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ORIGINAL RESEARCH

Predictors of COVID-19 Vaccine Acceptance Among Nigerian Medical Doctors

Nri-Ezedi CA*[1], Okechukwu C[2], Ofiaeli OC[1], Nwaneli E[1], Musa S[3], Kida I[4], Adetola H[5], Ulasi TO[1]

[1]Department of Paediatrics, Faculty of Medicine, Nnamdi Azikiwe University Awka, Anambra, Nigeria
[2]Department of Paediatrics, Rivers State University Teaching Hospital, Rivers State, Nigeria
[3]Infectious Disease Unit, Department of Paediatrics, Ahmadu Bello University /Teaching Hospital, Shika-Zaria, Nigeria
[4]Infectious Disease Unit, Department of Internal Medicine, University of Maiduguri, Maiduguri, Nigeria
[5]London School of Hygiene and Tropical Medicine, University of London, Keppel St, Bloomsbury, London WC1E 7HT, United Kingdom

*Correspondence: Dr CA Nri-Ezedi Chisom Adaobi, Department of Paediatrics, Nnamdi Azikiwe University Teaching Hospital, Nnewi, Anambra, Nigeria. E-mail: chisomnriezedi@gmail.com; ORCID – https://orcid.org/0000-0002-8023-686X.

Abstract

Background: Since its discovery in late 2019, COVID-19 has claimed approximately three million lives worldwide, causing a significant economic burden and strain on health care delivery and services. Therefore, the COVID-19 vaccine may offer the potential to promote global recovery.

Objective: To determine the acceptability of the COVID-19 vaccine among Nigerian doctors and the factors influencing the acceptance.

Methods: Using a cross-sectional design, an anonymous online survey was administered to medical doctors across the six geopolitical zones in Nigeria between 13 January and 31 January 2021, using the health belief model (HBM).

Results: Out of 830 respondents, 38.8% were willing to take the COVID-19 vaccine, 36.0% were unsure, while the remaining 26.5% refused to take the vaccine. Following adjustments, males were more likely to take the vaccine (OR = 3.357; 95% CI 2.009-5.610; p = 0.0001), whereas increasing age, higher perceived viral virulence and perceived viral infectivity were observed to be significantly associated with less likelihood of accepting the vaccine. Respondents who believed in the efficacy of ivermectin were much less likely to receive the vaccine (OR = 0.217; 95% CI 0.108-0.436; p = 0.001). Concerns on vaccination safety were the main barriers to vaccine acceptability. Hypothetically addressing these concerns increased vaccine acceptance rates by approximately a third (34.6%) (p < 0.001).

Conclusion: The proposed nationwide distribution of the COVID-19 vaccine may be met with poor vaccine acceptability among Nigerian medical practitioners. Measures specifically addressing vaccine safety concerns should be provided to allay fears and enhance the acceptability of the vaccine.

Keywords: COVID-19, Nigeria, Pandemic, Physicians, SARS-COV-2 Infection, Vaccine acceptance, Vaccine safety.

Introduction

Vaccine acceptance, especially among medical professionals, is crucial to the success of any vaccination programme, as it stimulates acceptance among other allied healthcare practitioners and, by extension, the general population. [1] Severe Acute Respiratory Syndrome Corona Virus 2 (SARS-CoV-2), the most recent novel coronaviruses and currently referred to as Coronavirus Disease 2019 or COVID-19, was first discovered in December 2019 in Wuhan, Hubei province of China. [2,3] The Federal Ministry of Health in Nigeria announced its first case of SARS-COV-2 infection in Lagos State on 27 February 2020. [4] As the pandemic progressed, additional infections and fatalities were reported, eventually reaching approximately 126,000 confirmed cases worldwide and three million deaths by 28 March 2021.[5] With the emergence of the second wave of the viral pandemic, global indices deteriorated further, impairing health care delivery for other endemic illnesses and jeopardising Nigeria's already precarious health system. [6,7] Additionally, the resulting breakdown of social and economic activity resulted in a worldwide recession and an increase in global poverty and hunger rates. [8,9] The definitive therapy for SARS-COV-2 infection remains uncertain, with the virus being generally contained by non-pharmacological means. [10] However, these chiefly behavioural measures have detrimental effects on social life and livelihood, resulting in poor compliance rates worldwide.[11]

The COVID-19 vaccine offers the benefit of slowing transmission rate and establishing herd immunity, hence expediting global recovery. Global interest in the development of the COVID-19 vaccine has resulted in a tremendous investment of human and material resources.[12] At least ten types of COVID-19 vaccines have been approved for use internationally, yet there are concerns of vaccination hesitation among medical professionals on a global scale. [13,14] Vaccine uptake rates varied from 78.1% in Israel to 27.7% in the Democratic Republic of the Congo. [13] Poor acceptance rates mainly derived from the rapid development of the COVID-19 vaccine, thereby raising concerns about its overall safety. At the time of conducting this research, the COVID-19 vaccine adoption rate among Nigerian medical practitioners was unclear, and the factors for potential vaccination hesitancy were unexplored, hence the study. The study's objective was to evaluate the COVID 19 acceptance rate among Nigerian medical doctors and the factors mitigating its acceptance.

Methods

Study location
With over 200 million people, Nigeria is the most populous nation in Africa. It is located in West Africa, on the Gulf of Guinea. [15] Nigeria consists of 36 autonomous states and the Federal Capital Territory. [15] These states are grouped into six geopolitical zones: North-Central (NC), North-East (NE), North-West (NW), South-East (SE), South-South (SS), and South-West (SW). [15] There are three major ethnic groups in Nigeria - Hausa, Igbo, and Yoruba. At the time of the study, about 35,000 doctors were practising in Nigeria, most of whom practice in urban metropolitan towns and cities. [16]

Study population
The research population included all practising physicians in Nigeria.

Study design
This was a cross-sectional, descriptive study. Between 13th and 31st January 2021 (18 days), a self-administered, anonymous online survey was sent to Nigeria-based medical practitioners, utilising the health belief model as a theoretical framework for analysing the acceptability of the projected COVID-19 vaccination.[17] Due to the

ongoing COVID-19 pandemic-related restrictions, physical access to an interviewer-administered questionnaire was restricted throughout the research period. Invitations to participate in the research were sent using a Google form-generated link. This link was distributed via *WhatsApp* to various doctors' organisations, including the Nigerian Medical Association, the Association of Resident Doctors, the Nigerian Dental Association, the Medical and Dental Consultants Association of Nigeria, the Medical Women Association of Nigeria, and the Association of General and Private Practitioners of Nigeria. *WhatsApp* was adopted as the medium for reaching out to prospective participants as it was the principal social media tool for most Nigerian physicians' organisations. The research team sent the online surveys to medical colleagues using the snowball sampling approach. Questions on vaccine acceptability were prepared in a format similar to those used in earlier research.[5,13]

Ethical considerations: The tenets of the Helsinki Declaration for research involving human participants were followed. [18] Confidentiality was observed, and consent to participate in the study was obtained from every participant.

Sample Size Determination
The sample size formula for a single proportion was used to determine the minimum sample size for this investigation.
$n = z(1-\alpha)^2 P(1-P)/d^2$
Where:
z = Critical value of normal distribution at the required confidence level
P = proportion of vaccine acceptance among medical doctors in the Republic of Congo[13]
d = margin of error
$n = (1.96)^2 \times 0.277(1-0.277)/0.05^2 = 307$
Assuming that 27.7% of individuals in our target group are willing to get vaccinated, this research needed a minimum sample size of 307 subjects to estimate the predicted proportion of vaccine

acceptance with an accuracy of 5% and a confidence level of 95%.
For this research, 843 participants responded to this survey which is considerably above the projected minimum sample size.

Data collection
The anticipated time to complete the semi-structured online questionnaire was ten minutes. The questions were piloted initially and then updated in response to pre-tester comments. Except for the vaccine-related concerns, all questions were closed-ended, with answer options supplied in the form of checkboxes. Most items were classified as categorical variables, while reported factors on the perceived risk of viral infection and threat to life were rated on a 10-item Likert scale. Subjects with scores of less than six were categorised as having a low perceived risk, while scores of six and above were classified as high perceived risk.

Statistical analysis
Statistical Package for Social Sciences (SPSS) Chicago, IL version 23 was used for data analysis, while R statistical software was used for data visualisation. Categorical variables were represented using frequencies and percentages, whereas continuous variables were summarized with mean and standard deviations. Bivariate and multivariate logistic regression were used to find the predictive variables for vaccine acceptance between the "accept" and "refuse" groups, utilising the computed odds ratio (OR), standard error (SE), and 95% confidence intervals (CI). The level of statistical significance chosen was $p < 0.05$.

Results

Socio-demographic characteristics of respondents
Out of the 843 participants from across the six geopolitical zones, 13 were excluded due to insufficient data, giving an overall response rate

of 98.5% (830/843). These 830 participants comprised 476 (57.3%) males and 354 (42.7%) females, giving a male-to-female ratio of 1.3:1. Table I illustrates the socio-demographic characteristics of the respondents. The NW region was the most represented zone (195; 23.5%), while the SW was the least represented zone (101; 12.2%). Others included NE (107; 12.8%), NC (140; 16.9%), SE (141, 17.0%) and SS (146; 17.6%). The respondents were mainly Igbo

(253; 30.5%), Hausa (178; 21.5%), Yoruba (130; 15.7%) and other ethnic groups (269; 32.3%). The mean age of the respondents was 37 ± 8.3 years. The male respondents were significantly older than the female respondents (38 ± 8.1 years *vs* 36 ± 8.2 years). The majority of the respondents (75.3%) were married, were Christians (55.6%), had children (68.9%), and worked as resident doctors (38.8%). The mean number of years post-basic qualification was 11 ± 7.7 years.

Table I: Socio-demographic characteristics of respondents

Characteristics	Frequency	Percentage
Gender		
Men	476	57.3
Women	354	42.7
Marital Status		
Single	181	21.8
Married	625	75.3
Widowed	11	1.3
Divorced	9	1.1
Separated	4	0.5
Status		
House Officers	52	6.3
Medical Officers	223	26.9
Private Practitioner	7	0.8
Resident Doctors	322	38.8
Consultant	196	23.6
Lecturers	6	0.7
Unemployed	24	2.0

Attitudes towards COVID-19 Infection and its vaccine

One hundred and one (12.2%) respondents reported testing positive for COVID-19. Over half (54.6%) of the respondents have come in contact with a confirmed COVID-19 case, while 218 (26.3%) had lost someone to COVID-19. Table II shows the perception of COVID-19 infection and other related factors across the six geopolitical zones. Respondents from all the northern zones had the highest perceived viral infectivity, while the NC zone had the highest perceived viral virulence score compared to other zones. While

the majority of the respondents (82%) knew about ivermectin as a potential therapy for COVID-19 infection, only a minority (15.2%) considered the drug to be a suitable alternative for the COVID-19 vaccine, and even fewer (6.2%) had recently taken the drug to treat COVID-19 infection. Approximately two-fifths of respondents (38.3%) indicated that they would take the vaccine if it became accessible in Nigeria (Table II and Figure 1).

Concerns about COVID-19 vaccine

Half of the respondents who were hesitant to or refused to get vaccinated cited vaccine safety concerns. Most of these respondents (54%) were from the SE zone. Several other issues raised include inadequate vaccine storage facilities and distrust in pharmaceutical firms to distribute high-quality vaccines to resource-poor nations. (Table III). Overall, addressing vaccine safety significantly increased respondents' willingness to take the vaccine across all the geopolitical zones (p = 0.001) (Figure 2).

Table II: Attitude to COVID-19 and the vaccine among the respondents distributed according to the geopolitical zones

Items tested	SW n = 101	SE n = 141	SS n = 146	NW n = 195	NC n = 140	NE n = 107	Total n = 830
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Tested positive to COVID-19	14 (13.9)	9 (8.9)	14 (13.9)	33 (32.7)	18 (17.8)	13 (12.8)	101 (12.2)
Perceived symptoms of COVID-19	34 (11.3)	58 (19.2)	38 (12.6)	77 (25.5)	50 (16.6)	45 (14.8)	302 (36.4)
Contact with a confirmed COVID-19 positive case	65 (14.3)	70 (15.5)	88 (19.4)	159 (35.1)	36 (7.9)	35 (7.8)	453 (54.6)
Lost someone to COVID-19	27 (12.4)	36 (16.5)	34 (15.6)	50 (22.9)	36 (16.5)	35 (16.1)	218 (26.3)
*Perceived infectivity of COVID-19	5.9 (2.8)	5.6 (2.8)	5.4 (2.7)	6.7 (2.4)	6.7 (2.5)	6.7 (2.7)	6.2 (2.7)
*Perceived fatality of COVID-19	5.0 (2.8)	5.3 (2.9)	4.8 (2.7)	5.7 (2.6)	6.0 (2.7)	5.8 (2.7)	5.4 (2.8)
Heard of ivermectin	87 (13.3)	121 (18.5)	117 (17.9)	146 (22.2)	106 (16.2)	78 (11.9)	655 (78.9)
Recent intake of ivermectin	11 (21.2)	21 (40.4)	6 (11.5)	6 (11.5)	4 (7.7)	4 (7.7)	52 (6.3)
Ivermectin is a good alternative to the COVID-19 vaccine	14 (11.1)	26 (20.6)	21 (16.7)	31 (24.6)	21 (16.7)	13 (10.3)	126 (15.2)
Willingness to take the vaccine	40 (12.4)	50 (15.5)	52 (16.1)	76 (23.6)	60 (18.6)	44 (13.8)	322 (38.8)
Willingness to take the vaccine if proven to be safe	77 (12.6)	103 (16.9)	101 (16.6)	149 (24.5)	103 (16.9)	76 (12.5)	609 (73.4)

NC – North Central; NE – Northeast; NW – Northwest; SS – South-South; SE – Southeast; SW - Southwest
*Mean scores with Standard deviation

Predictors of COVID-19 vaccine acceptance
Tables IV and V illustrate the logistic regression analysis of factors that influenced the acceptability of the COVID-19 vaccine. The final model demonstrated that males (OR = 3.357; 95% CI 2.009-5.610; p = 0.001) were more likely to take the COVID-19 vaccine than females. Although respondents who had previously tested positive for COVID-19 were more likely to take the vaccine, this was not statistically significant (OR = 5.662; 95% CI 0.632-50.734; p = 0.121). Respondents who rated higher in the Likert scores for perceived viral virulence (OR = 1.186; 95% CI 1.061-1.326) and fatality (OR = 1.317; 95% CI 1.195-1.451) were strongly more inclined to get vaccinated compared to those with lower scores. On the other hand, doctors who reported ivermectin as a viable substitute for the COVID-19 vaccine were less likely to be vaccinated (OR = 0.217; 95% CI 0.108-0.436); p = 0.001).

Discussion

The dramatic increase in COVID-19 cases, the emergence of new strains, and the unwavering global apathy to follow social measures that prevent viral transmission all but demand a different approach to combat the virus. [10,19]

Although known safety measures such as hand hygiene, face mask use, and social distancing remain critical, the COVID-19 vaccine has the added benefit of reducing transmission and promoting herd immunity, which could reverse the trend of the pandemic. [20] Based on recent events, the study hypothesised that if the COVID-19 vaccine were made available in the country, front-line health workers would readily accept it. A successful vaccine campaign requires an investigation into the willingness of Nigerian medical doctors to take the COVID-19 vaccine, as well as the factors that influence their decisions.

Table III: Concerns mitigating against COVID-19 vaccine acceptance among the respondents distributed according to the geopolitical zones*

Items tested	SW	SE	SS	NW	NC	NE	Total
	n = 117	n = 212	n = 208	n = 260	n = 198	n = 139	n = 1134
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Not a threat	2 (1.7)	2 (0.9)	4 (1.9)	5 (1.9)	1 (0.5)	3 (2.2)	17 (1.5)
Multiple resistant strains	7	16	21	25	20	18	107
	(6.0)	(7.5)	(10.1)	(9.6)	(10.1)	(12.9)	(9.4)
Poor storage facilities	0 (0.0)	) (0.0)	0 (0.0)	4 (1.5)	1 (0.5)	0 (0.0)	5 (0.4)
Vaccine safety	60	115	112	118	99	63	567
	(51.2)	(54.3)	(53.9)	(45.3)	(50.0)	(45.4)	(50.0)
Distrust in government	25	43	31	41	34	22	196
	(21.4)	(20.3)	(14.9)	(15.8)	(17.2)	(15.8)	(17.3)
Distrust in vaccine	23	36	40	67	43	33	242
manufacturers	(19.7)	(17.0)	(19.2)	(25.9)	(21.7)	(23.7)	(21.4)

NC – North Central; NE – Northeast; NW – Northwest; SS – South-South; SE – Southeast; SW – Southwest
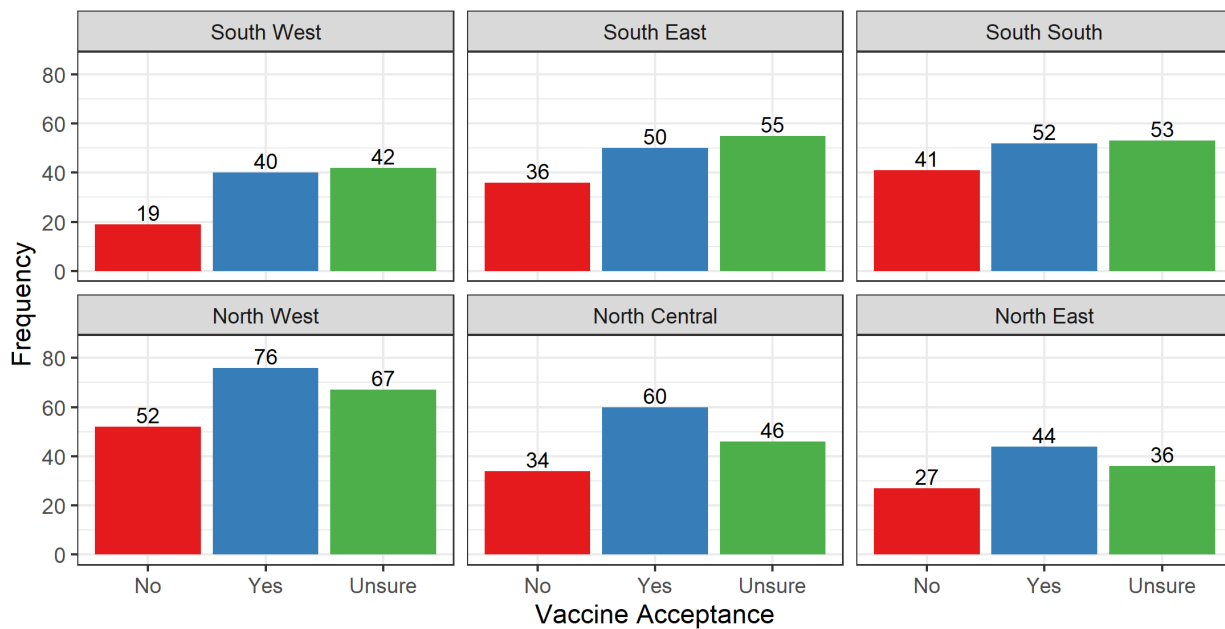***Collated as multiple responses per respondent per zone**

Figure 1: Vaccine acceptance among Nigerian medical doctors

Table IV: Logistic Regression analysis of predictors of COVID-19 vaccine acceptance

| Predictors	Crude OR	p-value	Adjusted OR	p-value
Age	0.985 (0.964-1.007)	0.195	0.884 (0.817-0.958)	0.002
Gender				
Female	1	1		
Male	2.311	0.001	3.357 (2.009-5.610)	0.001
Ethnicity				
Igbo	1	1		
Yoruba	1.007 (0.567-1.788)	0.981	-	-
Hausa	0.748 (0.454-1.231)	0.253	-	-
Religion				
Christian	1	1	-	-
Islam	0.926 (0.652-1.316)	0.668	-	-
Have children				
No	1	1		
Yes	0.903 (0.718-1.923)	0.522	-	-
Tested positive to COVID-19				
No	1	1	-	-
Yes	2.186 (1.207-3.959)	0.010	5.662 (0.632-50-734)	0.121
Perceived symptoms of COVID-19				
No	1	1		
Yes	1.293 (0.841-1.988)	0.241	0.614 (0.330-1.140)	0.643
Maybe	1.586 (0.991-2.537)	0.055	1.105 (0.597-2.046)	0.750
Contact with a confirmed case				
No	1	1		
Yes	1.505 (1.028-2.205)	0.306	1.308 (0.768-2.229)	0.323
Lost someone to COVID-19				
No	1	1		
Yes	1.404 (0.941-2.095)	0.097	1.133 (0.669-1.919)	0.643
Perceived contagiousness of COVID-19				
Low	1	1		
High	1.235 (1.152-1.324)	0.001	1.186 (1.061-1.326)	0.003
Perceived fatality of COVID-19				
Low	1	1		
High	1.289 (1.202-1.383)	0.001	1.317 (1.195-1.451)	0.001
Ivermectin is an alternative to the COVID-19 vaccine.				
No	1	1		
Yes	0.244 (0.142-0.417)	0.001	0.217 (0.108-0.436)	0.001
Maybe	0.436	0.001	0.535 (0.319-0.898)	0.018

OR = Odd Ratio
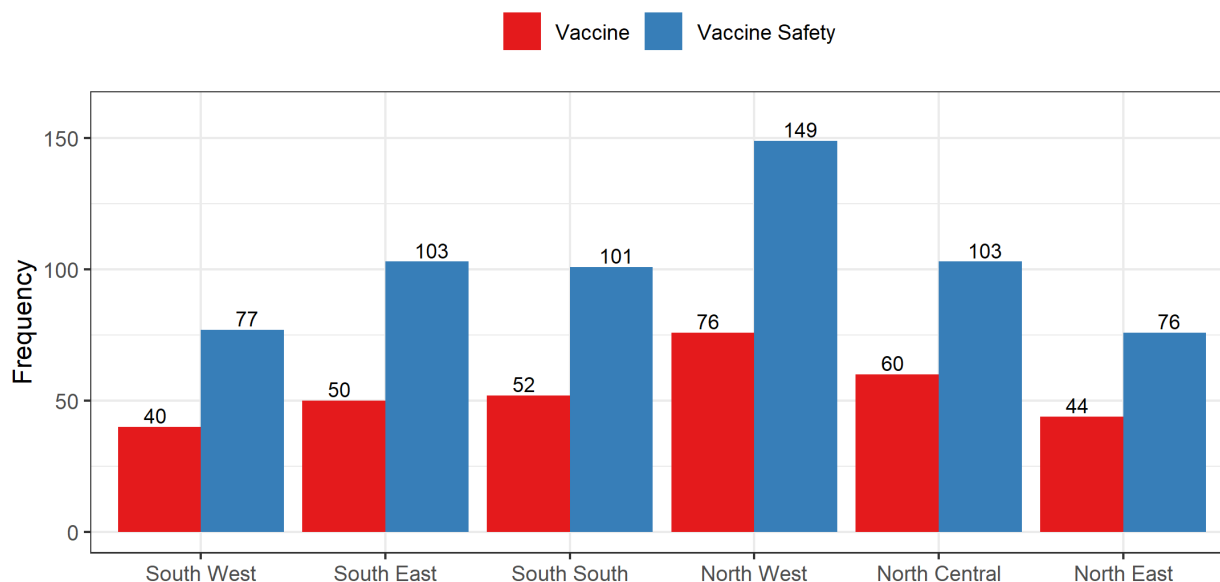
Figure 2: Impact of perceived vaccine safety on COVID-19 vaccine acceptance

Table V: Multivariate logistic regression analysis on predictors of COVID-19 vaccine acceptance

Predictors	*Categories*	*Odds ratio*	*95% CI*	*p-value*
Age		0.884	0.817-0.958	0.002
Gender	*Female*			
	Male	3.357	2.009-5.610	0.001
Tested positive to COVID-19	*No*			
	Yes	5.662	0.632-50.734	0.121
Perceived symptoms of COVID-19	*No*			
	Yes	0.614	0.330-1.140	0.643
	Maybe	1.105	0.597-2.046	0.750
Contact with a confirmed COVID-19 case	*No*			
	Yes	1.308	0.768-2.229	0.323
Lost someone to COVID-19	*No*			
	Yes	1.133	0.669-1.919	0.643
Perceived COVID-19 infectivity	Low	1	1	
	High	1.186	1.061-1.326	0.003
Perceived COVID-19 fatality	Low	1	1	
	High	1.317	1.195-1.451	0.001
Recently taken ivermectin	*No*			
	Yes	0.733	0.232-2.33	0.596
Ivermectin is an alternative to the COVID-19 vaccine	*No (ref)*			
	Yes	0.217	0.108-0.436	0.001
	Maybe	0.535	0.319-0.898	0.018

Surprisingly, about two-fifths of the 830 physicians surveyed indicated a willingness to receive the COVID-19 vaccine. This is alarming because all physicians have an additional

responsibility of advocating for vaccine uptake among the general public. Surprisingly, this finding corroborated international reports indicating low uptake among health care professionals and the general public. [13] Indeed, healthcare workers in Israel were more likely to accept the flu vaccine than the COVID-19 vaccine. [20]

Male physicians were three times more likely than female physicians to accept the covid-19 vaccine. This finding is consistent with an earlier survey among adults in the United States of America, which revealed a staggering gender disparity in favour of males. [21] A similar observation was made among Israeli health care workers. [22] Male predominance in vaccine acceptance may result from numerous reports indicating that COVID-19 adversely affects more males than females. [23]

The respondents' age correlated negatively with their likelihood to receive the vaccine. This is quite surprising, given that numerous studies conducted throughout the world have consistently demonstrated an increased risk of morbidity and mortality among the elderly. This well-known fact prompted most Nigerian health institutions to adopt novel concepts that allow elderly doctors to work from home, thus minimising contact with potentially infected patients. Therefore, older doctors who may consider that they are less likely to get the virus may depend more on non-pharmacological techniques to prevent the infection. Furthermore, previous research indicated that the present epidemic in Nigeria had a reduced psychological effect on the elderly. [24] These factors may be responsible for the older respondents' perception of a lower risk of contracting the virus, obviating the need for the vaccine.

Increased awareness of COVID-19 contagiousness and threat to life were positive predictors that influenced physicians' acceptance

of the vaccine. Numerous factors can contribute to this fear, including the virus's novelty, the emergence of more virulent variants, and the pervasive conspiracy theories spreading primarily via social media. Several other factors include ambiguous and inconsistent management protocols and the economic strain associated with the pandemic. [24-26] The findings in the present study corroborated those of a similar survey conducted in Israel among health care providers, in which an increased likelihood of accepting the vaccine was associated with a higher perceived risk of severe COVID-19 infection.[22]

Ivermectin, a drug that has been in use for long, was recently discovered to be effective against COVID-19. This broad-spectrum, anti-parasitic agent is currently being lauded as an effective agent for COVID-19 prophylaxis and treatment. [27] Respondents who considered this drug a substitute for the COVID-19 vaccine were less likely to accept the vaccine. In comparison to the vaccine, ivermectin is more readily available, less expensive, has an excellent safety profile, and is effective against COVID-19 *in vivo* and *in vitro*. [27-29] Despite a lack of robust global data on the drug's efficacy against COVID-19, several randomised trials were yet to be concluded.

Respondents who were parents had a lower likelihood of receiving the vaccine. Although this finding was not statistically significant, it was thought to be intriguing and should be explored further in future research. Interestingly, Dror and colleagues [22] found that study participants who were parents were less likely to accept the COVID-19 vaccine. It is believed that being among one's kindred, especially during this period of minimal social contact, can boost a favourable mental profile, thus negating the need for a vaccine. [24] Dror and colleagues [22] hypothesised that parents might be concerned about the vaccine's side effects, which could impair their ability to care for their children.

Many physicians who refused to take the vaccine expressed concerns about vaccine safety and mistrust in pharmaceutical companies which manufacture the vaccines. Additional concerns raised include the inadequate infrastructure for the cold chain nationwide, poor vaccine quality, and emerging viral strains that may be resistant to the vaccine. Concerns about vaccine safety were primarily associated with the vaccine's perceived side effects, which were facilitated by the lack of rigorous clinical trials, an unclear underlying mechanism, and the availability of multiple vaccines with varying potencies.

Recent developments in social media have exacerbated these concerns, owing to an onslaught of unverified information from conspiracy theorists. The conspiracies seek to portray the virus and, more recently, its vaccine as a ruse devised by interested parties for economic gain.[30] Addressing these legitimate concerns on vaccine safety may result in a significant increase in the uptake rates. This was successfully demonstrated in this study, which indicated a substantial increase of about 34.6% in respondents' willingness to accept the vaccine when safety concerns are addressed. Therefore, a widespread public campaign debunking vaccine safety myths can help reduce vaccine hesitancy.

Limitation of the study: Any online survey is subject to selection bias. Nigerian physicians who used *WhatsApp* regularly were more likely to access and respond to the survey than those who did not use the social media platform at all or only infrequently. This study is also subject to social desirability bias. Physicians are more likely to respond positively to vaccine acceptance as the more desirable course of action in the medical community.

Conclusion

Nigerian physicians had a low probability of accepting the COVID-19 vaccine with primary concerns on vaccine safety. To ensure the successful rollout of COVID-19 vaccines to Nigerian physicians and, by extension, other front-line health workers and the general public, vaccine safety concerns must be addressed comprehensively. Major stakeholders should also implement structured educational programs to boost vaccine uptake rates among Nigerian medical doctors.

Caveat: This research was conducted before the commencement of mass vaccination against COVID-19, and the manuscript was submitted for processing after the beginning of vaccination. - Editor

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