Open Access Library Journal
2026, Volume 13, e16128
ISSN Online: 2333-9721
ISSN Print: 2333-9705

Knowledge, Attitudes, and Perceptions of COVID-19 Vaccines and the Factors Influencing Acceptance among Undergraduate Students in a Nigerian University

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How to cite this paper: Dooga, S., Bolori, M.T. and Ekpenyong, B.N. (2026) Knowledge, Attitudes, and Perceptions of COVID-19 Vaccines and the Factors Influencing Acceptance among Undergraduate Students in a Nigerian University. *Open Access Library Journal*, **13**: e16128.
https://doi.org/10.4236/oalib.1116128

Received: October 6, 2026
Accepted: November 17, 2026
Published: November 20, 2026

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Abstract

Introduction: About 213,752,662 confirmed cases, with Africa ranking sixth among regions, behind the Americas, Europe, Southeast Asia, the Eastern Mediterranean, and the Western Pacific. Nigeria had 188,880 confirmed cases as of August 26, 2021, with 2,288 fatalities. WHO recommended vaccination as the best approach to build herd immunity, but vaccine hesitancy made it difficult to control and prevent the spread. This study assessed knowledge, attitudes, perceptions, and acceptance of COVID-19 vaccines among undergraduate students at a Nigerian University. **Method:** The sample size was 422 respondents. The study used a descriptive cross-sectional design. The study used a semi-structured questionnaire to collect data. The researchers used a multi-stage sampling procedure to select respondents. We analyzed the data using IBM SPSS version 20.0 and reported frequencies, means, and percentages, presented in tables. We used the chi-square test to assess associations between independent and dependent categorical variables. **Results:** Of the 422 questionnaire copies administered, we retrieved and used 417 for analysis, yielding a 98.8% response rate. About half of the respondents were from accounting (17.7%), Economics (14.9%), and Mass Communication (17.5%). Students from levels 100 to 400 were well represented. More than half (226; 54.2%) were female; 248 (59.5%) were between 19 and 23 years old. Almost all (381; 91.4%) were single, and more than half (232; 56.3%) lived on campus. Respondents' knowledge of the COVID-19 vaccine was categorized as high (62.7%), moderate (8.3%), or low (29.0%). About 49.3% of respondents had a positive attitude toward COVID-19 vaccines, while 50.7% had a negative attitude. About 50.5% of re-

spondents had a positive perception of the COVID-19 vaccine, while 49.5% had a negative perception. Regarding factors influencing vaccine acceptance, 52.9% reported negative influences, while 47.1% reported positive influences. Factors associated with COVID-19 vaccine acceptance included peer pressure, mistrust, worries about unforeseen effects, information on social/mass media, belief, and society/religion. **Conclusion**: Significant gaps exist in knowledge, attitudes, and perceptions of COVID-19 vaccines and the factors influencing respondents' acceptance. The hypothesis test revealed a significant association between socio-demographic factors and knowledge, attitude, perception, and vaccine acceptance. The study recommends further sensitization of students to improve their knowledge levels, attitudes, and perceptions toward COVID-19 vaccine acceptance.

Subject Areas

Public Health

Keywords

Knowledge, Attitudes, Perceptions, COVID-19 Vaccine, Acceptability, Undergraduate Students

1. Introduction

The emergence of novel coronavirus disease (COVID-19) in December 2019 halted an already busy world and threatened every nation. A novel type of acute pneumonia, closely resembling the previous Middle East Respiratory Syndrome (MERS) and severe acute respiratory syndrome (SARS) viruses, was reported to be much more lethal than either. The infection soon became a cause for concern, and the World Health Organization (WHO) declared COVID-19 a pandemic on March 11, 2020, recommending a globally coordinated effort to combat it [1]. Sub-Saharan African countries, where the pandemic arrived later, are home to over 1 billion people (14% of the world's population). Nigeria reported the first confirmed case of COVID-19 in sub-Saharan Africa on February 27, 2020. By April 1st, 2020, 43 of the 46 sub-Saharan African countries had reported confirmed COVID-19 cases [2]. As of August 26, 2021, the World Health Organization (WHO) reported 213,752,662 confirmed cases globally, with Africa ranking sixth among regions, behind the Americas, Europe, Southeast Asia, the Eastern Mediterranean, and the Western Pacific. According to these indices, Nigeria had 188,880 confirmed cases as of August 26, 2021, with 2,288 fatalities. The food system, economic activity, and poverty in Nigeria have all been affected by the pandemic and the subsequent lockdown and border closure. Because of restrictions on food services, Nigeria's agricultural food system declined by 11% during the lockdown, while the country's GDP fell by 23% due to declining remittances and export demand [3]. WHO recommended vaccination as the best approach to build herd immunity, but vac-

cine hesitancy made it difficult to control and prevent the spread. Vaccination rates were below 20% in some low- and middle-income countries (LMICs) [4]. Understanding the factors influencing vaccine acceptance is essential because the decision to accept a new vaccine is complex. Key approved COVID-19 precautionary guidelines include wearing face masks, social distancing, and avoiding crowded and poorly ventilated places. Earlier studies indicate that public knowledge and attitudes toward a pandemic vary by region [5]. Many centers are conducting research to identify specific therapeutic agents that could effectively treat the infection [6]. WHO recommends vaccination as the best way to build herd immunity [5] [6]. Researchers have developed and tested over 100 COVID-19 vaccines for safety and quality. Though these vaccines are reported to be safe and can produce mild symptoms, in very rare cases, they have been associated with fatalities due to anaphylaxis and thrombotic events [7]. Given these adverse events and the lack of clear information on how long they are effective, many people remain apprehensive about COVID-19 jabs [8]. However, given the pandemic situation and the benefit-risk ratio, WHO approved vaccines for the general public, especially the most vulnerable populations, and several countries have implemented vaccination programs [7]. Immunization can lead to herd immunity, which can reduce the circulation of infectious agents among the world population [9]. Further research is required to determine how novel COVID-19 mutations affect herd immunity. Research is also ongoing to determine how long it would take for herd immunity to develop, including the number of shots required, booster doses, and the percentage of the population to be vaccinated to achieve herd immunity [9]. The COVID-19 vaccination program has been recognized as an effective measure to ease the burden of the then ongoing pandemic; however, its success depended on high vaccine acceptance [10]. Vaccine hesitancy, defined as delayed acceptance or refusal of vaccines despite availability, is a major threat to vaccination program effectiveness [11] [12]. Anti-vaccination activists opposing COVID-19 vaccines have spread misinformation across multiple channels, potentially substantially affecting vaccine acceptance [8] [12]. Several factors can affect public acceptance of pandemic vaccines, including perceived disease risk, trust in health care systems, past vaccination, the general population's knowledge of vaccine safety and efficacy, and recommendations from healthcare personnel. Vaccines are the most important public health measure and the most effective strategy to protect the population from COVID-19, since SARS-CoV-2 is highly contagious and affects populations globally [12]. The race to develop COVID-19 vaccines to slow transmission and reduce the disease's catastrophic effects continues. As we carry the pandemic experience forward, researchers are likely to develop new, more effective vaccines [13]. Several COVID-19 vaccines have undergone human testing. To assess potential acceptance rates and the factors influencing COVID-19 vaccination acceptance, researchers polled 13,426 individuals in 19 countries in June 2020. Of these, 48.1% said they would accept their employer's recommendation to get a COVID-19 vaccine, and 71.5% said they would be very or somewhat inclined to

do so. Acceptance rates ranged from less than 55% in Russia to nearly 90% in China. Respondents who trusted information from government sources were more likely to accept vaccination and follow their employer's advice [14]. Several vaccines have been approved for use against coronavirus disease (COVID-19) and distributed globally in different regions. However, general community knowledge, attitudes, and perceptions toward COVID-19 vaccinations remain poorly understood [15].

1.1. Problem Statement

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which causes coronavirus disease 2019 [COVID-19], has had a significant worldwide impact. Mass vaccination remains crucial to preventing transmission and reducing morbidity and mortality. However, vaccine hesitancy remains a serious public health concern, particularly in middle- and low-income settings, for many reasons, including knowledge, attitudes, and perceptions about the vaccine. Assessing youths' specific knowledge and perceptions of SARS-CoV-2 vaccination is necessary to prevent vaccine hesitancy or rejection. If these issues go unchecked in the face of a possible recurrence of COVID-19, there may be devastating consequences, resulting in unexpectedly high morbidity and mortality, as well as unnecessary waste of resources. This study aims to investigate knowledge, attitudes, and perceptions towards COVID-19 vaccines.

1.2. The Study Objectives

The study objectives were to assess undergraduate University students' knowledge, attitudes, and perceptions, and to identify factors influencing COVID-19 vaccine uptake.

1.3. Research Hypothesis

HO_1: Socio-demographic variables (age, sex, education) are not associated with undergraduate university students' knowledge, attitudes, and perceptions of COVID-19 vaccines.

HO_2: Socio-demographic variables are not associated with undergraduate university students' acceptance of COVID-19 vaccines.

HO_3: Knowledge, attitude, and perception of COVID-19 vaccines are not associated with vaccine hesitancy among undergraduate University students.

1.4. Significance of the Study

The data from this research will enable concerned authorities to take positive steps and measures that will benefit students' health and the health of the wider population. It will enable schools and other stakeholders to increase sensitization of students and the public on the importance of COVID-19 vaccines. It will enable government leaders and other relevant authorities to formulate and implement policies and programs that encourage public awareness and access to COVID-19

vaccines. It will provide useful data to help healthcare providers and the government address factors that influence public vaccination. It will serve as reference material for researchers, academics, and other interested people.

1.5. Scope of the Study

The research focused on undergraduate students, who make up a large proportion of the country's population.

1.6. Definition of Terms

Vaccine hesitancy: The WHO's Strategic Advisory Group of Experts (SAGE) on Immunization defines vaccine hesitancy as "delay in acceptance or refusal of vaccines despite availability of vaccination services" [16].

Vaccine acceptance: This is defined as the degree to which individuals accept, question, or refuse vaccination [17].

Vaccine uptake: This is the total number of individuals who received a certain vaccination dose or doses [18].

Negative influence: Response that favors vaccination.

Positive influence: Response that disfavors vaccination.

2. Methodology

The study was conducted at the Federal University, Nasarawa State, North Central Zone of Nigeria. The University is a public institution of higher learning established in 2011. It has a total student population of about 35,000 in thirty-two departments across eight faculties. Nasarawa has a tropical wet-and-dry (savanna) climate. The state's average annual temperature is approximately 29.4˚C (84.9˚F). People from different cultural and ethnic backgrounds live there, including the Miligi (Koro), Alago, Mada, Gwandara, Kanuri, Hausa, Fulani, Gbagyi, Rindre, Buh, Afo, Eggon, Tiv, and Ebira. Agriculture is the economy's mainstay. The state's rich and diverse cultural heritage, traditional festivals with colorful dressing, exotic masquerades, and music and dance that people come to see draw tourists. The state is densely populated, which favors the spread of epidemics.

2.1. Study Design

This study used a cross-sectional descriptive design.

2.2. Study Population

The target population was 35,000 undergraduate students from various departments and faculties within the University.

2.3. Sample Size

The sample size for this study was determined using Cochran's formula [19]:

$$n = Z^2\ pq/e^2$$

Where n = desired sample size;

Z = 1.96 (95% confidence level);

p = prevalence estimate of the attitude towards the COVID-19 vaccine (50%).

$q = (1 - p)$;

e = the desired level of precision/confidence interval/margin of error: 5% (0.05 or 0.05).

Hence,

$$n = (1.96)^2 \times 0.5 \times (1 - 0.5) = 384.16(0.05)^2$$

To account for non-response, the sample size increased by 10%, making it 422.

Sampling procedure: The sampling procedure for this study was a multistage sampling technique that involved the following stages;

Stage one (selection of university): The Federal University of Lafia was purposively selected to save time and resources, and because of its unique location in the country.

Stage two (selection of faculty): From the institution's eight [8] faculties, the researchers selected four using simple random sampling to ensure each had an equal chance of inclusion.

Stage three (selection of department): Researchers selected departments using simple random sampling; they wrote each department name from the selected faculties on a piece of paper, folded it, placed it in a box, and shook the box thoroughly. Next, researchers selected two departments from each of the 4 selected faculties, for a total of eight departments for the study.

Stage four (selection of respondents): Researchers interviewed the undergraduate students on the premises of the eight selected departments, without asking whether they belonged to those departments, using convenience sampling for simplicity. Interviewers administered the questionnaire to nearly equal numbers of respondents from each of the eight selected departments.

2.4. Data Collection Instrument

Researchers used a semi-structured, interviewer-administered questionnaire. The questionnaire consisted of an introductory section with ethical considerations (consent form) and was further divided into 5 sections:

Section A covered respondents' socio-demographic characteristics.

Section B covered respondents' knowledge of COVID-19 vaccines.

Section C covered respondents' attitudes toward COVID-19 vaccines.

Section D covered respondents' perceptions of COVID-19 vaccines.

Section E covered factors influencing respondents' acceptance of COVID-19 vaccines.

Reliability and validity of the data collection instrument**:** We pretested the instrument with 10 percent of the total sample size (422) at the nearby University of Agriculture, Makurdi. We administered 42 copies of the survey instrument to 42

randomly selected undergraduate students at the University of Agriculture, Makurdi, to test the instrument's reliability. After 1 to 2 weeks, we pretested the instrument again with the same randomly selected students to observe their responses a second time. Then, we calculated Cronbach's alpha to assess the instrument's reliability before using it in the main study. The Cronbach's alpha value was 0.79. Three experts reviewed the instrument for wording, clarity, and cultural appropriateness to ensure its validity.

2.5. Data Collection

We collected data from respondents using a semi-structured questionnaire in December 2024. We trained three field assistants to support data collection. We administered 422 copies of the questionnaire and took adequate measures to ensure respondents answered each question.

2.6. Data Analysis

We analyzed the data using IBM SPSS version 20. The analysis included frequency distributions, graphical representations, charts, and tables. We used the mean and standard deviation for continuous variables. We used chi-square statistics to test associations between categorical independent and dependent variables.

2.7. Limitations of the Study

This school-based study included only undergraduate students at the Federal University of Lafia and may not represent the general population. Respondents may have recall bias when providing general information, which is common in cross-sectional descriptive studies.

2.8. Ethical Considerations

The Nasarawa State Research Ethics Committee and the State Ministry of Health granted ethical approval. The researchers obtained informed consent from respondents before administering the questionnaire. Participants were advised that participation was voluntary and that they could withdraw at any time without penalty. The study informed participants of confidentiality, nonmaleficence, and beneficence. No identifiers, such as the participant's name or address, were recorded to keep each participant's information confidential.

3. Results

3.1. Socio-Demographic Characteristics of Respondents

Of the 422 questionnaires administered to students, 417 were completed and used for data analysis, yielding a response rate of 98.8%. About half of the respondents were from accounting (17.7%), Economics (14.9%), and Mass Communication (17.5%). Most (66.2%) students were aged 19 - 28 years, the typical university age, followed by 9.6% aged ≤ 18 years and 6.5% older than 28 years. Furthermore, the vast majority (91.4%) of the students were single. The majority were from the 200

and 300 levels. Nevertheless, students from levels 100 to 400 were well represented. More than half of the respondents (226, 54.2%) were female, and (248, 59.5%) were aged 19 - 23 years. Almost all respondents (381; 91.4%) were single. More than half of respondents (232; 56.3%) lived on campus (Table 1).

Table 1. Socio-demographic characteristics of respondents (n = 417).

Characteristic	Frequency	Percentage (%)
Department		
Accounting	74	17.7
Business admin	26	6.2
Economics	62	14.9
Geology	29	7
Mass comm	73	17.5
Med/Surg.	41	9.8
Physics	51	12.2
Physiology	49	11.8
Others	12	2.9
Year of study		
100 level	90	21.6
200 level	155	37.2
300 level	121	29
400 level	51	12.2
Sex		
Male	191	45.8
Female	226	54.2
Age group		
≤18 years	40	9.6
19 - 23 years	248	59.5
24 - 28 years	102	24.5
≥29 years	27	6.5
Marital status		
Married	36	8.6
Single	381	91.4
Residence		
Campus	237	56.8

3.2. Knowledge of COVID-19 Vaccines among the Respondents

Table 2 presents the results on knowledge of COVID-19 vaccines among the students. Almost all respondents (410; 98.3%) reported knowing about COVID-19

vaccines. Less than half (136; 33.2%) reported hearing about COVID-19 vaccines through mass media. Most (343; 83.7%) said there are different types of COVID-19 vaccines. More than half (229; 55.9%) said pregnant women or young adults are not expected to receive the COVID-19 vaccine. Most respondents (284; 72.3%) agreed that COVID-19 vaccines are effective. A larger proportion (359, 87.6%) reported that health facilities can administer COVID-19 vaccines. More than half (239, 58.4%) reported that COVID-19 vaccines do not make someone susceptible to other diseases. Almost half (204, 49.8%) reported that vaccination may lead to adverse reactions. More than half (221, 53.9%) reported that it is false that headaches, fever, injection-site swelling and pain, muscle pain, and diarrhea are side effects of COVID-19 vaccines. Most respondents (254; 62.0%) reported that once fully vaccinated, they may not need to wear a mask in public places.

Table 2. Knowledge of COVID-19 vaccines among respondents.

Characteristic	Frequency	Percentage (%)
Know about COVID-19 vaccines (417)		
Yes	410	98.3
No	5	1.2
Don't know	2	0.5
Source of information about COVID-19 vaccines (410)		
Family	21	5.1
Friends/students	106	25.9
Govt. agencies	6	1.5
HCWs	116	28.3
Mass media	136	33.2
Social media	25	6
Different types of COVID-19 vaccines (410)		
TRUE	343	83.7
FALSE	67	16.3
Pregnant women/young adults expected to take the vaccines (410)		
Yes	141	34.4
No	229	55.9
Don't know	40	9.7
COVID-19 vaccine effectiveness (393)		
Yes	284	72.3
No	68	17.3
Don't know	41	10.4
Where to take the vaccines (n = 410)		
Health facility	359	87.6

Continued

Home	47	11.4
Others	4	1
COVID-19 vaccines make someone susceptible to other diseases (n = 409)		
Yes	106	26
No	239	58.4
Don't know	64	15.6
Vaccination increases allergic reactions (n = 410)		
Yes	204	49.8
No	114	27.8
Don't know	92	22.4
Headache, fever, injection site swelling and muscle pain diarrhea is a side effects of COVID-19 vaccines (n = 410)		
TRUE	189	46.1
FALSE	221	53.9
Once fully vaccinated against COVID-19, there may be no need to wear a mask in public places (n = 410)		
TRUE	254	62
FALSE	156	38

3.3. Attitudes of Undergraduate Students towards COVID-19 Vaccines (Table 3)

Most respondents (299; 71.9%) reported not having received COVID-19 vaccines at the time of the study. Of those who reported receiving the vaccines (100; 85.5%), they had received only the first dose. A greater proportion (295, 71.8%) agreed that COVID-19 vaccines are safe to receive. Less than half (154, 37.5%) agreed that vaccination cannot reduce the incidence of COVID-19 disease. Less than half (191, 46.0%) disagreed that they will not receive COVID-19 vaccines. Most respondents (295, 71.4%) agreed they will encourage their course mates and colleagues to get vaccinated against COVID-19.

Table 3. Attitude of respondents toward COVID-19.

Variables	Frequency	Percentage (%)
Taken COVID-19 vaccine (n = 416)		
Yes	117	28.1
No	299	71.9
Number of doses (n = 117)		
First dose	100	85.5
Both doses	17	14.5
COVID-19 vaccines are safe (n = 411)		

Continued

Agree	295	71.8
Disagree	33	8
Undecided	83	20.2
Not possible to reduce incidence of COVID-19 diseases without vaccination (n = 411)		
Agree	154	37.5
Disagree	122	29.7
Undecided	135	32.8
Will take COVID vaccination without any hesitation (n = 415)		
Agree	158	38.1
Disagree	191	46
Undecided	66	15.9
Will encourage my course mates/colleagues to get vaccinated (n = 413)		
Agree	295	71.4
Disagree	40	9.7
Undecided	78	18.9
Others	4	1
COVID-19 vaccines make someone susceptible to other diseases (n = 409)		
Yes	106	26
No	239	58.4
Don't know	64	15.6
Vaccination increases allergic reactions (n = 410)		
Yes	204	49.8
No	114	27.8
Don't know	92	22.4
Headache, fever, injection site swelling and muscle pain diarrhea is a side effects of COVID-19 vaccines (n = 410)		
TRUE	189	46.1
FALSE	221	53.9
Once fully vaccinated against COVID-19, there may be no need to wear a mask in public places (n = 410)		
TRUE	254	62
FALSE	156	38

3.4. Perception of COVID-19 Vaccines among the Respondents (Table 4)

Most respondents (334, 81.1%) believed that if everyone maintains preventive measures, the COVID-19 pandemic can be eradicated without vaccination. Half of the respondents (206; 50.6%) believe COVID-19 vaccines have adverse effects.

When asked which population or group should be prioritized for COVID-19 vaccination, more than half (265; 65.1%) indicated that the public should be prioritized. Most of the respondents (297; 72.8%) feel COVID-19 vaccines should be free. Fewer than half (185; 45.7%) believe the COVID-19 vaccine is being promoted to reduce the population. More than half of respondents (237; 57.5%) disagreed that pharmaceutical companies promote the COVID-19 vaccine for financial reasons.

Table 4. Perception of COVID-19 vaccines among respondents.

Variables	Frequency	Percentage
Do you think the COVID-19 pandemic can be eradicated without vaccination if everyone maintains preventive measures? (n = 412)		
Yes	334	81.1
No	44	10.6
Don't know	34	8.3
Do you think COVID-19 vaccines have adverse side effects? (n = 407)		
Yes	206	50.6
No	176	43.2
Don't know	25	6.2
Which population groups should be prioritized for vaccination? (n = 407)		
Children	9	2.2
Elderly	19	4.7
General public	265	65.1
Health workers	92	22.6
Students	22	5.4
Do you feel COVID-19 vaccines should be free? (n = 408)		
Yes	297	72.8
No	91	22.3
Don't know	20	4.9
Do you think the COVID-19 vaccine is being promoted to reduce the population? (n = 405)		
Yes	150	37
No	185	45.7
Don't know	70	17.3
Do you think the COVID-19 vaccine is being promoted for the commercial gain of pharmaceutical companies? (n = 412)		
Agree	123	29.9
Disagree	237	57.5
Undecided	52	12.6

3.5. Determination of Factors That Influence COVID-19 Vaccine Acceptance and Uptake among Respondents

Table 5 shows that most of the respondents (323; 79.2%) reported that peer pressure can affect the uptake of COVID-19 vaccines. Less than half (168; 42.2%) reported a general mistrust of vaccine efficacy. Most respondents (254; 64.0%) reported that their beliefs, society, and religion affect their decision to get vaccinated. More than half (235; 58.5%) reported worries about unforeseen effects of the COVID-19 vaccines. Many respondents (332; 81.2%) reported that what they saw and read on social and mass media influenced their decision to get the COVID-19 vaccine.

Table 5. Factors that influence COVID-19 vaccine acceptance among respondents.

Variables	Frequency	Percentage (%)
Peer pressure affecting COVID-19 vaccine acceptance? (n = 408)		
Yes	323	79.2
No	57	14
Don't know	28	6.8
General mistrust of vaccine efficacy (n = 398)		
Yes	168	42.2
No	160	40.2
Don't know	70	17.6
Belief, society & religion affecting decisions to take COVID-19 vaccines (n = 397)		
Yes	254	64
No	104	26.2
Don't know	39	9.8
Worries about unforeseen effects of the COVID-19 vaccine (n = 402)		
Yes	235	58.5
No	144	35.8
Don't know	23	5.7
Information on social/mass media influences your uptake of COVID-19 vaccine (n = 409)		
Yes	332	81.2
No	55	13.4
Don't know	22	5.4

3.6. Level of Influence of Factors Affecting COVID-19 Vaccine Uptake among Respondents

Table 6 shows the findings on the influencing factors: [1] peer pressure; [2] general mistrust of vaccines; [3] beliefs, society, and religion; [4] unforeseen effects of COVID-19 vaccines; and [5] information on social and mass media. Many (213, 52.9%) responded negatively (negative influence), while (190, 47.1%) responded

positively (positive influence). Furthermore, when we cross-tabulated the influencing factors regarding COVID-19 vaccine uptake with attitude and perception using the Chi-square test, the variables showed statistically significant associations ($\chi^2 = 368.516$, df = 1, p = 0.001; $\chi^2 = 357.704$, df = 1, p = 0.001). This indicates that these factors positively influence vaccine uptake (Table 6). Therefore, we rejected the null hypothesis.

Table 6. Association between influencing factors and attitude/perception regarding the COVID-19 vaccine among respondents.

		Attitude			Perception		
Influence	n (%)	χ^2	df	p-value	χ^2	df	p-value
Positive	190 (47.1)	357.704	1	0.001*	368.516	1	0.001*
Negative	213 (52.9)						

Note: *Significance level < 0.05.

$H0_1$: Socio-demographic variables are not statistically associated with respondents' knowledge, attitudes, and perceptions of COVID-19 vaccines.

We tested the association between socio-demographic factors and knowledge, attitude, and perception of COVID-19 vaccines using the Chi-square test of independence, as shown in Table 7. Socio-demographic factors such as age, source of information, year of study, marital status, and residence were significantly associated with knowledge, attitude, and perception of COVID-19 vaccines among students at the 0.05 significance level. Therefore, we rejected the null hypothesis. However, respondents' sex was not significantly associated with knowledge, attitude, and perception of COVID-19 vaccines among undergraduate students (p = 0.108). Therefore, we failed to reject the null hypothesis.

Table 7. Association between socio-demographic variables and knowledge, attitude, and perception of COVID-19 vaccines among respondents.

Socio-demographic	χ^2	df	p-value	χ^2	df	p-value	χ^2	df	p-value
Sex	212.878	2	0.103	371.812	1	0.067	361.089	1	0.108
Age	404.486	6	0.001*	183.995	3	0.001*	187.801	3	0.001*
Source of Information	400.471	10	0.001*	297.405	5	0.001*	299.825	5	0.001*
Year of study	409.725	6	0.001*	283.913	3	0.001*	289.378	3	0.001*
Marital status	23.495	2	0.001*	41.036	1	0.001*	39.852	1	0.001*
Residence of students	319.853	4	0.001*	302.528	2	0.001*	311.515	2	0.001*

Note: *Significance level < 0.05.

H02: Socio-demographic variables are not statistically associated with respondents' acceptance of COVID-19 vaccines.

We used the Chi-square test to assess the association between respondents' socio-demographic characteristics and acceptance of COVID-19 vaccines at a 0.05

significance level, as shown in Table 8. The results showed that age, source of information, marital status, and residence were significantly associated with COVID-19 vaccine acceptance. Therefore, we rejected the null hypothesis. In contrast, sex is not statistically associated with COVID-19 vaccine acceptance; therefore, we failed to reject the null hypothesis.

Table 8. Association between socio-demographic variables and COVID-19 vaccine acceptance among respondents.

Variables	N	χ^2	df	p-value
Knowledge/vaccine hesitancy	403	256.656	2	0.001*
Attitude/vaccine hesitancy	403	357.704	1	0.001*
Perception/vaccine hesitancy	403	368.516	1	0.001*

Note: *Significance level < 0.05.

H03: Knowledge, attitude, and perception of COVID-19 vaccines are not statistically associated with vaccine hesitancy among respondents.

We tested the association between knowledge, attitude, and perception of COVID-19 vaccines and vaccine hesitancy among respondents using Chi-square statistics at a 0.05 significance level, as shown in Table 9. The test results showed that there was a statistically significant association between the tested variables (knowledge/vaccine hesitancy: $\chi^2 = 256.656$, df = 2, p = 0.001; attitude/vaccine hesitancy: $\chi^2 = 357.704$, df = 1, p = 0.001; perception/vaccine hesitancy: $\chi^2 = 368.516$, df = 1, p = 0.001). Therefore, we rejected the null hypothesis.

Table 9. Association between knowledge, attitude, and perception of COVID-19 vaccines and vaccine hesitancy among respondents.

Variables	N	χ^2	df	p-value
Knowledge/vaccine hesitancy	403	256.656	2	0.001*
Attitude/vaccine hesitancy	403	357.704	1	0.001*
Perception/vaccine hesitancy	403	368.516	1	0.001*

Note: *Significance level < 0.05.

4. Discussion

Most students were aged 19 - 28 years, the typical university age, followed by 9.6% aged ≤ 18 years and 6.5% older than 28 years, as shown in Table 1. Furthermore, the vast majority (91.4%) of the students were single. Most were in the 200 (37.2%) and 300 (29.0%) level courses. This is comparable to the age groups involved in a COVID-19-related study among Kurdistan University undergraduates [20]. Most respondents reported knowing about the COVID-19 vaccine (98.3%), the different vaccine types (83.7%), and their effectiveness (72.3%), as shown in Table 2. More than half of respondents demonstrated good knowledge, indicating they understand the vaccines. More than half of respondents demonstrated good

knowledge, indicating they understand the vaccines, unlike the findings by Obarisiagbon and Mokogwu [21]. However, this report corroborates Adetayo et al. [22], who conducted an anonymous online survey among Nigerian students and reported a good level of knowledge. However, fewer than half (34.4%) knew that pregnant women are also expected to be vaccinated, that COVID-19 vaccines have side effects (46.1%), and that fully vaccinated people also need to wear face masks (38.0%). They also reported that knowledge of COVID-19 vaccines is related to intent to vaccinate and concluded that students' knowledge and attitudes toward vaccines are essential for acceptance. However, the present study's results differed from those of a study conducted in Bangladesh, which reported 40% good knowledge, 44% fair knowledge, and 16% poor knowledge among participants. In contrast, the present study's results also disagree with a study of 400 traders in Benin City, Edo State, Nigeria [21]. They reported that 30% of respondents had good knowledge of COVID-19, and 375 (93.8%) had poor knowledge of the COVID-19 vaccine. This variation may indicate that most traders in the study were either illiterate or never saw the need to learn basic information about COVID-19 vaccines. However, undergraduate students were educated and had basic knowledge of the vaccines, as reflected in the knowledge results reported in the present study.

Regarding attitudes toward COVID-19 vaccines (**Table 3**), about half (50.6%) of respondents reported negative attitudes toward accepting or agreeing to be vaccinated. About 71.9% of respondents had never received a COVID-19 vaccine available at the time of the study, which means about 28.1% were vaccinated. The acceptance rate is higher than that recorded in two selected southwestern Nigerian Universities by Adetayo [22]. However, both studies attributed negative attitudes to similar reasons, mostly general mistrust. In Adetayo's study [22], negative attitudes were also linked to worries about unanticipated effects, a preference for natural immunity, widespread distrust of vaccine benefits, and concerns about commercial profiteering. The current study's findings did not align with James's study results from southeastern Nigeria, which revealed mostly positive attitudes among participants [23].

Regarding perceptions of COVID-19 vaccines (**Table 4**), most (81.1%) believed vaccination could eradicate COVID-19. Some (37.0%) believed COVID-19 vaccines are meant to reduce the human population, while others (29.9%) thought they were mainly for commercial gains. These perceptions are largely negative. On the other hand, about half (50.6%) thought COVID-19 vaccines have side effects. Many (65.1%) thought the general population should be prioritized equally, rather than one group over another, and that the vaccine should be given free of charge (72.8%). These are positive perceptions of COVID-19 vaccines. This suggests that some respondents have poor perceptions of COVID-19 vaccines. An assessment of the association between influencing factors and attitude/perception regarding the COVID-19 vaccine among respondents showed that 47.1% of the factors had a positive influence, while the remaining 52.9% of factors had a nega-

tive influence, as shown in Table 6. This finding aligns with James's study in southeastern Nigeria, which reported that 53.0% of respondents had poor perceptions of COVID-19 vaccines [23]. James also reported that age, education, gender, and marital status were associated with vaccine acceptance [$p < 0.05$], which aligns with the present study's findings except for gender. The present study found different results for the association between gender and perception than James *et al.* [23]. Furthermore, the present study agrees with Islam *et al.* among the general population of Bangladesh, who reported that 95% of respondents believed COVID-19 vaccines should be administered free of charge, and almost 90% believed that the COVID-19 vaccines used in Bangladesh may have side effects [24]. The present study reported that 72.8% of respondents felt COVID-19 vaccines should be free, while 50.6% felt adverse side effects would arise from taking the vaccines.

Factors That Influence COVID-19 Vaccine Acceptance among the Respondents

The respondents admitted that the factors that influence their acceptance of the COVID-19 vaccines include peer pressure (79.2%), general mistrust of the vaccines (42.2%), belief, society, and religion (64.0%), worries about unforeseen effects of the vaccines (58.5%), and information on social media (86.2%), as shown in Table 5. Over half of respondents (52.9%) reported that these factors strongly influenced their low acceptance and uptake of COVID-19 vaccines, as shown in Table 6. This result aligns with findings from three studies in Nigeria [health workers], Egypt [university students], and China (parents of COVID-19 vaccine-eligible children) [25]-[27].

Assessment of the association between socio-demographic variables and respondents' knowledge, attitudes, and perceptions of COVID-19 vaccines revealed associations for all variables except sex (p-value > 0.05), as shown in Table 7. Socio-demographic variables were also associated with COVID-19 vaccine acceptance, except for sex (Table 8). Compared with Katelyn *et al.* in the US, women may have been more reluctant than men to receive the vaccine early in the pandemic, but this may not have translated into actual behavior or attitude. Gender-sensitive public health initiatives may allay vaccine concerns, and even more so when individuals are taken into consideration [28]. Socio-demographic factors were also significantly associated with knowledge, attitudes, perceptions, and vaccine hesitancy (Table 9). This aligns with a study, "Vaccine hesitancy' among university students in Italy during the COVID-19 pandemic," which examined intentions to prevent COVID-19 and evaluated the impact of university curricula [healthcare vs. non-healthcare curricula] on intention to vaccinate. The results also agree with a study by Kelekar *et al.* [29], who assessed immunization behavior, attitudes toward, and perceived acceptance of the COVID-19 vaccine among US medical and dental students. Their study reported that students were significantly more likely to accept COVID-19 vaccination. Educated individuals were

significantly more likely to be vaccinated, underscoring education's role in shaping vaccine access and acceptance, agreeing with a study in Tanzania among communities [30].

5. Conclusion

The results revealed high knowledge of the COVID-19 vaccine among respondents, most likely due to their educational status, highlighting education's influence on vaccine acceptance and access. Negative attitudes and perceptions hindered acceptance and uptake among undergraduates in the study area. Sociodemographic disparities are an important factor to consider in COVID-19 vaccination. Thus, the study recommends more vaccine sensitization programs at the University, using various media channels, to encourage students to receive the COVID-19 vaccine. Recommendations include ongoing sensitization programs on the importance of vaccination among university students, supported by the government and other stakeholders, to increase uptake. The government should always support students at all levels, not just during mass vaccination exercises. The government should set up centers in universities to assess students' general health before administering the COVID-19 vaccine, to minimize post-vaccine side effects that may result from underlying health conditions. Collection centers should consistently stock needed vaccines to make them easy for students to access. Healthcare workers should encourage students to get vaccinated by treating everyone with the utmost respect. Mass and social media should share accurate information about all needed vaccines, including the COVID-19 vaccine, to increase acceptance and uptake.

Conflicts of Interest

The authors declare no conflicts of interest.

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