

COVID-19 Vaccination Coverage and its Associated Factors Among Healthcare Students at a Nigerian University

Ismail Tajudeen Hamza

ismailthamza01@gmail.com

Usmanu Danfodiyo University

Amir Yahaya

Usmanu Danfodiyo University

Ibrahim Anas Muhammad

Usmanu Danfodiyo University

Ibrahim Abubakar Sadeeq

Usmanu Danfodiyo University

Suleiman Abdullahi SarkinFulani

Usmanu Danfodiyo University

Abdulsalam Bello

Usmanu Danfodiyo University

Alhassan Ibrahim Mohammed

Usmanu Danfodiyo University

Adeyemi Sallam Febilola

Usmanu Danfodiyo University

Ahmad Onikoko Abdulgafar

Usmanu Danfodiyo University

Jubril Aminullahi Faki

Usmanu Danfodiyo University

Fuhad Olalekan Suleiman

Usmanu Danfodiyo University

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Abstract

Background

Healthcare students are a priority group for COVID-19 vaccination due to occupational exposure during clinical training, yet uptake remains suboptimal in Nigerian universities. This study assessed vaccination coverage, motivators, barriers, and predictors of uptake among health science students at Usmanu Danfodiyo University, Sokoto.

Methods

A cross-sectional study was conducted among undergraduate health science students recruited via stratified random sampling. Data were collected using a pretested, structured, self-administered online questionnaire. The primary outcome was receipt of at least one dose of a COVID-19 vaccine. Bivariate associations were examined using chi-square tests, and independent predictors of vaccination uptake were identified through binary logistic regression. Statistical significance was set at $p < 0.05$.

Results

A total 408 students participated, and only 67 (16.4%) had been vaccinated. The leading motivator was personal health protection (71.2%). Major barriers included lack of access (29.0%), vaccine distrust (21.3%), and perceived non-necessity (20.7%). In bivariate analysis, gender, age group, religion, and type of residence were significantly associated with vaccination uptake ($p < 0.05$). After multivariable adjustment, only type residence predicted vaccination: hostel residents (aOR = 4.69; 95% CI: 1.52–14.52) and off-campus residents (aOR = 7.77; 95% CI: 2.43–24.83) had significantly higher odds than students living with family. The model demonstrated adequate fit (Hosmer-Lemeshow $p = 0.249$; Nagelkerke $R^2 = 0.187$).

Conclusions

COVID-19 vaccination coverage among these healthcare students is critically low, with residence type as the strongest independent predictor. On-campus vaccination services, institutional mandates, and peer-led education addressing access and distrust are urgently needed.

INTRODUCTION

The global COVID-19 pandemic caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has resulted in over 779 million confirmed cases and more than 7 million deaths since its emergence. [1] In Nigeria, the outbreak placed enormous strain on a fragile health system, with healthcare workers (HCWs) disproportionately affected due to their frequent contact with infected patients and

contaminated materials. [2] Vaccination remains the most effective public health measure to reduce severe illness, hospitalization, and death from COVID-19. [3] In response, the World Health Organization (WHO) Strategic Advisory Group of Experts on Immunization (SAGE) has prioritized the vaccination of high-risk groups, including health workers and trainees, in its strategic preparedness and response plan for 2023–2025. [4]

Healthcare students represent a uniquely important subgroup in the vaccination effort. During their training, they are regularly exposed to clinical environments through hospital postings, laboratory sessions, and patient care activities, placing them at elevated occupational risk of SARS-CoV-2 infection. [5, 6] Because they rotate between hospital wards and educational settings, under-vaccinated students can also act as vectors for nosocomial transmission, endangering vulnerable patients. [7] Despite these risks, global studies have documented persistently high levels of COVID-19 vaccine hesitancy among healthcare students. A systematic review and meta-analysis estimated that approximately one in five healthcare students worldwide were unwilling to receive a COVID-19 vaccine. [8] Similar trends have been reported in sub-Saharan Africa, where concerns about vaccine safety, efficacy, and misinformation have driven hesitancy. [9, 10]

In Nigeria, COVID-19 vaccine uptake among university students remains suboptimal. Several studies have found that less than 30% of students had received at least one vaccine dose, with major barriers including lack of access, fear of adverse effects, distrust of the vaccine, and the perception that the disease is not severe. [11, 12] Healthcare students in northern Nigerian universities may face additional challenges, such as limited access to vaccination services, inadequate institutional policies, and the influence of socio-cultural norms. [13] While data on vaccination coverage and determinants exist for practicing HCWs in Sokoto and surrounding areas, there is a paucity of institution-specific evidence on COVID-19 vaccination among health science students at Usmanu Danfodiyo University, Sokoto (UDUS); one of the largest training institutions for health professionals in northwestern Nigeria.

Without local data, university health services and faculty administrators are unable to identify specific barriers, design targeted education campaigns, or implement evidence-based policies to protect students. Given that these students are the future frontline healthcare workforce, understanding their vaccination coverage, motivators, barriers, and occupational risk perceptions is essential for developing effective public health strategies. This study therefore aimed to assess COVID-19 vaccination coverage, identify factors associated with uptake, and explore motivators and barriers among health science students at UDUS, Sokoto.

METHODS

Study Design and Setting

This cross-sectional study was conducted at Usmanu Danfodiyo University, Sokoto (UDUS), a federal university located in Sokoto State, North-Western Nigeria. The university offers several health-related

undergraduate programmes, including Medicine (MBBS), Nursing, Pharmacy, Medical Laboratory Science (MLS), Radiography, Physiotherapy, Optometry, and Veterinary Medicine. Clinical and laboratory training for students takes place primarily at the Usmanu Danfodiyo University Teaching Hospital (UDUTH) and affiliated healthcare facilities.

Study Population and Sampling

The target population comprised all undergraduate students enrolled in the aforementioned health science programmes who were present on campus during the data collection period. Post-graduate students, students from non-health faculties, and those on leave or external clinical attachment were excluded.

The minimum sample size was calculated using the Cochran formula for a single proportion: $n = Z^2p(1 - p)/d^2$, where $Z = 1.96$ (95% confidence level), $p = 0.50$ (maximum variability, as no prior estimate was available for this population), and $d = 0.05$ (acceptable margin of error). This gave an initial requirement of 384 participants. After adjusting for a 10% non-response rate, the target sample was 427.

A stratified random sampling technique was employed. Students were stratified by department and level of study. Within each stratum, participants were selected proportionally to the stratum size using simple random sampling. A total of 408 students were ultimately recruited.

Data Collection

Data were collected using a structured, self-administered questionnaire adapted from validated instruments used in similar studies. The questionnaire was pretested among 20 health science students at a neighboring university to assess clarity and face validity; ambiguous items were revised accordingly.

The final questionnaire comprised four sections relevant to this analysis: (A) socio-demographic characteristics (age, gender, religion, department, level of study, type of residence, clinical posting status); (B) COVID-19 vaccination status (receipt of vaccine, number of doses, vaccine type, vaccination site, motivators for acceptance, and barriers to non-acceptance); (C) occupational exposure risk (history of needle-stick or sharps injury, contact with blood/body fluids, glove use, awareness of infection control, perceived risk of COVID-19, availability of personal protective equipment, and infection control training); and (D) barriers and motivators rated on a four-point Likert scale or through multiple-response checklists.

The survey was administered online using Kobotoolbox over a twelve-week period. The link was distributed via departmental WhatsApp groups and with the assistance of class representatives. The questionnaire was configured to accept only one response per device, and the first page contained the informed consent form; only those who provided consent could proceed.

Variables

The primary outcome was COVID-19 vaccination uptake, defined as having received at least one dose of a COVID-19 vaccine (yes/no). Independent variables included age (continuous, subsequently categorized into ≤ 20 , 21–23, 24–25, and ≥ 26 years for bivariate analysis), gender (male/female), religion (Islam/Christianity), department, level of study (100–600), type of residence (hostel, off-campus, with family), and commencement of clinical posting (yes/no).

Statistical Analysis

Data were cleaned in Microsoft Excel and analyzed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as frequencies, percentages, means, and standard deviations. Bivariate associations between categorical predictors and vaccination uptake were tested with Pearson's chi-square test. Binary logistic regression was performed to identify independent predictors of vaccination uptake. The Hosmer-Lemeshow test was used to assess model goodness-of-fit, and Nagelkerke R^2 was calculated. All tests were two-tailed, and statistical significance was set at $p < 0.05$.

RESULTS

Sociodemographic Characteristics

A total of 408 health science students participated in this study. The mean age of participants was 22.38 ± 2.93 years. The sociodemographic characteristics of the study population are presented in Table 1. Most respondents were male (57.4%) and of the Islamic faith (83.8%). MBBS students constituted the largest departmental group (27.9%), followed by Pharmacy (18.9%) and Medical Laboratory Science (MLS) (16.2%). More than a quarter of participants were in the 500 level of study (27.0%), and about half resided in hostels (49.5%). Approximately half (52.0%) had commenced clinical hospital postings.

Table 1
Sociodemographic characteristics of the study
participants (N = 408)

Variables	Frequency	Percent (%)
Continuous variables		
Age (years), Mean $\pm$ SD	22.38 $\pm$ 2.93	—
Categorical variables		
Gender		
Female	174	42.6
Male	234	57.4
Department		
MBBS	114	27.9
MLS	66	16.2
Nursing	51	12.5
Optometry	16	3.9
Pharmacy	77	18.9
Physiotherapy	35	8.6
Radiography	25	6.1
Veterinary Medicine	24	5.9
Level of study		
100 level	81	19.9
200 level	52	12.7
300 level	71	17.4
400 level	72	17.6
500 level	110	27.0
600 level	22	5.4
Religion		
Christianity	66	16.2
Islam	342	83.8
Residence		

Variables	Frequency	Percent (%)
Continuous variables		
Hostel	202	49.5
Off-campus	115	28.2
With family	91	22.3
Clinical posting status		
No	196	48.0
Yes	212	52.0

SD = Standard Deviation

COVID-19 Vaccination Coverage

Of the 408 participants, 67 (16.4%) reported having received at least one dose of a COVID-19 vaccine, while 341 (83.6%) had never been vaccinated.

Motivators for COVID-19 Vaccination

Among the vaccinated students (n = 66 who provided motivator data), personal health protection was the most frequently cited reason for vaccination (71.2%). Other motivators included peer/family influence (25.8%), public/media campaigns (13.6%), requirement for clinical posting (9.1%), institutional policy (7.6%), and trust in WHO/government (7.6%) (Fig. 1).

Barriers to COVID-19 Vaccination

The most commonly reported barrier was lack of access to vaccines (29.0%), followed by distrust of the vaccine (21.3%), and the perception that vaccination was unnecessary (20.7%). Fear of side effects was cited by 19.8% of respondents, while 14.8% were waiting for more evidence on vaccine safety and effectiveness. Religious or cultural concerns were the least reported barrier (1.8%) (Fig. 2).

Willingness to Receive Future COVID-19 Vaccination

Among the 341 unvaccinated students, 54 (15.8%) indicated willingness to receive the COVID-19 vaccine in the future, 9 (2.6%) were unsure, and 3 (0.9%) expressed unwillingness. The remaining 275 unvaccinated students did not respond to this item.

Factors Associated with COVID-19 Vaccination Uptake

Bivariate analysis

The results of the chi-square tests are displayed in Table 2. Gender, age group, religion, and type of residence were significantly associated with vaccination uptake. Male students had a higher vaccination rate (20.5%) compared to female students (10.9%) ($\chi^2 = 6.692$, $p = 0.010$). Vaccination uptake increased with age group, from 11.0% among those aged ≤ 20 years to 23.1% among those aged 26 years and above ($\chi^2 = 8.005$, $p = 0.046$). Muslim respondents were more frequently vaccinated (18.1%) than Christian respondents (7.6%) ($\chi^2 = 4.489$, $p = 0.034$). Residence type showed the strongest association: only 4.4% of students living with family were vaccinated, compared with 17.3% of hostel residents and 24.3% of those living off-campus ($\chi^2 = 14.974$, $p = 0.001$) (Fig. 3). Department, clinical posting status, and level of study were not significantly associated with vaccination uptake ($p > 0.05$).

Table 2
Bivariate associations between sociodemographic factors and COVID-19 vaccination uptake

Variable	Vaccinated n (%)	Unvaccinated n (%)	Total n (%)	χ^2	df	p-value
Gender				6.692	1	.010*
Female	19 (10.9%)	155 (89.1%)	174 (100.0%)			
Male	48 (20.5%)	186 (79.5%)	234 (100.0%)			
Age group				8.005	3	.046*
≤ 20	13 (11.0%)	105 (89.0%)	118 (100.0%)			
21–23	10 (11.6%)	76 (88.4%)	86 (100.0%)			
24–25	32 (21.1%)	120 (78.9%)	152 (100.0%)			
26+	12 (23.1%)	40 (76.9%)	52 (100.0%)			
Religion				4.489	1	.034*
Christianity	5 (7.6%)	61 (92.4%)	66 (100.0%)			
Islam	62 (18.1%)	280 (81.9%)	342 (100.0%)			
Department				6.273	7	.508
MBBS	19 (16.7%)	95 (83.3%)	114 (100.0%)			
MLS	11 (16.7%)	55 (83.3%)	66 (100.0%)			
Nursing	12 (23.5%)	39 (76.5%)	51 (100.0%)			
Optometry	4 (25.0%)	12 (75.0%)	16 (100.0%)			
Pharmacy	7 (9.1%)	70 (90.9%)	77 (100.0%)			
Physiotherapy	6 (17.1%)	29 (82.9%)	35 (100.0%)			
Radiography	5 (20.0%)	20 (80.0%)	25 (100.0%)			

Variable	Vaccinated n (%)	Unvaccinated n (%)	Total n (%)	χ^2	df	p-value
Veterinary Medicine	3 (12.5%)	21 (87.5%)	24 (100.0%)			
Residence				14.974	2	.001*
Hostel	35 (17.3%)	167 (82.7%)	202 (100.0%)			
Off-campus	28 (24.3%)	87 (75.7%)	115 (100.0%)			
With family	4 (4.4%)	87 (95.6%)	91 (100.0%)			
Clinical posting status				0.726	1	.394
No	29 (14.8%)	167 (85.2%)	196 (100.0%)			
Yes	38 (17.9%)	174 (82.1%)	212 (100.0%)			
Level of study				6.262	5	.282
100 level	13 (16.0%)	68 (84.0%)	81 (100.0%)			
200 level	9 (17.3%)	43 (82.7%)	52 (100.0%)			
300 level	12 (16.9%)	59 (83.1%)	71 (100.0%)			
400 level	7 (9.7%)	65 (90.3%)	72 (100.0%)			
500 level	19 (17.3%)	91 (82.7%)	110 (100.0%)			
600 level	7 (31.8%)	15 (68.2%)	22 (100.0%)			

Significant at $p < 0.05$.

Multivariable logistic regression

The results of the binary logistic regression are presented in Table 3 and illustrated as a forest plot in Fig. 4. After adjusting for all covariates, type of residence remained the only independent predictor of COVID-19 vaccination uptake. Compared with students living with family, those residing in hostels had 4.69 times higher odds of being vaccinated (aOR = 4.69, 95% CI: 1.52–14.52, $p = 0.007$), while students

living off-campus had 7.77 times higher odds (aOR = 7.77, 95% CI: 2.43–24.83, $p = 0.001$). Gender, religion, department, level of study, age, and clinical posting status were not statistically significant predictors in the adjusted model. The Hosmer-Lemeshow goodness-of-fit test indicated that the model adequately fit the data ($\chi^2 = 10.26$, $p = 0.249$), and the Nagelkerke R^2 was 0.187.

Table 3
Binary logistic regression model predicting COVID-19 vaccination uptake

Variables	cOR [95% CI]	P-value	aOR [95% CI]	P-value
Age	1.13 [1.03–1.24]	0.009*	1.09 [0.96–1.25]	0.197
Gender				
Female (R)	–	–	–	–
Male	2.11 [1.19–3.73]	0.011*	1.86 [0.97–3.58]	0.063
Religion				
Islam (R)	–	–	–	–
Christianity	0.37 [0.14–0.96]	0.041*	0.39 [0.14–1.11]	0.077
Department		0.538		0.178
MBBS (R)	–	–	–	–
MLS	1.00 [0.44–2.26]	1.000	1.96 [0.67–5.79]	0.222
Nursing	1.54 [0.68–3.47]	0.299	4.03 [1.27–12.80]	0.018*
Optometry	1.67 [0.49–5.73]	0.417	2.61 [0.57–11.91]	0.217
Pharmacy	0.50 [0.20–1.26]	0.140	0.82 [0.25–2.68]	0.744
Physiotherapy	1.03 [0.38–2.83]	0.947	1.98 [0.50–7.89]	0.332
Radiography	1.25 [0.42–3.74]	0.690	2.43 [0.72–8.20]	0.151
Veterinary Medicine	0.71 [0.19–2.64]	0.614	0.45 [0.10–1.99]	0.291
Residence		0.002*		0.002*
With family (R)	–	–	–	–
Hostel	4.56 [1.57–13.24]	0.005*	4.69 [1.52–14.52]	0.007*
Off-campus	7.00 [2.36–20.80]	< 0.001*	7.77 [2.43–24.83]	0.001*
Clinical posting				
No (R)	–	–	–	–
Yes	1.26 [0.74–2.13]	0.395	0.76 [0.27–2.15]	0.598
Level		0.316		0.166
100 (R)	–	–	–	–
200	1.10 [0.43–2.78]	0.849	0.97 [0.29–3.23]	0.956
300	1.06 [0.45–2.51]	0.888	0.57 [0.16–2.06]	0.392

Variables	cOR [95% CI]	P-value	aOR [95% CI]	P-value
400	0.56 [0.21–1.50]	0.251	0.54 [0.14–2.10]	0.371
500	1.09 [0.51–2.36]	0.823	1.17 [0.32–4.26]	0.818
600	2.44 [0.83–7.16]	0.104	3.40 [0.60–19.39]	0.168

* Statistically significant ($p \leq 0.05$); R = reference category; cOR = crude odds ratio; aOR = adjusted odds ratio; 95% CI = 95% confidence interval. Hosmer-Lemeshow test $p = 0.249$; Nagelkerke $R^2 = 0.187$.

DISCUSSION

This study found a very low COVID-19 vaccination coverage (16.4%) among health science students at Usmanu Danfodiyo University, Sokoto, with only 67 out of 408 participants having received at least one dose. The coverage is considerably lower than the 61.9% pooled prevalence reported in a global meta-analysis of medical students [14] and far below the Nigerian national target of 70% set for the end of 2022. The figure is, however, consistent with other campus-based surveys in Nigeria, where uptake among university students has ranged from 9.7% to 25%. [9, 15] The low uptake underscores the urgent need for targeted interventions in this vulnerable population of future healthcare professionals.

Personal health protection was the dominant motivator (71.2%), mirroring findings among healthcare students elsewhere. [16, 17] This suggests that self-preservation rather than external mandates drives vaccine acceptance in this group. Only 9.1% cited a requirement for clinical posting, implying that institutional policies were not routinely enforced. Given that over half of the participants had commenced clinical postings, incorporating vaccination as a mandatory requirement while ensuring free access could substantially improve coverage.

Lack of access (29.0%) was the most frequently cited barrier, followed by distrust of the vaccine (21.3%) and the belief that vaccination was unnecessary (20.7%). Fear of side effects (19.8%) and waiting for more evidence (14.8%) were also prominent. This pattern aligns with findings from multi-institutional studies across Nigeria. [10, 12] and reflects broader regional challenges, including vaccine distribution bottlenecks, misinformation on social media, and weak health system trust. Importantly, religious or cultural concerns were negligible (1.8%), indicating that faith-based barriers were not a major driver of hesitancy in this predominantly Muslim population. The prominence of “lack of access” as a barrier suggests that bringing vaccination services onto campus could rapidly close the coverage gap.

In bivariate analysis, male sex, older age, and Muslim religion were significantly associated with vaccination, consistent with some previous reports. [11, 13] However, after adjusting for covariates, only type of residence remained an independent predictor. Students living in hostels or off-campus had approximately five to eight times higher odds of being vaccinated compared with those residing with family. This striking finding has plausible explanations: hostel and off-campus students may have greater peer influence, easier access to vaccination centres, and more autonomy over health decisions,

whereas students living with family may face parental vaccine hesitancy or mobility restrictions. This is consistent with research showing that peer norms and living arrangements strongly shape health behaviors among university students. [18] Additionally, the nursing department emerged as a significant predictor in the adjusted model, with nursing students having over four times the odds of vaccination compared with MBBS students. This may reflect stronger emphasis on occupational health and infection control in nursing curricula or departmental vaccination drives.

The lack of independent effect of gender, age, and clinical posting status suggests that their bivariate associations were confounded by residence. For example, older students and males were more likely to live in hostels or off-campus, which could explain the apparent differences. The non-significance of clinical posting status indicates that mere exposure to clinical environments without a concurrent institutional mandate is insufficient to drive uptake.

Among unvaccinated students, only about 16% expressed willingness to receive a future vaccine. This relatively low willingness, coupled with high rates of distrust and perceived non-necessity, signals that supply-side interventions alone will not suffice. Educational campaigns that rebuild trust, address specific misconceptions, and leverage peer advocates, especially within hostel communities, are needed.

LIMITATIONS

This study has several limitations. First, the cross-sectional design precludes causal inference. Second, data were self-reported, which may introduce recall or social-desirability bias. Third, the willingness question suffered from substantial non-response (only 66 out of 341 unvaccinated students answered), limiting the precision of that estimate. Finally, the study was conducted in a single institution in northwestern Nigeria, potentially limiting generalizability to other regions.

CONCLUSION

COVID-19 vaccination coverage among health science students at UDUS is critically low. Residence type is the strongest independent predictor, with students living on campus or off-campus significantly more likely to be vaccinated than those living with family. Addressing access barriers through on-campus vaccination drives, strengthening institutional mandates, and delivering peer-led education campaigns that tackle vaccine distrust are practical steps to improve coverage. These findings provide a local evidence base for university health policymakers and highlight the importance of considering living arrangements when designing vaccination strategies for healthcare trainees.

Abbreviations

aOR: Adjusted Odds Ratio

CI: Confidence Interval

cOR: Crude Odds Ratio

COVID-19: Coronavirus Disease 2019

df: Degrees of Freedom

HCWs: Healthcare Workers

IBM: International Business Machines

MBBS: Bachelor of Medicine, Bachelor of Surgery

MLS: Medical Laboratory Science

NY: New York

p: Probability (p-value)

R: Reference Category

SAGE: Strategic Advisory Group of Experts on Immunization

SARS-CoV-2: Severe Acute Respiratory Syndrome Coronavirus 2

SD: Standard Deviation

SPSS: Statistical Package for the Social Sciences

UDUS: Usmanu Danfodiyo University, Sokoto

UDUTH: Usmanu Danfodiyo University Teaching Hospital

USA: United States of America

WHO: World Health Organization

χ^2 : Chi-square

Declarations

Ethics approval and consent to participate

Ethical clearance was obtained from the Health Research and Ethics Committee of Usmanu Danfodiyo University Teaching Hospital (approval number: UDUTH/HREC/2025/1607/V1). All participants provided electronic informed consent before accessing the questionnaire. Anonymity and confidentiality were strictly maintained, and no personally identifiable information was collected. Participation was voluntary, and respondents could withdraw at any point without consequence.

Accordance statement

The study was conducted in accordance with the Declaration of Helsinki and National Code for Health Ethics of Nigeria.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Clinical trial number

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DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE MANUSCRIPT PREPARATION PROCESS

During the preparation of this work the author(s) used DeepSeek and Grammarly to summarize, paraphrase, interpret some analytical findings and in language editing for ease of reading. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the published article.

DATA AVAILABILITY STATEMENT

The datasets generated and analyzed during this study are available from the corresponding author on reasonable request. Relevant data supporting the findings are included within the article and its supplementary materials.

AUTHOR CONTRIBUTIONS

I.T.H: Was involved in the conceptualization of study title, it methodology, resource provision, data curation, investigation/data collection, formal analysis, wrote the original draft, and supervision.

A.Y: Participated in Data curation, investigation, resource provision, writing manuscript and editing of figures.

I.A.M: Was involved in data curation, investigation/data collection, resource provision, writing manuscript, and editing.

I.A.S: participated in data curation, investigation/data collection, resource provision, writing manuscript, and editing.

S.A.S.F: Data curation, investigation/data collection, resources, writing manuscript, and editing.

A.B: Investigation/data collection, resource provision, writing manuscript, and supervision.

A.I.M: Investigation/data collection, resources, writing manuscript, and editing.

A.S.F: Investigation/data collection, writing manuscript, and editing.

A.O.A: Methodology, investigation/data collection, writing manuscript, and editing.

J.A.F: investigation/data collection, writing review and editing.

F.O.S: Participated in investigation/data collection, writing manuscript, and editing.

All authors read and approved the final manuscript and declare no competing interest.

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Figures

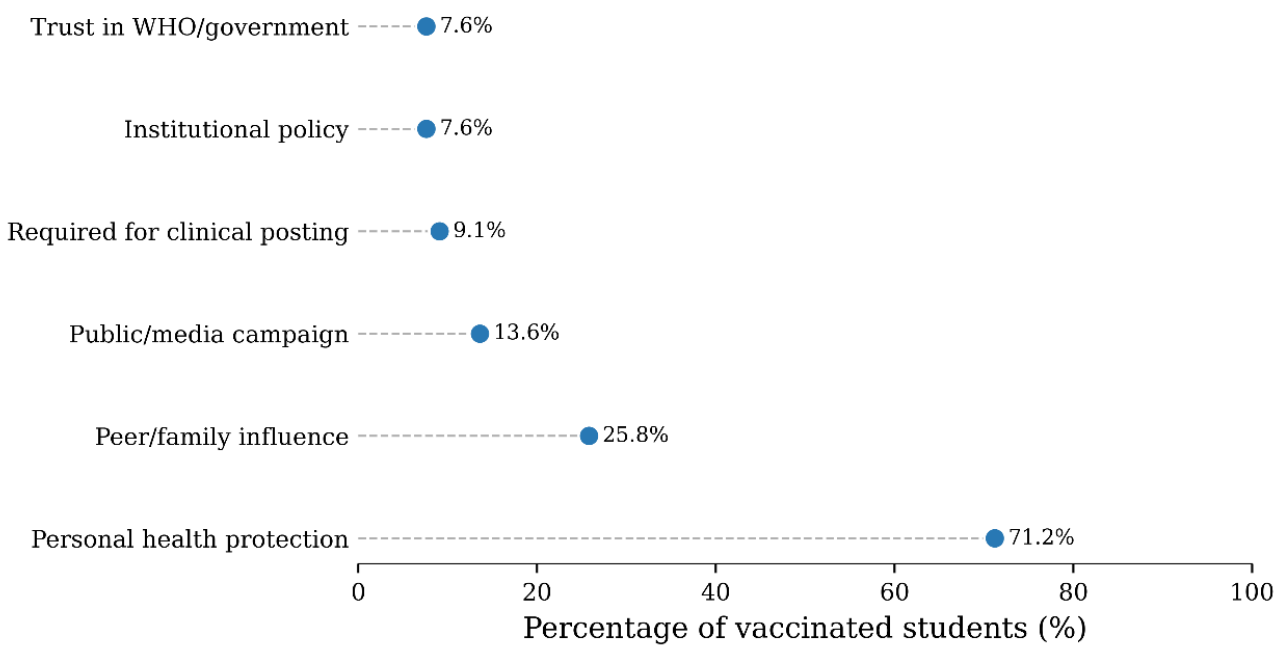


Figure 1

Motivators for COVID-19 Vaccination Among Vaccinated Students (n=66)

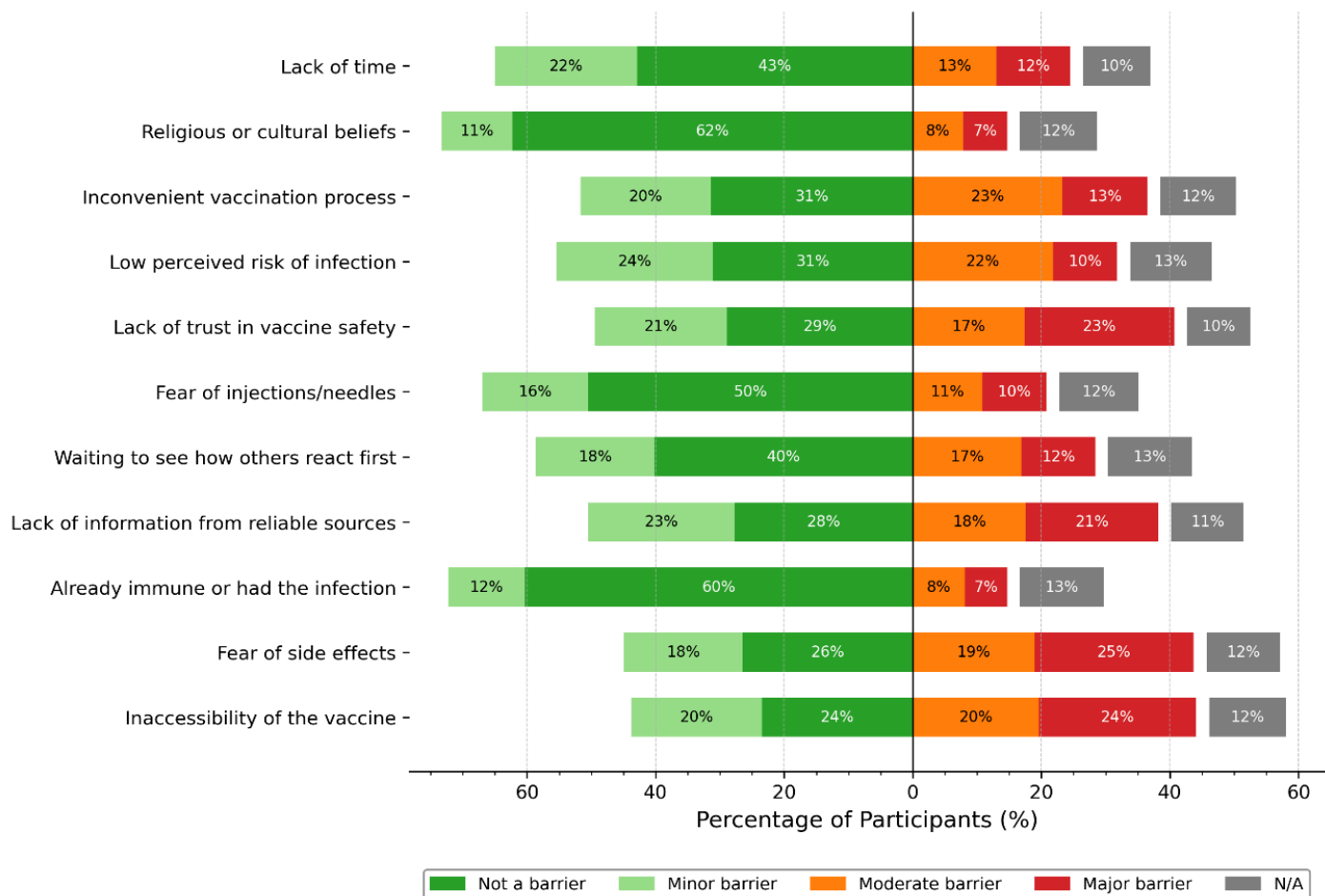


Figure 2

Barriers to COVID-19 Vaccination Among Participants (n=408)

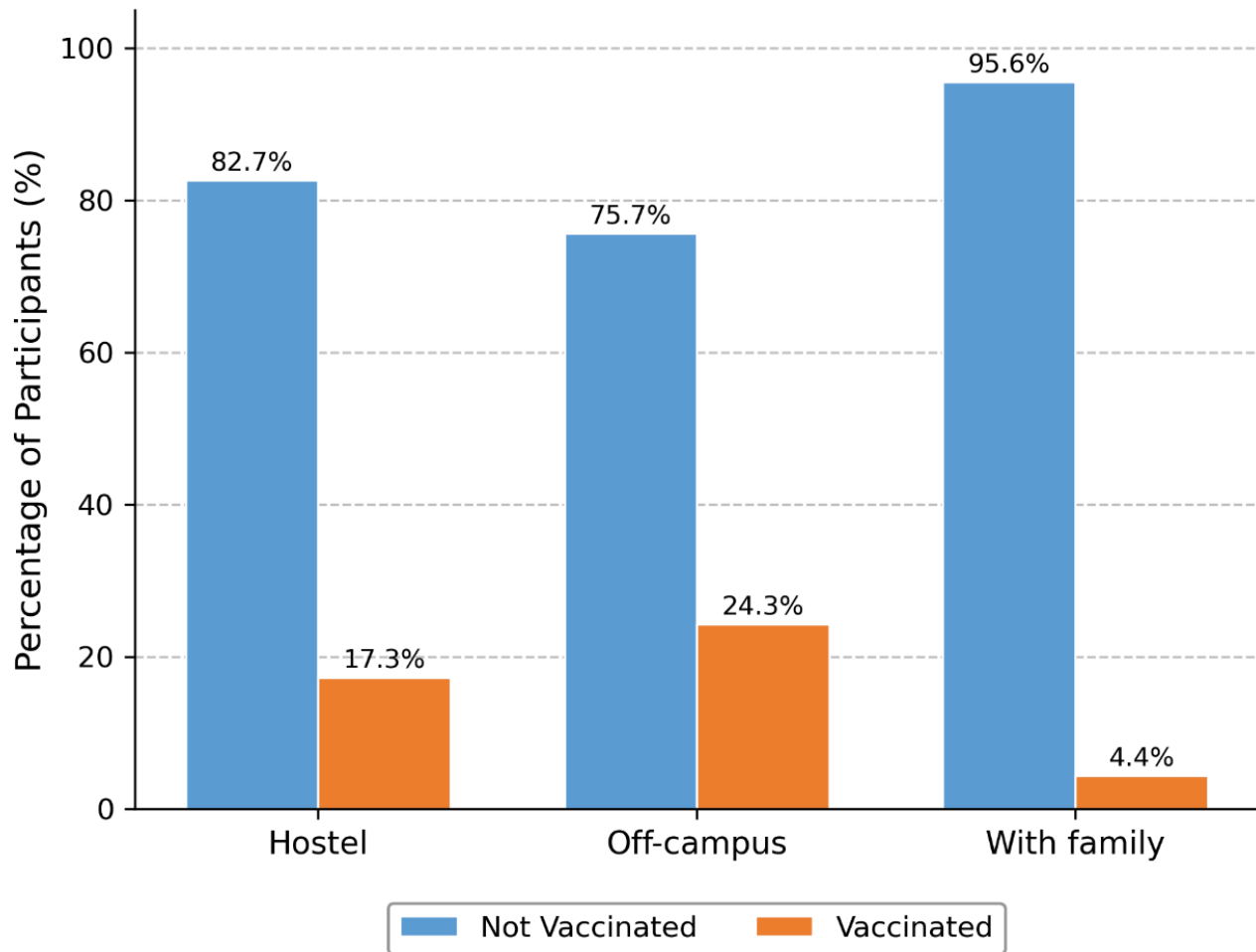


Figure 3

COVID-19 Vaccination Coverage by Type of Residence

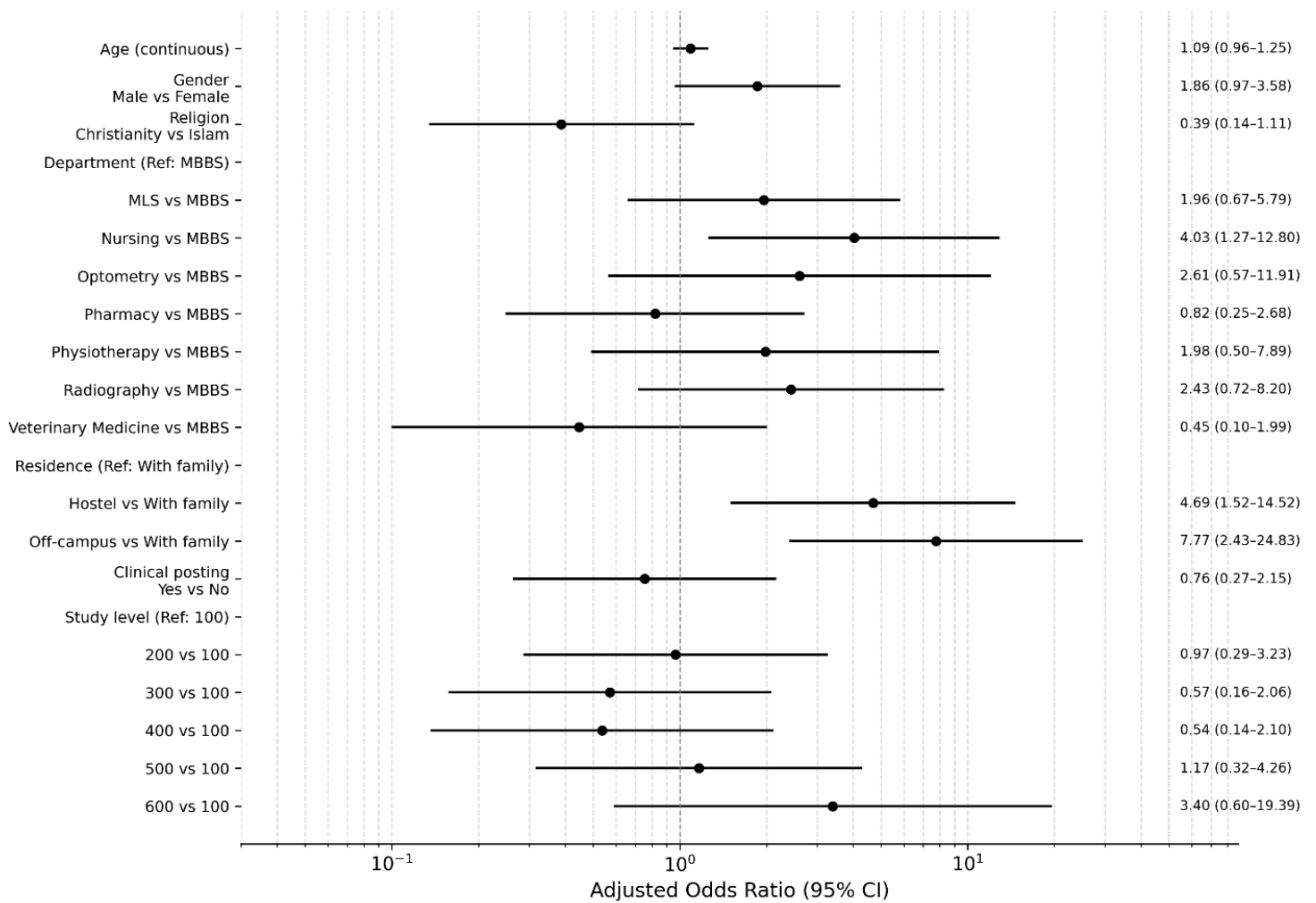


Figure 4

Forest Plot of Adjusted Odds Ratios from Logistic Regression