International Journal of Design & Nature and Ecodynamics
Vol. 18, No. 1, February, 2023, pp. 219-224
Journal homepage: http://iieta.org/journals/ijdne

# On COVID-19 Vaccination in Nigeria: An Empirical Study

Olumide S. Adesina[1], Adedayo F. Adedotun[2*], Nureni O. Adeboye[3], Tolulope F. Adesina[4], Hilary I. Okagbue[2], Ayobami F. Gboyega[1]

[1] Department of Mathematics & Statistics, Redeemers University Nigeria, Ede 232101, Osun State, Nigeria
[2] Department of Mathematics, Covenant University, Ota 112101, Ogun State, Nigeria
[3] Department of Statistics, Osun State University, Osogbo 210001, Osun State, Nigeria
[4]Department of Banking and Finance, Covenant University, Ota 112101, Ogun State, Nigeria

Corresponding Author Email: adedayo.adedotun@covenantuniversity.edu.ng

https://doi.org/10.18280/ijdne.180128

**Received:** 6 September 2022
**Accepted:** 20 December 2022

***Keywords:***
*COVID-19, healthcare workers, vaccination, logistic regression, cross-validation*

**ABSTRACT**

This study assessed the knowledge and perception of Nigerians about COVID-19 vaccination. A cross-sectional survey was conducted comprising Health and Non-health workers in Nigeria. The knowledge, attitude, and perception of respondents on COVID-19 vaccination in Nigeria was obtained through an online. Logistic regression was employed to determine which factor imparted on COVID-19 vaccination decision. The study showed a significant relationship between COVID-19 vaccination and immigration requirements. The survey showed that 74.07% of the health workers had been vaccinated, while 47.06% of non-Health Workers had been vaccinated. This study recommends that Governments at all levels should create more awareness of the importance of COVID-19 vaccination to increase the number of vaccinated individuals.

## 1. INTRODUCTION

A recently identified coronavirus, SARS-CoV-2, is what causes the 2019 coronavirus disease, also known as COVID-19. It is thought that this new infection first surfaced in December 2019 in Wuhan City, Hubei Province, China. The World Health Organization (WHO) classified COVID-19 as a pandemic on March 11, 2020 [1]. This emerging illness has sickened more than 170 million people worldwide and resulted in more than 3 million fatalities as of early June 2021 [1].

The emergence of acute upper respiratory tract infections in humans caused by the coronavirus, which have claimed many lives, has called for the urgent need to curb the spread, hence the need for vaccination against the pandemic. Kahn et al. [2-4] discussed the negative impact of the coronavirus from 2002 to 2003 until the recent occurrence, which was first discovered in late 2019 in Wuhan, China. Various forms of coronavirus have been newly discovered, such as delta and omicron, mutations of the SARS virus.

The first case of COVID-19 in Nigeria was reported on February 27, 2020, in Lagos, and as of March 23, 2022, there were 255,190 cases reported [3]. The management of the pandemic is primarily dependent on strict adherence to the advised precautionary measures, the administration of vaccines, and the use of recently approved medications for the treatment of COVID-19 patients given the high global disease burden and associated fatalities. The general public's knowledge, attitudes, and perception of risk have the biggest impact on the effectiveness of these measures. In the end, the knowledge, attitude, and risk perception of the individual play a significant role in influencing decisions involving risky behaviors. People with low-risk perceptions tend to reduce preventive behavior, whereas those with high-risk perceptions tend to engage in preventive behavior.

Vaccines help prevent infectious diseases, which often lead to mortality of people in the past. It is essential to control the spread of infectious diseases because of the damage it has caused to human lives [5]. The studies [6-12] showed that vaccination has significantly reduced the rate of spread of infectious diseases. History shows that Edward Jenner was the founder of vaccinology in 1796 when he was trying to inoculate against smallpox. Since then, other vaccines have been produced to inoculate against epidemics such as polio, Cholera Vaxchora, Yellow fever, Human Papillomavirus (HPV), Hepatitis B. to mention but a few [13].

In the same vein, producing and administering the COVID-19 vaccines would help to reduce the spread the virus [10] [11].

More than 100 COVID-19 vaccines are currently being developed [14]. The Food and Drug Administration (FDA) authorized Moderna and Pfizer/BioNTech COVID-19 vaccines in a mass immunization program about 11 months after the disease first emerged [15]. About 43,661 people were enrolled in stage three clinical trials for Pfizer/BioNTech vaccines and 30,000 people were enrolled for Moderna vaccines [16, 17]. The outcomes of the clinical trials showed that these vaccines can shield recipients from COVID-19 infections by generating antibodies and granting immunity to the virus [15]. Other businesses are also competing to develop vaccines and are nearing the end of trials. The United Kingdom was one of the first nations to begin administering the COVID-19 vaccine to large populations [18]. Other vaccines use a variety of other types of antigen, such as viral vector, attenuated virus, and inactivated virus, in contrast to Moderna and Pfizer, which use mRNA as the active ingredient [19]. A recent development in vaccine development is the use of messenger RNA (mRNA), which instructs cells to produce an antigen-acting protein.

Most importantly, an individual vaccinated in COVID-19

vaccination would not feel the impact of the virus as much as a person who is not vaccinated. However, preventive measures such as washing hands, wearing a nose mask, and keeping social distance would still be observed after being vaccinated. According to the Ministry of Health in Ontario Canada [20], vaccines teach one's immune system to recognize and fight against the COVID-19 virus, thereby preventing illness should one contract the virus. COVID-19 vaccines such as Pfizer, AstraZeneca, and Moderna are being taken, and more vaccines are being developed to combat COVID-19. The associated side effects of the COVID-19 vaccines that may occur include but are not limited to pain and swelling on the spot injected (usually the left shoulder), tiredness, headache, mild fever, and severe rare side effects. The study [21] consists of the factors that contribute to the acceptance of the COVID-19 vaccination.

The next obstacle will be overcoming vaccine hesitancy as safe and effective vaccines are made available. One of the current health threats is vaccine hesitancy, which is defined as the unwillingness to receive a vaccine despite its availability [22]. The health belief model (HBM) was used by Wong et al. [23] to conduct a population-based study on the acceptance of the COVID-19 vaccine in Hong Kong. They discovered that perceived vaccine benefits, perceived severity, cues to action, self-reported health outcomes, and trust were all strong signs of acceptance. The perception of infection vulnerability did not significantly predict acceptance, whereas the perception of access barriers and harm did [23]. In addition, a community-based study discovered that people's desire to receive the COVID-19 vaccine has decreased significantly throughout the pandemic, with more than half of the population being reluctant or unwilling to receive the vaccine [24]. Before the introduction of a potent vaccine against COVID-19, false information and unfounded rumors about the disease were widely disseminated on social media platforms [25]. Some have sensationalized the use of mRNA genetic material in several vaccines by asserting falsely that the vaccine can change human DNA [26]. Additionally, even among the medical staff, concerns have reportedly been raised about the safety and long-term effects of COVID-19 vaccines due to their rapid development [26]. The results of studies involving healthcare professionals (HCWs) are concerning because a small number of HCWs do not plan to receive the COVID-19 vaccine [26, 27].

Rey et al. [28] highlighted the vaccine risk-benefit analysis and why people would generally avoid vaccination and COVID-19 hesitancy [29]. Since the emergence of the novel Coronavirus, many studies have been conducted. Studies relating to knowledge, attitude, and practices among health professionals can be found in the studies [30-35]. Noh and Danuser [36] presented the estimation procedure for computing the fraction of COVID-19 infected people, and the method is applicable worldwide. Angelo et al. [37-40] are studies relating to the attitude and practices of health-workers towards COVID-19 vaccination.

In most of the affected nations, the rate of infection has slowed, and various levels of lock-downs imposed to slow the virus' spread have been lifted. In the light of the public perceptions about vaccines and COVID-19 vaccines, this study intends to identify the knowledge, attitude, and perception of Health and Non-health care workers towards COVID-19 vaccination in Nigeria. The research design is a cross-sectional data analysis approach, where data were gotten from different categories of individuals at a single time. The study will also help determine the motive of Nigerians behind taking the COVID-19 vaccine. Furthermore, this study's outcome would help determine if immigration requirements are a significant reason why Nigerians take the COVID-19 vaccines.

## 2. MATERIAL AND METHODS

This research evaluates the knowledge and perception of health and non-healthcare workers towards COVID-19 vaccination in Nigeria. Empirical data are collected by examining google based questionnaires on both divides of personnel. This research considered two hundred and forty-one (241) questionnaires, being the total responses received from the online survey carried out through. Statistical techniques such as binary logistic regression, correlation analysis, t-test, and Chi-square were adopted after a leave-one-out cross-validation exercise was carried out on the data generated.

### 2.1 Logistic regression

The logistic regression and support vector machine techniques are used to analyze the data. The basic assumptions of logistic regression model are (i) the response variable is binary (ii) the observations are independent of each other (iii) there is a linear relationship between explanatory variables and the logit of the response variable. The response variables in this study are vaccinated and unvaccinated personality; thus, it is binary and can only be modelled using logistic regression. Therefore, the binary logit model is considered in this study as appropriate to model an outcome's probability. A simple linear regression model is of the form:

$$Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i \tag{1}$$

The logistic regression uses the logistic function

$$P(X) = \frac{e^{\beta_0+\beta_1 X}}{1+e^{\beta_0+\beta_1 X}} \tag{2}$$

where, $\beta_0$ and $\beta_2$ are the parameter of interest.

From (2) we obtain the odd ratio expressed as

$$\frac{P(X)}{1-P(X)} = e^{\beta_0+\beta_1 X} \tag{3}$$

Further workings give

$$log\left(\frac{P(X)}{1-P(X)}\right) = \beta_0 + \beta_1 X \tag{4}$$

The left-hand side of Eq. (3) and Eq. (4) is known as odd ratio and logit or log-odds respectively. The odds ratio represents the constant effect of a predictor $X$, on the likelihood that an outcome will occur.

The parameters $\beta_0 + \beta_1$ in equation Eq. (2) to Eq. (4) can be obtained using the maximum likelihood estimation approach.

The response variable for vaccination status was coded (Not Vaccinated=0, vaccinated=1), the first independent variable VIR (vaccinated based on immigration requirements) was coded as (No=0, may be=1, and Yes=2) and the second independent variable is VNA (vaccine not readily available).

### 2.2 Cross-Validation

The leave-one-out cross-validation is a special case of cross-validation where the number of folds equals the number of instances in the data set. It means that one observation will be used for testing while the remaining data will serve as the training set, and this would be done for each observation in the dataset. The idea of Cross-validation in applied machine learning enables a given model to learn from unseen data. It estimates how the model is expected to perform in general when used to make predictions on data. In leave-one-out cross-validation, the rest of the data would be used for training while one datum would be used for the test part, and the process continues until the whole process is completed for the entire dataset [41]. The software package by James et al. [42] was used for implementing the analyses packages such as [43] and [44] was also used from the R library and the study of Wong et al. [45]. The leave-one-out cross-validation is computed using

$$CV_{(n)} = \frac{1}{n}\sum_{i=1}^{n} MSE_i \tag{5}$$

where, $MSE$ is the mean square error of the data set.

## 3. RESULTS

An online survey was conducted on the vaccination status of Nigerians between 30th November 2021 and 4th January 2022 with the aid of James et al. [46]. The survey data aim to harvest the perception of Nigerians on the COVID-19 vaccination, which was introduced to combat the spread of Covid-19 across the globe. The results from the survey showed that 54 (22.4%) are health workers, while 187 (77.6%) are non-health workers. 120 (49.8%) males and 121 (50.2%) females, the percentage of male and female respondents are almost the same. Respondents who practice Christianity are 220 (91.3%), while Muslims are 21 (8.7%). Table 1 shows that 110 (50%) of Christians have been vaccinated and the 110 (50%) have not been vaccinated. While 18 (85.71%) of Muslims respondents have been vaccinated, and 3 (14.28%) of Muslim respondents have not been vaccinated. Respondents from Lagos, Ogun, Oyo, and Osun were 208 (86.31%), while respondents from other states in Nigeria were 33 (13.7%). The survey also showed that 128 (53.1%) respondents have been vaccinated, while 113 (46.9%) have not been vaccinated.

On the questions relating to why people would not want to take the COVID-19 vaccine, responses from the questionnaire revealed that 69 (28.6%) lacked correct information about the vaccine. 2 (0.8%) opined that it was due to religious reasons, 44 (18.3%) said it was due to the associated side effects. 6 (2.5%) said it was because of an underlying ailment, 82 (34.0%) could not give any reason in particular, and 38 (15.8%) mentioned other reasons. The responses from the respondents show that other reasons why people would not take the vaccine include (i) They have trust issues with ability of the COVID-19 vaccines preventing people from contracting the virus (ii) Little or no research on the potency of the vaccnines (iii) Inadequate information about COVID-19 Vaccine (iv) Health status or lactating mother, and (v) uncertainties as relates to the vaccines.

**Table 1.** Cross-tabulation of Religion and Vaccination status

| | | COVID-19 Vaccination Status | | Total |
|---|---|---|---|---|
| | | Vaccinated | Not Vaccinated | Vaccinated |
| Religion | Christianity | 110 | 110 | 220 |
| | Muslim | 18 | 3 | 21 |
| Total | | 128 | 113 | 241 |

Null hypothesis: There is no association between religion and vaccination status.

The Chi-square test was conducted based on the contingency table (Table 1) to determine the if there was significant association between religion and vaccination status. The hypothesis of no association was rejected at Chisq = 14.717, p-value = 0.005325. We concluded that Muslim folks believes more in the vaccine than the Christians.

### 3.1 Modelling and testing

In this section, modelling and statistical tests such as tests for independence, and one sample t-test were conducted and the results are presented in Tables. Table 2 contains the logistic regression modelling results with the leave out one cross-validation error of 0.2166.

**Table 2.** Logistic regression output

| | Estimate | Std. Error | z value | Pr(>\|z\|) |
|---|---|---|---|---|
| (Intercept) | 1.09419 | 0.37827 | 2.893 | 0.00382 |
| VIR | -0.99833 | 0.17839 | -5.596 | 2.19e-08 |
| VNA | -0.08869 | 0.11980 | -0.740 | 0.45911 |

From Table 2, each one-unit change in the number of people who would take the COVID-19 vaccine based on travel requirements will decrease the log odds of Vaccination status by 0.9983, and its p-value indicates that it is significant in determining vaccination status. Also, each one-unit change in the number of people who have not taken COVID-19 because the vaccine was not readily available will decrease the log odds of Vaccination status by 0.0887. However, the p-value indicates that it is insignificant in determining vaccination status. The response variable for vaccination status was coded (Not Vaccinated=0, vaccinated=1), the independent variable "vaccinated based on immigration requirements," was coded as (No=0, may be=1, and Yes=2). Since VIR is significant; from Eq. (2), we calculate the probability as follows:

$$Pr\left(C.V = Yes | TR = Yes\right) = 0.28854$$
$$Pr(C.V = Yes \mid TR = No) = 0.74917$$

where, $C.V$ stands for COVID-19 vaccinated, and $T.R$ stands for travel requirements.

Therefore, the probability of an individual taking COVID-19 vaccination based on immigration requirements is 0.2885, while the likelihood of taking COVID-19 vaccination without a condition attached is 0.7492. The results suggest that

majority of the people who accepted to take the COVID-19 vaccines took it so as to meet one of the immigration requirements.

**Table 3.** Tabulation for the test of association between COVID-19 vaccination status and category of workers

| Nature of work | Vaccinated | Not Vaccinated | Total |
|---|---|---|---|
| Health Worker | 40 | 14 | 54 |
| Non-Health Worker | 88 | 99 | 187 |
| Total | 128 | 113 | 241 |

Table 3 showed that 40 (74.074%) of the health workers have been vaccinated, while 88 (47.058%) of non-Health Workers have been vaccinated. The null hypothesis that there is no association between the category of workers (Health and non-health workers) and the number of vaccinated individuals were rejected at $\chi^2 = 12.28$, and p-value = 0.000458. The results showed that health workers are well-informed on the need to be vaccinated.

**Table 4.** T-Test for the significance of Knowledge, Perception, and Attitude of Respondents on COVID-19 Vaccination

| | T | Df | Sig.(2-tailed) | Mean Difference | 95% L-C.I | 95% U-C.I |
|---|---|---|---|---|---|---|
| Knowledge | 8.875 | 240 | 0.000 | .631 | 0.49 | 0.77 |
| Perception | -42.941 | 240 | 0.000 | -2.266 | -2.37 | -2.16 |
| Attitude | -14.538 | 240 | 0.000 | -.763 | -0.87 | -0.66 |

From Table 4, which presents results on knowledge of the subject of COVID-19 Vaccination; the null hypothesis that the respondents do not have significant knowledge of the issue of Vaccination was rejected at a T-value of 8.875, with 240 degrees of freedom, p-value, the test value was "3" being neutral view. We then conclude that the respondents are knowledgeable about COVID-19 Vaccination—95% L-C. It stands for a 95% lower confidence interval of the difference while 95% U-C. I stand for a 95% upper confidence interval of the difference.

On perception, the null hypothesis of the respondents having conservative ideas on the subject of Vaccination was rejected at the t-value degree of freedom, p-value. We then conclude that the respondents are not conservative about the idea of COVID-19 Vaccination. Finally, on attitude, the null hypothesis of the respondents having a repulsive attitude towards COVID-19 Vaccination was rejected at the t-value degree of freedom, p-value. We then conclude that the respondents do not have a repulsive attitude toward COVID-19 Vaccination.

## 4. CONCLUSION

The COVID-19 pandemic is currently affecting every country on earth. High levels of anxiety and serious psychological issues have also been brought on by this pandemic in addition to numerous health issues. Without a doubt, the healthcare industry exacerbates these effects. The severity of the disease itself, the scope of its spread, and the overall mortality rate can all be impacted by knowledge, attitudes, and practices surrounding infectious diseases [47-49]. In order to stop the outbreak, it is crucial to protect Health Care Workers HCWs. When these professionals contract the disease, it negatively impacts the availability of medical services, lowering the effectiveness of the healthcare system's response to the pandemic and leading to an unchecked rise in the incidence rate. HCWs are on the front lines, so the effectiveness of any response depends on their knowledge and preventative behaviors. Increasing HCWs' understanding of the illness is crucial for lowering their anxiety levels [50-52]. Understanding HCWs' current level of knowledge, preventive practices, and risk perceptions is crucial.

This study obtained knowledge, attitude, and perception on COVID-19 vaccination in Nigeria through an online survey. The survey showed that 40 (74.074%) of the health workers had been vaccinated, while 88 (47.058%) of Non-Health Workers had been vaccinated. The Chi-square test revealed an association between the number of the vaccinated and the number of health workers, which showed that health workers identified the need to be vaccinated compared to non-health workers. The variable COVID-19 vaccine based on travel requirements (VIR) was used to determine if people take COVID-19 due to compulsory travel requirements. In the same vein, VIR, which represents people who have not taken COVID-19 because the vaccine was not readily available, was used to determine if some people have not been vaccinated due to the unavailability of the vaccines. The study also showed that the respondents are knowledgeable about vaccination. The respondents do not have a conservative idea about the COVID-19 vaccination. Also, the respondents do not have a repulsive attitude towards the COVID-19 vaccination.

To further achieve the objective of this study, the Logistic regression was fitted to the data using leave out one cross-validation. The results show immigration requirements significantly explained why an individual would accept to take the COVID-19 vaccine with the probability of 0.2885. In contrast, without immigration requirements, people would naturally take the vaccine with a probability of 0.7492. This study showed that people have diverse reasons why they would not like to take the COVID-19 vaccine aside reasons outlined in the questionnaire. These reasons were outlined in Section 3 of this study, and they are logical reasons because lives were involved.

Lastly, as part of the SDGs goals, ongoing education should be conducted to deepen comprehension and dispel any misconceptions or false information regarding COVID-19 vaccines. Health education should ideally be thorough, multilingual, and accessible. All citizens from all walks of life, including those who live in rural areas and lack access to modern technology, should hear the important messages. Some segments of the population may benefit from printed materials and in-person public talks in addition to web-based and application-based educational tools. Experts can hold public discussions involving religious groups inside places of worship. The focus should be on those with low acceptance and inadequate knowledge, especially those with chronic illnesses and those who are financially fortunate.

## ACKNOWLEDGMENT

The authors hereby acknowledge Covenant University Centre for Research, Innovation and Discovery (CUCRID) for their support toward the completion of this research.

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