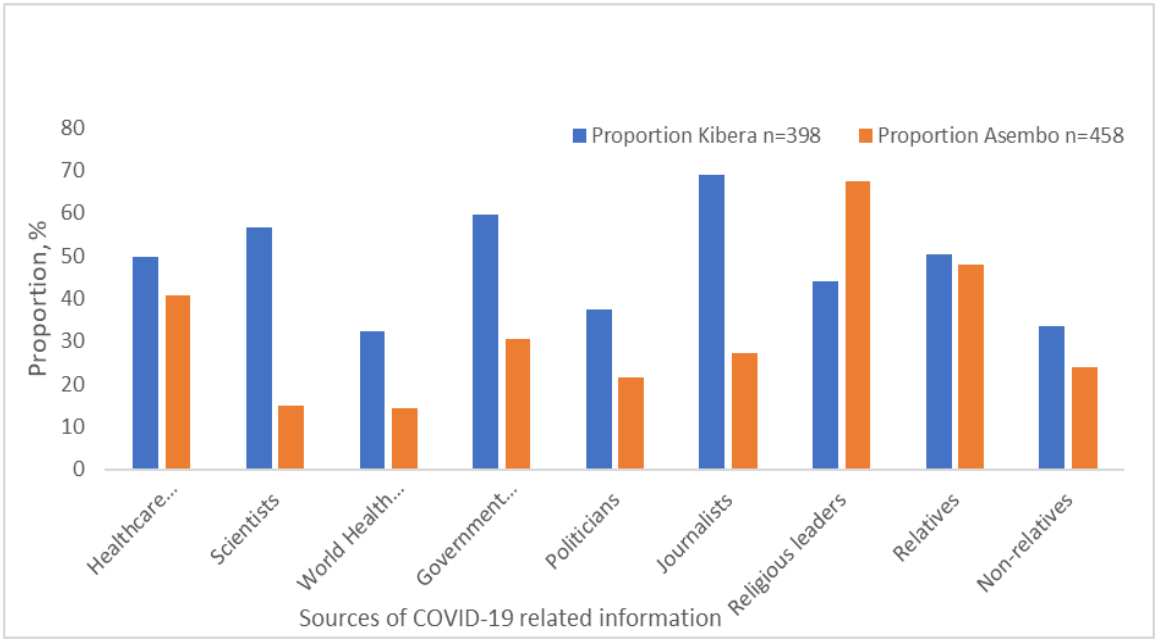

Figure 1: Sources of COVID-19 related information among study participants in Asembo and Kibera

The most trusted source of COVID-19 information were religious leaders (97.1%), healthcare workers (95.2%), and government officials (90.7%) in Asembo, while in Kibera they were World Health Organisation (WHO) (90.7%), scientists (86.7%), and healthcare workers (83.8%). Politicians were the least trusted sources of COVID-19 information in both Asembo (56.6%) and Kibera (46.3%) (Supplementary Figure 1).

3.3 Perceived risk of getting COVID-19

In Asembo, 413 (90.2%) participants and in Kibera, 327 (82.2%) were worried about contracting COVID-19. The perceived risk of getting COVID-19 was not associated with education level, sex, or marital status in both Kibera and Asembo (Table 4).

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Table 4: Factors associated with perceived risk of getting COVID-19 in Asembo, Siaya and Kibera, Nairobi County, Kenya on multivariable analysis

Characteristics	Asembo		Kibera	
Age	**odds ratio (95% CI)**	**p-value**	**odds ratio (95% CI)**	**p-value**
18-29yrs	Ref		Ref	
30-39yrs	1.22 (0.42-3.58)	0.714	2.19 (0.92-5.18)	0.076
40-49yrs	0.73 (0.21-2.50)	0.614	3.32 (1.37-8.03)	0.008*
50-59yrs	0.70 (0.14-3.58)	0.662	3.64 (1.15-11.49)	0.028*
60+	0.27 (0.07-0.98)	0.047*	2.69 (0.41-17.57)	0.301
Sex				
Female	Ref		Ref	
Male	0.87 (0.34-2.18)	0.759	0.66 (0.34-1.29)	0.224
Occupation				
Unemployed	Ref		Ref	
Employed formal	0.85 (0.19-3.88)	0.832	0.18(0.05-0.68)	0.011*
Employed informal	2.17 (0.28-16.68)	0.454	0.56(0.23-1.40)	0.218
Self employed	1.69 (0.82-3.47)	0.154	0.34(0.15-0.77)	0.010*
Education				
None	Ref		Ref	
Primary	0.95 (0.33-2.78)	0.927	1.84(0.19-17.83)	0.598
Secondary	0.71 (0.20-2.49)	0.592	1.15(0.12-10.95)	0.903
Post-secondary	0.52 (0.11-2.50)	0.417	5.75(0.51-65.31)	0.157
Marital status				
Single	Ref		Ref	
Married	0.75 (0.20-2.83)	0.665	0.95(0.42-2.15)	0.906
Divorced/separated		0.553		0.772
Widowed	0.62(0.13-3.05)		0.78(0.14-4.21)	

** Statistically significant (p-value <0.05)*

Participants 60 years and older in Asembo were less likely to be worried about contracting COVID-19 (aOR 0.27; 95% CI, 0.07-0.98) as compared to those 18-29 years old. Those 40-49 years of age in Kibera were more likely to be worried about contracting COVID-19 (aOR 3.32; 95% CI, 1.37-8.03) compared to those of ages 18-29 years. Kibera participants 50-59 years of age were also more likely to be worried about contracting COVID-19 relative to the reference group (aOR 3.64; 95% CI, 1.15-11.49). In Kibera, those with formal employment (aOR, 0.18; 95% CI, 0.05 – 0.68) and the self-employed (aOR, 0.34; 95% CI, 0.15 – 0.77) were less likely to be worried about contracting COVID-19 as compared to the unemployed. There was no association between employment status and perceived risk of COVID-19 infection in Asembo. The majority of the respondents from both sites (82.0% from Asembo and 80.9% from Kibera) were generally satisfied with the government measures to prevent COVID-19 (Supplementary Table 1).

3.4 Practices

In the seven days preceding the interview, a vast majority of the participants in Asembo (438, 94.8%) and Kibera (381, 94.6%) reported practising handwashing, with 72.2% and 67.8% of the participants always using soap when they washed their hands. Wearing face masks was reported by 426 (91.7%) of Asembo participants and 378 (94.4%)

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from Kibera. Five or more of the seven COVID-19 measures listed were practised by 153 (35.2%) and 275 (68.0%) of Asembo and Kibera participants, respectively, within the previous seven days (Table 5).

*Table 5: Frequency of observing COVID-19 prevention practices among participants in Asembo, Siaya county and Kibera, Nairobi County.***

	Asembo (N=458)	**Kibera (398)**	
COVID-19 prevention Practice	n (%)	n (%)	**p-value**
Handwashing	438 (94.8)	381 (94.6)	0.936
Use of hand sanitizers	144 (34.1)	303 (75.5)	<0.0001*
Keeping physical distance (>1.5meter)	286 (64.4)	306 (76.5)	0.002*
Use of face mask	426 (91.7)	378 (94.4)	0.221
Avoiding travel unless necessary	119 (27.3)	263 (65.6)	<0.0001*
Avoiding crowded places	323 (72.6)	293 (72.2)	0.918
Staying at home	88 (19.4)	200 (48.7)	<0.0001*
Number of mitigation measures practiced			
<2	9 (2.0)	5 (2.0)	<0.0001*
2-4	296 (62.8)	118 (30.0)	
≥5	153 (35.2)	275 (68.0)	

** Statistically significant (p-value <0.05)*

*** Values in the table have been weighted by populations' age and sex distribution*

3.5 Vaccine acceptability and factors associated

Awareness of the existence of a COVID-19 vaccine was higher in Asembo (411, 89.7%) than Kibera (266, 66.8%). If a COVID-19 vaccine was offered, 373 (83.6%; 95% CI, 79.9 – 86.9%) of the participants from Asembo and 231 (59.8%; 95% CI, 54.8 – 64.8) in Kibera would accept vaccination. Among the 75 who would not accept the vaccine in Asembo: 41 (54.7%) cited safety concerns; 20 (26.7%) insufficient information to decide; 8 (10.7%) didn't believe in the vaccine and 2(2.7%) felt they were not at risk of COVID-19. In Kibera: 54/160 (33.8%) were concerned about the safety of the vaccine; 34/160 (21.3%) didn't believe in the vaccine; 28/160 (17.5%) insufficient information to decide; 9/160 (5.6%) were concerned about the effectiveness of the COVID-19 vaccine and 9 (5.6%) felt they were not at risk of COVID-19 (Figure 2).

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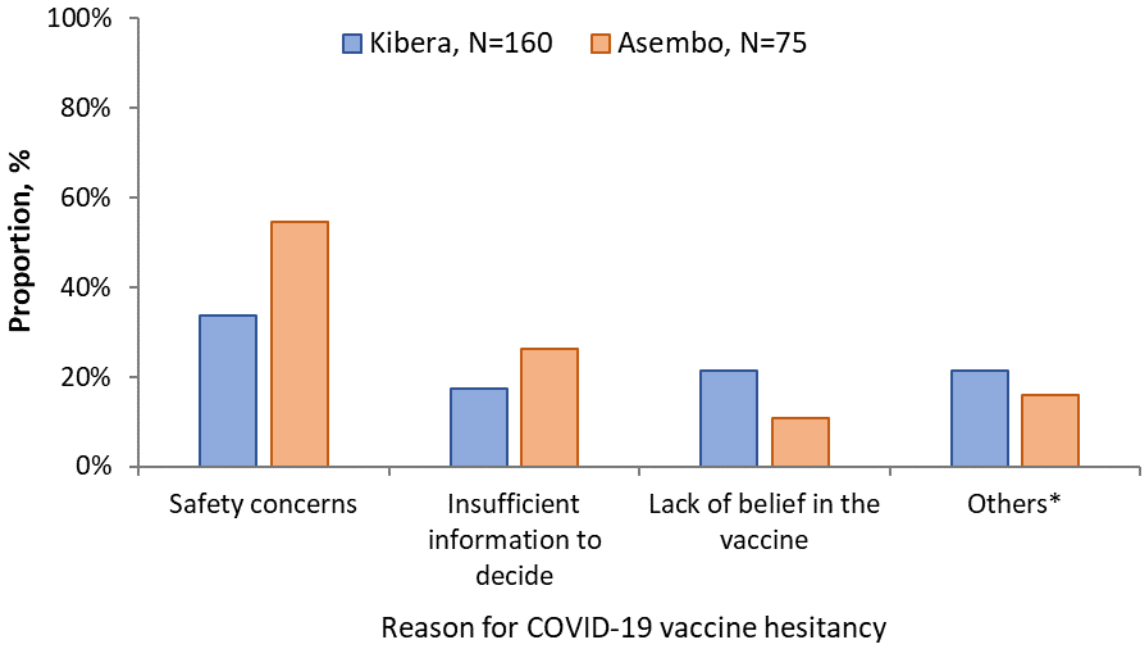

Figure 1: Reasons for vaccine hesitancy among study participants in Asembo and Kibera, 2021.

In Kibera, those with post-secondary education were less likely to accept the vaccine compared to those without education (aOR, 0.40; CI, 0.18-0.85). Knowledge scores, age, sex, occupation, marital status and COVID-19 risk perception were not associated with vaccine acceptability (Table 6).

Table 6: Factors associated with vaccine acceptability in Kibera, Nairobi and Asembo, Siaya County on multivariable analysis

Characteristics	**Asembo**		**Kibera**	
Age	**odds ratio (95% CI)**	**p-value**	**odds ratio (95% CI)**	**p-value**
18-29yrs	Ref		Ref	
30-39yrs	0.76(0.28-2.08)	0.596	0.89(0.46-1.71)	0.726
40-49yrs	0.68(0.23-1.94)	0.465	0.99(0.47-2.09)	0.987
50-59yrs	0.91(0.26-3.24)	0.888	2.59(0.93-7.24)	0.069
60+	0.68(0.22-2.08)	0.494	2.35(0.50-11.01)	0.278
Sex				
Female	Ref		Ref	
Male	1.10(0.60-2.04)	0.752	1.41(0.80-2.48)	0.231
Occupation				
Unemployed	Ref		Ref	
Employed	0.51(0.19-1.39)	0.187	0.90(0.47-1.74)	0.750
Self employed	1.39(0.64-3.03)	0.408	1.14(0.62-2.10)	0.664
Education				
None/Primary	Ref		Ref	
Secondary	0.79(0.34-1.82)	0.580	0.64(0.37-1.12)	0.119
Post-secondary	0.69(0.25-1.89)	0.465	0.40(0.18-0.85)	0.018*
Marital status				
Single	Ref		Ref	
Married	1.94(0.78-4.86)	0.155	1.19(0.61-2.34)	0.610

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Divorced/separated.	0.68(0.12-3.91)	0.666	1.16(0.24-5.56)	0.856
Widowed	0.84(0.21-3.30)	0.801	2.88(0.53-15.69)	0.219
Knowledge scores				
Good	Ref		Ref	
Poor	0.62 (0.11-3.30)	0.577	0.52 (0.18-1.47)	0.215
Covid-19 Risk				
Not Dangerous	Ref		Ref	
Dangerous	0.41(0.10-1.73)	0.226	3.88(0.35-43.61)	0.271
Covid-19 Worry				
Not Worried	Ref		Ref	
Worried	0.95(0.36-2.47)	0.909	1.60(0.89-2.86)	0.114

** Statistically significant (p-value <0.05)*

4. Discussion

We report a high level of COVID-19-related knowledge among adult residents in both Asembo (in rural Western Kenya) and Kibera (an informal urban settlement in Nairobi) as of May 2021. The primary sources of COVID-19 information were variable. People in Kibera and Asembo have some similar and some different trusted sources of information. Majority (>90%) of the respondents had a positive attitude towards mitigation measures at both rural and urban sites in Kenya. However, we observed lower awareness of COVID-19 vaccine existence (66.8%) and vaccine acceptance (59.8%) in Kibera compared to Asembo, an indicator of vaccine hesitancy, particularly in the informal urban population.

The high level of COVID-19 knowledge in the two populations may be due to extensive media coverage, including print and social media, of the pandemic since the first case was confirmed in March 2020 in Kenya. Utilization of formal and informal channels by the government to spread COVID-19 information may have successfully disseminated the information to both urban and rural populations [1]. Studies in other African countries and elsewhere have found moderate to high knowledge of the COVID-19 pandemic, which has been similarly attributed to media publicity and active public health programs [6,20,21]. Some of the common sources of vaccine information included social media and healthcare providers. In these studies, participants' knowledge of COVID-19 was found to be associated with age, gender, education and past COVID-19 infection. Our study, however, found no association between knowledge scores and age, gender and occupation. Participants with secondary education from the informal settlement were up to four times more likely to have good knowledge compared to those with no education. This disparity could be a reflection of higher access to COVID-19 literature through programs implemented by the government and other partners [22,23]. Another study in Nigeria, conducted in March 2020, found less than a third of the participants had good COVID-19 knowledge, despite half the participants having more than a tertiary education [24]. This was a population-based study among both urban and peri-urban dwellers, unlike our study, which was in an informal urban settlement and a rural population. Despite knowledge being a prerequisite for positive practices and attitudes, a recent scoping review of COVID-19 knowledge, attitudes, and practices studies carried out in Sub-Saharan Africa found that most participants had adequate knowledge, although the attitudes and practices were not always positive [13].

Our study found that 40.2% of the informal urban population would not accept the vaccine if offered, compared to 16.4% of the rural participants. Studies carried out among

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informal urban settlements found vaccine hesitancy levels of 34% in Brazil [25] and 41.9% in Bangladesh [26]. In the Bangladesh study, the participants from an informal settlement were 3.8 times more likely to be hesitant to receive the COVID-19 vaccine relative to the other urban dwellers. The sub-optimal COVID-19 vaccine acceptability levels in the informal settlements may be attributable to differences in socio-demographic factors associated with vaccine acceptance, such as age, dependency on informal employment, and inadequate access to preventive measures [26,27]. Informal urban dwellers tend to be younger, hence more likely to have lower risk perceptions of COVID-19. Our findings were also higher and different from that of a study in South Africa, where the vaccine hesitancy was 21% among the urban participants and 31% among the rural study participants [28]. In our study, residents of the urban site were predominantly young and dependent on informal employment. With the widely circulated information that youth had a low-risk of developing severe COVID-19 disease, young people may consider themselves less vulnerable to the infection [29–32]. The young people may also assume that they will have mild disease in case of infection [32]. The informal settlement dwellers, who largely depend on informal employment for a living, have been more economically affected by the mitigation measures against the pandemic [33,34]. Informal settlements have historically had inadequate access to essential services such as water, healthcare, and sanitation [35]. This may lead to a feeling of being marginalized and a lack of confidence in COVID-19 prevention measures initiated by the government, including the vaccine [33,36]. The period preceding our survey had heightened media coverage on potential side effects, including the formation of blood clots related to the AstraZeneca vaccine [37–39]. This was the most available vaccine in Kenya at the time of the survey and may have reduced vaccine acceptability. In Africa, a study carried out to assess the determinants of vaccine acceptability before their roll-out found that uptake was potentially determined by the attitude of healthcare workers towards the vaccine, COVID-19 misinformation, religious beliefs, and social influencers [40]. They also found that addressing these factors would improve the acceptability of the vaccine [40]. The higher COVID-19 vaccine acceptance observed among the rural population in our study is likely attributed to the relatively older population who has a higher risk perception due to the association between old age and severe forms of COVID-19. It could also be the result of the inaccessibility of online media sources relaying negative COVID-19 vaccine information. Other studies have also found higher vaccine acceptance rates among the rural populations as compared to the urban ones [41,42]. These higher rates of vaccine acceptance in the rural populations were thought to be due to low knowledge about vaccine side effects, a greater proportion of older adults and people with comorbidities are at higher risks of severe COVID-19 [43]. However, other studies found that rural populations were more likely to be hesitant about receiving the COVID-19 vaccine [10,44,45]. A study carried out in Kenya just before the roll-out of the vaccine found that rural counties were 2.5 times more likely to report COVID-19 vaccine hesitancy compared to urban counties [10]. In this phone-based Kenyan study, the vaccine acceptance level was 53.8% in the rural counties and 75.9% in the urban counties. The vaccine hesitancy in these rural populations has been associated with the inconvenience of travel involved in accessing the vaccine and the lack of confidence in the vaccine.

Our study had some limitations. The participants were drawn from an informal settlement in the capital city of Kenya; therefore, the findings may not be generalizable to the rest of the urban population with different socio-economic characteristics. Additionally, respondents may provide favourable respondents since the data is self-reported. Despite these limitations, the strength of our study lies in the population-based random selection of households.

5. Conclusions

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Our study highlights the need for the Ministry of Health and other public health stakeholders to address vaccine hesitancy to achieve the set vaccination targets. Educational programs promoting the benefits of the COVID-19 vaccine and more rapidly and effectively responding to reported safety and effectiveness concerns should be considered. Despite the good levels of COVID-19 knowledge, this study suggests that continued efforts be put into reinforcing the knowledge, attitude, and practices related to COVID-19 control. This study also indicates the need for additional studies to be carried out to provide more information on the drivers of vaccine hesitancy in Kenya.

6. Patents

Not applicable.

Supplementary Materials: The following supporting information can be downloaded at: www.mdpi.com/xxx/s1,

Figure S1: Trusted Sources of COVID-19 information

Table S1: Attitudes of study participants towards COVID-19 in Kibera, Nairobi and Asembo, Siaya County, Kenya

Table S2: COVID-19 related practices among the study participants.

Author Contributions: CN developed the data collection tools, prepared an analysis plan, and drafted the manuscript. AA, CO, and CO carried out daily data cleaning and carried out data analysis. DO trained the data collection teams and supervised the data collection. GA and AO developed data collection tools, trained the data collection teams, and supervised the data collection exercise. EO, IN and RN developed the study protocol, developed the data collection tools and the data analysis plan. PM conceptualized the study and developed the study protocol. AH-R conceptualized the study. GB and PM conceptualized the study, developed the study protocol, reviewed the data collection tools, reviewed the data analysis plan, carried out data analysis and drafted the manuscript.

All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Appendix A

Not applicable.

Appendix B

Not applicable

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