Title: Awareness, Coverage, and Barriers to COVID-19 Vaccination among Undergraduate Students in Nigeria

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Discussion Points:

- Are Nigerian tertiary students taking the COVID-19 vaccine?
- Does their willingness to be vaccinated translate to actual vaccination?
- What are the barriers to effective vaccination uptake among Nigerian undergraduates and how can public health stakeholders overcome these barriers?
- This study found a high level of awareness and willingness to be vaccinated among Nigerian tertiary students; however, the level of vaccine coverage was significantly low. We highlight ways to remove hesitancy and coverage barriers to increase COVID-19 vaccine uptake among Nigerian undergraduates.

#COVID19VaccineHesitancy #ExpandingCOVID19VaccineCoverage #Students #PriorityGroups

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ABSTRACT

Background: With the resumption of physical learning activities across Nigeria's higher education institutions, tertiary-level students, a prioritized group according to the WHO SAGE in the deployment of the COVID-19 vaccines, face circumstances that necessitate widespread vaccination coverage among them. This study aimed to assess Nigerian undergraduate students' knowledge, coverage, and barriers to COVID-19 vaccination.

Method: A cross-sectional survey of Nigerian undergraduates was conducted in October 2021, using an online questionnaire and a combined simple random and snowballing sampling technique. The questionnaire included sections on respondents' demographic characteristics, COVID-19 vaccine awareness, coverage, barriers, and recommendations. A total of 326 respondents electronically completed and returned the informed consent form along with the questionnaire. The data obtained were analyzed using the statistical package for the social sciences (SPSS) version 25.

Results: The overall awareness of COVID-19 vaccines among the sampled students was high; with 62.3%, 20.9%, and 16.9% having good, average, and poor levels of knowledge respectively. However, a majority of the respondents (81.3%) had not received the vaccines. The most prominent barrier to vaccination was misinformation about vaccine safety (23.6%). Opening vaccination centers on campuses (18.6%), demonstrating vaccine effectiveness and safety (18.7%), and organizing awareness campaigns (17.2%) were the most frequently recommended actions.

Conclusion: Most respondents were aware of the availability and potential benefits of COVID-19 vaccines; however, coverage remained extremely low. Our findings emphasize the importance of addressing vaccination barriers by public health stakeholders to achieve optimal COVID-19 vaccine coverage.

Key Words: COVID-19 Vaccines, Vaccination Coverage, Nigeria, Undergraduate, Pandemic response

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INTRODUCTION

The Chinese government reported to the World Health Organization (WHO) on December 31, 2019, an outbreak of viral pneumonia of unknown cause in Wuhan, Hubei Province, China.[1] The disease was dubbed COVID-19 after it was discovered to be caused by the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2; formerly known as 2019-nCoV).[2] As more COVID-19 cases were reported outside of China, the WHO declared the outbreak a Public Health Emergency of International Concern (PHEIC) on January 30, 2020.[3] The WHO declared the coronavirus outbreak a global pandemic on March 11, 2020,[4] emphasizing the importance of enforcing mitigation measures by stakeholders in various countries.

According to the Nigerian Centre for Disease Control, the first coronavirus case in Nigeria was reported on February 27th, 2020 in Lagos.[5] Since the index case, the number of cases reported has steadily increased, with 5,708,974 tested samples, 266,283 confirmed cases, 259,643 discharged cases, 3,485 active cases, and 3,155 deaths in the 36 states and Federal Capital Territory as of November 26, 2022.[6] When the first few cases were reported, Nigeria responded quickly by sweeping into action. Nigeria restricted flights from 13 countries where COVID-19 was confirmed endemic, established a Presidential Task Force to enforce safety measures, began contact tracing, prohibited large social gatherings, placed several states on lockdown, approved stimulus packages for households and businesses, and ordered school closures.[7] As a result, all academic institutions in the country were closed to reduce community transmission, with no provision for a viable alternative. While some tertiary institutions in Nigeria implemented online learning models to ensure education continuity, most institutions were completely shut down throughout the lockdown due to insufficient e-learning infrastructure to implement virtual learning. Tertiary institutions resumed physical activities in January 2021 to mitigate the devastating effects of school closure on Nigerian students.[8-9]

However, due to overcrowding and inadequate health infrastructure in the majority of Nigerian tertiary institutions, the resumption of physical activities raised concerns about the increased risk of COVID-19 spread in the institutions, worsening the national COVID-19 burden.[9] As a result, a safe, nationally implemented vaccination program would most likely be the long-term solution to COVID-19. As evident in previous vaccination campaigns, vaccines have the potential to break the chain of transmission and stabilize the incidence of an infectious disease.[10] Evidence suggests that densely populated settings like school campuses are at high risk of COVID-19 spread.[11] As such, tertiary university students who interact in such settings are considered a priority group for the national vaccination program, according to the WHO SAGE value framework for the allocation and prioritization of the COVID-19 vaccination.[3] Hence, the most effective way to save lives and keep students in school is to ensure that they can get a safe and effective vaccine quickly and for free.

In comparison to other parts of the world, Nigeria has had very low coverage of COVID-19 vaccination.[12] Since the start of Nigeria's vaccination program on March 5, 2021, about 91.5 million vaccine doses have been administered. 30.4% of citizens had received at least one dose of the vaccine and only 20.3% were fully vaccinated as of November 25, 2022.[13] This is far below the national COVID-19 vaccination coverage goal of 70% by mid-2022 recommended by the WHO.[14] Vaccine uptake and coverage are constantly hampered by

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factors such as fear, hesitancy, conspiracy theories, disgust, and distrust in the government.[12] However, vaccination programs can only be successful if the vaccines are widely accepted by the citizens. It is worthy of note that there is a significant difference in the levels of knowledge, perception, willingness, and compliance with the COVID-19 vaccines among citizens worldwide. This has been attributed to multiple factors including differences in socioeconomic, education, health, age, gender and personal belief statuses across the countries.[15] As a result, to improve vaccination coverage and uptake rates in Nigeria, a context-specific approach at various societal levels is required. It is important to understand the factors influencing vaccination intention and behavior of the people in Nigeria, particularly among undergraduate students, who are an important part of the large youthful populace.[3,16]

Some studies have assessed the level and factors influencing vaccine acceptance or hesitancy among tertiary students in specific Nigerian institutions and disciplines, such as the health sciences.[16,17] However, to design a more comprehensive vaccination program, more data is required about the coverage rate of the COVID-19 vaccine as well as the student-reported barriers to vaccination uptake across diverse institutional settings and disciplines. Therefore, this study assessed the COVID-19 vaccination awareness, coverage, and barriers among students in Nigerian tertiary institutions in different regions across the country. It also investigated the students' agreement with previously reported recommendations on ways of increasing vaccination uptake. This will serve as a means of informing policies to enhance the country's COVID-19 vaccination program and reduce virus spread.

METHODS

Study design

This cross-sectional study employed an open self-administered online survey conducted via Google Forms from October 20th to December 19th, 2021. A combined simple random and snowballing sampling technique was used to recruit participants for the study. Participants were invited by sharing the survey's hyperlink via electronic mail, social networking sites (Telegram, Facebook, Twitter, and WhatsApp) pages, and groups. In turn, respondents were requested to share the survey invitations on their social media pages and groups. To increase response rates, recurring reminders were sent. The Google Form used was set up to only accept one response per respondent using their unique email address. To improve questionnaire completion, key survey questions were also designated as 'required.' The guidelines for Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) were followed in conducting and reporting the findings of this study.[18]

Study setting and participants

Undergraduate students at Nigerian tertiary institutions were the target audience for this study. The survey was administered electronically and participants were contacted online. Eligible participants were Nigerian undergraduates above 18 years of age; with active studentship status; who were enrolled in an active academic session and had partially or completely resumed physical learning methods at their institutions; and who had a functional email account and internet access. Undergraduate students who did not meet the above eligibility criteria could not participate in the study.

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Survey questions and outcomes measure

The questionnaire for the study was developed using the WHO Strategic Advisory Group of Experts (SAGE) on Immunization's validated scale for assessing vaccination coverage[19] and hesitancy,[20] literature review, and relevant discussions with experts. Independent survey experts reviewed and validated the final survey tool. A pilot study of 48 undergraduate students was conducted to determine the tool's face validity. The pilot study's sample was excluded from the main study.

The research survey tool was divided into three sections. Following the consent form, the first section collected respondents' demographic data: age, place of residence, location of institution, level of study and mode of instruction at school at the time of the survey. The second section assessed respondents' knowledge of COVID-19 and COVID-19 vaccines, as well as their vaccination status at the time of the survey. The vaccination status assessment involved the number of doses of the available vaccines received, the vaccination schedule, and facility used. These first two sections were made up of closed-ended questions with the response options designed as categorical variables. The final section investigated the perceived or experienced barriers to COVID-19 vaccination by respondents, as well as recommendations for improving vaccination coverage among Nigerian undergraduate students. The response options in this section, also framed into categorical variables, were derived from a list of commonly reported barriers and recommendations in the literature,[21-23] while the respondents were allowed to include unmentioned ones.

Sample size determination

The minimum sample size for this study was calculated using the formula described by Kadam and Bhalerao.[24]

$n = Z^2 \times S^2 / m^2$

Where n is the sample size; Z is z-value for a 95% confidence level (1.960); S is the population standard deviation (0.5); and m is the margin of error of 5%.

The minimum sample size was determined to be 385.

Data preparation and analysis

The survey responses were downloaded into a Google spreadsheet and then imported into IBM SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY, USA.) for data analysis. The categorical variables were presented as frequencies, percentages, and histograms, as appropriate.

The level of knowledge (awareness) about COVID-19 and its vaccination among our study participants was assessed by scoring and summing the participants' responses to the questions asked with this objective. Four questions (Table 1) were asked and each appropriate answer was given a score of 1. Those who scored 1 out of 4 or less were categorized as having “poor” knowledge, 2 out of 4 as “average” knowledge and 3 out of 4 and 4 out of 4 (i.e. above average) as “good” knowledge (See Result). Two questions were used to assess vaccination coverage – ‘Have you received any of the COVID-19 vaccines?’ and ‘number of doses taken so far’ with options for participants to choose from. The proportion of the respondents that had received at least a dose of the vaccines at time of the survey was calculated. Chi-square test was used to determine the association

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between knowledge level and vaccination coverage among participants. A p-value of <0.05 was considered statistically significant. Descriptive statistics were conducted on the reported barriers and recommendations for improved vaccine uptake among the participants.

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RESULTS

Socio-demographic data of respondents

A total of 326 responses were obtained and analyzed. Most of the respondents were between the ages of 18 and 29 (97.2%) with more male respondents (54.3%) compared to females (45.7%). The represented institutions were mostly from the south-western part of the country (43.9%) followed by the south-south (22.1%) and south-east (17.8%). 89.3% of the respondents were residing in the urban parts of the country while the remaining 10.7% lived in rural areas. The educational level of the respondents ranged from 100 level to 600 level with 500 level students accounting for 33.7% of the total respondents, closely followed by 200 level students (29.8%). At the time of the survey, the majority (59.3%) of respondents had fully resumed physical learning methods, 38.7% were in programs running both physical and virtual lectures simultaneously, while 2.1% were having solely virtual lectures (Table 2).

Respondents' knowledge of COVID-19 and the COVID-19 vaccine

Four questions (Table 1) were asked of the participants to assess their knowledge of COVID-19 and the COVID-19 vaccine. Knowledge of COVID-19 and COVID-19 vaccines, according to literature, entailed understanding the likelihood of COVID-19 spreading on and off campuses, the availability of COVID-19 vaccines in Nigeria, and the ability of the vaccines to protect against COVID-19. These indicators correspond to data provided by health authorities both locally and globally. 62.3% of the respondents had good knowledge while 20.9% and 16.9% had average and poor knowledge, respectively.

Assessment of the COVID-19 vaccination coverage among the respondents

COVID-19 vaccination coverage level of the respondents was determined by the number of respondents that have received at least one dose of the vaccine at the time of the survey. Only 61 respondents (18.7%) had received at least one dose of the vaccine. Of these, 46 (75.4%) were fully vaccinated while the remaining 15 (24.6%) respondents had an incomplete vaccination status. 42.6% of those that had received the vaccine got their shots within the premises of their institutions while 45.8% claimed to have gotten the vaccine outside of their institution premises (Table 3). Correlation between the knowledge of COVID-19 and COVID-19 vaccine and vaccine coverage was carried out to determine if the level of awareness of the respondents had any significant influence on the level of vaccine uptake. Interestingly, we found that 91.8% (56/61) of the vaccinated respondents had 'good' knowledge of COVID-19/COVID-19 vaccines while 6.6% and 1.6% had 'average' and 'poor' knowledge respectively. Among the unvaccinated students, while 55.4% (147/265) of them had 'good' level of knowledge, 24.1% of them had 'average' knowledge and 20.4% had 'poor' knowledge of COVID-19/COVID-19 vaccines at the time of the survey. A Chi-square test result indicated a significant association *($\chi 2=28.189$ P-value<0.001)* between the knowledge of COVID-19/COVID-19 vaccines and vaccine coverage (Figure 1).

Responses on barriers to COVID-19 vaccination

Rumors about the safety of the vaccine (23.6%), difficulty in accessing vaccination centers (16.1%) and lack of trust in the government or country of vaccine import (15.2%) were the most prominent barriers to vaccination considered by the respondents (Figure 2a).

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Recommendations for improving vaccine uptake

Showing proof of vaccine safety (18.7%), opening of vaccination centers on campus (18.6%), and creating awareness on vaccine benefits (17.2%) were the actions mostly recommended by the students to improve the level of vaccine uptake among them (Figure 2b).

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DISCUSSION:

The extent to which an individual perceives the risk of an infectious disease and comprehends the potential benefits of vaccination influences their attitude toward vaccination.[25-27] Findings from our study indicate an association between the knowledge of COVID-19 vaccines and vaccination coverage i.e. individuals who demonstrate a high level of knowledge of COVID-19/COVID-19 vaccines are more likely to take the vaccines than those with poor knowledge. This suggests that understanding the risk of COVID-19 spread and the benefits of vaccination can increase the willingness to be vaccinated. Several studies have supported this assertion. A study in Jordan, for example, found that 76% of participants had a good understanding of the vaccine, with 72.4% having a favorable attitude toward it and 71.3% intending to use it.[25] Also, a community-based survey in Ethiopia found that people with a good understanding of the vaccine were more likely to accept the COVID-19 vaccine.[28] Furthermore, in Bangladesh, vaccine acceptability among the 605 adults included in a study was found to be significantly related to their knowledge of the COVID-19 vaccine, with up to 60% of the participants willing to be vaccinated and those with good understanding of COVID-19/COVID-19 vaccines showed 22.23 times higher odds of accepting the COVID-19 vaccine compare to people with lower knowledge.[29] A study in Malaysia, however, contradicts these findings. The web-based cross-sectional study, which assessed the knowledge, perception, and acceptance of the COVID-19 vaccine among 1,406 Malaysians, found that even though 62% had little or no knowledge of the vaccine, 65% were still willing to take it.[30] This could be due to the population's perception of the infection's risk.

According to our findings, the majority of undergraduates (83.2%) are aware of the availability of the COVID-19 vaccines at the designated vaccination centers and potential benefits of the COVID-19 vaccine. However, coverage remains very low (18.7%). This suggests that willingness to take the vaccine does not always translate into actual vaccination. Although increased knowledge can increase the willingness to get vaccinated, other identified vaccination barriers must be overcome in order to improve vaccine coverage. From our findings, the most significant barrier to vaccination is the fear of vaccine side effects. According to the Ipsos survey, the top three barriers were "worry about side effects," "doubt about vaccine effectiveness," and "perception of not being sufficiently at risk from COVID-19".[31] Furthermore, a survey conducted by Africa CDC in 15 African countries revealed that the reasons for not accepting COVID-19 vaccines were primarily based on trust in vaccines and perceptions of their safety and efficacy.[10] Access to vaccination centers is another significant barrier to COVID-19 vaccination among these students (16.1%). Access to vaccination centers can be difficult, leading to low vaccine uptake and, as a result, vaccine hesitancy.[26] Low vaccine uptake is especially problematic in low and middle-income countries, where factors such as a lack of resources, poor roads for transporting vaccines, insufficient cold-chain and storage, and limited funds for surveillance all play a role.[31-33] A study of COVID-19 vaccination disparities among low-, middle-, and high-income countries found that the national economic level of low and middle-income countries, as well as other socioeconomic factors, have a negative impact on vaccination levels and access to vaccination in these countries.[33] Findings from our study further identified belief in natural immunity, lack of knowledge about vaccine availability, vaccine affordability, rumors about vaccine safety, regulations, vaccine unavailability, regular absence of vaccinators, distrust in the government, and vaccinators' poor attitude as potential barriers to COVID-19 vaccination. These reported barriers are consistent

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with studies in China,[34] Zambia,[26] Malaysia,[35] and six Southeast Asian countries,[36] in addition to Nigerian studies.[10,23]

To overcome vaccine hesitancy caused by the fear of vaccine side effects, our study participants suggested that stakeholders demonstrate proof of vaccine safety, such as displaying scientific evidence of successful vaccinations. The students also suggested that various awareness campaigns should be developed to increase the knowledge of the vaccine's benefits while emphasizing the pandemic's perceived risk. This can be achieved via targeted educational interventions and/or media promotions: e.g. as described by Lessard and colleagues, which may include convening symposia with the students where the benefits and safety concerns about the vaccines can be addressed by trusted healthcare professionals; and through the use of broadcast and outdoor media tools like flyers, billboards, wallscapes etc. sited strategically in the institutions.[37] Furthermore, establishing vaccine advocacy groups on campuses was popular among the respondents and we predict this to be suitable and effective in promoting COVID-19 vaccine acceptance among the students. Starting a new student club or leveraging existing public health-leaning clubs on campus to disseminate sound information about COVID-19 vaccines and encourage vaccine uptake may be an efficient way to implement this. Studies have underscored the critical role students can play in response to the pandemic outbreak from awareness creation to contact tracing, screening, and vaccine promotion.[38-40] Additionally, in Nigeria, student-led advocacies and peer educator initiatives have been shown to promote positive beliefs and attitude toward disease prevention and vaccination among students.[41,42]

To address the challenges with accessibility of the COVID-19 vaccines among undergraduate students, the students proposed that vaccination centers should be established on campus. Availability of on-campus vaccination centers can ameliorate the difficulty in accessing vaccination centers. Existing health centers or clinics in the institutions can be used for this purpose, although necessary infrastructure such as cold chain storage facilities and trained personnel must be provided. Scheduled visits to campus using mobile vaccination teams may also work where permanent maintenance of cold chain and other infrastructure on-campus is not feasible due to cost.[43] Administering vaccines first to principal officers was recommended, which is expected to boost the confidence of the students in the safety of the vaccine. Providing vaccines at no cost to the student was also suggested as a means of increasing vaccine uptake. Willingness to pay for the COVID-19 vaccines has been generally low in the Nigerian populace, with some early surveys citing as much as three-quarter of respondents preferring the vaccines to be offered for free.[44,45] Along this line, the government of Nigeria through the primary health care program have made the COVID-19 vaccines available free of charge for all citizens; the policy could have encouraged earlier receivers of the vaccines, including some of our vaccinated study participants. Furthermore, requiring proof of vaccination as a ticket to important activities, such as examinations and convocations, was also recommended. Notably, this is the least popular recommendation among our respondents and it likely reflects the bigger controversy about the acceptance and justification of the mandatory vaccination policies in the public. Vaccine mandates can be an effective means to improve vaccination coverage among students, for example, Couture and colleagues (2023) demonstrated in one American college that mandating vaccination on campus increased the likelihood of taking the COVID-19 vaccine among the students.[46] Smith and Emanuel (2023) had further argued that vaccine mandate policies serve greater public health good and the policies are not necessarily coercive, discriminatory nor infringing on civil liberties as

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claimed by opponents.[47] They maintained that the policies are not uncommon e.g. among health workers, and are justifiable given the exceptions for medical and religious objections, communal benefits similar to tax and speed limit laws, and individual free will to disengage from circumstances or settings where vaccine mandates apply.[47] However, the WHO in its 2022 policy brief on mandatory vaccination has cautioned policymakers to balance vaccine mandate considerations with other values such as necessity for a defined objective, evidence of efficacy and safety, accessibility, public trust, and ethical procedures to prevent negative societal outcomes.[48] Overall, policies and strategies that encourage voluntary participation in vaccination such as educational and accessibility measures should be prioritized over intrusive means like a mandate, especially in complex settings like a tertiary institution.[48]

Limitations

The main strength of our study is in capturing the Nigerian tertiary students' perceived barriers to vaccine uptake and their recommendations for improving the prevalent low vaccine uptake. Our study allows students to suggest how health policies should be implemented and improved. Furthermore, our findings showed that increased vaccination knowledge does not always translate into increased coverage. Vaccination barriers must be overcome in order for coverage to increase.

The main limitation of our study is the small sample size. This may limit the generalizability of our result, and may warrant confirming the findings and recommendations in subsequent studies among a larger cohort of Nigerian undergraduates. However, we believe that the inclusion of our study participants from across the different regions of the country may enhance the representativeness and applicability of our findings. Also, we acknowledge that the reality of the COVID-19 pandemic in Nigeria may have changed over the periods between data collection and final publication. While this may determine the urgency with which the recommendations given should be applied, we are convinced that the recommendations can contribute to future pandemic preparedness or response among the study population.

Conclusion

This study found a link between good knowledge of COVID-19 and its vaccine and the uptake of the COVID-19 vaccines among Nigerian undergraduate students. However, data from the study also showed that, in spite of the level of awareness, safety concerns, as well as the inaccessibility of vaccination centers, are barriers strong enough to cause vaccine hesitancy and low vaccine uptake among students. Thus, the findings from this study suggest that to improve vaccine uptake, the safety of the vaccines needs to be demonstrated to the students by health authorities. This can be accomplished by presenting the evidence of successful vaccinations to the school community. Additionally, it will be required to launch campaigns and initiatives to promote the benefits of vaccination among the students and raise their awareness on the risks of the pandemic and vaccine hesitancy. For this purpose, it was suggested that establishing student-led vaccine advocacy groups on campuses could serve to increase the level of awareness of COVID-19 and the need for higher COVID-19 vaccine uptake among the students. The provision of vaccines at no cost and the opening of vaccination centers on campuses were also recommended to increase accessibility.

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SUMMARY - ACCELERATING TRANSLATION

This study titled “Awareness, Coverage, and Barriers to COVID-19 Vaccination among Undergraduate Students in Nigeria” is an observational study aimed at generating the necessary data required to design an effective COVID-19 vaccination program for undergraduate students in Nigeria.

The COVID-19 pandemic is still at force in Nigeria with reports of new variants of the virus. Since December 2021, the Nigerian Center for Disease Control and Prevention (NCDC) has been monitoring various emerging sub-lineages and variants of the virus in the country. Also, the COVID-19 vaccines have been rolled out since the second quarter of 2021 but uptake and coverage are still far below the needed threshold. Less than a quarter of the 207 million Nigerians are currently fully vaccinated. The resumption of physical learning activities in various tertiary institutions presents a need to prevent fatal outbreaks at the institutions. Studies have shown that places with a large number of inhabitants, such as school campuses, are potential hotbeds for COVID-19 virus spread. The WHO has also recognized this and has specified that tertiary students should be prioritized in vaccine allocation. Hence, the study is focused on this sector of the Nigerian population.

Hesitation towards getting vaccinated is a global problem that is prevalent in Nigeria, particularly among the large youthful populations, which includes tertiary students. This study investigated the knowledge (awareness), coverage (how much utilized), and barriers to the uptake of vaccines among tertiary students in the country. We conducted an online survey, where electronic questionnaires were administered to willing undergraduate students (respondents) in Nigeria and the data obtained were analyzed.

From the results of our study, we observed that a large proportion of our respondents were well aware of the availability and benefits of the COVID-19 vaccine. Yet, approximately 4 of every 5 respondents had not received a dose of the vaccine. The main reasons cited by the respondents were the fear of side effects and unavailability of vaccination centers on their campuses. To this end, most of the respondents agreed that providing proof of vaccine safety, opening vaccination centers on campus, and promoting the vaccine through tertiary students are viable ways to improve the acceptability and uptake of the COVID-19 vaccine among tertiary institutions students.

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639 **FIGURES AND TABLES.**
640
641 **Table 1. Questions assessing knowledge about COVID-19 and COVID-19 vaccines**
642

Questions	Appropriate response
Do you think COVID-19 pandemic is still ongoing in Nigeria	Yes
Do you think there is a possibility of the spread of COVID-19 on campus	Yes
Are you aware of the availability of COVID-19 vaccines in Nigeria	Yes
The COVID-19 vaccine can protect you from COVID-19. Do you agree?	Yes

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646 **Table 2:** Socio-demographic characteristics of the respondents

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Variable	Frequency (n = 326)	Percentage (%)
Age (years)		
18-29	317	97.2
30-39	8	2.5
40-49	1	0.3
Sex		
Female	149	45.7
Male	177	54.3
Religion		
Christianity	225	69.0
Islam	100	30.7
Other	1	0.3
Place of residence		
Rural	35	10.7
Urban	291	89.3
Location of institution		
North Central	21	6.4
North East	15	4.6
North West	15	4.6
South East	58	17.8
South South	72	22.1
South West	145	43.9
Level of study		
100L	13	4.0
200L	97	29.8
300L	33	10.1
400L	59	18.1
500L	110	33.7
600L	14	4.3
Current mode of instruction		

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Physical Classes	193	59.2
Virtual Classes	7	2.1
Both	126	38.7

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654 **Table 3:** Coverage of COVID-19 vaccine among the respondents

S/N	Questions	Frequency (n =326)	Percentage (%)
1	Have you received any of the COVID-19 vaccines?		
	Yes	61	18.7
	No	265	81.3
2	Number of doses taken so far?		
	Complete (one dose)	16	4.9
	Complete (two doses)	30	9.2
	Partial (one dose)	15	4.6
	None	265	81.3
3	If you picked YES to having been vaccinated, please indicate your last vaccination schedule; (Pick "Nil" if unvaccinated):		
	March, 2021	3	0.9
	May, 2021	2	0.6
	June, 2021	7	2.1
	July, 2021	5	1.5
	August, 2021	10	3.1
	September,2021	15	4.6
	October ,2021	8	2.5
	November 2021	9	2.8
	Nil	267	81.9
4	If you picked YES to having been vaccinated, please indicate where you received the vaccine; (Pick "Nil" if unvaccinated)		
	Health facility on campus	26	42.6
	Health facility off campus	28	45.9
	Nil	267	81.9

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Figure 1: Association between vaccination coverage and awareness (knowledge grading) about COVID-19 and COVID-19 Vaccines among Respondents

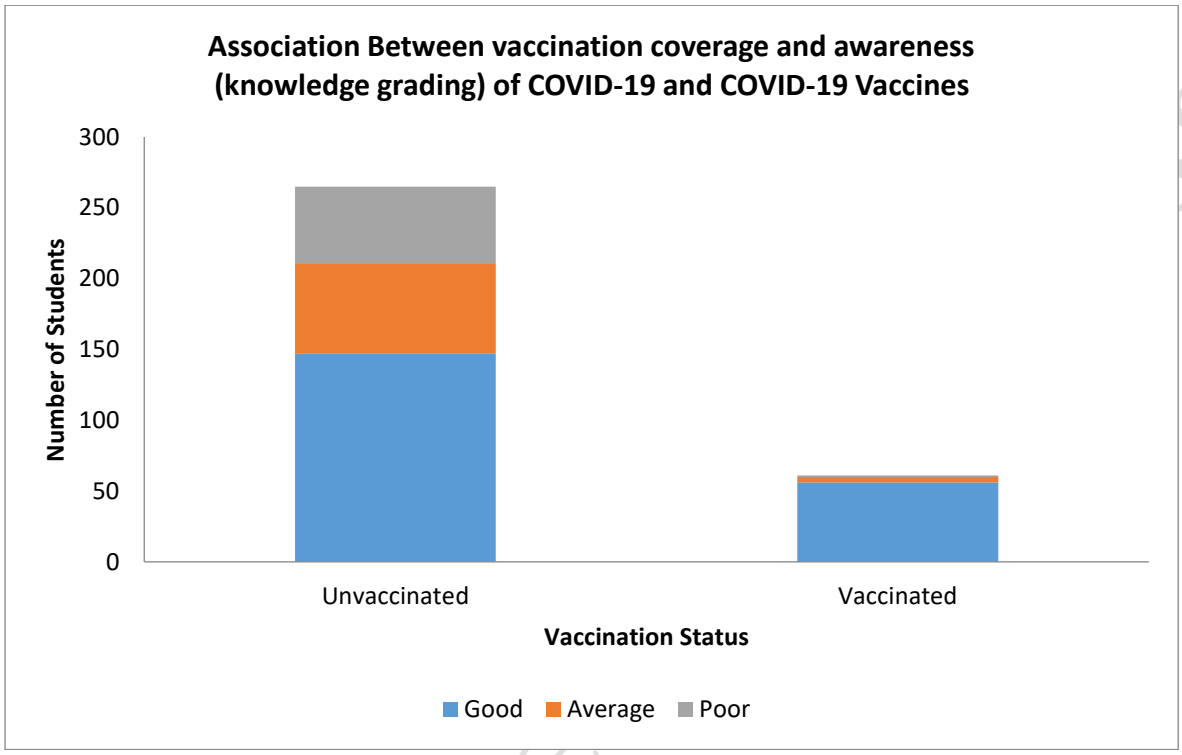

Fig 1: Chart reflecting the associations between vaccination coverage (uptake of the COVID-19 vaccines) and awareness (knowledge grading) of COVID-19 and COVID-19 vaccine among respondents. Having a good level of knowledge is associated with a higher chance of getting vaccinated. However, other factors may influence actual vaccination coverage in the population. X^2 = 28.189, $p < 0.001$, n = 326.

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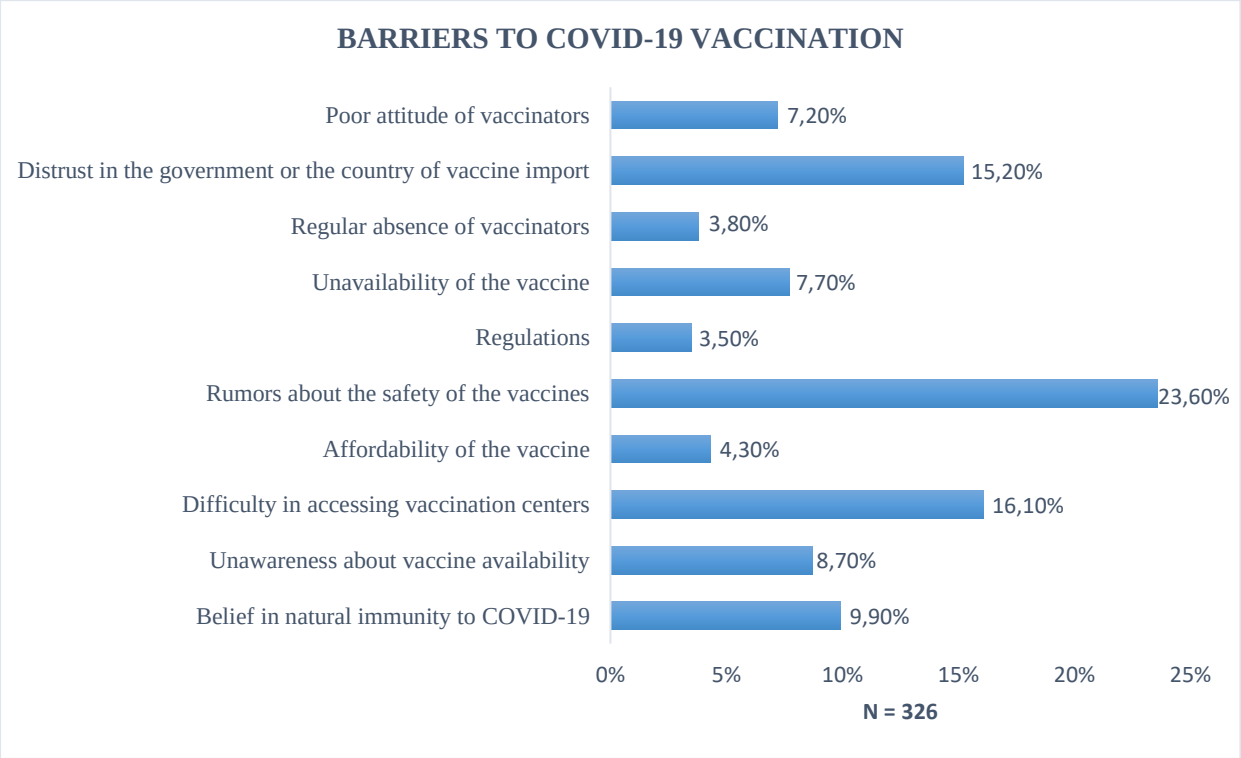
Figure 2: Barriers to vaccination and recommendations to improve the uptake of the COVID-19 vaccines among the respondents

2a. Barriers to COVID-19 vaccination



2b. Recommendations for improving vaccination uptake among tertiary students

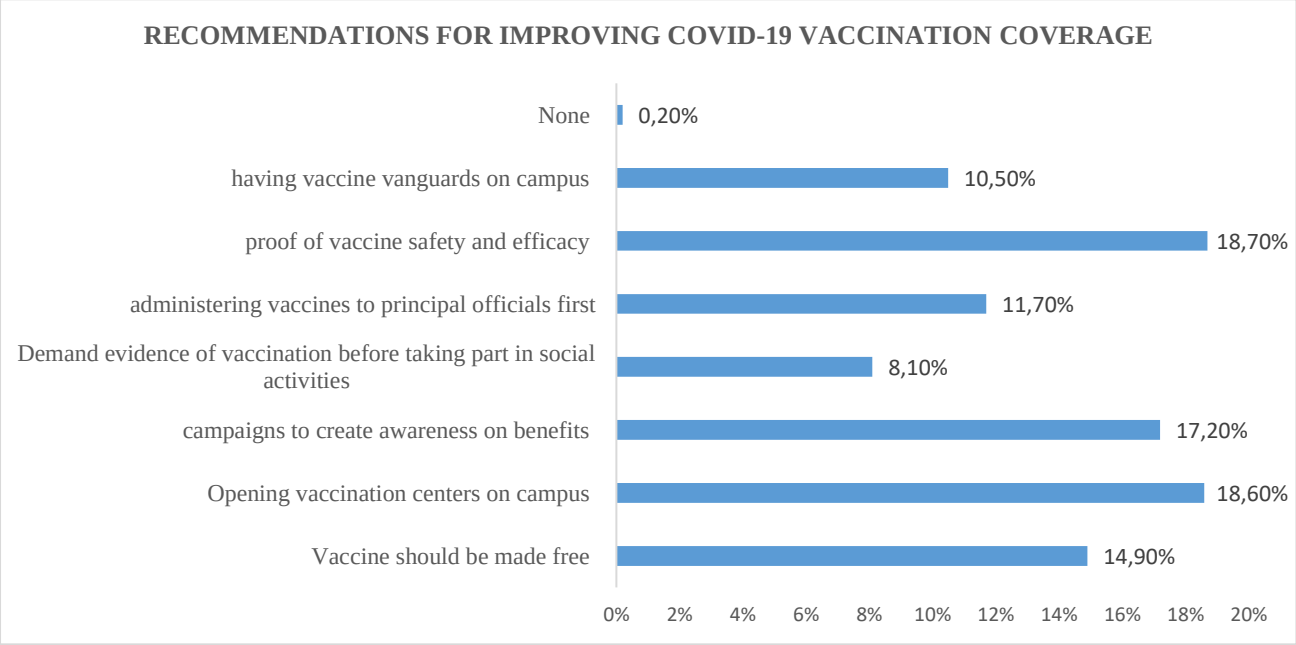


Fig 2: (a) Safety concerns and inaccessibility top the list of barriers to COVID-19 vaccination among respondents. (b) Tested recommendations to improve COVID-19 vaccination uptake among tertiary-level students in Nigeria