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COVID-19 Vaccine Hesitancy and Uptake Among Nigerian University Students: A Case Study of ABU Zaria

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ABSTRACT

Background: The COVID-19 pandemic has impacted various sectors, including education. While vaccines were developed to curb the virus's spread, studies and anecdotal evidence show low uptake among undergraduate students, largely due to concerns about side effects and conspiracy theories. This study assessed the level of knowledge, uptake, and the factors influencing COVID-19 vaccination decisions among undergraduate students.

Methods: A cross-sectional survey used electronic questionnaires to gather responses from 417 undergraduate students at Ahmadu Bello University (ABU), Zaria, Nigeria, through stratified random sampling. Data were analyzed with SPSS version 27. Descriptive statistics were presented in frequency tables and percentages. Multivariate logistic regression determined independent predictors of COVID-19 vaccine uptake.

Results: Most students (78.2%) had good knowledge of COVID-19, but only 9.7% were fully vaccinated. Uptake was facilitated by perceived severity (OR = 2.12, p = .017), sufficient information (OR = 2.50, p < .001), and mandatory requirements (OR = 3.89, p < .001), while side-effect concerns (OR = 0.27, p < .001), mistrust, and misinformation were key barriers. Health-related students were more likely to be vaccinated (OR = 2.85, p = .009), while other socio-demographic factors, including age, gender, religion, ethnicity, parental education, and academic level, were not significant predictors of vaccination (all $p > 0.05$).

Conclusions: There is a significant disconnect between the high level of knowledge and vaccine uptake among the study population. This was mainly due to conspiracy theories and fear of side effects. Therefore, targeted campaigns and vaccination mandates for university registration were recommended.

Keywords: COVID-19, vaccines, cross-sectional studies, students, Nigeria.

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INTRODUCTION

The COVID-19 pandemic, arguably the most significant crisis since World War II, profoundly affected every sector of society, leading to sickness and deaths while disrupting the everyday routines of billions of individuals worldwide.[1] The education sector is one of the sectors that experienced profound challenges due to the pandemic.[2] This was evident as schools, colleges, and universities worldwide faced sudden closures, disrupting the academic calendars of millions of students.[3] According to the World Economic Forum, more than 1.6 billion students globally were affected by school closures in over 190 countries at the pandemic's peak.[4] As a result, many universities and colleges shut down their campuses or transitioned to online classes to curb the spread of the virus.[4-5] Following a period, Nigeria's Federal Ministry of Education issued guidelines for reopening institutions. These guidelines included measures such as maintaining social distancing, promoting handwashing, and requiring personal protective equipment (PPE) for staff and students.[6] In addition, vaccination against COVID-19 was prioritized as a key strategy and a critical tool in combating the pandemic.[7] Two COVID-19 vaccines (Oxford–AstraZeneca and Moderna) were approved and deployed to Nigeria in 2021.[8] Despite the availability of the vaccine, a study conducted among students in southwestern Nigeria found a negative attitude towards the COVID-19 vaccine, with only 6% of respondents reporting that they had received the vaccine.[9] Another study in Lagos State revealed a more positive attitude towards vaccination, yet the uptake remained low at 9.4%.[10] In Northern Nigeria, several studies have examined the knowledge and perceptions of the COVID-19 vaccine; however, to the author's knowledge, none have investigated vaccine uptake among university students, specifically at ABU Zaria, Nigeria.[11-13] Additionally, anecdotal evidence revealed that vaccine hesitancy remains a significant challenge among ABU Zaria students, with some expressing reluctance or outright refusal to get vaccinated. Therefore, this study aimed to assess the level of knowledge, vaccine uptake, and factors influencing COVID-19 vaccine decisions among undergraduate students at ABU, Zaria, Nigeria. This study is novel in its use of a stratified faculty-based sampling approach, ensuring representation across ABU's 17 faculties, which is critical given the university's sociocultural and religious diversity. It focuses on ABU Zaria due to its large and diverse undergraduate population and its national mandate, drawing students from 19 northern states. This unique diversity reflects Nigeria's sociocultural and religious heterogeneity, making ABU Zaria an ideal setting to explore vaccine-related behaviors within the northern Nigerian context.[14]

This study was anchored on the Health Belief Model (HBM) as a theoretical framework, which posits that health-related behaviours, such as vaccine uptake, are influenced by factors including perceived susceptibility to the disease, perceived severity, perceived benefits and barriers to taking action, cues to action, and self-efficacy.[15] By applying the HBM, this study examines how these constructs shape ABU Zaria students' knowledge, uptake, and decisions regarding COVID-19 vaccination.

This study addresses the knowledge gap regarding COVID-19 vaccine uptake among undergraduate students. By identifying key factors influencing vaccination, this research informs the development of effective interventions to increase vaccination rates within this population, thereby enhancing public health in the university community and beyond. The findings will also provide evidence-based recommendations for healthcare professionals, university administrators, and policymakers while enriching future research and discussions on this important topic.

SUBJECTS AND METHODS

Study design

This study employed a cross-sectional descriptive design, which involved collecting data at a single time to provide a comprehensive snapshot of the population under investigation. This study was anchored to the health belief model.

Study Setting

This study was conducted at ABU, a prominent federal government university in Zaria, Kaduna State, Nigeria. The university was established in 1962 with 17 faculties and 110 departments.[16] It comprises a main Samaru campus, a satellite Kongo campus, and a pre-degree school in Funtua. The Samaru campus is vast, encompassing over 7,000 hectares and offering a variety of facilities crucial for student life, including a health center, a central library, and numerous research centers catering to diverse academic disciplines.[16]

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Study population

The target population included all the undergraduate students at ABU, Zaria, during the 2023/2024 academic year. According to the University's Management Information System, there were 35,096 undergraduate students during the 2023/2024 academic year.[17]

Sample size determination

A sample size of 435 was determined using the Taro Yamane formula, given that the target population is known (35,096) with an allowable error margin of 5% (Kirkwood & Sterne, 2010; Yamane, 1970). [18,19] A 10% buffer of the calculated sample size was added to cover for non-response.

$n = \frac{N}{1+Ne^2}$ where n = sample size, N = target population = 35,096, e = margin of error = 5% = 0.05

Sampling techniques

A proportionate stratified random sampling technique was used to select respondents according to their faculties, ensuring that every faculty member was captured in the survey. The total sample of 435 students was proportionally allocated across the 17 faculties of ABU Zaria based on each faculty's share of the total undergraduate population (N = 35,096). For instance, the Faculty of Education (19.8% of students) was allocated 86 respondents, while Dentistry (0.4%) received 2 respondents. Faculties with moderate populations, such as Engineering (14.3%, n = 62) and Arts (5.6%, n = 24), were similarly proportionally represented, ensuring balanced coverage across the university's diverse population. This is presented in Table 1 below.

Table 1: Sample Size Determination by Faculty (N = 35,096, n = 435)

Faculty	Population (N)	Population (%)	Allocation To Population (n)
ABU Business School	1,663	4.7	20
Administration	1,082	3.1	13
Agriculture	1,155	3.3	14
Allied Health Sciences	1,579	4.5	20
Arts	1,960	5.6	24
Basic Medical Sciences	983	2.8	12
Clinical Sciences	804	2.3	10
Dentistry	127	0.4	2
Education	6,953	19.8	86
Engineering	5,020	14.3	62
Environmental Design	2,401	6.8	30
Law	1,650	4.7	21
Life Sciences	2,555	7.3	32
Pharmaceutical Sciences	879	2.5	11
Physical Sciences	2,828	8.1	35
Social Sciences	2,666	7.6	33
Veterinary Medicine	791	2.3	10
Total	35,096	100.0	435

Study Instrument

An electronic researcher-constructed questionnaire structured on online Google Forms was used for data collection. For respondents without access to the internet, the printed version of the questionnaires was used. The questionnaire was developed after a comprehensive review of existing literature and standardized Knowledge, Attitude, and Practice (KAP) survey tools on COVID-19 and other immunization programs. The content was adapted to the context of undergraduate students at Ahmadu Bello University (ABU), Zaria.

To ensure face and content validity, the instrument was reviewed by three subject-matter experts in public health and nursing. They assessed the relevance, clarity, and appropriateness of each item using a 4-point relevance scale. The Content Validity Index (CVI) was computed and yielded a score of 0.91, indicating excellent content validity.

To support construct validity, items were systematically mapped to the HBM domains. Items on knowledge of COVID-19 transmission and prevention (Section B) align with perceived susceptibility and severity, while items in Section D on side effect concerns and government mistrust represent perceived barriers. The structure of the questionnaire, coupled with the study findings (e.g., high knowledge but low uptake), provided

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empirical evidence of both convergent and discriminant validity, consistent with HBM predictions.

A pilot study was conducted among 45 undergraduate students with characteristics similar to the main study population. The test–retest method was applied to assess stability reliability, with the same respondents completing the questionnaire again after an interval of one week. The results demonstrated consistent responses over time, supporting the stability of the instrument. Feedback from the pilot was also used to refine the questionnaire, ensuring clarity, logical flow, and cultural appropriateness.

Internal consistency reliability of the items was evaluated using Cronbach's Alpha, yielding a coefficient of 0.70, which meets the commonly accepted threshold (≥0.70) for survey-based research instruments.
The questionnaire was structured into four key sections designed to comprehensively assess the respondents' characteristics, knowledge, behaviors, and perceptions regarding COVID-19 vaccination.

- **Section A** captures socio-demographic information such as age, gender, marital status, religion, ethnicity, parents' educational level, campus, faculty or department, and the respondent's current academic level.
- **Section B** assesses knowledge of COVID-19 and its vaccines. It includes questions on the nature of the disease, modes of transmission, preventive measures, high-risk groups, the purpose of vaccination, and the ability to differentiate between recognized COVID-19 vaccines and unrelated drugs.
- **Section C** focuses on vaccine uptake. It evaluates whether respondents have received the vaccine, the type and number of doses taken, the interval between doses, methods of scheduling appointments, sources of information about the vaccine, and the primary reasons for deciding to get vaccinated.
- **Section D** explores the factors influencing decisions regarding vaccination using a five-point Likert scale. This section captures perceptions of the seriousness of COVID-19, confidence in vaccine safety and effectiveness, accessibility and ease of getting vaccinated, adequacy of information from media and healthcare providers, the impact of mandatory vaccination for travel or work, concerns about side effects or long-term risks, trust in government handling of the pandemic, the effect of misinformation, religious considerations, and past negative experiences with vaccination or healthcare systems.

Recruitment of participants
After presenting the ethical clearance to the heads of departments of each faculty, a list of all the students at the faculty was compiled. The table of random numbers application from the Google Play Store was used to select the students to participate in the study. Each chosen participant was tracked via their class representatives, and their phone numbers were collected.

Data collection procedure
Each selected participant was called, and the study was fully explained to them. The consent form was sent to the 435 selected participants electronically via WhatsApp and mail. After providing consent to participate in the study, the link to the questionnaire structured on Google Forms was sent to their WhatsApp numbers and corresponding mail. A total of 417 responses were returned, giving a 95.8% response rate.

Data analysis
Data analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 27. The Missing Indicator Method (MIM) was used to manage missing data. Descriptive statistics for the binary and categorical variables were presented as frequencies and percentages. Knowledge of the COVID-19 vaccine was the outcome variable in Table 3. Responses in this section were scored dichotomously, assigning 1 point for each correct answer and 0 for each incorrect answer. The total score for each respondent was summed to generate a knowledge index, which was subsequently categorized into levels (Low, Moderate, or High knowledge), which was presented as a bar chart. Section D (Factors Influencing Vaccination Decisions) was assessed using a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). For clarity in presenting the findings, responses of Strongly Disagree, Disagree, and Neutral were merged as "Disagree," while Agree and Strongly Agree were merged as "Agree." The dichotomized data were then summarized using frequencies and percentages in table. To identify independent predictors

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of COVID-19 vaccine uptake, a multivariate logistic regression was performed. The outcome variable was vaccine uptake (any dose: yes = 1, no = 0). Predictor variables included significant factors from the bivariate analysis, such as perceived severity of COVID-19, side effect concerns, sufficiency of information, and mandatory vaccination requirements, along with socio-demographic characteristics (age, gender, religion, education level, and campus location). Adjusted odds ratios (ORs), 95% confidence intervals (CIs), and *p*-values were reported, with model fit assessed using the Hosmer–Lemeshow test and McFadden's pseudo-R^2 to evaluate explanatory power.

Ethical Consideration

Ethical approval for this study was obtained from the Ahmadu Bello University Teaching Hospital, Shika, Zaria, Health Research Ethics Committee (Approval No: NHREC/ABUTH-NHREC/29/08/23). The study adhered strictly to the principles of the Declaration of Helsinki regarding research involving human participants.

Participants were informed about the purpose, objectives, and procedures of the study through an information sheet provided either online or in print. Informed consent was obtained from all respondents prior to participation. Respondents were assured that their participation was voluntary, that they could withdraw at any time without penalty, and that refusal to participate would not affect their academic standing. Data confidentiality and anonymity were maintained throughout the study. No identifying information was collected, and all responses were stored securely with access restricted to the research team. Data was reported only in aggregate form to ensure privacy.

RESULTS

Data from 417 responses were analyzed and presented according to the objectives below:

Table 2: Socio-demographics of respondents (n = 417)

Variables	Frequency	Percentage (%)
Age (in years)		
20 – 23	185	44.4
24 – 27	170	40.6
28 – 31	32	7.8
16 – 19	17	4.2
Above 35	8	1.8
32 – 35	5	1.2
Gender		
Male	217	52.1
Female	200	47.9
Marital status		
Unmarried	394	94.5
Married	23	5.5
Religious Affiliation		
Islam	271	64.9
Christianity	146	35.1
Ethnicity		
Others	182	43.7
Hausa	122	29.1
Yoruba	98	23.6
Igbo	15	3.6
Parent/Guardian's highest level of education		
Tertiary level	369	88.5
Secondary level	43	10.3
Primary level	5	1.2
Campus		

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Variables	Frequency	Percentage (%)
Samaru campus	396	95
Kongo campus	21	5
Faculty		
Education	86	20.7
Engineering	61	14.6
Physical Sciences	35	8.5
Social Sciences	33	7.9
Life Sciences	30	7.3
Environmental Design	28	6.7
Arts	25	6.1
Allied Health Sciences	20	4.8
Law	20	4.8
ABU Business School	15	3.6
Agriculture	15	3.6
Basic Medical Sciences	13	3
Clinical Sciences	13	3
Pharmaceutical Sciences	10	2.4
Veterinary Medicine	10	2.4
Department		
Science education	35	8.5
Botany	32	7.9
Political science	28	6.7
English	22	5.5
Civil law	20	4.8
Home economics	20	4.8
Mechanical engineering	20	4.8
Geology	17	4.2
Nursing science	16	4.2
Agricultural engineering	15	3.6
Biological sciences	15	3.6
Medicine	13	3
Forestry and wildlife	12	3
Architecture	10	2.4
Chemical engineering	10	2.4
Pharmacy	10	2.4
Veterinary medicine	10	2.4
Actuarial science and Insurance	8	1.8
Building	8	1.8
Computer science	8	1.8
Human anatomy	8	1.8
Water resources and environmental engineering	7	1.8
Accounting	5	1.2
Civil engineering	5	1.2
Educational foundation and curriculum	5	1.2
Human kinetics and health education	5	1.2
Human physiology	5	1.2
Mass communication	5	1.2
Physics	5	1.2

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Variables	Frequency	Percentage (%)
Urban and regional planning	5	1.2
Agricultural extension and rural development	3	0.6
Archaeology	3	0.6
Business administration	3	0.6
Chemistry	3	0.6
Computer engineering	3	0.6
Educational psychology and Counselling	3	0.6
Electronics and telecommunications engineering	3	0.6
Geomatics	3	0.6
Local government and development studies	3	0.6
Mathematics	3	0.6
Medical radiography	3	0.6
Level		
300	152	36.4
400	105	25.5
500	91	21.8
200	51	12.1
100	15	3.6
600	3	0.6

Source: Field survey, 2024

Table 2 shows that a significant majority (85%) of the respondents are between 20 and 27 years old. The sex distribution was nearly balanced, with a slightly higher percentage of males (52.1%) than females (47.9%). Most respondents were unmarried (94.5%), and the predominant religion was Islam (64.9%). While other ethnic groups make up the majority of respondents (43.7%), Hausa was the dominant group (29.1%) of the three main ethnic groups in Nigeria. Additionally, most respondents reported that their parent or guardian attained a tertiary level of education (88.5%). The Samaru campus accounted for the majority of respondents (95%), likely because it houses 15 of the 17 faculties at Ahmadu Bello University, Zaria, compared to the Kongo campus, which has only two faculties (Management Information System (M.I.S) Unit, ABU, Zaria, 2024). The Faculty of Education had the highest number of respondents (20.7%). At the departmental level, the Science Education department had the highest number of respondents (8.5%). Regarding academic level, the majority of respondents (36.4%) were at the 300 level, while those at the 600 level comprised the smallest proportion (0.6%).

Table 3: Knowledge of COVID-19 disease and vaccine (n = 417)

Variables	Frequency	Percent (%)
What is COVID-19		
A type of flu	23	5.5
A viral respiratory illness caused by the SARS-CoV-2 virus	376	90.3
A bacterial infection	15	3.6
A type of common cold	3	0.6
Transmission of COVID-19		
By direct contact with animals	10	2.4
Through respiratory droplets from an infected person	374	89.7
Through handshake	30	7.3
By ingesting contaminated food or water	3	0.6
Prevention of spread of COVID-19		
Consuming garlic and ginger daily	5	1.2
Avoiding wearing masks in public spaces	5	1.2
Bathing with salt solution	0	0

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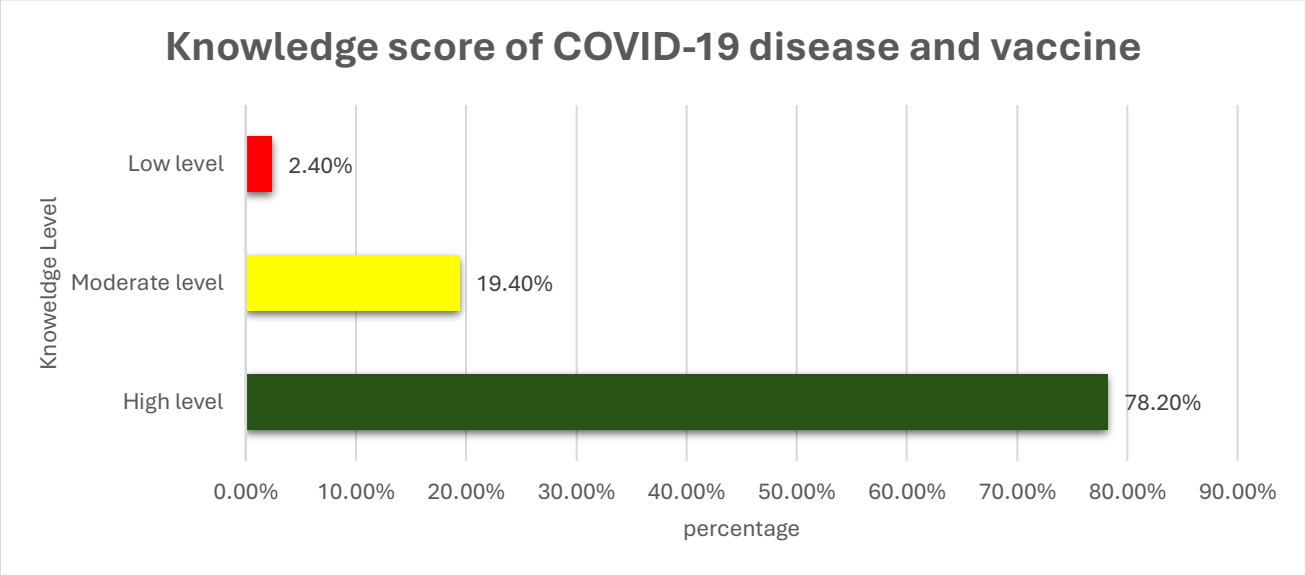
Variables	Frequency	Percent (%)
Practicing good hand hygiene, wearing masks, and maintaining physical distance	407	97.6
Who are considered high-risk groups for COVID-19		
Children above 5 years	10	2.4
Healthy young adults	17	4.2
Elderly individuals and those with pre-existing health conditions	387	92.8
Athletes	3	0.6
What is the primary purpose of COVID-19 vaccination		
To treat COVID-19 infections	41	9.7
To prevent spread of COVID-19 and reduce the severity if infected	361	86.7
To cure common cold symptoms and reduce fever and chills	10	2.4
To fulfil requirement for travel/employment or other official reasons	5	1.2
Which of these is not a COVID-19 vaccine		
Moderna	3	0.6
AstraZeneca	5	1.2
Pfizer-BioNTech	8	1.8
Amoxicillin	195	46.7
I don't know	206	49.7

Source: Field Survey, 2024

Table 3 above shows that 90.3% correctly identified COVID-19 as a viral respiratory illness caused by the SARS-CoV-2 virus. Regarding transmission, the vast majority (89.7%) recognized that COVID-19 primarily spreads through respiratory droplets from an infected person. Additionally, 97.6% of respondents correctly identified practicing good hand hygiene, wearing masks, and maintaining physical distance as effective measures for preventing the spread of the virus. Regarding high-risk groups, the majority (92.8%) correctly identified elderly individuals and those with pre-existing health conditions as being at higher risk for severe COVID-19. The primary purpose of COVID-19 vaccination was correctly understood by 86.7% of respondents, who indicated that the vaccine helps prevent the spread of COVID-19 and reduces the severity of the illness if infected. Lastly, a question about identifying a non-COVID-19 vaccine showed that 49.7% of respondents correctly identified Amoxicillin as not a vaccine, while others were unsure or mistakenly identified other vaccines.



Source: Field Survey, 2024.

Figure 1: Knowledge score of COVID-19 disease and vaccine (n = 417)

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Grading these responses, as shown in Figure 1, most respondents demonstrated a high level of knowledge regarding COVID-19, with 78.2% falling into this category.

Table 4: Uptake of COVID-19 vaccine

Variables	Frequency	Percentage (%)
Received any dose of the COVID-19 vaccine		
Yes	78	19
No	339	81
COVID-19 vaccine type received		
AstraZeneca	12	15.5
Johnson & Johnson (Janssen)	10	12.5
Moderna	5	6.3
Pfizer-BioNTech	15	18.8
I don't know the name of the vaccine I received	36	46.9
Number of COVID-19 vaccine doses received		
First dose only	39	50
Both first and second doses	39	50
Interval between doses of COVID-19 vaccine received		
Less than 4 weeks	5	12.5
4 – 8 weeks	12	31.2
8 – 12 weeks	10	25
More than 12 weeks	5	12.5
I don't know the interval	7	18.8
Vaccine appointment / scheduling method		
Scheduled online through a healthcare provider or the NPHCDA website		
Scheduled through my workplace or other institution	2	3.1
Walk-in appointment at a vaccination center	15	18.8
Scheduled through a mobile vaccination clinic	56	71.9
Source(s) of information for COVID-19 vaccine (select all that apply)		
Social media	109	26.1
Television/ Radio	72	17.2
Town announcements	28	6.7
Workplace announcements	40	9.7
Religious institution (church/ mosque)	47	11.2
Neighbours	43	10.4
Healthcare providers	78	18.7
Primary reason(s) for getting vaccinated (select all that apply)		
To protect myself, family and friends from COVID-19	171	40.9
To travel or for official requirements	54	12.9
To contribute to achieving herd immunity/ protecting the broader community	63	15.1
To protect myself from new variants of COVID-19	72	17.2
Healthcare provider recommendation	58	13.9

Source: field survey, 2024.

As shown in Table 4, a significant majority (81.0%) of the respondents had not received any COVID-19 vaccine, with only 19.0% vaccinated. Among those vaccinated, vaccine types varied, with AstraZeneca (15.5%) and Pfizer-BioNTech (18.8%) being the most administered. In comparison, a notable proportion of respondents (46.9%) were unsure of the vaccine they received. Half of the vaccinated respondents received both doses, while the remaining 50.0% received only the first dose. The interval between doses was most reported as 4 to 8 weeks (31.2%), with 18.8% of respondents unsure of the interval between their doses. When examining the method of scheduling vaccination appointments, most respondents (71.9%) reported utilizing walk-in appointments at vaccination centers, while 18.8% scheduled them through their workplace or another institution. Only a small percentage (3.1%) scheduled appointments online through a healthcare

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provider or the National Primary Health Care Development Agency (NPHCDA) website, and 6.2% used mobile vaccination clinics. The sources of information on the COVID-19 vaccine were diverse, with social media (26.1%) and healthcare providers (18.7%) being the most common sources. Other sources, such as television/radio (17.2%) and neighbours (10.4%), also played significant roles in disseminating information about the vaccine. The primary reasons for getting vaccinated included the desire to protect oneself, family, and friends from COVID-19 (40.9%) and the need to travel or meet official requirements (12.9%). Additionally, contributions to herd immunity (15.1%) and protection against new variants (17.2%) were notable motivators for vaccination, along with healthcare provider recommendations (13.9%).

Table 5: Factors that influence the decision to take COVID-19 vaccine (n = 417)

Variables	Disagree (n)%	Agree (n)%
COVID-19 is a very serious disease	79(18.9)	338(81.1)
The COVID-19 vaccine is safe and effective	245(58.8)	172(41.2)
It was easy for me to get the COVID-19 vaccine	313(75.1)	104(24.9)
I received sufficient information from the media and/or healthcare providers regarding COVID-19 and the vaccine	207(29.6)	210(50.4)
I received the vaccine after I was diagnosed with and treated COVID-19	349(83.7)	68(16.3)
It was compulsory to take the vaccine for travel purposes, employment, or other official reasons	147(35.3)	270(64.7)
I have concerns about potential side effects and long-term effects of the vaccine.	151(36.2)	266(63.8)
I do not trust the government's handling of the COVID-19 pandemic	200(48.00	217(52.0)
The COVID-19 vaccine was developed too quickly	258(61.9)	159(38.1)
I heard that the vaccine contains microchips, and can cause infertility or other chronic disease conditions	275(65.90	142(34.1)
It is against my religion to receive the COVID-19 vaccine	362(86.8)	55(13.20
I have had negative experiences with vaccination and the healthcare system in general	331(79.4)	86(20.6)

Source: Field survey, 2024.

Table 5 shows that the major factors influencing COVID-19 vaccine uptake were the perception that COVID-19 is a very serious disease (81.1%), receiving sufficient information from media or healthcare providers (50.4%), compulsory vaccination for travel, employment, or other official reasons (64.7%), concerns about potential side effects and long-term risks (63.8%), and distrust in the government's handling of the pandemic (52.0%).

Table 6 Multivariate Logistic Regression Analysis of Factors Predicting COVID-19 Vaccine Uptake (*N* = 417)

Predictor	*B*	*SE*	OR	95% CI	*p*
Intercept	-2.85	0.52	0.06	[0.02, 0.15]	<.001
Perceived Severity (Agree)	0.72	0.31	2.05	[1.12, 3.76]	.020
Side Effect Concerns (Agree)	-1.25	0.24	0.29	[0.18, 0.46]	<.001
Sufficient Information (Agree)	0.89	0.24	2.44	[1.53, 3.89]	<.001
Mandatory Vaccination (Agree)	1.32	0.24	3.74	[2.31, 6.05]	<.001
Age (20–27 years)	0.41	0.30	1.51	[0.83, 2.74]	.176
Gender (Male)	-0.15	0.24	0.86	[0.54, 1.37]	.526
Religion (Islam)	-0.28	0.24	0.76	[0.47, 1.22]	.253
Education (Tertiary)	0.33	0.34	1.39	[0.71, 2.73]	.339
Campus (Samaru)	0.19	0.47	1.21	[0.48, 3.04]	.688

Note: OR = odds ratio, CI = confidence interval, *B* = regression coefficient, *SE* = standard error. Pseudo R^2 = .28 (McFadden's). Hosmer-Lemeshow test: $\chi^2(8) = 7.84$, $p = .41$.

Table 7 presents the results of a multivariate logistic regression analysis predicting COVID-19 vaccine uptake (any dose) among 417 ABU Zaria students. Adjusted odds ratios (ORs) indicate that perceiving COVID-19 as serious (OR = 2.05, p = .020), receiving sufficient information (OR = 2.44, p < .001), and mandatory vaccination requirements (OR = 3.74, p

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< .001) significantly increased uptake, while side effect concerns reduced it (OR = 0.29, p < .001). Socio-demographic variables were not significant (p > .05). The model explained 28% of variance (pseudo R^2 = .28) and showed adequate fit, $\chi^2(8) = 7.84$, p = .41.

DISCUSSION

This study aimed to assess the knowledge, uptake, barriers and predictors of the COVID-19 vaccine uptake among undergraduate students at Ahmadu Bello University in Zaria. The respondents were mainly unmarried, 300-level young adults between 20 and 27 years of age from the Department of Science Education, Faculty of Education, with a reasonably even gender distribution (both male and female). They were predominantly Muslims and Hausas. Most of them had a parent or guardian who had achieved tertiary education. The results revealed that despite a high level of knowledge on COVID-19 and its vaccines, its uptake remained low. The major barriers to uptake were concerns about potential side effects, mistrust in the government's handling of the pandemic, and the influence of misinformation, including conspiracy theories about the vaccine. Multivariate analysis showed that perceived severity, adequate information, and mandatory vaccination promoted uptake. Health-related students were more likely to be vaccinated, whereas other socio-demographics were not significant.

The high knowledge level (78.2%) is consistent with prior studies in Nigeria and globally, which reported moderate to high COVID-19 knowledge among university students.[20][21,22] For instance, 90.3% of respondents correctly identified COVID-19 as a viral respiratory illness, and 86.7% understood the vaccine's purpose, reflecting robust awareness likely due to the university setting and access to educational resources.[22] However, the low uptake (19.0%) despite high knowledge mirrors findings from other Nigerian studies, such as the University of Benin and southwestern Nigeria.[23-26] This disconnect suggests that knowledge alone is insufficient to drive vaccination behavior, a key tenet of the HBM, which emphasizes the role of perceived barriers and cues to action.[15]

Although students were knowledgeable, perceived susceptibility may have been low, as most were young, unmarried adults who might consider themselves at minimal risk for severe disease. However, multivariate analysis indicated that perceived severity significantly increased the likelihood of vaccination (OR = 2.12, p = .017), demonstrating that students who recognized the potential seriousness of COVID-19 were more inclined to vaccinate. This aligns with HBM theory, which posits that heightened perceived threat motivates preventive behaviours. Comparatively, studies in China reported similar findings, where perceived disease severity outweighed risk concerns, promoting vaccine acceptance.[23-24]

Perceived benefits, such as protection from infection and contribution to herd immunity, may have been recognized, yet perceived barriers particularly concern about side effects, mistrust in government handling of the pandemic, and exposure to misinformation were decisive in limiting uptake (OR = 0.27, p < .001). These barriers outweighed perceived benefits for many students, consistent with HBM predictions. The persistence of misinformation, including conspiracy theories and skepticism regarding vaccine safety, highlights the challenge of translating knowledge into action, even among highly educated populations.[27,28,29]

Structural cues to action emerged as critical facilitators. Mandatory vaccination requirements for travel, employment, and institutional purposes significantly increased uptake (OR = 3.89, p < .001). Similarly, sufficient information from media or healthcare providers acted as an important cue (OR = 2.50, p < .001), suggesting that timely, reliable guidance can trigger protective behaviour. The low overall uptake despite high knowledge indicates that informal or inconsistent cues may have been insufficient to overcome perceived barriers for most students.[25,26]

Health-related students were more likely to be vaccinated, reflecting the influence of professional training, familiarity with medical evidence, and perceived social norms within their faculties. Other socio-demographics, including age, gender, religion, ethnicity, parental education, and academic level, were not significant predictors, reinforcing the HBM premise that beliefs and perceptions rather than demographic characteristics primarily drive preventive health behaviors.[30]

Limitations

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Notably, this study did not account for all possible confounding factors influencing vaccine uptake, such as socioeconomic status and access to healthcare. These unmeasured variables can affect the interpretation of the results. Additionally, the study used quantitative methods, which may not fully capture the depth of attitudes, beliefs, and motivations behind vaccine hesitancy.

Implications for the findings

We recommend targeted public health education campaigns, a no-appointment-needed vaccination scheduling approach, and exploration of social media and religious institutions for information dissemination, among other interventions, to address these specific concerns, enhance trust, and improve access to reliable information to increase vaccine uptake and move closer to achieving herd immunity. Furthermore, COVID-19 vaccination should be required for the re-registration of returning students and the admission of new students at the start of each session.

Future research should explore the impact of targeted misinformation correction interventions on vaccine hesitancy among university students. Additionally, longitudinal studies could assess how vaccine attitudes and uptake evolve as the pandemic and vaccination campaigns progress. Furthermore, qualitative research should assess the attitudes, beliefs, and motivations behind vaccine hesitancy. Additionally, further studies are suggested to track changes in COVID-19 vaccine uptake over time among university students and assess vaccination campaigns' long-term effectiveness and impact.

CONCLUSION

This study highlights a significant knowledge-behavior gap in COVID-19 vaccination among university students. High awareness did not translate into high uptake due to perceived barriers and insufficient cues to action, despite recognition of disease severity and benefits of vaccination. HBM constructs, particularly perceived severity, barriers, and cues to action, proved pivotal in understanding behaviour. Addressing these constructs through targeted education, accessible vaccination services, policy mandates, and trust-building interventions is essential to increase vaccine uptake and move closer to herd immunity in Nigeria. Future studies should incorporate longitudinal and qualitative approaches to explore evolving attitudes and the effectiveness of interventions within university settings.

Declarations

Ethical Consideration: Ethical approval for this study was obtained from the Ahmadu Bello University Teaching Hospital, Shika, Zaria, Health Research Ethics Committee (Approval No: NHREC/ABUTH-NHREC/29/08/23). Informed consent was obtained from all respondents before participation.
The study adhered strictly to the principles of the Declaration of Helsinki regarding research involving human participants.

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