---

**Article:**
Sanda, M.E., Ngene, A.C. orcid.org/0000-0001-8880-1635, Otuh, P.I. et al. (11 more authors) (2023) Cross-sectional study on COVID-19 prevention and vaccination status of veterinary colleges in Southeast Nigeria. Advances in Public Health, 2023. 8455852. ISSN 2356-6868

https://doi.org/10.1155/2023/8455852

---

Hindawi
Advances in Public Health
Volume 2023, Article ID 8455852, 14 pages
https://doi.org/10.1155/2023/8455852

*Research Article*

# Cross-Sectional Study on COVID-19 Prevention and Vaccination Status of Veterinary Colleges in Southeast Nigeria

**M. E. Sanda,[1] A. C. Ngene,[2] P. I. Otuh,[3] F. A. Oyeleye,[4] B. N. Ogunro,[5] S. O. Olorunleke,[6] E. A. Nwokeoji,[7] E. Kalu,[3] N. U. Njoku,[8] I. J. Ogbonna,[1] C. J. Aronu,[9] A. A. Okokon,[1] J.C. Amadi,[10] and C. A. N. Akpan[1]**

[1]*Department of Veterinary Medicine, College of Veterinary Medicine, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria*
[2]*Department of Nursing and Community Health, School of Health and Life Sciences, Glasgow Caledonian University, London, UK*
[3]*Department of Veterinary Public Health and Preventive Medicine, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria*
[4]*Department of Public Health and Preventive Medicine, Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Nigeria*
[5]*Veterinary Teaching Hospital, University of Ibadan, Ibadan, Oyo State, Nigeria*
[6]*Department of Animal Science, Faculty of Agriculture and Natural Resources Management, Ebonyi State University, Abakaliki, Nigeria*
[7]*School of Biosciences, University of Sheffield, Sheffield, UK*
[8]*Department of Veterinary Surgery and Radiology, College of Veterinary Medicine, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria*
[9]*Department of Animal Health and Production, Faculty of Veterinary Medicine, University of Nigeria, Nsukka, Enugu State, Nigeria*
[10]*African Centre of Excellence for Genomics of Infectious Diseases, Ikorodu, Lagos State, Nigeria*

Correspondence should be addressed to A. C. Ngene; angene200@caledonian.ac.uk

Received 11 September 2022; Revised 13 February 2023; Accepted 18 April 2023; Published 20 May 2023

Academic Editor: Jianrong Zhang



COVID-19 vaccination and compliance with the established prevention protocols are integral to curbing the spread of the COVID-19 virus; however, there is a paucity of information on compliance with these measures among veterinary schools within southeast Nigeria. To fill this gap, we evaluated the vaccination status and individual's perception of the preventive measures against COVID-19 infections. A cross-sectional study using a self-reported internet-based questionnaire was employed to obtain responses from students and staff of the veterinary colleges in southeast Nigeria. Multivariate binary logistic regression analysis was used to identify significant factors associated with vaccination status and compliance with the COVID-19 prevention protocols by the respondents. A total of 183 individuals participated in the online survey. Although 75% (138/183) of the respondents revealed a willingness to take the COVID-19 vaccine, only 25.1% (46/183) of the respondents had received one or more doses of the COVID-19 vaccine. We observed that male respondents (28 ± 4.4% (95% CI 19–37)) had a higher percentage of vaccinated individuals than female respondents. Furthermore, the academic staff of the veterinary colleges were 39.70 (95% CI 2.50–630.65; $p = 0.01$) times more likely to get vaccinated than undergraduate students. The educational status of the respondent greatly contributed to the willingness to get vaccinated, and individuals within the age bracket of 31 to 40 years were 10.2 ± 1.07 (95% CI 1.33–92.25; $p = 0.03$) times less likely to comply with the COVID-19 prevention protocols. Although a high proportion of the respondents had a good perception of the COVID-19 prevention protocols, only 25.1% of the members of the veterinary colleges in southeast Nigeria had been vaccinated. Therefore, there is a need to create better awareness channels to improve the vaccination status of members of veterinary colleges in southeast Nigeria.

## 1. Introduction

Coronavirus disease (COVID-19) is the greatest pandemic of the 21st century, with over 500 million cases reported globally as of June 2022 since its onset [1]. It is a transmissible disease caused by the SARS-CoV-2 virus that exists in respiratory and air droplets [2]. The virus belonging to the family *Coronaviridae* is highly pathogenic, especially in immunocompromised individuals [3, 4]. Notable symptoms of the disease range from mild pneumonia to severe respiratory failure and multiple organ failure, with some patients requiring oxygen therapy and intensive care. Notwithstanding, there is also evidence of asymptomatic cases with patients showing no recognisable symptoms [5, 6]. Severe and prolonged illness, especially in patients suffering from long COVID, could result in long-term health challenges [7, 8]. Hence, there is an urgent need for the promotion of worldwide vaccination coverage to mitigate the devastation.

In the past, coronaviruses were of little significance to human health. The onset of coronavirus outbreaks such as the severe acute respiratory syndrome (SARS) epidemic became a public health concern in the human population; however, in the poultry industry, the virus causes huge economic losses. Globally, the avian coronavirus causes infectious bronchitis (IB), a highly contagious disease of birds that results in large-scale deaths and is a burden on poultry producers due to huge losses [9–11]. In the 1950s, mass vaccination was instrumental in managing the IB crisis [12]. Similarly, vaccine development was imperative to curb the spread of COVID-19, improve herd immunity, and decrease the death rate [13, 14]. However, the awareness level of diseases that are vaccine-preventable does not correlate with real compliance and acceptance of the vaccination, according to Murele et al. [15]. As observed worldwide, certain factors appeared to influence personal views on the uptake of COVID-19 vaccination. These factors are not limited to educational status, religion, misinformation, poor coverage, cost, mistrust of the government, and vaccine safety concerns [16–18]. In Nigeria, it was observed that health professionals were more knowledgeable and willing to be vaccinated as compared to nonhealth professionals [16, 19]. In addition, the public's mistrust of government and religious beliefs often played a role in people's nonchalance to participate in routine vaccination programmes, as observed in the boycott of polio vaccination in northern Nigeria, which led to high polio cases recorded in the recent past [20, 21]. Recently, the principal source of information has been the media. Anorue et al. [22] concluded that the safety of COVID-19 vaccine communication through the media was very low, neither convincing nor sufficient, leading to negative perceptions of the vaccine in Southeast Nigeria. In addition, misconceptions about the effects of the vaccine continued to propagate on social media, largely contributing to the vaccination hesitancy observed around the world [23]. (Salem 2021). Across India and China, it was observed that women were more reluctant to be vaccinated, and this was due to misinformation suggesting vaccine uptake was associated with infertility, despite claims that these concerns were unconfirmed [24–26]. Although vaccine acceptance rates in the UK and USA were relatively lower compared to some Asian nations, the unwillingness to take the vaccines was based on a lack of confidence in their safety and effectiveness [27]. Currently, just over 46 million people are vaccinated in Nigeria, representing less than 25% of the general population [28]. This is worrisome because herd immunity can only be achieved when over 70% of the population is vaccinated [14]. Surprisingly, the COVID-19 infection rate continues to rise slowly compared to Europe and America, where vaccination has been strategically implemented and effective. However, it is probable that the low number of positive cases recorded in Nigeria could be a result of poor disease reporting and surveillance.

At the onset of the pandemic, before the advent of a vaccine, there was a demand for alternative ways to prevent infection. This need fuelled an increase in research for possible methods to prevent the spread of the virus. Although recommended protective strategies against COVID-19, such as the use of face masks, physical distancing, restrictions on social gatherings, and constant hand washing, were effective to an extent, vaccination proved to be more effective [29, 30]. Unfortunately, the COVID vaccine misconceptions also pushed the demand for nonpharmaceutical remedies. For instance, in some communities, the consumption of dietary supplements and herbal concoctions intensified [31–35]. Arguably, it is also likely that vaccine safety concerns, as well as vaccine cost and misinformation [36, 37], further drove the demand for alternative medicine as a more desirable and reliable option for preventing COVID-19 infection [38]. Additionally, one of the challenges with COVID-19 vaccination was the emergence of SARS-CoV-2 variants that appear to be immune evasive. Some studies show that vaccine effectiveness is significantly improved after 2 doses; however, the omicron variant can elude immune response. Immune evasiveness reduces vaccine effectiveness; hence, it is expedient to mitigate the transmission of new variants [39–41]. Our study aims to evaluate the vaccination status and individual perceptions of preventive measures against COVID-19 infection in veterinary schools in Southeast Nigeria.

## 2. Methodology

*2.1. Study Design.* To achieve our objectives, a cross-sectional study using a self-reported internet-based questionnaire (Google form), as a survey tool, was employed. The Google form was distributed to the target population within the veterinary schools in Southeast Nigeria. The inclusion criteria include the members of staff and students in the veterinary schools in Southeast Nigeria while the exclusion criteria included the nonveterinary staff and students. Currently, there are two veterinary schools located within the Southeast geopolitical zone: the University of Nigeria Nsukka in Enugu State and the Michael Okpara University of Agriculture Umudike in Abia State (Figure 1).

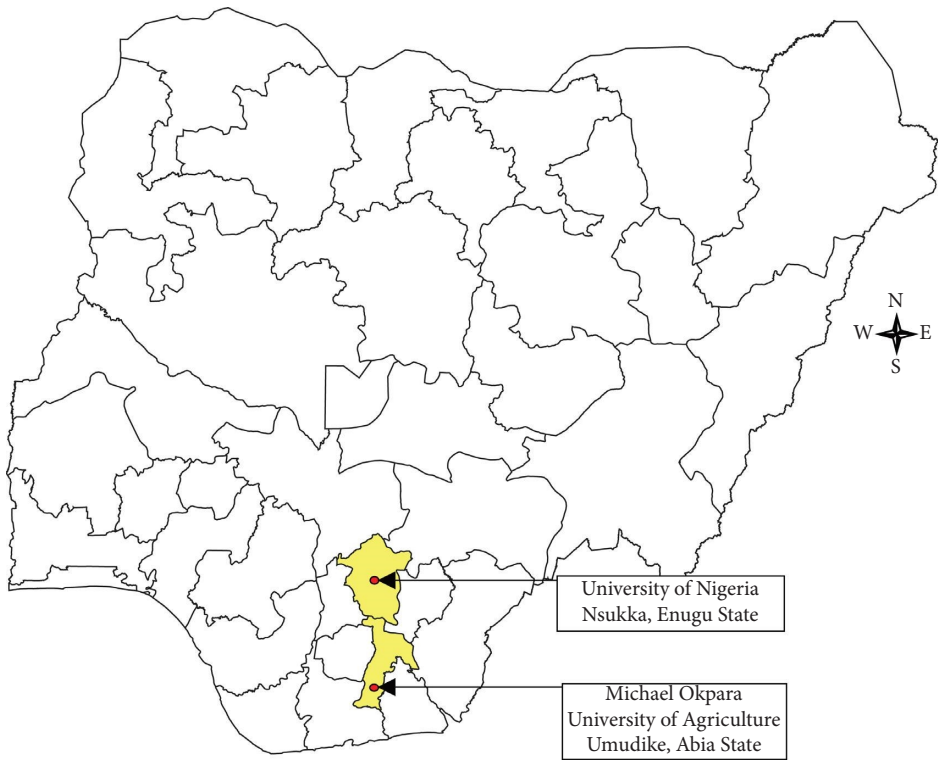


Figure 1: Map of Nigeria showing the location of the two veterinary schools in southeast Nigeria (study area) that participated in the online survey between May and June 2022. Geographical area of the southeast Nigeria in the study.

*2.2. Questionnaire Design and Data Collection.* The English language (British) was used as the medium for data collection in this study. The survey instrument was a structured questionnaire comprising a total of 29 open- and closed-ended questions grouped into four segments, each directed towards a specific objective of the study. The first segment gave a brief description of the objectives of the survey and included a statement of confidentiality and a request for the respondent's consent to participate in the study, while the second segment was tailored to elicit responses on the sociodemographic characteristics of the respondents. The third segment was designed to elicit responses on the respondent's travel history, vaccination status, perception, and compliance to the WHO nonpharmaceutical COVID-19 prevention protocol/intervention (use of a face mask, washing of hands, use of hand sanitizers, physical distance, and self-isolation). The questionnaire was face-validated by an experienced statistician. This was followed by a 3-month content validation by six-man panel assessors, which included two potential respondents, two public health experts, and two statisticians. The survey instrument, which was assessed for clarity and relevance, had a validity index of 0.9. However, the construct validity study was not done due to logistical limitations.

A pilot study was conducted on the survey instrument, and the feedback from the pilot study on each of the items in the questionnaire was taken, and the questions were modified accordingly. The link to the Google form was distributed through social media platforms, mainly via staff and students' WhatsApp group platforms. One-on-one sharing of the link was also carried out by the researchers, which helpedreach more participants. The survey was available online for four weeks to enable the target audience to participate in the survey. Data obtained from the online Google form survey were collated and analysed between May and June 2022.

Little or no difficulty was encountered in filling out the online form in the course of the survey since the target population was university academics and college students, who are literate and have Internet exposure.

*2.3. Data Analysis.* The responses to the Google forms were downloaded as a Microsoft Excel Worksheet (.xlsx) and imported into R version 4.2.0 [42] using the readxl package [43]. Data cleaning and sorting were accomplished with the *dplyr* package [44], and a graphical representation of the results was done with the ggplot2 package [45]. Other R packages used for the analysis and model training include *psych* [46], Stat2Data [47], and *caret* [48].

*2.4. Data Classification and Scoring.* Summary statistics were derived using "veterinary colleges" (MOUAU, UNN), "sex," and "group" (academic staff, nonteaching staff, undergraduate students, and postgraduate students-Figure2) as grouping variables. "Perception" and "compliance" with COVID-19 prevention protocols were scored on a 5-point Likert scale, where a score of "1" was regarded as "very poor" and a score of "" was regarded as "excellent." An average score of "<3" was regarded as "poor," while a score of "≥3"

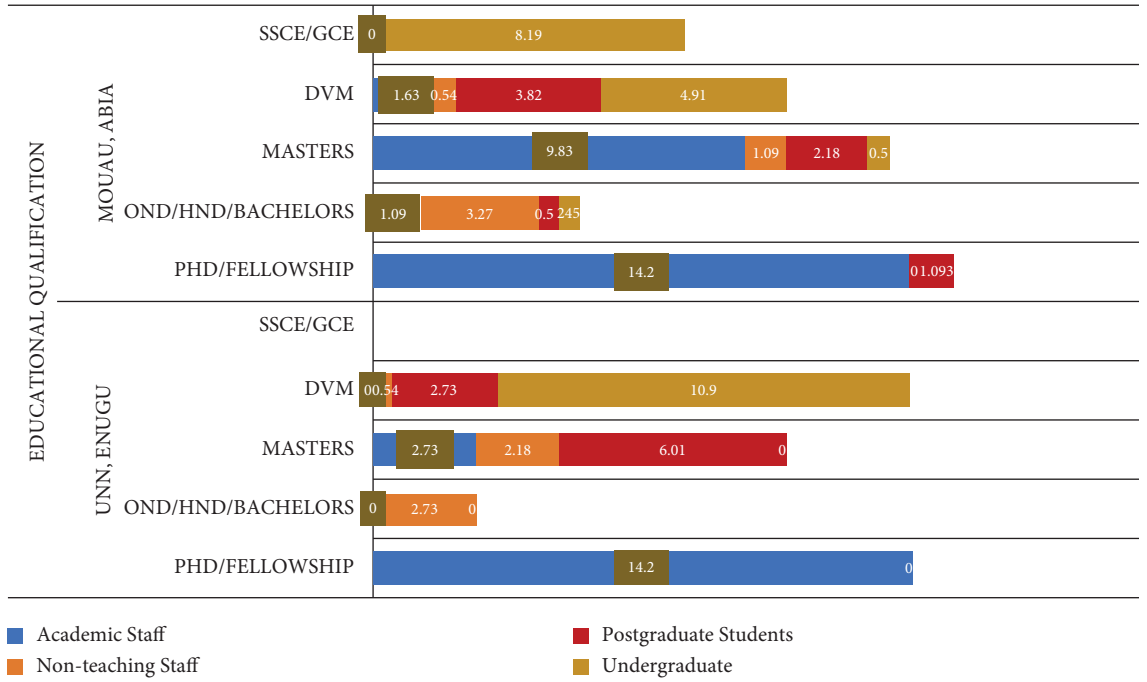


Figure 2: Percentage distribution of the education qualification of the respondents.

was regarded as "good," which served as cut-offs for bivariate analysis. In addition, a score of "5" was allotted to vaccinated individuals, whereas a score of "1" was given because vaccination status was regarded as an important indication of COVID-19 compliance. Compliance with COVID-19 prevention protocols was accessed under two broad categories:

(1) Nonpharmaceutical protocols, which included the use of face masks, proper and regular hand-washing, use of hand sanitizers, and observing social distancing.

(2) Reception of COVID-19 vaccine.

The average score on compliance with nonpharmaceutical methods accounted for 50% of respondents' compliance scores. The remaining 50% was allocated to the vaccination status of the respondent because vaccine reception is regarded as the most important compliance practice. Compliance scores derived from both protocols were regarded as "adjusted" compliance scores because they were calculated with more weight allocated to the vaccination status.

*2.5. Statistical Tests and Model Training.* Hypothesis testing was carried out using a chi-squared test for independence (categorical variables) and a multivariate binary logistic regression analysis was also performed using all independent variables to determine probable predictors for "compliance" with COVID-19 prevention protocols in the primary model. Ordinal variables were entered as nominal variables. To derive the final model, multivariate binary ogistic analysis was repeated using only significant predictors from the primary model of various predictors of "compliance" with COVID-19 prevention protocols using only statistically significant predictors from the primary model. Furthermore, a Wald test was performed on the statistically significant residuals from the secondary model to verify the predictive power of the residuals. The final model was trained for internal cross-validation using the K-fold validation (Stone, 1974) with ten iterations to determine the predictive accuracy of the final model. All hypothesis tests were carried out at an alpha level of 0.05.

*2.6. Assumptions Testing.* The data set was checked for compliance with the basic assumptions for binomial logistic regression [49]. There was one set of dichotomous independent variables (good compliance and poor compliance) and sets of categorical "predictor" variables (educational status, age group, category, frequency of travel, veterinary college, and sex) (Figure 2). Polytomous variables were treated as factors using the "as.factor" function in R so that ordinal variables such as age class would be computed as nominal entries. This was done because of the relatively limited sample sizes of the categories and thus eliminated the need for comparing the linearity of independent variables with the log odds. The responses were screened for outliers using Cook's distance analysis [50].

## 3. Results

*3.1. Demographic Features of Respondents.* A total of 183 individuals, comprising 76 females (41.53%) and 107 males (58.47%) from the two veterinary colleges in Southeast Nigeria, responded to the online survey. The sociodemographic distribution of the respondents within each of the veterinary colleges as presented in Figure 3 revealed variations in the ratio of male to female participation in all the

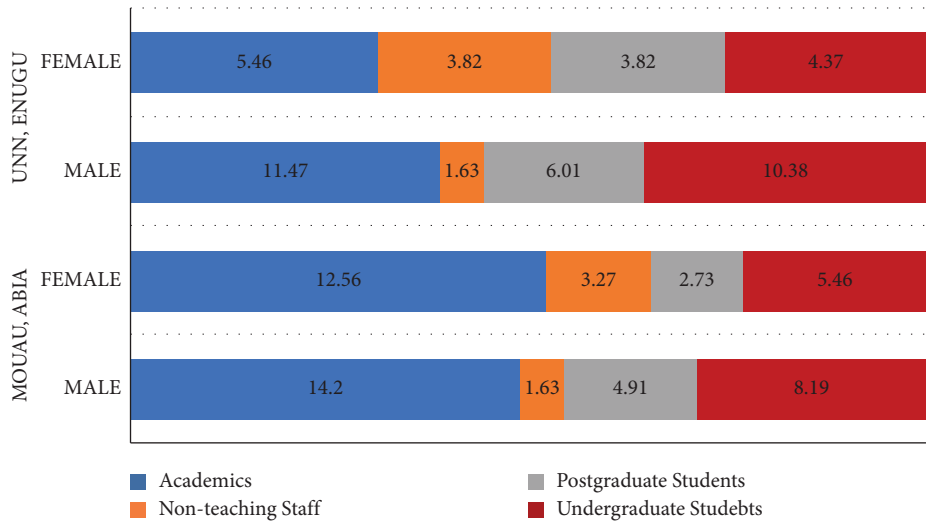


Figure 3: Percentage distribution of the respondent's gender.

categories (academic staff, nonteaching staff, postgraduate students, and undergraduate students). In general, 80 (43.72%) academic staff, 19 (10.38%) nonteaching staff, 32 (17.49%) postgraduate students, and 52 (28.42%) undergraduate students participated in the online survey (Figure 4). The highest mean age of the respondents was identified among academic staff, and it ranged between $44.98 \pm 9.02$ and $47.26 \pm 8.96$, while the least mean age was identified among the undergraduate category, as expected, and it ranged between $24.56 \pm 2.89$ and $24.70 \pm 2.84$ (Table 1). The predominant age group in this study was 19–30 years old, accounting for 33.9% of the respondents, while the least frequent were those in the age bracket of 61–69 years old (Table 2). The distribution of the respondents by educational status varied between 8.2% and 30.6% for OND/HND/Bachelors and PhD/Fellowship, respectively.

*3.2. Vaccination Status.* Out of the 183 respondents, only 25.1% (46/183) have taken at least one dose of the COVID-19 vaccine (Figure 5). We also observed that about 80% (37/46) of the respondents who had been vaccinated had taken a booster second dose of COVID-19 vaccines (Table 3). The two predominant COVID-19 vaccine brands used within the study area were Moderna/Spikevax and Oxford/AstraZeneca/Vaxzervria (Figure 5). To further understand the pattern of distribution of vaccinated Veterinary Faculty members, we cross-tabulated the binary outcomes with the dependent variables (Table 4). Respondents from MOUAU, Abia State, recorded the highest percentage of vaccinated individuals ($26 \pm 4.5\%$ (95% CI 17–35)) when compared with those from UNN, Enugu ($24 \pm 4.7\%$ (95% CI 15–34)). Male respondents ($28 \pm 4.4\%$ (95% CI 19–37)) had a higher percentage of vaccinated individuals than female respondents. It was observed that as the age group increased, the percentage of individuals vaccinated also increased (Table 4). Similarly, there was an increase in the percentage of individuals vaccinated with the type of role undertaken in the veterinary college. We observed that the percentage of vaccinated individuals increased from students to academic staff. This same trend was observed with additional qualifications in the education status of individuals; however, respondents who only possessed an OND/HND/Bachelor ($47 \pm 13.3\%$ (95% CI 18–75)) were observed to have the highest percentage of vaccinated individuals. Furthermore, the percentage of individuals vaccinated increased with the frequency of travel. It was observed that individuals that travelled more than 10 times a year ($36 \pm 6.7\%$ (95% CI 23–49)) had the highest percentage of individuals that had taken the COVID-19 vaccines at least once. Also, we identified that $50 \pm 13.9\%$ (95% CI 20–80) of individuals with a positive COVID-19 vaccination status had recently embarked on an international trip (Table 4).

The result of the binary logistic regression (Table 5) of positive COVID-19 vaccination status among faculty members and students at the veterinary colleges in Southeast Nigeria indicated that there was a significant association between all the individual predictors (educational status, age group, category, frequency of travel, veterinary college, and sex) derived from the respondents ($\chi^2$ (17) = 41.34, $p = 0.001$). It was observed that the academic staff of the veterinary colleges were 39.70 (95% CI 2.50–630.65, $p = 0.01$) times more likely to get vaccinated than undergraduate students. Similarly, the likelihood of getting a COVID-19 vaccine was 38.17 (95%CI 2.84–511.89, $p = 0.01$) and 27.87 (95% CI 1.30–597.61, $p = 0.03$) times among postgraduate students and nonteaching staff, respectively. The stepwise backward regression analysis revealed that only educational status and category contributed to the fitness of the model.

*3.3. Perceptions Influencing the Adoption of COVID-19 Vaccines and Prevention Protocols.* About 75% (138/183) of the respondents revealed that they knew they were less likely to contract COVID-19 or have less severe symptoms if vaccinated, which remains the key motivation for getting

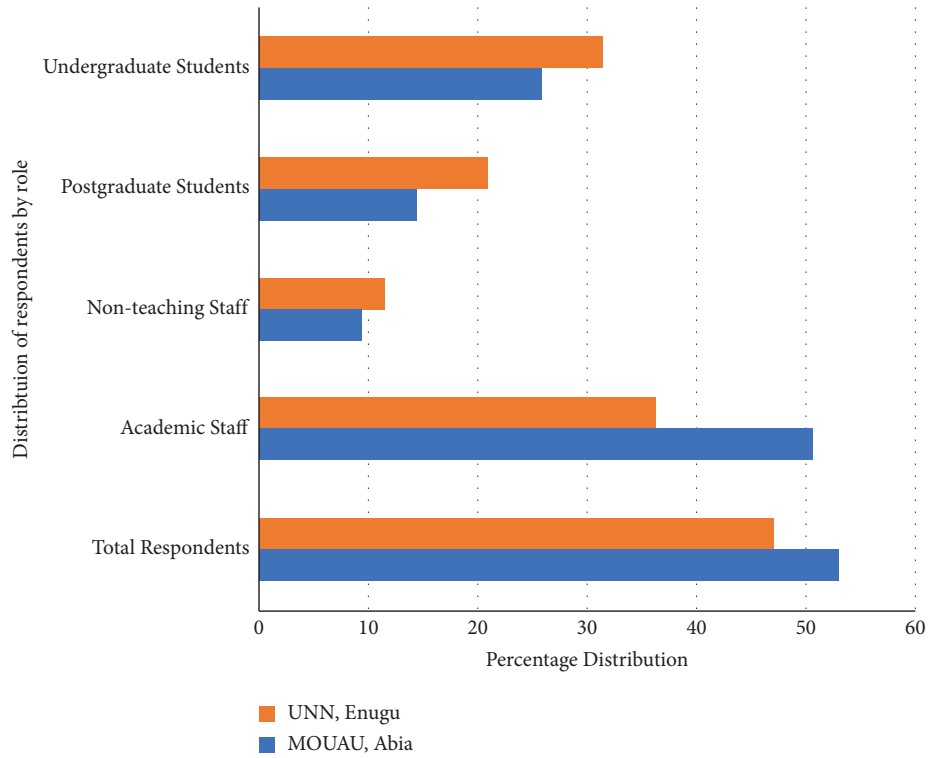


Figure 4: Percentage distribution of respondents by role within the veterinary colleges in southeast Nigeria.

Table 1: Mean age distribution of various respondent groups.

| Description | MOUAU, Abia (mean ± SD) | UNN, Enugu (mean ± SD) |
|---|---|---|
| Academic staff | 44.98 ± 9.02 | 47.26 ± 8.96 |
| Non-teaching staff | 36.89 ± 5.60 | 44.10 ± 6.95 |
| Postgraduate students | 36.07 ± 6.68 | 37.06 ± 6.89 |
| Undergraduate student | 24.56 ± 2.89 | 24.70 ± 2.84 |

Table 2: Distribution of the respondent categories by age group.

| Category/age group | MOUAU, Abia | UNN, Enugu |
|---|---|---|
| *Academic staff* | | |
| 19–30 | 2 | 0 |
| 31–40 | 12 | 7 |
| 41–50 | 22 | 13 |
| 51–60 | 10 | 9 |
| 61–69 | 3 | 2 |
| *Non-teaching staff* | | |
| 19–30 | 1 | 0 |
| 31–40 | 7 | 3 |
| 41–50 | 1 | 4 |
| 51–60 | | 3 |
| *Postgraduate students* | | |
| 19–30 | 4 | 4 |
| 31–40 | 6 | 8 |
| 41–50 | 4 | 6 |
| *Undergraduate students* | | |
| 19–30 | 25 | 26 |
| 31–40 | 0 | 1 |

a jab of the COVID-19 vaccine. However, some of the respondents (6.6%, 12/183) revealed that getting a COVID-19 vaccine jab was out of compulsion, anchored on the rules and regulations governing international travel or institutional conditions. About 36% (66/183) of the respondents in this study were discouraged from getting a jab of the COVID-19 vaccine because they were afraid of the side effects, while 20.8% (38/183) declined to get vaccinated because of the conspiracies about the COVID-19 vaccines on the Internet. However, 24% (44/183) of the respondents agreed to get vaccinated only after many people around them got at least a jab of the COVID-19 vaccine without showing any adverse reactions.

The evaluation of the perception of the various groups on COVID-19 prevention protocols is presented in Figure 6. Aside from the noteaching staff group (63.16%, 12/19), all the groups evaluated in the veterinary colleges in Southeast Nigeria had excellent perception (ranging between 80 and 81.25%) of the COVID-19 prevention protocols. On the contrary, the perception did not translate into compliance as

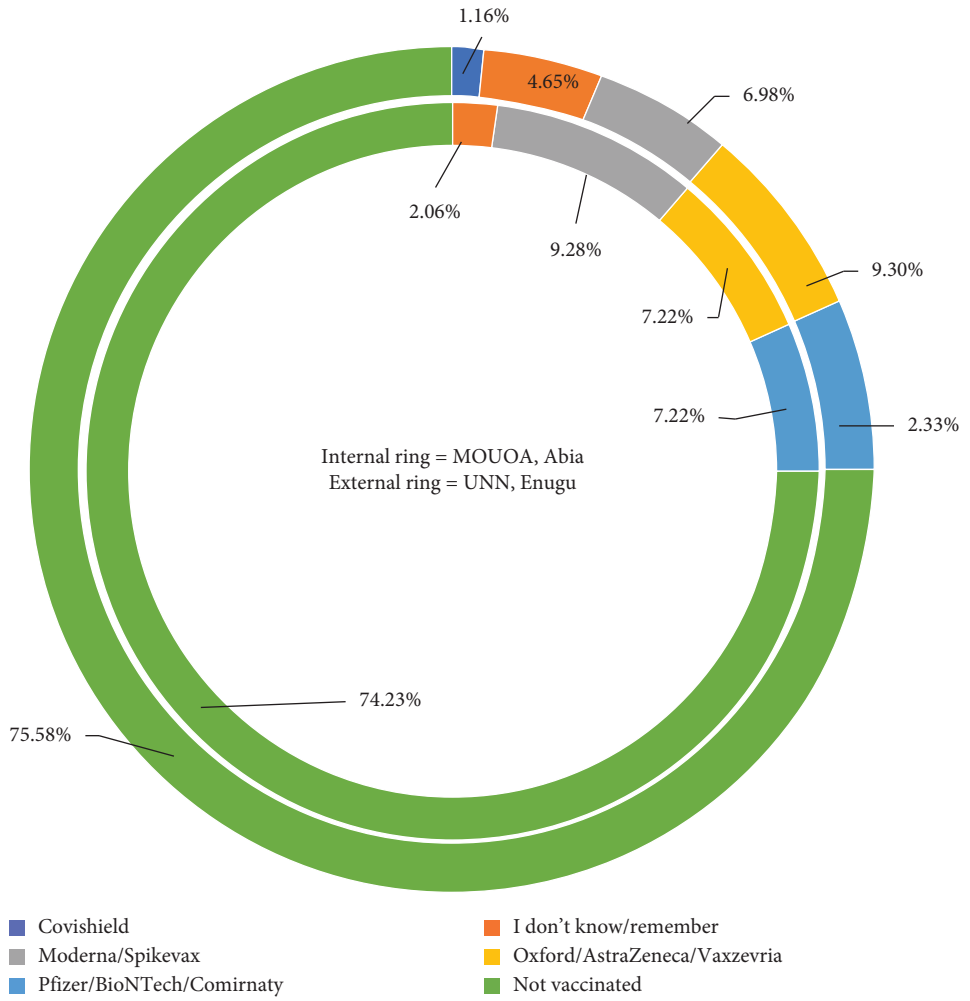


Figure 5: Distribution of predominant type of COVID-19 vaccines used by respondents.

Table 3: Frequency of travels out of the state of residence.

| Frequency of travels | MOUAU, Abia state (%) | UNN, Enugu state (%) | Grand total (%) |
|---|---|---|---|
| Academic staff | 50.52 | 36.05 | 43.72 |
| <Once a year | 4.08 | 12.90 | 7.50 |
| >10 times a year | 38.78 | 35.48 | 37.50 |
| 1–4 times a year | 26.53 | 41.94 | 32.50 |
| 5–10 times a year | 30.61 | 9.68 | 22.50 |
| Non-teaching staff | 9.28 | 11.63 | 10.38 |
| <Once a year | 11.11 | 50.00 | 31.58 |
| >10 times a year | 33.33 | 20.00 | 26.32 |
| 1–4 times a year | 33.33 | 20.00 | 26.32 |
| 5–10 times a year | 22.22 | 10.00 | 15.79 |
| Postgraduate student | 14.43 | 20.93 | 17.49 |
| <Once a year | 7.14 | 11.11 | 9.38 |
| >10 times a year | 64.29 | 22.22 | 40.63 |
| 1–4 times a year | 7.14 | 22.22 | 15.63 |
| 5–10 times a year | 21.43 | 44.44 | 34.38 |
| Undergraduate student | 25.77 | 31.40 | 28.42 |
| <Once a year | 12.00 | 37.04 | 25.00 |
| >10 times a year | 20.00 | 0.00 | 9.62 |
| 1–4 times a year | 48.00 | 55.56 | 51.92 |

Table 4: Cross-tabulation of the vaccination history of respondents and dependent variables.

| Category | Variables | Vaccinated ± SE (%) | 95% confidence interval (%) |
|---|---|---|---|
| School | MOUAU, Abia | 26 ± 4.5 | 17–35 |
| | UNN, Enugu | 24 ± 4.7 | 15–34 |
| Sex | Male | 28 ± 4.4 | 19–37 |
| | Female | 21 ± 4.7 | 12–30 |
| Age group | 19–30 | 13 ± 4.3 | 4–21 |
| | 31–40 | 25 ± 6.6 | 12–38 |
| | 41–50 | 30 ± 6.5 | 17–43 |
| | 51–60 | 41 ± 10.7 | 19–63 |
| | 61–69 | 60 ± 24.5 | 8–100 |
| Role | Academic staff | 35 ± 5.4 | 24–46 |
| | Non-teaching staff | 32 ± 11.0 | 9–55 |
| | Postgraduate student | 31 ± 8.3 | 14–48 |
| | Undergraduate student | 4 ± 2.7 | 2–9 |
| Educational status | SSCE/GCE | 5 ± 4.5 | 5–14 |
| | DVM | 15 ± 5.4 | 4–26 |
| | Masters | 16 ± 5.6 | 5–27 |
| | OND/HND/Bachelors | 47 ± 13.3 | 18–75 |
| | PhD/Fellowship | 43 ± 6.7 | 29–56 |
| Frequency of travel | <Once a year | 11 ± 6.0 | 1–23 |
| | 1–4 times a year | 17 ± 4.8 | 8–27 |
| | 5–10 times a year | 33 ± 7.6 | 18–49 |
| | >10 times a year | 36 ± 6.7 | 23–49 |
| International travel | Yes | 50 ± 13.9 | 20–80 |
| | No | 23 ± 3.3 | 17–29 |

Table 5: Multivariate binary logistic analysis of various predictors of positive COVID-19 vaccination status among members of staff and students of veterinary colleges in Southeast Nigeria.

| Variable | Explanatory variable | Odds ratio | 95% confidence interval | *p*-value |
|---|---|---|---|---|
| Educational status | SSCE/GCE | Reference variable | | |
| | DVM | 0.61 | 0.34–10.99 | 0.74 |
| | Masters | 0.43 | 0.17–11.11 | 0.61 |
| | OND/HND/Bachelors | 3.43 | 0.12–98.73 | 0.47 |
| | PhD/Fellowship | 1.47 | 0.05–42.53 | 0.82 |
| Age group | 19–30 | Reference variable | | |
| | 31–40 | 0.19 | 0.022–1.63 | 0.13 |
| | 41–50 | 0.22 | 0.011–4.18 | 0.31 |
| | 51–60 | 0.21 | 0.003–14.42 | 0.47 |
| | 61–69 | 0.37 | 0.001–142.58 | 0.74 |
| Category | Academic staff | 39.70 | 2.50–630.65 | 0.01* |
| | Non-teaching staff | 27.83 | 1.30–597.61 | 0.03* |
| | Postgraduate student | 38.17 | 2.84–511.89 | 0.01* |
| | Undergraduate student | Reference variable | | |
| Frequency of travel | <Once a year | 0.40 | 0.08–1.97 | 0.26 |
| | 1–4 times a year | 0.84 | 0.28–2.46 | 0.75 |
| | 5–10 times a year | 1.06 | 0.37–2.99 | 0.92 |
| | >10 times a year | Reference variable | | |
| Veterinary college | MOUAU Abia | Reference variable | | |
| | UNN Enugu | 1.24 | 0.54–2.85 | 0.62 |
| Sex | Male | Reference variable | | |
| | Female | 0.65 | 0.27–1.56 | 0.33 |

*Significant *p*-value.

seen in Figure 7. The compliance of the various study groups to COVID-19 prevention protocols was below 50%. To further explain the various predictors of the adjusted compliance, we subjected the data to multivariate binary logistic analysis (Table 6). The analysis revealed that those without a history of traveling are 5 ± 0.68 (95% CI

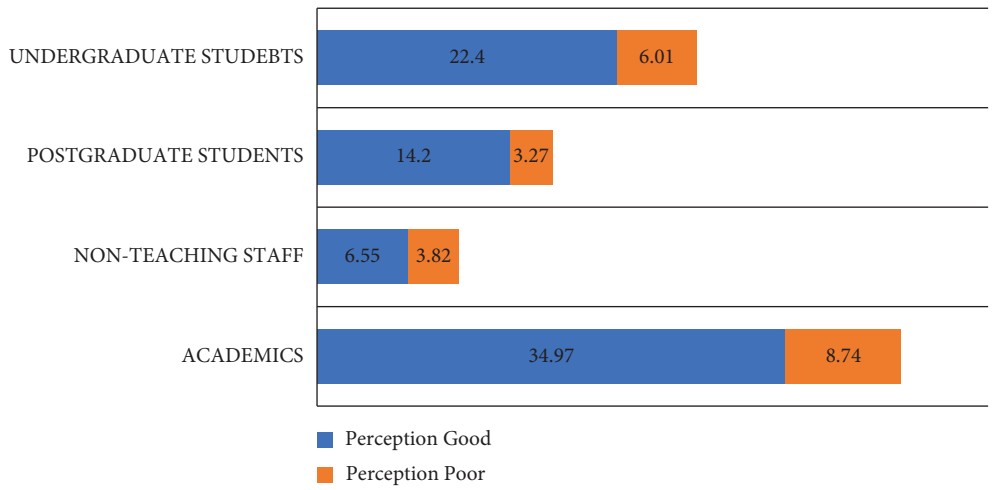


Figure 6: Percentage perception of various groups to COVID-19 prevention protocols.

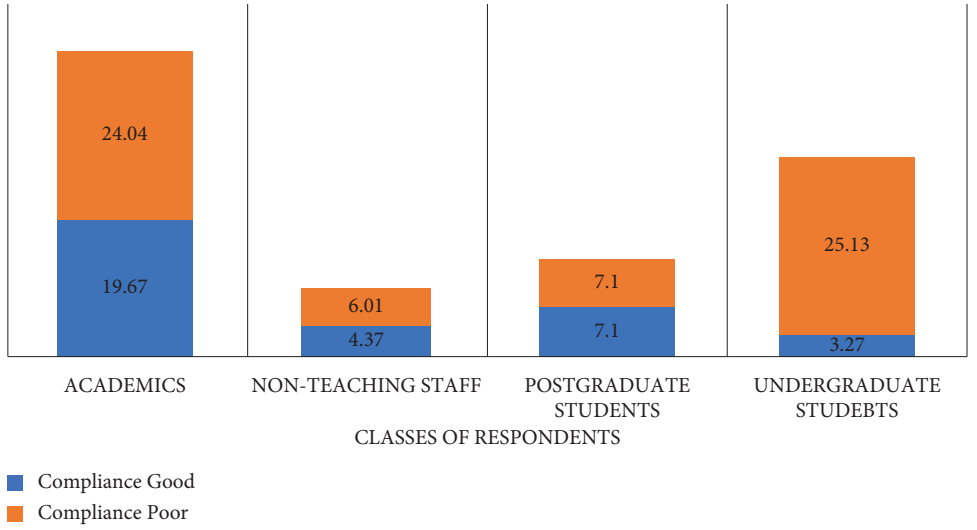


Figure 7: Percentage compliance of various groups to COVID-19 prevention protocols.

Table 6: Multivariate binary logistic analysis of various predictors of "adjusted" compliance to COVID-19 prevention protocols.

| Predictors | Estimate | Std. error | *Z*-value | OR | 95% CI | *p*-value |
|---|---|---|---|---|---|---|
| (Intercept) | 0.349 | 2.173 | 0.161 | 1.4 | 0.01–101.71 | 0.872 |
| Veterinary college: UNN Enugu | 0.374 | 0.392 | 0.956 | 1.5 | 0.68–3.17 | 0.339 |
| Age | −0.053 | 0.073 | −0.736 | 0.9 | 0.82–1.09 | 0.462 |
| Category: non-teaching staff | −0.187 | 0.861 | −0.218 | 0.8 | 0.16–4.86 | 0.828 |
| Category: postgraduate student | −0.268 | 0.612 | −0.438 | 0.8 | 0.23–2.61 | 0.662 |
| Category: undergraduate student | 3.585 | 1.217 | 2.945 | 36.1 | 3.87–498.93 | 0.003* |
| Travel history no | 1.803 | 0.675 | 2.672 | 5.0 | 1.67-25.00 | 0.008* |
| Educational status: masters | 1.058 | 0.744 | 1.423 | 2.9 | 0.65-12.49 | 0.155 |
| Educational status: OND/HND/bachelors | −0.389 | 0.909 | −0.428 | 0.7 | 0.11–4.07 | 0.669 |
| Educational status: PhD/fellowship | −0.075 | 0.850 | −0.088 | 0.9 | 0.17–4.92 | 0.930 |
| Educational status: SSCE/GCE | −1.116 | 0.976 | −1.143 | 0.3 | 0.04–2.07 | 0.253 |
| Age group: 31–40 | 2.320 | 1.071 | 2.166 | 10.2 | 1.33–92.25 | 0.030* |
| Age group: 41–50 | 2.440 | 1.449 | 1.684 | 11.5 | 0.70–213.19 | 0.092 |
| Age group: 51–60 | 1.373 | 2.063 | 0.666 | 3.9 | 0.07–234.85 | 0.506 |
| Age group: 61–69 | 2.600 | 2.902 | 0.896 | 13.5 | 0.05–4306.87 | 0.370 |
| Sex: male | 0.080 | 0.400 | 0.201 | 1.1 | 0.49–2.38 | 0.841 |

*Significant *p*-value.

1.67–25.00, $p = 0.008$) times more less likely to comply with the COVID-19 prevention protocols than those who have a travel history. Furthermore, undergraduate students were observed to be $36.1 \pm 1.22$ (95% CI 3.87–498.93, $p = 0.003$) times less likely to comply with the COVID-19 protocols than the academic staff in the veterinary colleges in Southeast Nigeria. Individuals in the age bracket of 31 to 40 years were also observed to be $10.2 \pm 1.07$ (95% CI 1.33–92.25, $p = 0.03$) times less likely to comply with the COVID-19 prevention protocols when compared with those within the age group of 19–30 years.

To derive the final model, a multivariate binary logistic analysis of various predictors of "adjusted" compliance to COVID-19 prevention protocols was performed using only the statistically significant predictors from the primary model. A Wald test performed on the residuals from the secondary model also indicated that Age group ($X^2 = 17.8$, $df = 4$, $p = 0.0013$) and role ($\chi^2 = 15.4$, $df = 3$, $p = 0.0015$) significantly contribute to the prediction of compliance (Table 7). The secondary model was further trained for internal cross-validation using the K-fold validation ($K = 10$, $n = 183$). The results showed that our secondary model (Log(C/1 − C) = 3.152 (undergraduate student) − 1.513 (travel history = yes) + 2.179 (age group 31–40) + 1.778 (Age group 41–50), where $C$ = probability of being noncompliant to COVID-19 preventive protocols) predicts compliance with 73% accuracy (Table 8).

## 4. Discussion

With the biggest global health crisis of the 21st century still ravaging the world, it is imperative to intensify research efforts across varied strata of the population. Our study was conceptualized from the need to assess what is on the ground around the two veterinary schools in Southeast Nigeria, centered on COVID-19 vaccination, perception, and compliance among the respondents. For most infectious diseases with a high magnitude of infection rate as well as mortality, mass vaccination is a key public health approach towards protection, prevention of spread, and control of such diseases [51]. Currently, the COVID-19 vaccine remains the most effective means to control this pandemic, and the goal should be that it be accepted by a good number of the population, comprising 70% of the world's population, for the pandemic to be combated [52]. Arising from the background of the dearth of information on COVID-19 vaccination status in veterinary schools in Nigeria, this study explored a close kit population of MOUAU and UNN. The findings will form a baseline study for the assessment of other veterinary schools in the different regions of Nigeria.

In this cross-sectional study, an overall low COVID-19 vaccine acceptability of 25% among the respondents was recorded, although different percentages when assessed according to age, gender, education status, role categories, and other demographic variables were observed. Comparing the findings from this study with several types of research conducted within and outside Nigeria, there is a level of similarity with the outcome of this study. In a review conducted by [17], a 20.0%–58.2% acceptance rate was calculated among Nigerians, which invariably showed a COVID-19 vaccine hesitancy rate of 41.5%–80%. Consequently, in some surveys carried out in some African countries, low COVID-19 acceptance rates of 13.5%, 31.4%, and 39.3% were recorded in Egypt, Ethiopia, and Ghana, respectively. On the contrary, some African countries like Uganda, the Democratic Republic of Congo, and South Africa recorded appreciable acceptance rates of 53.6%, 55.9%, and 63.3%, indicating a low hesitancy rate [53]. In a larger population like India, COVID-19 vaccine hesitancy provides a cause of worry. A nationwide survey that indicated myriads of reasons for nonacceptance of the vaccine [25] attributed concerns about the vaccine to safety and side effects, effectiveness, and the rapidness of COVID-19 vaccine development as major reasons why Indians were reluctant to be vaccinated. Females tend to be less disposed to accepting COVID-19 vaccination in the majority of studies, including this particular survey [17, 25]. The reasons are speculations that their fertility will be affected, causing them to be sterile or genetically affecting their children after birth [54]. These are all part of unfounded conspiracy theories without scientific backing, which have bedeviled vaccination programmes for long [55, 56]. Among other factors, the hesitation of the Nigerian populace to accept the vaccination against COVID-19 may be largely due to misconceptions about the effects of the vaccine on social media [23] (Salem 2021).

The result from this study supports previous findings on gender, where higher male respondents were vaccinated against COVID-19 than female respondents [25, 57]. Even when booster dose acceptability was assessed in India, 71% of the female population ($n = 462$) were unwilling to take the COVID-19 booster dose [58]. Out of the seven approved COVID-19 vaccine types in Nigeria, Moderna/Spikevax and Oxford/AstraZeneca/Vaxzervria remained the most used by respondents in this study which might be an off-shoot of more availability of these particular vaccines in Nigeria [59]. Another striking finding among the respondents in the veterinary colleges in Southeast Nigeria was that the older the age group, the higher the percentage number of vaccinated individuals. Several researchers have reported similar findings [27, 60, 61]; however, on the contrary, El-Elimat et al. [62] reported that in Jordan, age groups >35 years were found to be less likely to accept COVID-19 vaccines. Also, in the survey conducted by [25], the younger population showed more willingness to be vaccinated. No factor could be attributed to these variations in the age variable concerning vaccine acceptance. With an increase in COVID-19 vaccine acceptability, ranging from students to academic staff, one could deduce that maturity and enlightenment are integral to the refusal in accepting misinformation, disbelief, and fear of the unknown, which are some of the factors mitigating vaccine acceptance [52, 63]. Furthermore, most academic staff have reasons to travel for conferences, seminars/workshops, or further study, hence the need to get vaccinated. Another factor for consideration in the demography of the respondents is the travel history, which revealed from this study that individuals who travel more often were more likely to be vaccinated. Ban on travel for

Table 7: Residuals of secondary model.

| Predictors | Estimate | Standard error | $z$-score | $p$-value |
|---|---|---|---|---|
| (Intercept) | −0.991 | 0.788 | −1.257 | 0.209 |
| Category: non-teaching staff | −0.324 | 0.588 | −0.552 | 0.581 |
| Category: postgraduate student | 0.042 | 0.526 | 0.081 | 0.936 |
| Category: undergraduate student | 3.152 | 0.904 | 3.489 | 0.000* |
| Travel history: yes | −1.513 | 0.625 | −2.422 | 0.015* |
| Age group: 31–40 | 2.179 | 0.8 | 2.723 | 0.006* |
| Age group: 41–50 | 1.778 | 0.794 | 2.24 | 0.025* |
| Age group: 51–60 | 0.098 | 0.914 | 0.108 | 0.914 |
| Age group: 61–69 | 0.585 | 1.206 | 0.485 | 0.627 |

*Significant $p$-value.

Table 8: Results of model training for predictors of COVID-19 compliance.

| Predictors | Accuracy | Kappa | Remark* |
|---|---|---|---|
| Category + travel history + age group | 0.73 | 0.36 | Fair agreement |
| Category + age group | 0.74 | 0.10 | Slight agreement |
| Age group + travel history | 0.71 | 0.27 | Fair agreement |
| Age group | 0.70 | 0.22 | Fair agreement |
| Travel history | 0.67 | 0.09 | Slight agreement |
| Category | 0.67 | −0.03 | No agreement |

*Classification of Kappa value.

unvaccinated people became a top priority strategy to curb the spread of COVID-19 worldwide. This prompted people who travel for different purposes to quickly accept to be vaccinated [64–66]. International travel has been identified as a key factor in the spread of COVID-19, for instance, in less than two months after the first case of COVID-19 was reported in mainland China, international flights brought COVID-19 cases to 26 countries [67]. Therefore, many efforts were channelled to border control measures to prevent the further spread of COVID-19. One such measure is ensuring that individuals are fully vaccinated before leaving their home country and are screened upon arrival in the next country. It was not surprising to identify that about 50% of the individuals who had received the COVID-19 vaccines had a history of traveling either more than 10 times outside of the base or have embarked on international travel. Individuals with no travel history ($p = 0.008$) were significant negative predictors of the adjusted compliance to COVID-19 prevention protocol in this study.

Interestingly, assessment on perception and compliance in the context of this study elucidated good outcome, indicatting that about 80% of the respondents demonstrated good perception. It was identified that respondents within the age group of 31–40 years were 10.2 times less likely to be compliant with the COVID-19 prevention protocols. This may probably explain why this age group has been identified as the most vulnerable age group by the Nigerian Centre for Disease Control [68]. In addition, individuals who have not travelled abroad in the past 24 months were 5 times less likely to be compliant with the COVID-19 protocols than those who have. This finding depicts that the regulations governing international travel, force individuals to be compliant with the COVID-19 prevention protocols. Although recommended protective strategies against COVID-19 include the use of face masks, physical distancing, restrictions on social gatherings, and constant hand washing, were effective to an extent; more innovative interventions such as vaccination should be emphasized on [29, 30]. Several studies have outlined the factors that facilitate the willingness of individuals to get vaccinated with the COVID-19 vaccines. These factors include but are not limited to age, sex, educational status, gender, income, residency, occupation, marital status, race/ethnicity, perceived risk of COVID-19, trust in the health system, health insurance, norm, attitude towards vaccine, perceived benefits, perceived severity of COVID-19, perceived effectiveness of COVID-19 vaccine, beliefs, and online conspiracies [53, 69, 70].

In this study, we identified that above 70% of the respondents had a good perception of the established COVID-19 prevention measures, which include the use of face mask, hand washing/use of hand sanitizer, keeping social distance, self-isolation, and COVID-19 vaccination. Consistent with our findings, studies in Ethiopia and Nigeria, revealed that high perception rate among respondents towards COVID-19 vaccines are associated with willingness to receive the vaccine and comply with the COVID-19 prevention protocols [71, 72]. Conversely, it was observed that though the respondents in this study had a good perception of COVID-19, they exhibited a poor compliance attitude. This may not be unrelated to the myths associated with the conspiracy theories propagated on the Internet [69].

Generally, the result of vaccine acceptance of 25% recorded in this survey was below the national average of 50% vaccination coverage reported by the Nigerian Honourable Minister of Health in March 2021 [70]. Our finding was also below the 29% of individuals vaccinated against COVID-19 reported by Njoga et al. [72]. Therefore, more insight has been created as a result of this study, and it is advocated that support and encouragement should be given for widespread surveys of this nature to bring to limelight the actual situation on the ground, especially in the hinterlands where electronic/internet-based surveys are limited. It is imperative to note that creating better awareness and increasing COVID-19 vaccination coverage will play a major role in mitigating the effects of other variants (Omicron and Delta strains) and slowing down the mutation process that may herald the emergence of virulent future strains [73].

## 5. Conclusion

In summary, our study showed that only 25.1% of the respondents from the veterinary colleges in Southeast Nigeria had been vaccinated with the COVID-19 vaccine. We also established that the most vulnerable age group (31–40 years), as identified by the NCDC, had 10 times the odds of noncompliance with the COVID-19 prevention protocols. Although the perception of the COVID-19 prevention protocol was good, compliance with the protocol was poor among the respondents. Hence, there is a need to employ a holistic measure through community networks to create awareness and channels for dialogue on COVID-19 prevention measures among faculty members in veterinary colleges in southeast Nigeria.

## Data Availability

The data used to support the findings of this study are included within the article. More detailed data used to support the findings of this study are available through the given link: https://forms.gle/a1kKt9X7j2dBYPk2A.

## Ethical Approval

Ethical approval for the conduct of this study was sought on January, 2022. After fulfilling all the necessary conditions, the approval was granted in March 2022 (Ref No: VPH/REC/201/021).

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

## Supplementary Materials

Supplementary material contains questionnaire validation documents ethical approval certificate. (*Supplementary Materials*)

## References

[1] World Health Organisation, "COVID-19 situation reports," 2022, https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports.

[2] L. Kirubananthan, R. Illuri, R. Rajendran, and P. R. Chandrasekaran, "Mechanism and Transmission Routes of COVID-19," *Environmental and Health Management of Novel Coronavirus Disease*, vol. 19, pp. 65–88, 2021.

[3] M. M. Lamers and B. L. Haagmans, "SARS-CoV-2 pathogenesis," *Nature Reviews Microbiology*, vol. 20, no. 5, pp. 270–284, 2022.

[4] B. Rockx, T. Kuiken, S. Herfst et al., "Comparative pathogenesis of COVID-19, MERS, and SARS in a nonhuman primate model," *Science*, vol. 368, no. 6494, pp. 1012–1015, 2020.

[5] W. Guan, Z. Ni, Y. Hu et al., "Clinical characteristics of coronavirus disease 2019 in China," *New England Journal of Medicine*, vol. 382, no. 18, pp. 1708–1720, 2020.

[6] A. Parasher, "COVID-19: current understanding of its pathophysiology, clinical presentation and treatment," *Postgraduate Medical Journal*, vol. 97, no. 1147, pp. 312–320, 2021.

[7] M. T. Heneka, D. Golenbock, E. Latz, D. Morgan, and R. Brown, "Immediate and long-term consequences of COVID-19 infections for the development of neurological disease," *Alzheimer's Research and Therapy*, vol. 12, no. 1, pp. 1–3, 2020.

[8] S. Lopez-Leon, T. Wegman-Ostrosky, C. Perelman et al., "More than 50 long-term effects of COVID-19: a systematic review and meta-analysis," *Scientific Reports*, vol. 11, no. 1, pp. 1–12, 2021.

[9] L. P. Colvero, L. Y. B. Villarreal, C. A. Torres, and P. E. Brandão, "Assessing the economic burden of avian infectious bronchitis on poultry farms in Brazil," *Revue Scientifique et Technique de l'OIE*, vol. 34, no. 3, pp. 993–999, 2015.

[10] Y. S. Malik, D. P. Patnayak, and S. M. Goyal, "Detection of three avian respiratory viruses by single-tube multiplex reverse transcription-polymerase chain reaction assay," *Journal of Veterinary Diagnostic Investigation*, vol. 16, no. 3, pp. 244–248, 2004.

[11] S. Payne, "Family Coronaviridae," *Viruses*, vol. 149, p. 158, 2017.

[12] J. K. A. Cook, M. Jackwood, and R. C. Jones, "The long view: 40 years of infectious bronchitis research," *Avian Pathology*, vol. 41, no. 3, pp. 239–250, Article ID 680432, 2012.

[13] F. Amanat and F. Krammer, "SARS-CoV-2 vaccines: status report," *Immunity*, vol. 52, no. 4, pp. 583–589, 2020.

[14] P. Fine, K. Eames, and D. L. Heymann, "Herd immunity": a rough guide," *Clinical Infectious Diseases*, vol. 52, no. 7, pp. 911–916, 2011.

[15] B. Murele, R. Vaz, A. Gasasira, P. Mkanda, T. Erbeto, and J. Okeibunor, "Vaccine perception among acceptors and non-acceptors in Sokoto State, Nigeria," *Vaccine*, vol. 32, no. 26, pp. 3323–3327, 2014.

[16] H. Adedeji-Adenola, O. A. Olugbake, and S. A. Adeosun, "Factors influencing COVID-19 vaccine uptake among adults in Nigeria," *PLoS One*, vol. 17, no. 2, Article ID e0264371, 2022.

[17] O. Olu-Abiodun, O. Abiodun, and N. Okafor, "COVID-19 vaccination in Nigeria: a rapid review of vaccine acceptance rate and the associated factors," *PLoS One*, vol. 17, no. 5, Article ID e0267691, 2022.

[18] J. K. Ward, F. Gauna, A. Gagneux-Brunon et al., "The French health pass holds lessons for mandatory COVID-19 vaccination," *Nature Medicine*, vol. 28, no. 2, pp. 232–235, 2022.

[19] C. N. P. Mbachu, C. M. C. Azubuike, I. I. Mbachu et al., "COVID-19 infection: knowledge, attitude, practices, and impact among healthcare workers in a South-Eastern Nigerian State," *J Infect Dev Ctries*, vol. 14, no. 9, pp. 943–952, 2020.

[20] A. S. Jegede, "What led to the Nigerian boycott of the polio vaccination campaign?" *PLoS Medicine*, vol. 4, no. 3, p. e73, 2007.

[21] World Health Organisation, *Polio Eradication—Global Status and Progress,* vol. 17,World Health Organization, Geneva, Switzerland.

[22] L. I. Anorue, A. C. Ugwu, S. U. Ugboaja, U. O. Nwabunze, C. C. Ugwulor-Onyinyechi, and C. Njoku, "Communicating COVID-19 vaccine safety: knowledge and attitude among residents of South east, Nigeria," *Infection and Drug Resistance*, vol. 14, pp. 3785–3794, 2021.

[23] L. M. Bogart, B. O. Ojikutu, K. Tyagi et al., "COVID-19 related medical mistrust, health impacts, and potential vaccine hesitancy among black Americans living with HIV," *JAIDS*

*Journal of Acquired Immune Deficiency Syndromes*, vol. 86, no. 2, pp. 200–207, 2021.

[24] W. Bai, H. Cai, S. Liu et al., "Attitudes toward COVID-19 vaccines in Chinese college students," *International Journal of Biological Sciences*, vol. 17, no. 6, pp. 1469–1475, 2021.

[25] S. Chandani, D. Jani, P. K. Sahu et al., "COVID-19 vaccination hesitancy in India: state of the nation and priorities for research," *Brain Behav Immun Health*, vol. 18, Article ID 100375, 2021.

[26] R. S. Morris, "SARS-CoV-2 spike protein seropositivity from vaccination or infection does not cause sterility," *F&S reports*, vol. 2, no. 3, pp. 253–255, 2021.

[27] J. V. Lazarus, S. C. Ratzan, A. Palayew et al., "A global survey of potential acceptance of a COVID-19 vaccine," *Nature Medicine*, vol. 27, no. 2, pp. 225–228, 2021.

[28] Reuters, "Nigeria: The Latest Coronavirus Counts, Charts and Maps," 2022, https://graphics.reuters.com/world-coronavirus-tracker-and-maps/countries-and-territories/nigeria/.

[29] World Health Organisation, "COVID-19 Vaccines Advice," 2021, https://www.who.int/emergencies/diseases/novel-coronavirus-2019/covid-19-vaccines/advice.

[30] U. M. Chukwuocha, C. O. Emerole, G. N. Iwuoha et al., "Stakeholders' hopes and concerns about the COVID-19 vaccines in Southeastern Nigeria: a qualitative study," *BMC Public Health*, vol. 22, no. 1, p. 330, 2022.

[31] E. Aysin and M. Urhan, "Dramatic increase in dietary supplement use during covid-19," *Current Developments in Nutrition*, vol. 5, no. 2, p. 207, 2021.

[32] K. W. Chan, V. T. Wong, and S. C. W. Tang, "COVID-19: an update on the epidemiological, clinical, preventive and therapeutic evidence and guidelines of integrative Chinese-western medicine for the management of 2019 novel coronavirus disease," *The American Journal of Chinese Medicine*, vol. 48, no. 3, pp. 737–762, 2020.

[33] V. Paudyal, S. Sun, R. Hussain, M. H. Abutaleb, and E. W. Hedima, "Complementary and alternative medicines use in COVID-19: a global perspective on practice, policy and research," *Research in Social and Administrative Pharmacy*, vol. 18, no. 3, pp. 2524–2528, 2022.

[34] A. Puścion-Jakubik, J. Bielecka, M. Grabia et al., "Consumption of food supplements during the three COVID-19 waves in Poland—focus on zinc and vitamin D," *Nutrients*, vol. 13, no. 10, p. 3361, 2021.

[35] B. Vellingiri, K. Jayaramayya, M. Iyer et al., "COVID-19: a promising cure for the global panic," *Science of the Total Environment*, vol. 725, Article ID 138277, 2020.

[36] A. N. Bitar, M. Zawiah, F. Y. Al-Ashwal et al., "Misinformation, perceptions towards COVID-19 and willingness to be vaccinated: a population-based survey in Yemen," *PLoS One*, vol. 16, no. 10, Article ID e0248325, 2021.

[37] T. Nuzhath, S. Tasnim, R. K. Sanjwal et al., "COVID-19 Vaccination Hesitancy, Misinformation and Conspiracy Theories on Social media," *A Content Analysis of Twitter Data*, vol. 23, 2020.

[38] I. A. Kretchy, J. A. Boadu, J. P. Kretchy et al., "Utilization of complementary and alternative medicine for the prevention of COVID-19 infection in Ghana: a national cross-sectional online survey," *Preventive Medicine Reports*, vol. 24, Article ID 101633, 2021.

[39] L. Atlani-Duault, B. Lina, F. Chauvin, J. F. Delfraissy, and D. Malvy, "Immune evasion means we need a new COVID-19 social contract," *The Lancet Public Health*, vol. 6, no. 4, pp. e199–e200, 2021.

[40] K. Kupferschmidt, "New mutations raise specter of 'immune escape," *Science*, vol. 371, no. 6527, pp. 329-330, 2021.

[41] B. J. Willett, J. Grove, O. A. MacLean et al., "SARS-CoV-2 Omicron is an immune escape variant with an altered cell entry pathway," *Nature microbiology*, vol. 7, no. 8, pp. 1161–1179, 2022.

[42] R Core Team, *R: A Language and Environment for Statistical Computing*, R Foundation for Statistical Computing, Vienna, Austria, 2022.

[43] H. Wickham and J. Bryan, "Readxl: Read Excel Files," 2022, https://CRAN.R-project.org/package=readxl.%20R%20package%20version%201.4.0.%202.

[44] H. Wickham, R. Francois, H. Lionel, and K. Muller, "Dplyr: A Grammar of Data Manipulation," 2022, https://CRAN.R-project.org/package=dplyr.

[45] H. Wickham, *ggplot2: Elegant Graphics for Data Analysis*, Springer-Verlag, Berlin, Germany, 2016.

[46] W. Revelle, "Procedures for Psychological, Psychometric, and Personality Research," 2017, http://personality-project.org/r/psych.

[47] A. Cannon, G. Cobb, B. Hartlaub et al., "Datasets for the textbook Stat2: modeling with regression and ANOVA," *The Package Also Includes Data for the First Edition, Stat2: Building Models for a World of Data and a Few Functions for Plotting Diagnostics*, W.H.Freeman & Co Ltd Location, New York, NY, USA, 2 edition, 2019.

[48] M. Kuhn, "Caret: Classification and Regression Training," 2022, https://cran.r-project.org/package=caret.

[49] J. C. Stoltzfus, "Logistic regression: a brief primer," *Academic Emergency Medicine*, vol. 18, no. 10, pp. 1099–1104, 2011.

[50] R. D. Cook, "Detection of influential observations in linear regression," *Technometrics*, vol. 22, pp. 494–508, 1977.

[51] O. A. Adesegun, T. Binuyo, O. Adeyemi et al., "The COVID-19 crisis in sub-saharan Africa: knowledge, attitudes, and practices of the Nigerian public," *The American Journal of Tropical Medicine and Hygiene*, vol. 103, no. 5, pp. 1997–2004, 2020.

[52] M. Marti, M. de Cola, N. E. MacDonald, L. Dumolard, and P. Duclos, "Assessments of global drivers of vaccine hesitancy in 2014 - looking beyond safety concerns," *PLoS One*, vol. 12, no. 3, Article ID e0172310, 2017.

[53] A. D. Wake, "The willingness to receive COVID-19 vaccine and its associated factors: "vaccination refusal could prolong the war of this pandemic" - a systematic review," *Risk Management and Healthcare Policy*, vol. 14, pp. 2609–2623, 2021.

[54] V. J. Hall, S. Foulkes, A. Saei et al., "COVID-19 vaccine coverage in health-care workers in England and effectiveness of BNT162b2 mRNA vaccine against infection (SIREN): a prospective, multicentre, cohort study," *The Lancet*, vol. 397, no. 10286, pp. 1725–1735, 2021.

[55] A. Bish, L. Yardley, A. Nicoll, and S. Michie, "Factors associated with uptake of vaccination against pandemic influenza: a systematic review," *Vaccine*, vol. 29, no. 38, pp. 6472–6484, 2011.

[56] C. I. Amuzie, F. Odini, K. U. Kalu et al., "COVID-19 vaccine hesitancy among healthcare workers and its socio-demographic determinants in Abia State, Southeastern Nigeria: a cross-sectional study," *Pan African Medical Journal*, vol. 40, p. 10, 2021.

[57] S. Zintel, C. Flock, A. L. Arbogast, A. Forster, C. von Wagner, and M. Sieverding, "Gender differences in the intention to get vaccinated against COVID-19: a systematic review and meta-analysis," *Journal of Public Health*, vol. 1, pp. 1–25, 2022.

[58] G. C. Achrekar, K. Batra, Y. Urankar et al., "Assessing COVID-19 booster hesitancy and its correlates: an early evidence from India," *Vaccines*, vol. 10, p. 1048, 2022.
[59] A. I. Al-Mustapha, M. Oyewo, A. S. Olugbon, and N. Elelu, "A mix and match approach to COVID-19 vaccinations: does Nigeria have a choice?" *Frontiers in Public Health*, vol. 9, Article ID 755974, 2021.
[60] M. Al-Mohaithef and B. K. Padhi, "<p>Determinants of COVID-19 vaccine acceptance in Saudi arabia: a web-based national survey</p&gt," *Journal of Multidisciplinary Healthcare*, vol. 13, pp. 1657–1663, 2020.
[61] A. A. Malik, S. M. McFadden, J. Elharake, and S. B. Omer, "Determinants of COVID-19 vaccine acceptance in the US," *EClinicalMedicine*, vol. 26, Article ID 100495, 2020.
[62] T. El-Elimat, M. M. AbuAlSamen, B. A. Almomani, N. A. Al-Sawalha, and F. Q. Alali, "Acceptance and attitudes toward COVID-19 vaccines: a cross-sectional study from Jordan," *PLoS One*, vol. 16, no. 4, Article ID e0250555, 2021.
[63] J. Tobin, A. Rogers, I. Winterburn et al., "Hospice care access inequalities: a systematic review and narrative synthesis," *BMJ Support Palliat Care*, vol. 12, no. 2, pp. 142–151, 2021.
[64] K. A. Grépin, T.-L. Ho, Z. Liu et al., "Evidence of the effectiveness of travel-related measures during the early phase of the COVID-19 pandemic: a rapid systematic review," *BMJ Global Health*, vol. 6, no. 3, Article ID e004537, 2021.
[65] S. X. W. Gwee, P. E. Y. Chua, M. X. Wang, and J. Pang, "Impact of travel ban implementation on COVID-19 spread in Singapore, Taiwan, Hong Kong and South Korea during the early phase of the pandemic: a comparative study," *BMC Infectious Diseases*, vol. 21, no. 1, p. 799, 2021.
[66] A. J. Kucharski, M. Jit, J. G. Logan et al., "Travel measures in the SARS-CoV-2 variant era need clear objectives," *The Lancet*, vol. 399, no. 10333, pp. 1367–1369, 2022.
[67] C. R. Wells, P. Sah, S. M. Moghadas et al., "Impact of international travel and border control measures on the global spread of the novel 2019 coronavirus outbreak," *Proceedings of the National Academy of Sciences*, vol. 117, no. 13, pp. 7504–7509, 2020.
[68] Z. Hassan, M. J. Hashim, and G. Khan, "Population risk factors for COVID-19 deaths in Nigeria at sub-national level," *The Pan African medical journal*, vol. 35, no. 2, pp. 1–10, 2020.
[69] T. Akther and T. Nur, "A model of factors influencing COVID-19 vaccine acceptance: a synthesis of the theory of reasoned action, conspiracy theory belief, awareness, perceived usefulness, and perceived ease of use," *PLoS One*, vol. 17, no. 1, Article ID e0261869, 2022.
[70] I. C. Uzochukwu, G. U. Eleje, C. H. Nwankwo et al., *COVID-19 Vaccine Hesitancy Among Staff and Students in a Nigerian Tertiary Educational Institution*, SAGE Publications, Thousand Oaks, CA, USA, 2021.
[71] M. Adane, A. Ademas, and H. Kloos, "Knowledge, attitudes, and perceptions of COVID-19 vaccine and refusal to receive COVID-19 vaccine among healthcare workers in northeastern Ethiopia," *BMC Public Health*, vol. 22, no. 1, pp. 1–14, 2022.
[72] E. O. Njoga, P. P. Mshelbwala, K. O. Abah et al., "COVID-19 vaccine hesitancy and determinants of acceptance among healthcare workers, academics and tertiary students in Nigeria," *Vaccines*, vol. 10, no. 4, p. 626, 2022.
[73] A. B. Suthar, J. Wang, V. Seffren, R. E. Wiegand, S. Griffing, and E. Zell, "Public health impact of covid-19 vaccines in the US: observational study," *BMJ*, vol. 377, Article ID e069317, 2022.