



Knowledge, Attitudes and Practices towards COVID-19 Vaccination: Comparison Study between Makerere University Medical Students and Katanga Slum Residents, in Uganda

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Abstract

Introduction: COVID-19 pandemic posed unprecedented challenges on global health systems. COVID-19 vaccines emerged crucial in curbing its spread. Existing studies on KAP among medical students and slum community residents revealed mixed findings, with knowledge gaps, misconceptions, and barriers to vaccine acceptance. Understanding KAP of vaccine uptake is essential for effective public health strategies. **Objective:** The objective of this study was to assess knowledge, attitudes, and practices related to COVID-19 vaccine among medical students and residents of Katanga slum in Uganda. **Method:** Cross-sectional study done in Katanga community & Makerere University Medical School employing a quantitative method with interviewer-administered questionnaire. Data was analyzed using descriptive statistics. A p-value of <0.05 at multivariable logistic regression was considered statistically significant and the presence of association was described by using odds ratio (OR) with their 95% confidence interval (CI). **Results:** In this study, 384 participants were enrolled. The average age of participants was 26.68 ± 7.5 years. Common sources of COVID-19 vaccine information were television (31.25%) and social media (17.19%). The overall knowledge of participants was good in only 39.84%, secondary to family history of COVID-19 infection and COVID training. Attitude towards the vaccine was poor in 67.27% of participants. Joint family setting (AOR = 2.31, 95% CI (1.43 - 3.73) $p < 0.001$) and having family members with suspected COVID-19 symptoms (AOR =

1.96, 95% CI (1.08 - 3.54) $p < 0.026$) were associated with poor attitude. The prevalence of poor practice towards vaccination was 36.72. Barriers to vaccination included scary information from media/friends/family and concerns over side effects and the effectiveness of the vaccine. **Conclusion:** The study highlights the critical role of knowledge in COVID-19 vaccine uptake. However, negative attitudes were expressed by a significant proportion, including medical students despite their good knowledge. Only one-third demonstrated good vaccination practices. Tailored interventions are key to increasing positive attitudes, vaccination uptake, and coverage by addressing unique factors driving vaccine hesitancy in each population. Knowledge and awareness can be enhanced by dispelling myths with accurate language, and easy-to-understand language for populations with lower educational achievements through vaccination campaigns.

Subject Areas

Epidemiology, Global Health, Health Policy, Infectious Diseases, Public Health

Keywords

Knowledge, Attitude, Practices, COVID-19 Vaccine, Uganda

1. Introduction

The COVID-19 pandemic has had a profound impact posing unprecedented challenges on global health systems. The COVID-19 vaccine emerged as a pivotal tool being crucial in curbing its spread. Medical students, as future healthcare professionals, play an integral role in disseminating accurate information and encouraging vaccine acceptance, while residents of slum communities, often facing unique socio-economic and healthcare disparities, require attention.

This study, among medical students and slum community residents', aims to provide an understanding of the intricate interplay between knowledge, attitudes, and practices (KAP) towards COVID-19 vaccination which is paramount for devising effective strategies that foster widespread vaccine acceptance and uptake, ultimately contributing to global efforts of controlling the spread of COVID and any other future pandemics.

The existing scientific literature on KAP towards COVID-19 vaccines among medical students and slum community residents presented a complex picture, with both positive and negative findings. While some studies reported good knowledge, positive attitudes, and high acceptance rates, others highlighted knowledge gaps, misconceptions, and barriers to vaccine acceptance. In light of these diverse findings, it was essential to comprehensively review KAP towards COVID-19 vaccines among medical students and slum community residents in Uganda to better understand the current knowledge landscape and identify key knowledge gaps.

Numerous studies have explored the KAP towards COVID-19 vaccines among medical students and have reported mixed findings. Some studies have shown that medical students possess good knowledge about COVID-19 vaccines, with a positive attitude towards vaccination and a high likelihood of getting vaccinated themselves. For instance, a study by Singh *et al.* (2020) in India reported positive attitudes and high acceptance of COVID-19 vaccines among medical students, with a majority expressing willingness to get vaccinated. However, other studies have highlighted knowledge gaps and misconceptions among medical students, with concerns about vaccine safety, efficacy, and side effects. For instance, a study by Shima M. Saied *et al.* (2021) in Egypt [1] revealed that medical students had misconceptions about the COVID-19 vaccine, with concerns about side effects and lack of trust in vaccine safety [2].

Vaccine uptake and adherence to recommended vaccination schedules are crucial for achieving effective immunity against COVID-19. Uganda, like many other nations, has confronted multifaceted challenges in its vaccination endeavors. This manuscript delves into a comparative analysis of KAP towards COVID-19 vaccination between two disparate yet interconnected groups: Makerere University Medical Students and residents of Katanga Slum in Uganda.

Makerere University Medical Students represent a cohort of individuals engaged in healthcare education, and scientific while, Katanga Slum, located in Uganda's capital, Kampala, embodies a community with socioeconomic disparities and limited access to healthcare resources. By juxtaposing these contrasting demographics, this study aims to unravel the dynamics shaping COVID-19 vaccination attitudes across varied social strata.

By using this comparison, policymakers and health practitioners can tailor targeted interventions that resonate with the needs and perceptions of diverse communities. Ultimately, fostering vaccine confidence and addressing hesitancy within the society for achieving equitable vaccine distribution and advancing towards collective immunity against the COVID-19 pandemic or any future pandemics.

2. Method

2.1. Study Design, Setting and Population

This was a cross-sectional study, conducted within the Katanga community and the Makerere University medical school students. This study was conducted employing a quantitative method with an interviewer-administered questionnaire to attain the objectives of the study with a simple random sampling of participants. Participants included were either residents of Katanga area or medical students of Makerere University College of Health Sciences and only English speaking participants. The study excluded individuals below 18 years of age. The participants were recruited by simple random sampling technique and they were interviewed from their places of residence and work for residents of Katanga as well as from their respective colleges for the students.

2.2. Sample Size Calculation

Makerere University was estimated to have 3000 undergraduate students, while 5000 students were estimated to reside in Makerere University halls of residence, and, Katanga residents were estimated at 7000 people. The total estimate was therefore 10,000. Using Yamane's formula (1967): $n = N/(1 + Ne^2)$. N being the population size of 10,000. " e " being the degree of precision at a significant level = 5% (1.96). " n " being the sample size, which was calculated as 384 participants.

2.3. Data Collection Tool and Procedure

Data related to the KAP and socio-demographic characteristics were collected using a structured and pre-tested interviewer-administered questionnaire for all participants. Based on the literature review in the background, the authors drafted a questionnaire to assess the knowledge, attitude, and aspects of practices and barriers to COVID-19 vaccination. The participants were recruited by simple random sampling technique and they were interviewed from their places of residence and work for Katanga participants as well as from their respective colleges for the MAK-CHS students.

The questionnaire was divided into four sections. The first section assessed the socio-demographic characteristics of the participants. The second section assessed the respondents' COVID-19 vaccine-related knowledge. The third section assessed the respondents' COVID-19 vaccine-related attitude and the fourth section assessed the respondents' COVID-19 vaccination practice. The questionnaire was developed based on a comprehensive review of existing literature. Overall, the questionnaire items were designed to capture key variables related to COVID-19 vaccination, including knowledge about the vaccine, attitudes towards vaccination, perceived barriers and facilitators to vaccination, and vaccination practices. Additionally, the questionnaire underwent pilot testing among a subset of the target population to assess its clarity, comprehensibility, and relevance. Each variable was operationalized using multiple items, and internal consistency reliability analysis was performed to assess the reliability of the questionnaire. Feedback from the pilot study participants was incorporated into the final version of the questionnaire to improve its validity and reliability.

2.4. Knowledge, Attitude and Practice

KAP related to COVID-19 vaccine was assessed using a total of 22 items/questions (7 knowledge, 10 attitudes and 5 practice). The different number of items and value scoring systems used to categorize KAP were then categorized using Bloom's cut-off point:

- good if the score was between 80% and 100%
- moderate if the score was between 60% and 79%, and
- poor if the score was less than 60% [3] [4].

Knowledge about COVID-19 vaccine was based on a 7-item scale that assessed the participants understanding about the vaccine, who to vaccinate, where to get vaccinated as well as how vaccines are made. Each knowledge question

had a possible response of “Yes”, “No” and “Don’t know”. Then, the correct answer (Yes) was coded as 1, while the wrong answer (No/Don’t know) was scored as 0 during analysis. Accordingly, the total score ranged from 0 - 7, with an overall greater score indicating adequate/good knowledge based on the Bloom’s cut-off point.

To measure attitude towards COVID-19 vaccine a 5-point Likert scale was used: strongly agree scored 4, Agree scored 3, Neutral scored 2, Disagree scored 1, and strongly disagree scored 0, based on 10-items that assessed participants’ concern about contracting COVID-19 without vaccine, family opinion, protecting family/colleagues and related importance of vaccination. Accordingly, the total score ranged from 0 - 40, with an overall greater score indicating good/positive attitude based on the Bloom’s cut-off point.

COVID-19 vaccination-related practice was based on 5-item scale that assessed whether the participant undertook the COVID-19 vaccination and doses completed as well as hesitancy towards the vaccine and encouraging others to vaccinate. Each knowledge question had a possible response of “Yes” and “No”. Then, the correct answer (Yes) was coded as 1, while the wrong answer (No) was scored as 0 during analysis. Questions on number of doses completed and encouraging family/friends/colleagues each scored 3 points for correct answer. Accordingly, the total score ranged from 0 - 7, with an overall greater score indicated good practice based on the Bloom’s cut-off point.

2.5. Data Analysis

After the data was collected, it was checked for inconsistency and eligibility issues. The collected data was coded and entered into epicollect5 software for cross-checking and exported for analysis using Microsoft Office Excel 2016 and STATA 16.0 software.

Descriptive statistics such as frequency, percentages, mean, and standard deviation were computed to summarize categorical and numerical data. During the analysis, frequencies of different variables were determined, followed by cross-tabulation to compare the frequencies. The overall knowledge, attitude and practice were categorized, using Bloom’s cut-off point, as good if the score was between 80% and 100%, moderate if the score was between 60% and 79%, and poor if the score was less than 60%.

Binary logistic regression analysis was used to assess the association between the candidate’s independent and dependent variables. All variables that showed statistical significance in the bivariate analysis with a P-value of ≤ 0.2 , were entered into a multivariable logistic regression model to determine the independent factors associated with KAP among the participants. A p-value of < 0.05 was considered statistically significant and the presence of association was described by using odds ratio (OR) with their 95% confidence interval (CI).

2.6. Ethics Statement

This study complied with the declaration of Helsinki on research involving hu-

man subjects [5]. Ethical clearance and approval were obtained from the Makerere University, School of Public Health - Institutional Review Board (Approval no: SPH-2022-246). The approval to conduct the study within Katanga was obtained from the Chairpersons of both Busia and Kimwanyi Zones. The enrolment of participants into the study was solely voluntary and only after the aim of the study was clearly explained, written consent was obtained from all study participants. The participants were however free to withdraw from the study at any time point. Identification numbers instead of names of the respondents were used and the privacy and confidentiality of information was also strictly guaranteed by data collectors as well as investigators and the data collected were treated with the utmost confidentiality.

3. Results

3.1. Sociodemographic Characteristics

Out of a total sample size of 384 participants, the majority (340) 88.54% were between 18 and 34 years. Of the participants, 229 (59.64%) were males and 155 (40.36%) were females. The mean age of the participants was 26.68 ± 7.5 SD years. An equal number of 192 participants were from Katanga and Makerere University College of Health Sciences (MAK-CHS). Of the participants, 125 (32.55%) followed the Catholic religion and 215 (55.99%) stayed in nuclear family. 189 (46.23%) respondents had not experienced COVID-19 symptoms (Table 1).

3.2. Knowledge of the Participants about COVID-19 Vaccine

All participants had information on COVID-19 vaccine. Television, 120 (31.25%) and social media, 66 (17.19%) were the most commonly stated sources of information (Figure 1).

The average knowledge score of the participants was 6.43 (SD = 2.00, ranging from 0 to 9). The overall knowledge of the participants towards COVID-19 vaccine indicated that 153 (39.84%) had good knowledge while 128 (33.33%) had

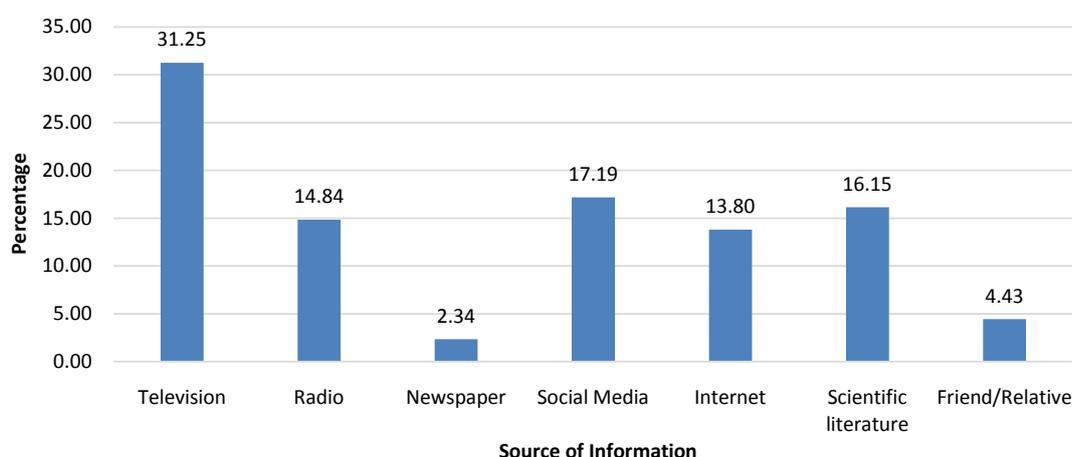


Figure 1. Source of information about COVID-19 vaccine among MAK-CHS students and Katanga residents.

Table 1. Socio-demographic characteristics.

Variables	Category	Freq.	Percent
Age	18 - 34 years	340	88.54
	35 - 51 years	35	9.11
	≥52 years	9	2.34
Sex	Female	155	40.36
	Male	229	59.64
Group	Katanga	192	50
	MAK-CHS	192	50
	MBChB	160	23.33
MAK-CHS course	Dental surgery	11	5.73
	Others	21	10.94
MAK-CHS year	1	41	21.47
	2	37	19.37
	3	42	21.99
	4	41	21.47
	5	30	15.71
Religion	Others	44	11.46
	Anglican	97	25.26
	Born again	60	15.63
	Catholic	125	32.55
	Muslim	58	15.1
Marital status	Divorced	5	1.3
	Married	99	25.78
	Single	274	71.34
	Widowed	6	1.56
Family size	Joint/>4 members	169	44.01
	Nuclear/<4 members	215	55.99
Chronic diseases	None	339	88.51
	Allergy	8	2.09
	Hypertension	13	3.39
	Diabetes Mellitus	2	0.52
	Asthma	10	2.61
	Others	11	2.87
Katanga education level	None	14	7.29
	Primary	51	26.56
	Secondary	95	49.48
	Tertiary	32	16.67

Continued

Katanga monthly income	<50,000 shs	13	6.81
	50,000 - 100,000 shs	42	21.99
	100,000 - 500,000 shs	97	50.79
	>500,000 shs	39	20.42
COVID infected before	I had no symptoms	189	49.22
	I had suspected symptoms but I didn't verify with a doctor and/or specific test	141	36.72
	I had suspected symptoms but confirmed negative test	23	5.99
	Yes confirmed positive test with no symptoms	6	1.56
	Yes confirmed positive test with mild symptoms	20	5.21
	Yes confirmed positive test with severe symptoms	5	1.3
Family COVID infected before	Had no symptoms	159	41.41
	Had suspected symptoms but I didn't verify with a doctor and/or specific test	125	32.55
	Had suspected symptoms but confirmed negative test	17	4.43
	Yes confirmed positive test with no symptoms	12	3.13
	Yes confirmed positive test with mild symptoms	47	12.24
	Yes confirmed positive test with severe symptoms	24	6.25

poor knowledge. The provided statistics regarding the COVID-19 vaccine are highly significant indicators in understanding the state of vaccine literacy within the studied populations. The average knowledge score of 6.43 out of 9 suggests a moderate level of understanding, with considerable variability among individuals. These findings emphasize the importance of targeted public health interventions aimed at addressing knowledge gaps, dispelling misinformation, and enhancing vaccine literacy for widespread acceptance of the COVID-19 vaccine, thus contributing to effective pandemic control efforts within these communities.

3.3. Factors Associated with Good Knowledge about COVID-19 Vaccine

Participants whose family member/members had been infected by COVID before were 2 to 12 times more likely to have good knowledge than those whose

families had no symptoms. The odds of having good knowledge increased by 3.5 times among those who attended a COVID training before (**Table 2**).

3.4. Attitude of Participants towards COVID-19 Vaccination

The overall attitude of the participants towards COVID-19 vaccine indicated that 261 (67.27%), 114 (29.38%), and 13 (3.35%) of them had a poor, moderate and good attitude, respectively.

From all the factors, in a bivariate analysis, only 6 had a significant effect on poor attitude towards COVID-19 vaccination. Though at bivariate analysis poor knowledge showed a significant relation with poor attitude (OR = 1.89, 95% CI (1.18 - 3.05) $p = 0.009$) there was a weak positive relationship between poor knowledge of the participants and poor attitude due to a Spearman correlation coefficient of 0.1344 ($p = 0.008$). Only two of the factors were significantly associated with poor attitude through multivariate analysis which indicated that the participants who stayed in a joint family were 2.31 times (AOR = 2.31, 95% CI (1.43 - 3.73)) likely to have a poor attitude towards COVID vaccination than

Table 2. Factors associated with good knowledge.

Variables	GOOD KNOWLEDGE		COR (95% CI)	AOR (95% CI)	p-value
	No	Yes			
Group					
Katanga	182	10	1	1	
MAK-CHS	49	143	54.44 (26.66 - 111.20)	63.55 (23.49 - 171.91)	0.00
Religion					
Others	24	20			
Anglican	51	46	1.06 (0.52 - 2.17)	3.50 (1.16 - 10.61)	0.027
Born again	45	15	0.39 (0.17 - 0.17)	1.56 (0.46 - 5.27)	0.476
Catholic	71	54	0.93 (0.47 - 1.85)	2.70 (0.97 - 7.50)	0.057
Muslim	40	18	0.57 (0.25 - 1.28)	4.76 (1.21 - 18.74)	0.026
Family COVID infected before					
Had no symptoms	136	23	1	1	
Had suspected symptoms but I didn't verify with a doctor and/or specific test	60	65	6.50 (3.70 - 11.42)	3.79 (1.52 - 9.47)	0.004
Had suspected symptoms but confirmed negative test	2	15	45.00 (9.64 - 209.91)	12.26 (1.57 - 95.90)	0.017
Yes confirmed positive test with no symptoms	5	7	8.40 (2.46 - 28.73)	7.65 (1.00 - 58.73)	0.05
Yes confirmed positive test with mild symptoms	14	33	14.57 (6.79 - 31.25)	2.76 (1.02 - 7.48)	0.046
Yes confirmed positive test with severe symptoms	14	10	4.71 (1.91 - 11.64)	1.61 (0.41 - 6.27)	0.494
COVID training					
No	124	28	1	1	
Yes	107	125	5.12 (3.17 - 8.26)	3.54 (1.66 - 7.53)	0.001

those who stayed in the nuclear family. Also participants whose family member/members had suspected COVID symptoms earlier but they didn't verify with a doctor and/or specific test, had 1.96 times (AOR = 1.96, 95% CI (1.08 - 3.54)) poor attitude towards COVID-19 vaccine than whose family member had no symptoms before (**Table 3**).

The findings reveal critical insights into the factors influencing attitudes towards COVID-19 vaccination among the participants. While poor knowledge initially showed a significant association with poor attitude in the bivariate analysis, the weak positive relationship suggests that knowledge alone may not be the sole determinant of attitudes. Multivariate analysis highlighted two significant factors: participants residing in joint families were 2.31 times more likely to have a poor attitude towards vaccination compared to those in nuclear families, indicating the potential influence of familial dynamics on vaccine acceptance. Additionally, participants whose family members experienced suspected COVID symptoms but did not seek medical confirmation were nearly twice as likely to harbor poor attitudes towards vaccination, underlining the impact of personal experiences and healthcare-seeking behaviors on vaccine perceptions. These findings emphasize the need for comprehensive interventions addressing not only knowledge gaps but also familial and healthcare-related factors to promote vaccine acceptance and uptake within the studied populations.

3.5. Practice of Participants towards COVID-19 Vaccination

The prevalence of poor practice among participants was 141 (36.72%) and 129 (33.59%) of them had a good practice. Among the participants, 184 (47.92%) had ever resisted COVID-19 vaccination. But 282 (73.44%) had taken the COVID-19 vaccine and of these only 16 (4.17%) had completed all 3 doses while 179 (46.61%) completed two doses and 87 (22.66%) completed only one dose (**Figure 2**). The

Table 3. Factors associated with poor attitude towards COVID-19 vaccine

Variables	POOR ATTITUDE		COR (95% CI)	AOR (95% CI)	p-value
	No	Yes			
Family size					
Nuclear/<4 members	89	126	1	1	
Joint/>4 members	38	131	2.43 (1.55 - 3.82)	2.31 (1.43 - 3.73)	0.001
Family COVID infected before					
Had no symptoms	51	108	1	1	
Had suspected symptoms but I didn't verify with a doctor and/or specific test	29	96	1.53 (0.90 - 2.1)	1.96 (1.08 - 3.54)	0.026
Had suspected symptoms but confirmed negative test	9	8	0.41 (0.15 - 1.13)	0.59 (0.19 - 1.78)	0.348
Yes confirmed positive test with no symptoms	7	5	0.33 (0.10 - 1.09)	0.37 (0.11 - 1.28)	0.116
Yes confirmed positive test with mild symptoms	23	24	0.50 (0.26 - 0.97)	0.75 (0.35 - 1.61)	0.466
Yes confirmed positive test with severe symptoms	8	16	0.99 (0.40 - 2.43)	1.43 (0.55 - 3.72)	0.468

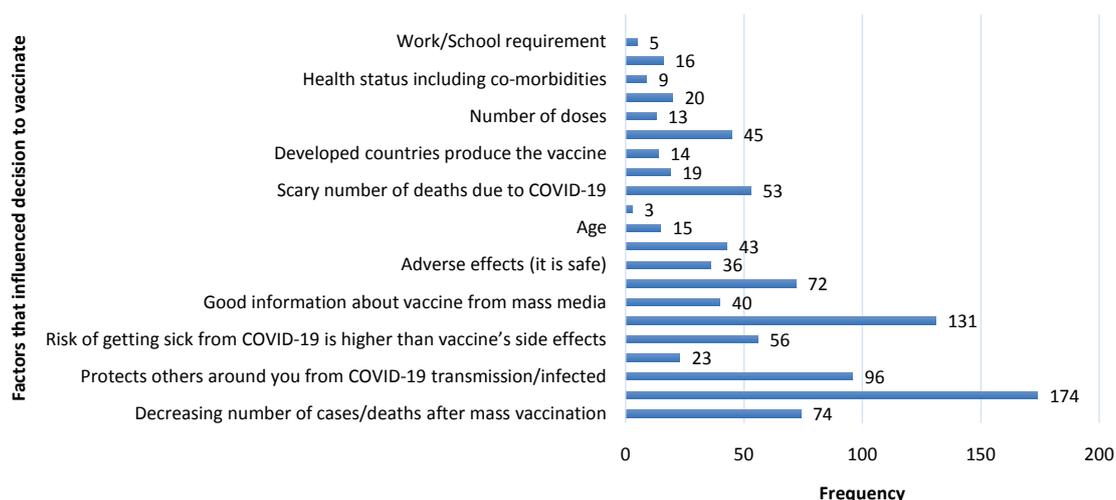


Figure 2. Factors that influenced the decision to vaccinate among MAK-CHS students and Katanga residents.

most common vaccine used was Oxford–AstraZeneca (178) followed by Pfizer–BioNTech (89). Besides this, among those who had not been vaccinated 66 (64.71%) were not likely to be vaccinated in the next two months. The prevalence of poor practices, with over a third of participants exhibiting such behaviors, underscores the importance of addressing barriers to adherence to recommended preventive measures. While a substantial proportion (47.92%) reported vaccine hesitancy, the encouraging vaccination uptake rate (73.44%) demonstrates some level of willingness to receive the COVID-19 vaccine within the studied populations. However, the low completion rates for multiple doses highlight potential challenges in ensuring full vaccination coverage.

Among those who took the vaccine, the most common factors that influenced them to take the vaccine were: The vaccine protects one from getting severely infected (174) and COVID-19 vaccination was recommended Ministry of Health/WHO (131).

Among those who did not take the vaccine, the most common barriers towards COVID-19 vaccination were: scary information about the vaccine from mass/social media/friends/family (128) and concern over side effects (110) and the vaccine was ineffective (84). (See **Figure 3**)

The Spearman correlation coefficients of poor knowledge and poor attitude with poor practice were only fairly positive, 0.2387 ($p = 0.00$) and 0.28824 ($p = 0.00$) respectively. The variables; sex, poor knowledge and poor attitude had a significant association with the poor practice, with $p < 0.05$ at multivariate analysis. Males were 2.10 times (AOR = 2.10, 95% CI (1.27 - 3.48)) more likely to have poor practice. Participants with poor knowledge and poor attitude towards COVID-19 vaccine were 2.71 times [AOR = 2.71, 95% CI (1.41 - 5.23)] and 4.69 times (AOR = 4.49, 95% CI (2.61 - 8.45)) more likely to have poor practice on COVID-19 vaccination respectively (**Table 4**). While the Spearman correlation coefficients between poor knowledge, poor attitude, and poor practice were moderately positive, multivariate analysis revealed their independent associations

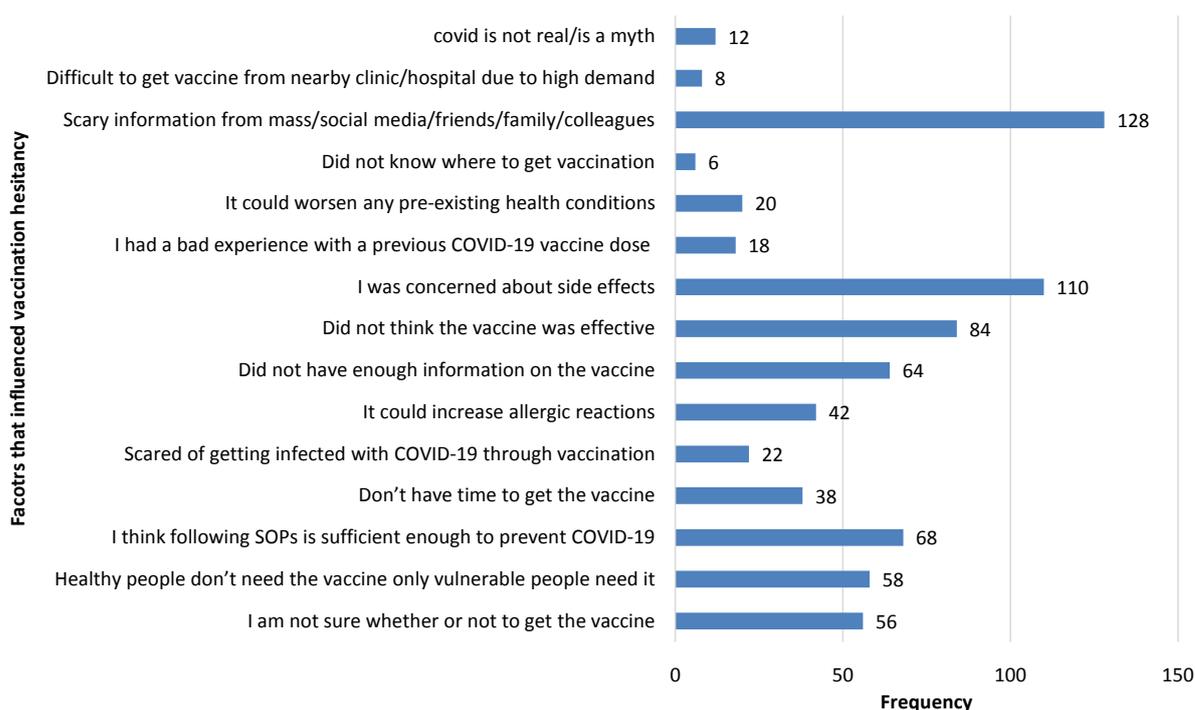


Figure 3. Barriers towards COVID-19 vaccination among MAK-CHS students and Katanga residents.

Table 4. Factors associated with poor practice towards COVID-19 vaccine.

Variables	POOR PRACTICE		COR (95% CI)	AOR (95% CI)	p-value
	No	Yes			
sex					
Female	107	48	1	1	
Male	136	93	1.49 (0.98 - 2.25)	2.10 (1.27 - 3.48)	0.004
POOR ATTITUDE					
No	105	22	1	1	
Yes	138	119	3.91 (2.41 - 6.34)	4.69 (2.61 - 8.45)	0.00
POOR KNOWLEDGE					
No	182	74	1	1	
Yes	61	67	2.81 (1.82 - 4.33)	2.71 (1.41 - 5.23)	0.003

with poor practice. Males exhibited a higher likelihood of poor practice, suggesting potential gender-specific factors influencing vaccination behaviors. Moreover, individuals with poor knowledge or negative attitudes were prone to engaging in poor vaccination practices. These results emphasize the importance of addressing knowledge gaps and fostering positive attitudes to mitigate vaccine hesitancy and promote adherence to recommended vaccination practices.

4. Discussion

In this study we set out to assess knowledge, attitudes, and practices related to

COVID-19 vaccine among medical students and residents of Katanga slum in Uganda. We found out that Katanga residents have poor knowledge regarding COVID 19 vaccination as compared to medical students. However, negative attitudes towards COVID 19 vaccines were expressed by a significant proportion, including medical students despite their good knowledge. Only one-third demonstrated good vaccination practice.

A comparative methodology was utilized in this study to evaluate disparities in vaccination uptake and associated factors. Knowledge about COVID-19 vaccination is a critical factor that influences vaccine acceptance and uptake. The study revealed that overall only 153 participants (39.84%) had good knowledge, with 74.4% of them being university medical students. This finding was slightly higher than a similar study conducted in Saudi Arabia, where 63.6% of medical students agreed on the safety of taking two different COVID-19 vaccines, and 67.3% correctly stated that the COVID-19 vaccine does not decrease immunity though on the other hand 18% participants believed that the COVID-19 vaccine was not important in decreasing community spread, and 34.3% stated that they did not know how the vaccine worked [6]. These findings contrasted with a study from Nigeria, where only 2.6% of university medical students had good knowledge, and only 20.6% had moderate knowledge [7]. In contrast only 5.2% of residents in Katanga slum had good knowledge about COVID-19 vaccines. Interestingly, knowledge regarding COVID-19 vaccinations did not significantly differ based on participants' sex. Moreover, individuals who were well-educated might have the ability to acquire accurate knowledge [8] as well as question any rumors prevailing about the COVID-19 vaccine by verifying information from different sources.

Overall the common sources of COVID-19 vaccine information were television (31.25%) and social media (17.19%). Among university students, the most common sources of information about the COVID-19 vaccine were scientific literature (31.2%) and the Internet (22.4%), while television (42.7%) and radio (28.1%) were more frequently used by Katanga residents. The higher level of knowledge about COVID-19 among medical students may be attributed to their access to reliable medical platforms, healthcare professionals, government media briefings, and university newsletters. These sources may have enhanced their existing knowledge. Additionally, their training as volunteers in the healthcare system could also contribute to their higher level of knowledge. Participants who had received training on COVID-19 and vaccines were 3.5 times more likely to have better knowledge (p -value < 0.001). Of the participants, 60.4% had ever received teaching on COVID-19 vaccine, with 76% of these being medical students compared to only 55% Katanga residents. This could explain why more university students had good knowledge about the COVID-19 vaccine. Efforts should be focused on increasing awareness, knowledge, and addressing myths and misinformation about COVID-19 infection and the safety of the COVID-19 vaccine among populations with lower educational achievements. Using non-medical terminologies that are accurate and easy to understand in educational messages

related to the vaccine and infection should be emphasized.

The participants whose families had been previously infected with COVID-19 were 2 to 12 times more likely to possess higher knowledge about the vaccine compared to those whose family members had not exhibited any symptoms. This could be attributed to the fact that medical students are frequently approached by their family members for medical advice, which motivates them to acquire more knowledge about COVID-19 and the vaccine [9] [10].

This study also discovered that a significant proportion of participants (67.27%) exhibited a poor attitude towards COVID-19 vaccination. Notably, among this group, a striking 60.4% were medical students, which surpassed the percentages reported in previous studies among medical students from Nigeria (48.9%), Bangladesh (35.19%) and Ethiopia (15.5%) [7] [11] [12]. Furthermore, the authors found that 73.4% of Katanga residents also expressed a negative attitude towards the vaccine. Additionally, the study identified that participants who lived in joint families with more than four members were twice as likely to exhibit a poor attitude towards the COVID-19 vaccine. Therefore, individuals from larger families or joint families held negative attitudes towards vaccination, suggesting that the decision-making dynamics are often influenced by elder members and their negative attitudes towards vaccination may impact the views of younger family members [13] [14]

Additionally, our study found that participants who did not verify suspected symptoms of COVID-19 in their family members with a doctor or through specific tests were 1.96 times more likely to exhibit a poor attitude towards the vaccine (p -value < 0.026). This finding aligns with a study conducted in Pakistan which observed that participants who had experienced COVID-19-related deaths among their family, friends, or colleagues were more accepting of the vaccine. Witnessing the impact of COVID-19 on close acquaintances may dispel misconceptions and encourage adherence to expert recommendations, potentially explaining why individuals acquainted with deaths were more likely to get vaccinated [15].

Our study revealed that only 33.59% of the participants demonstrated good practice towards COVID-19 vaccination. Notably, Makerere University students were 3.9 times more likely to receive the COVID-19 vaccine compared to Katanga residents (COR = 3.9, 95% CI: 2.38 - 6.46, p -value < 0.001). Among university medical students, a high prevalence of 86% had received the vaccine, surpassing the 61% vaccination rate among Katanga slum residents. However, only 11 (5.7%) and 114 (59.4%) of the university medical students had completed the full three-dose and two-dose series, respectively. The stark disparity in vaccination rates between Makerere University students and Katanga residents highlights existing inequalities in vaccine access and uptake. However, the sub-optimal completion rates among university medical students raise concerns regarding the attainment of full vaccination coverage even within this more accessible demographic. It is crucial to address barriers to vaccination, enhance accessibility, and promote vaccination coverage across all segments of the popu-

lation.

On the other hand, a significantly lower prevalence of completed vaccination was observed among Katanga slum residents, with only 5 (2.6%) and 65 (33.9%) having completed the full three-dose and two-dose series, respectively. This prevalence was lower than the rates reported in India, with 8.5% fully vaccinated and 91.42% partially vaccinated [16] and slightly lower than slum residents who completed full vaccination in Uganda (43.8%) [17]. It is also noteworthy that approximately one-fourth of the respondents expressed probable acceptance but exhibited some hesitancy. Thus, vaccination campaigns should focus on translating high levels of probable acceptance into actual acceptance to ensure broader vaccine coverage. Educational campaigns can be held at the university and throughout the slums of Kampala, to broaden the knowledge of the population. These campaigns can focus on providing general knowledge about vaccinations, including discussing the potential implications of poor vaccination prevalence and its consequences on public health, then demonstrating good practices, and finally addressing all issues regarding the uptake of the vaccine.

In our study, the most commonly cited reasons for COVID-19 vaccine uptake were self-protection from COVID-19 (61.3%), recommendations from WHO/MOH/Doctor (46.1%), and protection of others (33.8%). Literature has shown that recommendations from doctors can significantly influence vaccine acceptance among the general population [18] [19].

Fifty-six (14.5%) university medical students and 85 (22%) Katanga slum residents exhibited overall poor practice towards COVID-19 vaccination. Even among university medical students, who are considered future healthcare professionals, vaccine hesitancy was prevalent. In our study, 90 (46.9%) medical students reported vaccine hesitancy, which is higher compared to studies conducted among university medical students in the United States, such as the University of Kansas Medical Centre (9.9%) [20], Michigan medical students (23%) [21], Bangladesh (26.06%) [11], and India (10.6%) [12]. The disparity in findings may be attributed to differences in the impact of COVID-19 across countries, as evidenced by a study conducted in 22 countries that reported a lower likelihood of vaccine acceptance among individuals who perceived themselves to be at low risk of COVID-19 infection [22]. It could also be due to confirmation bias or societal influence.

Similarly, residents of Katanga slum community, a marginalized population facing socio-economic challenges, also exhibited vaccine hesitancy, with a prevalence of 94 (48.9%) similar to that of university medical students in our study. However, this prevalence was slightly lower than the 55% reported in rural areas of India [23], but comparable to the 46.4% reported in rural Western Uganda [24].

In terms of gender differences, our study revealed that males were 2.1 times more likely to exhibit overall poor practice regarding COVID-19 vaccination compared to females. Only 68.1% of males took the vaccine, and 51% of males reported vaccine hesitancy, while 81.3% of females took the vaccine and 43% of

females reported vaccine hesitancy. However, there was no significant difference in the association of sex with poor practice between the two groups. While males exhibited a higher likelihood of overall poor vaccination practices compared to females, with lower vaccine uptake and higher rates of hesitancy, it's significant to note that this difference did not translate into a significant variation in the association of sex with poor practice between the two genders. Therefore, the underlying determinants contributing to poor vaccination practices may be multifaceted and extend beyond gender alone.

In this study, the most common reasons cited for vaccine hesitancy were “scary information from mass/social media” (68.1%), “concern about side effects” (58.5%), and “doubt about the vaccine’s effectiveness” (44.7%). The prevalence of vaccine hesitancy was similar in both groups in this study, this could be attributed to the poor attitude exhibited by the participants which had a strong association with poor practice (AOR = 4.69, 95% CI (2.61 - 8.45) p-value < 0.00). Additionally, rumors and misleading information that are spread fast with broad coverage through mass and social media, contribute profoundly to vaccine hesitancy and refusal [25] [26] [27] [28]. This could explain the high vaccine hesitancy observed among university students who used social media frequently. Meanwhile, the vaccine hesitancy observed among Katanga residents could be explained by the positive association between poor knowledge and poor vaccine practice, as reported previously, where low levels of education were valid indicators of vaccine refusal [29].

The potential implications of poor vaccination prevalence and its consequences on public health include increased transmission and outbreaks, risk of resurgence, economic decline, as well as an overburdened healthcare system.

Limitation of our study, firstly, our study focused specifically on Makerere University medical students and residents of the Katanga slum, which may limit the extrapolation of our results to medical students from other institutions or slum communities in different regions of Uganda. Variations in demographics, socioeconomic status, and access to healthcare services among different populations could influence the applicability of our findings. Secondly, factors such as cultural differences, educational backgrounds, and healthcare infrastructure may vary across different medical schools and slum areas, potentially affecting the outcomes observed in our study. Despite these limitations, our study provides valuable insights into the challenges of COVID-19 and its vaccination uptake faced by medical students and residents of slum communities in Uganda, which can inform targeted interventions and policies to address these issues.

5. Conclusion

This study underscores the critical role of knowledge in influencing COVID-19 vaccine acceptance and uptake. Access to reliable information sources, training on COVID-19 and vaccines, and concern about family history of COVID-19 played a significant role in improving knowledge. A significant proportion of

participants, including medical students, expressed negative attitudes towards the vaccine. Failure of family members to verify COVID-19 symptoms with a doctor and joint family dynamics were associated with poor attitudes towards vaccination. Only a third of the participants demonstrated good practices towards COVID-19 vaccination, with university students being more likely to receive the vaccine compared to Katanga residents. Tailored interventions are needed to increase awareness, knowledge, positive attitude and vaccination uptake and coverage taking into account the unique factors influencing vaccine hesitancy in each population and dispelling myths and misinformation about vaccination with accurate and easy-to-understand language, particularly among populations with lower educational achievements.

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Operational Definitions

Bloom's cut-off point:

- good if the score was between 80% and 100%;
- moderate if the score was between 60% and 79%;
- poor if the score was less than 60% [6] [7].

Conflicts of Interest

The authors declare no conflicts of interest.

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