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DRIVING IMMUNIZATION: INNOVATIVE APPROACHES TO COVID-19 VACCINATION ON COLLEGE CAMPUSES

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Abstract: The impact of COVID-19, three years post-pandemic declaration, remains significant, with global efforts focused on vaccination as a key strategy for mitigation. The rapid development and distribution of vaccines have become essential in the fight against the virus. However, vaccine acceptance among the public is influenced by a myriad of factors, including cultural, religious, economic, and geopolitical considerations. This phenomenon, known as vaccine hesitancy, poses a challenge to achieving widespread immunization. Addressing vaccine hesitancy is crucial in maintaining public health and achieving herd immunity. This article explores the multifaceted nature of vaccine hesitancy and highlights the importance of understanding and addressing the underlying reasons for vaccine reluctance.

Keywords: COVID-19, vaccine hesitancy, public health, vaccination, herd immunity.

1. Introduction

The ravages of the coronavirus disease 2019 (COVID-19) are still vivid, three years after the World Health Organization (WHO) declared it a pandemic (Cucinotta & Vanelli, 2020; Sohrabi *et al.,* 2020). With China as the epicenter, it was not long before the world came under the siege of COVID-19 (Byttebier, 2022; Rabi *et al.,* 2020; Rothan & Byrareddy, 2020), prompting various public health measures, at a national and international scale, including enhanced hand hygiene and social distancing, restricted movements and intensified screening towards mitigating the crippling morbidity and mortality associated with the disease (Halperin *et al.,* 2021; Huang *et al.,* 2021; Mudenda, *et al.,* 2022; Piret & Boivin, 2021).

At an unprecedented pace, not previously seen in the drug discovery landscape, vaccines were rolled out within 2 years of the pandemic breakout, to add to the armamentarium in fighting the scourge (Piret & Boivin, 2021). However, providing a vaccine may not guarantee that there will be adequate acceptance by the public due to multifaceted factors ranging from cultural, religious, economic, and geopolitical reasons (Mudenda, 2021; Mudenda, *et al.,* 2022). Vaccine hesitancy occurs when there is a delay or refusal to be vaccinated despite the availability of vaccination services (Kumar *et al.,* 2016; MacDonald *et al.,* 2015).

Inconsistent observations have been made across geographical locations regarding vaccine acceptance (Cascini *et al.,* 2021; George *et al.,* 2023; Mudenda, *et al.,* 2022; Noushad *et al.,* 2022; Pagador *et al.,* 2022; Sallam, 2021; Sallam *et al.,* 2021; Sharma *et al.,* 2022).

For example, moderate vaccination acceptance rates against COVID-19 were reported in the general population (Cascini *et al.,* 2021; Mudenda, *et al.,* 2022; Wang *et al.,* 2022), among healthcare workers (HCWs) (Leigh *et al.,* 2022; Nomhwange *et al.,* 2022), and university students (Barello *et al.,* 2020; Mudenda, *et al.,* 2022). Concerns about side effects and doubts over vaccine effectiveness have been key contributors to low vaccine acceptance rates (Kelekar *et al.,* 2021; Kricorian *et al.,* 2022; Lucia *et al.,* 2020; Papagiannis *et al.,* 2021; Zhang *et al.,* 2022). In addition, misinformation, including myths with unfounded basis, have fanned vaccine hesitancy (Asres & Umeta, 2022; Ngai *et al.,* 2022; Ogunleye *et al.,* 2022; Sallam *et al.,* 2021; Tahir *et al.,* 2021).

The resumption of conventional academic activities, many of which had been suspended or shifted to virtual learning platforms at the height of the pandemic, required that students adhere to the recommended COVID-19 prevention measures including strong considerations to be vaccinated (Ahmed, 2022; Lufungulo *et al.,* 2021; Melnick *et al.,* 2020; Mwila *et al.,* 2021). However, COVID-19 vaccine hesitancy has been observed among university students, a key population in the fight against such pandemics (Osur *et al.,* 2022; Shah *et al.,* 2022). Consequently, university, and indeed other college-going students, are a critical population to consider when formulating public health interventional strategies, such as mass vaccination campaigns (Mudenda, *et al.,* 2022).

In Kenya, the acceptance of COVID-19 vaccines has been reported in a few studies involving the general population and HCWs, wherein one study found a high vaccine hesitancy of 36.5% (Orangi *et al.,* 2021). However, little is known about the acceptance of COVID-19 vaccines among university students. Therefore, this study assessed vaccine acceptance and hesitancy among students in one of the premier universities in Kenya. Insights regarding hindrances to, and motivations for, vaccination uptake are crucial in providing empirical evidence towards formulating appropriate strategies to enhance vaccine uptake for future pandemics, should these require vaccination as an intervention.

2. Materials and methods

1. Study Design, Site, and Population

This cross-sectional study was conducted among undergraduate students enrolled at the Jomo Kenyatta University of Agriculture and Technology (JKUAT), Main Campus from September 2022 to November 2022. JKUAT is a premier public university situated in Kiambu County, Kenya, 36 kilometres Northeast of Nairobi, with a population of over 30,000 students. The university admits students from across the country through a centralised Government-operated university admission system supervised by the Kenya Universities and Colleges Central Placement Service, a state corporation. To be eligible, a student had to be currently registered and provided consent to participate in the study.

2. Sample Size Estimation and Sampling Technique

The sample size for the study was determined using Yamane's formula (Charan & Biswas, 2013). With no previous study conducted in Kenya among this sub-population, we applied a total estimated student population of 30,000 and a margin of error of 5% which resulted in a sample size of 395. We took into consideration a 20% non-response rate, and this led to a minimum sample size of 474 students.

The calculated sample size was then divided among the five colleges of the university, namely, the College of Health Sciences (COHES), College of Engineering and Technology (COETEC), College of Pure and Applied Sciences (COPAS), College of Agriculture and Natural Resources (COANRE) and the College of Human Resource and Development (COHRED). The stratified sample size from each College was representative of the percentage of the total student population from that College.

Class representatives from the various colleges were approached to assist with distributing the online questionnaire via respective class WhatsApp groups. Each response was then labelled with a study number, from which responses were randomly selected for the study from each stratum.

3. Data collection

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Data was collected using a self-administered structured questionnaire adapted from a related study (Sethi *et al.*, 2021), designed using Google Forms. The first section of the questionnaire contained a provision for informed consent to be able to participate in the study. Those who provided consent were then automatically directed to subsequent sections related to the study, while those who did not provide consent were prompted to submit the questionnaire, thereby terminating their further progress to participate in the study.

The second section of the questionnaire consisted of questions to obtain sociodemographic information including participants' college of enrolment, course of study, year of study, gender, religion, and residence. The third section comprised of questions related to a participant's encounter with COVID-19, and their vaccination status. Those who indicated that they were vaccinated were asked to provide information about the type of vaccine that they received and their motivation for being vaccinated.

For the partially vaccinated individuals, they were asked to provide reasons for not completing the vaccine dose schedule. On the other hand, the unvaccinated respondents were asked about their willingness to consider receiving a COVID-19 vaccination and those not willing to take the vaccine formed the vaccine hesitant population. This group was asked to provide reasons for their vaccine hesitancy. In addition, participants were asked about their opinions on vaccine effectiveness and their suggestions on what would enhance vaccination uptake, especially among the youth.

4. Data analysis

Data was collected and cleaned in Microsoft Excel 2016 while coding and analysis were performed using IBM Statistical Package for Social Sciences (SPSS) Version 25. Descriptive statistics are presented as frequencies and percentages. A Pearson-Chi-square test was used to compare between the vaccinated and unvaccinated frequencies of categorical variables and in all cases, a value of $p < 0.05$ was considered statistically significant.

5. Ethical approval

Ethical approval was sought from the JKUAT Institutional Research and Ethics Committee before the commencement of the study (JKU/ISERC/02316/0744). Participants were assured of their anonymity and the confidentiality of the information obtained as no personal identifiers were used in collecting the information. The study purpose and objectives were also explained, and informed consent was sought from study participants prior to participation in the study.

3. Results

1. Demographics of study participants

The study attracted 476 respondents with an almost equal gender distribution (female, 242, 50.8%), the majority of whom (435, 91.3%) professed the Christian religion (Table 1). Having applied a stratified sampling technique, the college distribution of the respondents reflected the population distribution among the five colleges in the university with COHRED and COANRE having the most (164, 34.4%) and least (37, 7.8%) number of respondents, respectively. Most participants were either in their second (153, 32.1%) or fourth (131, 27.5%) year of studies and resided outside of the university, that is, not within university hostels (372, 78.2%) (Table 1).

Table 1. **Sociodemographic characteristics and vaccination status of study participants (N=476)**

Category	**Total Population, n (%)**	**Vaccinated**		**p Value**
		Yes, n (%)	**No, n (%)**	
Gender				
Male	234 (49.2)	117 (46.1)	117 (52.7)	
Female	242 (50.8)	137 (46.1)	105 (52.7)	0.148
Religion				

Christian	435 (91.3)	236 (92.9)	199 (89.6)	
Muslim	28 (5.9)	12 (4.7)	16 (7,2)	0.438
Others*	13 (2.8)	6 (2.4)	7 (3.2)	
College of enrollment				
COANRE	37 (7.8)	22 (8.7)	15 (6.7)	
COETEC	86 (18.1)	50 (19.7)	86 (18.1)	
COHES	68 (14.3)	36 (14.2)	32 (14.4)	0.717
COHRED	164 (34.4)	82 (32.3)	82 (32.3)	
COPAS	121 (25.4)	64 (25.2)	57 (25.7)	
Year of study				
First	61 (12.8)	37 (14.6)	24 (10.8)	
Second	153 (32.1)	60 (23.6)	93 (41.9)	
Third	86 (18.1)	51(20.1)	35 (15.8)	
Fourth	131 (27.5)	78 (30.7)	53 (23.9)	0.001
Fifth	36 (7.6)	20 (7.9)	16 (7.2)	
Six	9 (1.9)	8 (3.2)	1 (0.45)	
Residence				
University hostels	104 (21.8)	61(24.0)	43 (19.4)	0.221
Home or private accommodation	372 (78.2)	193 (76.0)	179 (80.6)	
Overall	476	254 (53.4)	222 (46.6)	

Others* (Non-religious, pagan, atheist, spiritual, agnostic)

2. Vaccine Hesitancy

Out of the 476 participants, 222 (46.6%) were not vaccinated. Only 36 (16.2%) participants among the unvaccinated group were willing to consider receiving a COVID-19 vaccine. Vaccine hesitancy was comparable between the male and female genders but appeared to vary across the college of study (Figure 1).

Figure 1. A comparison of Vaccine hesitancy between male and female students and across the college of study.

Notably, those professing Islamic religion were largely undecided with most participants who were outrightly unwilling to receive a vaccination being those who subscribed either to the Christian (144, 57.3%) or other (6, 86%) religions (Figure 2).

Figure 2. Profile of vaccine hesitancy stratified by Religion.

As summarised in Table 2, the main reason for vaccine hesitancy was concern about vaccine-related side effects (120, 54.1%), while the most identified measure towards improving vaccine uptake among the youth was educative programs to combat COVID-19 vaccine misinformation (252, 53%).

Table 2: Reasons for vaccine hesitancy and possible interventions to improve vaccine uptake.

Information	**Frequency**	**Percentage**
Reason for Vaccine Hesitancy		
Vaccine side effects	120	54.1

Sceptical of vaccine's effectiveness	55	24.8
Vaccine is not safe	20	9
COVID-19 is not as severe as reported	17	7.7
Close friends or family developed severe side effects	6	2.7
Other reasons*	4	1.8
Convincing information to take the Vaccine		
No further information is required	61	27.5
Assurance of vaccine safety	47	21.2
Assurance of vaccine efficacy	41	18.5
Assurance that the fast-tracked development of vaccine did not compromise its safety	44	19.8
Contracting COVID-19 is worse than the vaccine side effects	29	13
Measures towards improving Vaccine Uptake		
Educative programs to combat COVID-19 vaccine misinformation	252	53
Provide accessible vaccination centres much closer to the people	122	25.6
School-located vaccination programs	30	6.3
Youth-led vaccination campaigns	54	11.3
Financial incentives on getting vaccinated	8	1.7
Make getting vaccinated mandatory	10	2.1

*Include reasons such as immunity was sufficient, not interested, vaccination centres are not easily accessible

3. Participants' attitudes and sources of information regarding COVID-19 vaccines

When asked about their perception of the importance of the vaccine, only slightly more than half of the respondents (245, 51.5%) held the opinion that vaccination is essential for preventing COVID-19 transmission. Additionally, a third of participants found vaccine information provided to the public to be either unclear and confusing or inconsistent and contradictory. The internet and social media (345, 72.5%) were identified as the most popular sources of information about COVID-19 (Table 3).

Table 3: Participants' attitudes and sources of information regarding COVID-19 vaccines

Information	**Frequency**	**Percentage**
Taking COVID-19 vaccination is important		
Agree	245	51.5
Neutral	150	31.5
Disagree	81	17
Views on Vaccine Information		

Inconsistent and contradictory	93	19.5
Unclear and confusing	51	10.7
Clear and understandable	332	69.7
Source of information		
Health workers	20	4.2
Internet/social media	345	72.5
Radio/TV	100	21
Family/friends	11	2.3

4. Discussion

This study sought to assess vaccine uptake and hesitancy among undergraduate university students, a prime subpopulation classified among super-spreaders, at the peak of the pandemic (Rodriguez-Paredes *et al.*, 2022). Super-spreaders were found to be mostly asymptomatic while bearing high viral loads and contributed to rapid community transmission due to their extensive social interactions. We found an average vaccine uptake (53%) and rather low vaccine acceptance (16.2%) among those who were unvaccinated, at the time of the study. Combined, the overall vaccine acceptance of 69.2% compares with that reported in a study among students in Egypt (69%) (Tharwat *et al.*, 2023), much lower than observations made in Zambia (82.4%) (Mudenda *et al.*, 2022) and a 26-country survey (85%) on vaccine acceptance (Irfan *et al.*, 2022), but higher than seen in other studies (Asres & Umeta, 2022; L. Jain *et al.*, 2021; Kelekar *et al.*, 2021; Khatiwada *et al.*, 2023; Lucia *et al.*, 2020; Mascarenhas *et al.*, 2021; Raja *et al.*, 2022).

The low proportion of students willing to be vaccinated in the current study was mainly attributed to the fear of vaccine side effects and concerns about vaccine long-term safety and efficacy. In addition, misinformation from friends, family, and even the media appeared to influence the decision to (not) be vaccinated. These concerns, also reported in studies from Egypt (Saied *et al.*, 2021), the USA (Lucia *et al.*, 2020), Afghanistan (Azimi *et al.*, 2023), and Zambia (Mudenda *et al.*, 2022, Kampamba *et al.*, 2023) emphasize the importance of ensuring buy-in from the public prior to rolling out a nationwide public health intervention strategy such as mass vaccination. Also, to win their confidence and motivate voluntary uptake, the general population must be assured of product safety and efficacy. Otherwise, as seen in this study and expressed by research participants in earlier studies in other countries including Japan (Yoda & Katsuyama, 2021), the USA (Mercadante & Law, 2021), and China (Wang *et al*., 2020), targeted populations were prone to delay getting vaccinated due to safety concerns and scepticism over the expedited pace of vaccine development. Consequently, effective communication from the concerned scientific research community, in this case the pharmaceutical industry involved in vaccine development, is critical in enhancing product development transparency. Doing so, together with collaboration with the media fraternity and national governments, can improve the public perception towards vaccination and improve its uptake. The influence of media outlets including the internet is profound as evidenced by the high proportion (73%) of study participants who indicated that the internet and social media were their primary source of information regarding the COVID-19 vaccine. As reported elsewhere, the proliferation of anti-vaccine sentiments on social media platforms can dampen vaccine uptake and increase vaccine hesitancy (Wong *et al*., 2021). Investing in an effective communication strategy should be considered upfront since, if delayed, it may be difficult to win back the confidence of an already decided population. As revealed in our study, most unvaccinated students indicated that they did not need further information about vaccines to convince them to be vaccinated. This hard-line decision could have been possibly averted had they received convincing information before the launch of the vaccination campaign.

The present study identified measures that can impact positively vaccine acceptance and uptake, thereby addressing vaccine hesitancy. These strategies include educational programs to address misinformation and myths about COVID-19 vaccinations, establishing adequate vaccination centres at accessible sites to the public including in learning institutions, and increasing youth-led vaccination campaigns. When a society is poorly motivated to seek an intervention such as massive vaccination, the chances to do so get even slimmer when there are inconveniences relating to access or long queues, hence time wastage.

Together with the financial constraints that worsened during the pandemic, many people would be discouraged from spending money on transport costs and then be held up for long hours waiting for a service they are sceptical about in the first place. For this reason, removing barriers to vaccine access by ensuring strategic location of vaccination centres which are adequately staffed, is critical. While this is easier to achieve in richer countries, it can be challenging in less developed countries due to a myriad of factors including weak infrastructure, understaffing and fragile vaccine supply chain and related logistics. Involving suitably trained peers to offer or champion the vaccination is another innovative approach that has the potential to improve vaccine uptake. This method has produced promising results in other public health campaigns including sexual and reproductive health and HIV/AIDs (Hensen *et al.,* 2023).

Compared to a similar study conducted among medical and dental students in the United States, a lower proportion of participants from the present study believed the vaccine to be important in preventing COVID-19 transmission (Kelekar *et al.,* 2021). Given that our study surveyed students across diverse fields of academic study, this overall profile is expected. Indeed, when we consider the opinions of those respondents who were enrolled at the College of Health Sciences, we find a higher proportion, compared to those in non-medical courses, who opined that the COVID-19 vaccine is important. Based on the nature of their studies, which makes them more knowledgeable about the disease and intervention, as well as the fact that they bear greater risks of potential exposure to the virus during clinical rotations and patient interactions, this finding is unsurprising. Studies conducted among medical students in India (Jain *et al.,* 2021), Zambia (Mudenda, *et al.,* 2022), and Saudi Arabia (Habib *et al.,* 2022) have also revealed low rates of vaccine hesitancy.

The religious backgrounds of respondents in this study were not found to significantly influence their opinions on COVID-19 vaccine safety and its importance in controlling the spread of the pandemic. In contrast, based on secondary data from 90 countries, a cross-national comparison of religion as a predictor of COVID-19 vaccination rates found that Christianity was negatively related to vaccine uptake (Trepanowski & Drążkowski, 2022). In that study, no relation was found between vaccination rates with Islam, Buddhism, Hinduism, and nonbelief. A similar study carried out in the United States found that religious conservatism is positively associated with higher rates of anti-vaccine attitudes and Christian nationalism was a strong indicator of vaccine hesitancy among the respondents (Corcoran *et al.,* 2021). These observations vindicate the central role that culture and religion may have in influencing vaccine hesitancy in society and it is probable that, had we surveyed a larger and more diverse population, this trend could have emerged.

The important findings of the current study should be viewed considering inherent limitations including its cross-sectional design which is not able to capture detailed information about the factors, and interactions thereof, affecting vaccine acceptance and hesitancy. Also, it is not possible to generalize the findings to all universities in the country. Nonetheless, the study gives vital information about the reasons for vaccine hesitancy which may be used by stakeholders and policymakers to develop effective strategies that, when appropriately implemented, can increase vaccine uptake and could be vital in controlling future pandemics.

5. Conclusion

This study found an average COVID-19 vaccine uptake and a high hesitancy among unvaccinated students. While vaccine safety and efficacy emerged as crucial factors leading to vaccine hesitancy, effective communication

strategies and peer-led campaigns were cited as vital approaches to increase vaccine acceptance. Our findings demonstrate the need to develop and implement strategies that increase vaccine acceptance and uptake among university students, a critical subpopulation in the effective implementation of public health preventative strategies during pandemic crises.

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