RedFame

Studies in Media and Communication
Vol. 10, No. 2; December 2022
ISSN: 2325-8071 E-ISSN: 2325-808X
Published by Redfame Publishing
URL: http://smc.redfame.com

Beyond Health Belief: Modeling the Predictors of COVID-19 Vaccine Uptake among Social Media Users in Nigeria

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Received: April 20, 2022 Accepted: June 5, 2022 Online Published: June 10, 2022

doi:10.11114/smc.v10i2.5600 URL: https://doi.org/10.11114/smc.v10i2.5600

Abstract

There have been sustained global efforts to promote the uptake of COVID-19 vaccines, yet studies suggest the upsurge of vaccine resistance around the world. Considering the wide adoption of social media as crucial sources of health information, the nature of popular online debates on vaccination initiatives can significantly sway people's vaccine-related decisions. This study develops a structural equation model for the predictors of COVID-19 vaccine uptake among Nigerian social media users. Using an online survey of 436 respondents, the study fundamentally extends the constructs of the Health Belief Model by examining the unique roles of social media exposure, fear, and anticipated regret in the prediction of individuals' vaccination decisions. We found that perceived susceptibility to and perceived severity of vaccination risk, perceived barriers to vaccination, exposure to vaccine-critical posts on social media, fear of vaccination risk, and anticipated regret for vaccine uptake significantly predicted COVID-19 vaccine uptake. However, the perceived benefits of COVID-19 vaccine uptake and anticipated regret for inaction related to vaccination did not predict COVID-19 vaccine-related decisions. The findings accentuate why stakeholders in the public health sector should pay adequate attention to social media-related trends on public health promotion schemes, and counter any detected falsehood with credible information.

Keywords: Anticipated regret, COVID-19, health belief, PLS-SEM, social media users, vaccine uptake

1. Introduction

There have been spirited global efforts to develop effective human vaccines to contain COVID-19 since its outbreak in December 2019 (Zizzo, 2020). Notably, these experiments have produced some relatively promising vaccines for the respiratory disease (World Health Organisation [WHO], 2020). However, there appears to be strong behavioural resistance toward the acceptance and uptake of COVID-19 vaccines by a significant number of people globally (Piltch-Loeb & DiClemente, 2020). This surge in vaccine hesitancy, coupled with the inadequate availability of vaccine doses, especially at earlier stages of production, has resulted in the low vaccination coverage of the human population against COVID-19 (Olomofe et al., 2021).

Vaccines are widely recommended for the effective management of infectious diseases (Galistiani et al., 2021). Such recommendation is even more salient for the control of the COVID-19 pandemic which has infected millions of people globally (Apuke & Tunca, 2021). General immunisation through vaccine administration is not only cost-effective but also crucial to public health-related intervention efforts, especially in building herd immunity among a large population (Panchapksan et al., 2018). It is estimated that proper immunisation through vaccination programmes prevents about two to three million global deaths every year, and vaccines are widely considered the most promising solution to the lingering COVID-19 pandemic (Biro & Szabo-Morvai, 2021).

Vaccine uptake denotes the percentage of an eligible population who received a particular vaccine during a given vaccination period (Crocker-Buque et al., 2016). Previous research indicates that there is strong global resistance to vaccines uptake (Iwasa & Wada, 2013; Kwong et al., 2010; Yuen & Tarrant, 2014), and this challenge is particularly

worse in developing and low-income countries where vaccination coverage struggles to reach a suboptimum target (Odone et al., 2015). For instance, research has shown a low COVID-19 vaccination coverage among Nigerians with most of them showing an unwillingness to accept recommended vaccines (Olomofe et al., 2021). The National Primary Health Care Development Agency (NPHCDA, 2022) reports that only 9.7% of Nigerians targeted for COVID-19 vaccination had been fully vaccinated (received a second dose of the vaccine), while 16.3% had received the first dose of the vaccine as of March 18, 2022. Arguably, the success of vaccination programmes for infectious diseases like COVID-19 is influenced by the public's overall level of acceptance and uptake, which may in turn affect the growth of herd immunity among the general population (Thumstrom et al., 2020).

Health behavioural researchers generally posit that people's beliefs about certain health problems can influence their response to recommended health actions, including their vaccine-related decisions (Oh et al., 2021; Renner et al., 2015). Specifically, proponents of the Health Belief Model (HBM) assert that individuals' self-assessment of their susceptibility, severity, benefits, and/or barriers related to the adoption of suggested health behaviour will influence their decision to disregard or comply with such health recommendations (Renner et al., 2015). Accordingly, research suggests that these four constructs can predict peoples' vaccination intention and actual uptake of recommended vaccines against infectious diseases (Viswanath et al., 2021; Yuen & Tarrant, 2014). Similarly, previous evidence indicates that exposure to social media as well as people's emotional disposition toward certain health problems can predict their response to such problems (Han & Liu, 2018; Wu & Li, 2017).

Therefore, this study incorporates both discrete emotions and social media exposure in an attempt to build upon the theoretical postulations of the HBM in understanding the predictors of COVID-19 vaccine uptake among Nigerian netizens. Understanding the main determinants of social media users' willingness to accept preventive vaccines is vital to the effective management of the coronavirus pandemic, especially with the surging rate of infodemics and anti-vaccine sentiments that are propelling vaccine hesitancy among the wider population; hence, the relevance of this study.

2. Literature Review

2.1 Theoretical Framework and Hypotheses Building

The Health Belief Model (HBM) formed the theoretical base of this study. The model is a social-psychological approach for predicting the public's health behaviour, especially in the adoption of suggested health services. It postulates that individuals' beliefs about certain health problems, perceived benefits of action, and barriers to taking such actions can significantly determine their participation or non-participation in health-promoting behaviours, including the uptake of vaccines (Siddiqui et al., 2016). The desire to understand people's refusal to get involved in health promotion programmes and disease prevention initiatives motivated the conceptualisation of the HBM in the 20th century. The model was advanced in the works of four researchers, Godfrey Hochabaum, Irvin Rosenstock, Howard Leventhal, and Stephen Kegeles who sought to unravel the reasons behind the widespread failure of a free tuberculosis-screening scheme initiated for adults despite efforts to provide the screening x-rays at the beneficiaries' convenience (Oyeoku et al., 2021). Their investigations showed that perceived risk toward the ailment and the accompanying perceived benefits inherent in taking appropriate actions were the most crucial motivations for the few adults who utilised the programme. Hence, the HBM construct was proposed and extensively used to predict public health-related behaviour (Suleiman et al., 2015; Siddiqui et al., 2016).

2.1.1 Perceived Susceptibility

This construct refers to individuals' self-judgment regarding the probable risk of developing a health problem or contracting a disease. Thus, it measures individuals' subjective opinions on their degree of liability to certain health risks (Yuen & Tarrant, 2014). Generally, people who perceive that their possibility of contracting a given illness is low would engage in risky behaviours, whereas those whose personal assessment places them on a high pedestal of liability to infection would engage in health-related behaviours that decrease their chances of getting infected (Apuke & Omar, 2020). Consistent with the HBM, an individual's increased feeling of susceptibility toward certain health risks will motivate his/her engagement in health-promoting behaviours, including the uptake of vaccines aimed at preventing diseases (Choi et al., 2017). For instance, research shows that people with high perceived susceptibility toward influenza disease tend to have a greater intention and willingness to get vaccinated than their counterparts with low perceived liability to the illness (Panchapkesan et al., 2018). We wondered if in like manner individuals' perception of vaccination risk influences their vaccine decisions. Therefore, we formulated our first hypothesis as follows:

H1: Perceived susceptibility to vaccination risk would be negatively related to COVID-19 vaccine uptake among Nigerian social media users.

2.1.2 Perceived Severity

Within the sphere of the HBM construct, perceived severity denotes one's self-appraisal of the seriousness of certain health risks and their potential consequences (Choi et al., 2017; Maayan-Metzger et al., 2005). Generally, individuals tend to disengage from health-promoting behaviours if they perceive that the consequence of such disengagement will not be serious. Conversely, individuals who perceive certain health problems as serious and with negative consequences would likely engage in preventive behaviours against such identified problems (Deng et al., 2020). In this wise, perceived severity transcends the narrow question of whether the health implications of contracting a disease are life-threatening to include the broader possible impact of the illness on the social functioning of an individual (Suleiman et al., 2015). For instance, the severe consequences of contracting COVID-19 may not only be assessed from the morbidity and mortality of the infected patient but also the corollary economic consequence of the patient's death on his/her immediate family, especially when the deceased is the major breadwinner of the family. For this reason, individuals who adjudge COVID-19 to be a serious health risk would be more likely to engage in recommended preventive behaviours, including the uptake of vaccines, than those whose subjective appraisal of the infection places it to be less severe. We viewed the perceived severity of COVID-19 as similar to the perceived risk of one's vaccination decisions. Consequently, we formulated our second hypothesis thus:

H2: Perceived severity of vaccination risk would be negatively related to COVID-19 vaccine uptake among Nigerian social media users.

2.1.3 Perceived Benefits

Another major premise of the HBM suggests that individuals will likely take a health-related action if they feel that a negative health condition is avoidable by successfully taking recommended actions (Walsh et al., 2015). In the management of public health-related issues, the ultimate goal is to stimulate the requisite action from the audience who, nonetheless, must assess such recommended action from its utilitarian value (Panchapakesan et al., 2018). Research suggests that people with a high subjective perception of the efficacy of recommended actions (such as vaccination) concerning the prevention of diseases will engage in such activities if they adjudge its benefits to be relatively higher than its likely risk (Han & Liu, 2018; Wong et al., 2021). Therefore, we formulated a third hypothesis as follows:

H3: Perceived benefit of vaccination would be positively related to COVID-19 vaccine uptake among Nigerian social media users.

2.1.4 Perceived Barrier

In the spheres of health communication, perceived barrier denotes the various obstacles militating against individuals' successful engagement in recommended health actions. The perceived barrier construct is quite crucial to health behavioural modifications and people's willingness to accept recommended health actions (Oraby et al., 2014). Health behavioural scholars assert that when individuals' perceived barrier to taking certain health actions outweighs the perceived benefit, severity, and susceptibility related to the risks inherent in such actions, they become less willing to take such actions (Cheney & John, 2013; Kim & Lee, 2011; Yuen & Tarrant, 2014). Therefore, we made our fourth hypothetical assumption as follows:

H4: The perceived barrier to vaccination would be negatively related to COVID-19 vaccine uptake among Nigerian social media users.

2.2 Social Media Exposure and Vaccine Uptake

The mass media are widely regarded as major influencers of people's health knowledge, intentions, attitudes, and behaviours (Wu & Li, 2017; Erubami, 2022). Such influence also extends to the public's vaccination demands and actual vaccine uptake (Biro & Szabo-Morvai, 2021). Similarly, recent studies show that social media play a critical role in people's definition of their health needs and aversions (Brunson, 2013). Generally, social media platforms allow users to comment on a wide range of topics, including health issues (Erubami et al., 2021). Although this has promoted media freedom, the phenomenon has also encouraged the propagation of extreme views that are inimical to public health promotion efforts (Wilson & Wiysonge, 2020).

Observably, this trend has promoted the rise of anti-vaccine movements across various popular social media sites where a significant amount of vaccine-related debates revolve around anti-vaccination messages. For instance, research has demonstrated the pervasiveness of intense anti-vaccine sentiments and vaccine-averse debates on Facebook and Twitter (Jamison et al., 2019; Smith & Graham, 2019). Similar studies equally suggest a strong association between exposure to vaccine-critical websites and people's intention to vaccinate (Betsch et al., 2010). Given that the COVID-19 outbreak has triggered many social media-related debates (Huynh, 2020), people's exposure to such debates would likely influence their perceived risk and vaccines-related decision about the ailment (Choi et al., 2017; Erubami et al., 2021; Han & Liu, 2018). Therefore, we hypothesised that:

H5: Exposure to social media vaccination information would be negatively related to COVID-19 vaccine uptake among Nigerian social media users.

2.3 Emotions and Vaccine Uptake

Emotions play critical roles in people's response to public health-related emergencies. This is mainly because discrete affects like fear, anger, and regrets do not only determine people's level of risk perception but also constitute major determinants of individuals' preventive behaviour during diseases outbreak (Oh et al., 2021). The occurrence of risky health situations like the coronavirus pandemic often results in overwhelming emotional outbursts as people continue to express concerns over the dimensions of the ailments and the associated preventive measures, including vaccination initiatives. Under such volatile situations, some of the frequently expressed emotions related to suggested preventive actions are fear (Galistiani et al., 2021; Erubami et al., 2021) and anticipated regret (Godinho et al., 2016).

The Positive and Negative Affect Schedule identifies fear as a common emotion among humans (Oh et al., 2021). Fear is defined as the fright, anxiety, and sometimes, extreme veneration that people develop when exposed to an unexpected risky situation or required to take certain health-related decisions. Generally, emotional influence on people's overall response to public health-related challenges could take either positive or negative dimensions. For instance, the fear of risky situations may either serve as a trigger for recommended preventive health behaviour during infectious diseases outbreak (Harper et al., 2021; Khosravi, 2020) or undermine people's cognitive abilities to rationally conceive health risks and engage in preventive behaviour (Broche-Pérez et al., 2020; Erubami et al., 2021). For instance, there is a common fear that the COVID-19 vaccines development timeline was abridged and the products did not undergo thorough testing before approval, thereby breeding a considerable degree of distrust and low confidence in the safety and efficacy of the vaccines (Fadhel, 2021; Zizzo, 2020). Therefore, it is likely that this perception would negatively affect people's readiness to accept vaccines.

Conversely, anticipated regret denotes a condition in which individuals perceive that a likely future occurrence (such as contracting a disease) would make them wish they had made a different decision in the past (like getting vaccinated and following recommended preventive behaviours or otherwise). Like fear, anticipated regret could be either way. People may regret not taking certain actions at an earlier time (anticipated regret for inaction) or regret taking certain actions in the past (anticipated regret for action) (Brewer et al., 2016). Past research suggests that people's anticipated regret may predict the direction of their health behaviour. For instance, people's belief that rejecting a vaccine may predispose them or their loved ones to COVID-19 in the future (anticipated regret for inaction) may positively motivate them to accept the vaccine, whereas the feeling that accepting the COVID-19 vaccine now would cause serious side effects in the future (anticipated regret for action) may diminish their prospect of COVID-19 vaccine uptake (WHO, 2020). Therefore, the study hypothesised that:

H6: Fear of vaccination risk would relate negatively to COVID-19 vaccine uptake among Nigerian social media users.

H7: Anticipated regret for action toward vaccination would relate negatively with COVID-19 vaccine uptake among Nigerian social media users.

H8: Anticipated regret for inaction toward vaccination would relate positively with COVID-19 vaccine uptake among Nigerian social media users.

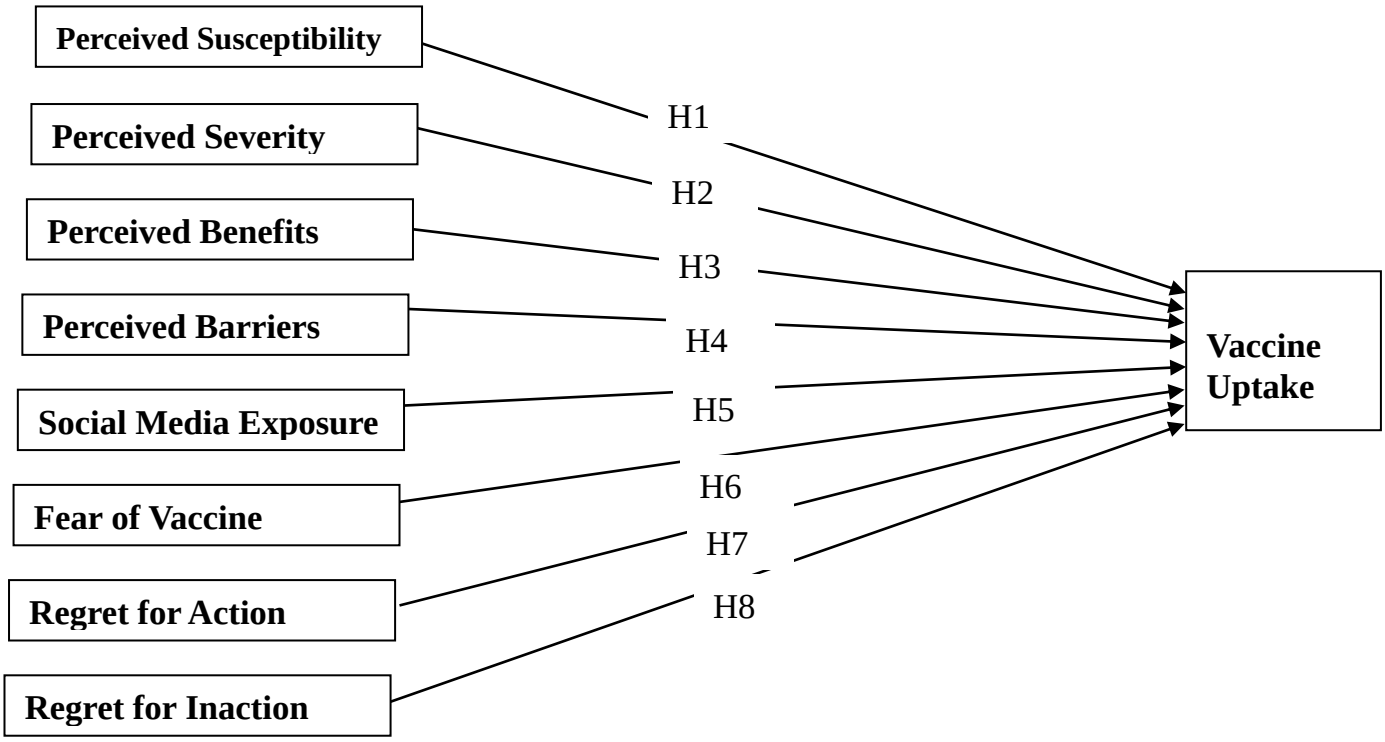

Figure 1. Hypothesised research model for COVID-19 vaccine uptake

3. Methods

3.1 Sample and Procedure

To test the proposed research model for COVID-19 vaccine uptake, the study employed an online survey of Nigerian social media users, estimated to be about 30.9 million active users (Oji & Erubami, 2020). The online survey technique is advantageous in terms of cost, respondents' inclusivity, and reach, especially for a heterogonous population (Baltar & Brunet, 2012). The survey questionnaire was created via Google Form, a freely available online survey platform, and the data were collected between August 15, 2021 and October 23, 2021. To obtain a representative sample of the Nigerian population, we used the G*power statistical tool to conduct a priori power analysis as widely recommended in previous research (Oyeoku et al., 2021). Our proposed model had eight predictors and the priori analysis was calculated with 0.8 power ($1-\beta$), 0.15 effect size (f^2), and 0.05 probability value (α), yielding a minimum required sample of 109. However, considering the heterogeneous nature of the study population, we multiplied the obtained sample size by four to increase its extent of representativeness (Apuke & Omar, 2020; Hair et al., 2019). Therefore, the final sample size was 436.

We used the snowball sampling technique to share the survey link among eligible respondents. This technique enables researchers to advertise a survey link across various online platforms and enlist eligible study respondents within their social networks. Thereafter, the initially chosen participants are requested to identify/refer other eligible participants in their social network to participate in the study and share the survey link among their friends on social media (Oyeoku et al., 2021). The process continued until we obtained the requisite number of respondents. To address the methodological drawbacks of sample generalisation and bias associated with online surveys, we compared the obtained outcome of the sample with the broad stratification of the Nigerian online and offline population to ascertain the level of representativeness and/or distortion (Sadler et al., 2010). The major inclusion/exclusion criteria for the study's participants were active social media usage (at least 30 minutes a day) and being at least 18 years old. Initial screening questions were included in the online questionnaire to determine the respondents' eligibility for the survey. To reduce the possibility of missing data, all fields in the online questionnaire were marked important, but the participants were free to withdraw from the survey should they decide to. Ethical approval for the research was granted by the Faculty of the Social Sciences Research Ethics Committee, Delta State University, Abraka, with approval number DELSU/FSS/FSSREC/01342021.

3.2 Construct Measurement

Our proposed model had nine latent constructs, comprising eight independent variables and one dependent variable (vaccine uptake). All the measures were reflective and essentially adapted from previous research. The variables were gauged using 5-point Likert scales with likely answers varying from 1 (strongly disagree) to 5 (strongly agree). The content validity technique was used to gauge the match between the research instrument and study objectives. In doing this, the research instrument was evaluated by an expert in the field of measurement and evaluation and another in the field of media and communication studies, both from Delta State University, Abraka. The experts assessed the clarity, appropriateness, and logicality of the instrument, and offered suitable suggestions that guided the rewording of the final version of the instrument. On the instrument's reliability, we conducted a pilot test on 22 respondents (5% of the sample) which yielded acceptable Cronbach Alpha values that were above 0.75. The results of the validity and reliability tests were used to reword the final version of the study instrument.

3.3 Data Analysis

Descriptive statistics were initially used to present respondents' demographic data, while structural equation modeling was explored to analyse the final research model. Specifically, the Partial Least Square statistical technique was used for the analysis given its robustness for skewed data, small samples, and handling of both reflective and formative measurement models without identification problems (Hair et al., 2019). We used a bootstrap re-sampling method with 5000 samples to determine the model's path and tested the study hypotheses at a <0.05 significance level. Additionally, we estimated the measurement and structural models as recommended in previous research (Apuke & Omar, 2020; Hair et al., 2019).

4. Results

We closed the survey link after receiving 436 submissions. Based on the respondents' demographic data, 52.5% of the respondents were males, while 47.5% were females. The respondents' modal age range was 21-35 years, and 81.4% of them had various forms of employment. By region of residence, 56.9% of the respondents were residents of southern Nigeria, while the remaining 43.1% were from the country's northern region. Furthermore, most of the study participants (53.9%) have received tertiary education and a combined 84.4% of them used social media for at least two hours daily. On COVID-19 vaccine uptake, 19.3% of the study participants were fully vaccinated, 25.2% have received the first dose of the vaccine, and 55.5% were unvaccinated.

On the whole, the sample results point out that the stratification of our study respondents did not differ much from Nigeria's online social stratification which consists of more male netizens (67%), with 78% of them being between 19 and 35 years old, and at least 45% being students (Teragon Insight, 2013). In addition, we checked for Common Method Bias (CMB) using the correlation matrix technique since the study data were collected from the same survey respondents. The outcome showed that the correlation among all the latent variables was within the acceptable threshold of ≤ 0.90; hence, our model had no CMB problem (Apuke & Omar, 2020).

4.1 The Measurement Model

The measurement model indicates the association between the latent construct and the indicator variables. Both convergent validity and discriminant validity were used to evaluate the psychometric properties of the model's measures (Ringle et al., 2018). Convergent validity was assessed using the values of the Cronbach Alpha (CA), outer loading (OL), average variance extracted (AVE), and composite reliability (CR) (Hair et al., 2017). The output (shown in Table 1) shows that CA and OL figures were greater than 0.7 and lower than 0.95 respectively. Similarly, AVE values were higher than 0.5 and CR figures surpassed the minimum benchmark of 0.7; thus, the model's convergent validity was acceptable.

For the discriminant validity, the Fornell & Larcker criterion presented in Table 2 shows that the AVE's square root of each latent construct was greater than its corresponding correlations with other constructs and, therefore, acceptable (Oyeoku et al., 2021). However, considering the drawback of the Fornell & Larcker criterion in disclosing discriminant validity problems (Henseler et al., 2015), we used the Heterotrait Monotrait (HTMT) Ratio procedure to further assess the discriminant validity of the research model. Previous research suggests that a good discriminant value is attained when the most conservative threshold value of the HTMT ratio is ≤ 0.90 (Henseler et al., 2015). As indicated in Table 3, all the HTMT values were less than 0.90; hence, our model had discriminant validity. In all, the outputs show that our model had excellent psychometric properties.

Table 1. Output for convergent validity

Construct	Code	Items	Outer loading		CR	AVE	M	SD	Source
Perceived Susceptibility	PSU1	I am likely to be affected by the side-effects of COVID-19 vaccine	0.85	0.82	0.91	0.79	3.6	1.21	Fadhel (2021)
	PSU2	I'm worried that I might be affected by the adverse effects of COVID-19 vaccines	0.88				4.2	0.64	Erubami et al. (2021)
	PSU3	I perceive that accepting COVID-19 vaccines will expose me to allergies, blood clots and similar health conditions	0.79				3.8	1.28	Hu & King (2021)
Perceived Severity	PSE1	The possible consequences of accepting COVID-19 vaccines are serious to me	0.84	0.81	0.94	0.75	3.5	0.78	Maayan-Metzger et al. (2005)
	PSE2	I feel that the adverse effects of COVID-19 vaccines uptake will be dangerous to me and the people around me	0.87				3.3	1.31	
	PSE3	I feel that it will be tough for me to effectively control the side effects of COVID-19 vaccines should they arise in the future	0.85				3.4	1.41	Deng et al. (2020)
	PSE4	I feel that if I am not careful about my COVID-19 vaccination decision, my family and I may suffer harsh consequences	0.86				3.5	1.11	
Perceived Benefits	PBE1	The uptake of COVID-19 vaccines will protect me from the disease	0.86	0.85	0.88	0.77	3.1	1.41	Walsh et al. (2015)
	PBE2	I would rather take COVID-19 vaccines than risk contracting the virus	0.81				4.1	0.61	Panchapakesan et al. (2018)
	PBE3	I feel that by taking recommended COVID-19 vaccines, I fulfill a great obligation to myself and my community	0.80				3.7	1.31	
	PBE4	It is gainful to be vaccinated	0.87				3.4	1.16	
Perceived Barriers	PBA1	My uptake of COVID-19 vaccines is hindered by the inconvenient time and place approved for vaccination	0.76	0.87	0.91	0.80	3.8	1.13	Kim & Lee (2011)
	PBA2	Most people around me do not approve/recommend the uptake of COVID-19 vaccines	0.88				4.0	0.62	Oraby et al. (2014)
	PBA3	My religion does not allow human vaccination	0.86				3.6	1.21	Olomofe et al. (2021)
	PBA4	Healthy people do not need to get COVID-19 vaccines	0.75				3.5	1.34	Cheney & John (2013); Panchapakesan (et al. (2018)
	PBA5	I always wonder about the safety of COVID-19 vaccines	0.88				3.7	1.23	
Vaccine Fear	VCF1	I am fearful about the adverse effects of COVID-19 vaccines	0.83	0.871	0.91	0.79	3.8	0.68	Galistiani et al. (2021)
	VCF2	I fear that COVID-19 vaccines were rushed and not thoroughly tested before approval	0.92				3.8	1.17	Fadhel (2021); WHO (2020)
	VCF3	I fear that COVID-19 vaccines may contain hidden chips that symbolise the mark of the anti-Christ	0.86				3.4	1.43	Olomofe et al. (2021)
	VCF4	I fear that COVID-19 vaccines may be a disguised population control strategy designed to hamper human fertility and procreation	0.88				3.8	1.31	
Anticipated Regret for Action	ARA1	I will not forgive myself if I develop side effects from COVID-19 vaccines	0.78	0.84	0.94	0.74	3.1	1.56	Cassell et al. (2006)
	ARA2	Should a negative consequence arise from my uptake of COVID-19 vaccines, I will feel guilty over my action	0.89				3.3	1.14	Christy et al. (2016)
	ARA3	Should the COVID-19 vaccines cause future health complications in my body, I will not be proud of my vaccination status	0.88				3.3	1.41	
Anticipated Regret for Inaction	ARI1	It will be my avoidable fault to contract COVID-19 after rejecting recommended preventive vaccines	0.90	0.88	0.93	0.79	3.2	1.32	Brewer et al. (2016)
	ARI2	It will hurt me if I am denied access to public places in the future due to my COVID-19	0.82				3.7	1.12	

		vaccination status							
	ARI3	Irrespective of what happens, I will be satisfied with future health occurrences related to COVID-19 knowing that I took recommended vaccines	0.77				3.5	1.32	Marcatto & Ferrante (2008)
Social Media Exposure	SME1	I am highly exposed to social media information on vaccine resistance	0.81	0.83	0.87	0.77	3.8	0.79	Erubami (2022); Fadhel (2021)
	SME2	I have seen a good number of vaccines adverse posts and comments on social media	0.86				3.2	0.77	
	SME3	The majority of posts and comments on my social network do not support the uptake of COVID-19 vaccines	0.79				4.0	0.51	
	SME4	I am exposed to much media rhetoric between doctors who support and those who oppose the uptake of COVID-19 vaccines	0.77				3.6	0.53	
Vaccine Uptake	VCU1	I have heard about the COVID-19 vaccine	0.88	0.86	0.91	0.74	3.8	1.12	Winger et al. (2016)
	VCU2	I have been inoculated with the approved COVID-19 vaccine	0.86				3.6	0.88	
	VCU3	I will accept another jab of COVID-19 vaccines if I am required to do so	0.91				3.6	0.75	

Table 2. Fornell-Larcker Criterion for Discriminant Validity

	Construct	1	2	3	4	5	6	7	8	9
1	Perceived Susceptibility	***0.75***								
2	Perceived Severity	0.58	***0.79***							
3	Perceived Benefits	0.56	0.59	***0.73***						
4	Perceived Barriers	0.44	0.53	0.62	***0.81***					
5	Vaccine Fear	0.41	0.48	0.63	0.68	***0.75***				
6	Anticipated Regret for Action	0.41	0.47	0.58	0.63	0.70	***0.77***			
7	Anticipated Regret for Inaction	0.36	0.43	0.61	0.61	0.71	0.58	***0.79***		
8	Social Media Exposure	0.34	0.42	0.58	0.59	0.66	0.56	0.56	***0.75***	
9	Vaccine Uptake	0.42	0.37	0.57	0.58	0.64	0.63	0.58	0.58	***0.77***

Table 3. Heterotrait Monotrait Ratio for Discriminant Validity

	Construct	1	2	3	4	5	6	7	8
1	Perceived Susceptibility								
2	Perceived Severity	0.72							
3	Perceived Benefits	0.68	0.63						
4	Perceived Barriers	0.78	0.74	0.73					
5	Vaccine Fear	0.65	0.81	0.73	0.75				
	Anticipated Regret for Action	0.81	0.77	0.76	0.69	0.82			
7	Anticipated Regret for Inaction	0.75	0.68	0.77	0.82	0.80	0.77		
8	Social Media Exposure	0.79	0.74	0.84	0.74	0.71	0.81	0.74	
9	Vaccine Uptake	0.81	0.76	0.74	0.79	0.79	0.76	0.78	0.76

4.2 The Structural Model

The structural model seeks to establish links between constructs through a set of paths that are often reflective of research hypotheses (Ringle et al., 2018). To evaluate the structural model, we analysed the path coefficients (β), the result of the t-test analysis, the summative effects of the hypothesised relationship on the endogenous construct (f^2), the coefficient of determination (R^2), and the model's predictive power (Q^2). For the path coefficients and t-test values, we

tested the hypotheses using a 5000 bootstrapping technique at a 5% significance level with a two-tailed option. The data presented in Table 4 indicate that the study outcome showed significant support for six out of the eight hypothesised relationships: Perceived susceptibility *(β =-0.44, $p < 0.01$*), Perceived severity *(β =-0.51, $p < 0.001$*), Perceived barrier *(β =-0.47, $p < 0.05$)*, Social media exposure *(β -0.34, $p < 0.05$)*, Fear of vaccine *(β =-0.38, $p < 0.001$)* and Anticipated regret for action *(β =-0.42, $p < 0.05$*). However, the results did not support two hypotheses: Perceived benefit *(β =0.31, $p > 0.05$)* and Anticipated regret for inaction *(β =-0.41, $p > 0.05$)*.

Table 4. Result of the structural model

Ha	Assumed relationship	β and *t* values	Q^2	f^2	Outcome
H1	Perceived susceptibility → vaccine uptake	-0.44 (5.88) **		0.08	Accepted
H2	Perceived severity → vaccine uptake	-0.51 (6.25) ***		0.06	Accepted
H3	Perceived benefit → vaccine uptake	0.31 (4.58)		0.12	Rejected
H4	Perceived barrier → vaccine uptake	-0.47 (2.15) *		0.08	Accepted
H5	Social media exposure → vaccine uptake	-0.34 (4.22) *		0.07	Accepted
H6	Fear of vaccine → vaccine uptake	-0.38 (8.76)***		0.14	Accepted
H7	Anticipated regret for action → vaccine uptake	-0.42 (3.95) *		0.08	Accepted
H8	Anticipated regret for inaction → vaccine uptake	0.41 (2.23)	0.381	0.15	Rejected

Significant at p <0.05*; p < 0.01**; p < 0.00***

Furthermore, we assessed the summative effect size of the hypothesised interaction among the variables (Ringle et al., 2018). According to the results shown in Table 4, the effect sizes for the six accepted hypotheses ranged from small to medium effects (0.06-0.14) which is significant (Apuke & Omar, 2020). Also, we checked the R^2 value to measure the model's in-sample predictive power (Hair et al., 2017). The results in Figure 2 suggest that about 78.2% of the variance in COVID-19 vaccine uptake is explained by the interactive influence of the exogenous variables, and this variance is significant and strong (Hair et al., 2019; Ringle et al., 2018). Finally, we estimated the model's predictive relevance by accessing the Q^2value obtained using a blindfolding procedure. The obtained Q^2 value of 0.381 (38.1%) was greater than zero, indicating that the model's predictive power is excellent (Apuke & Omar, 2020). The final structural model is shown in Figure 2.

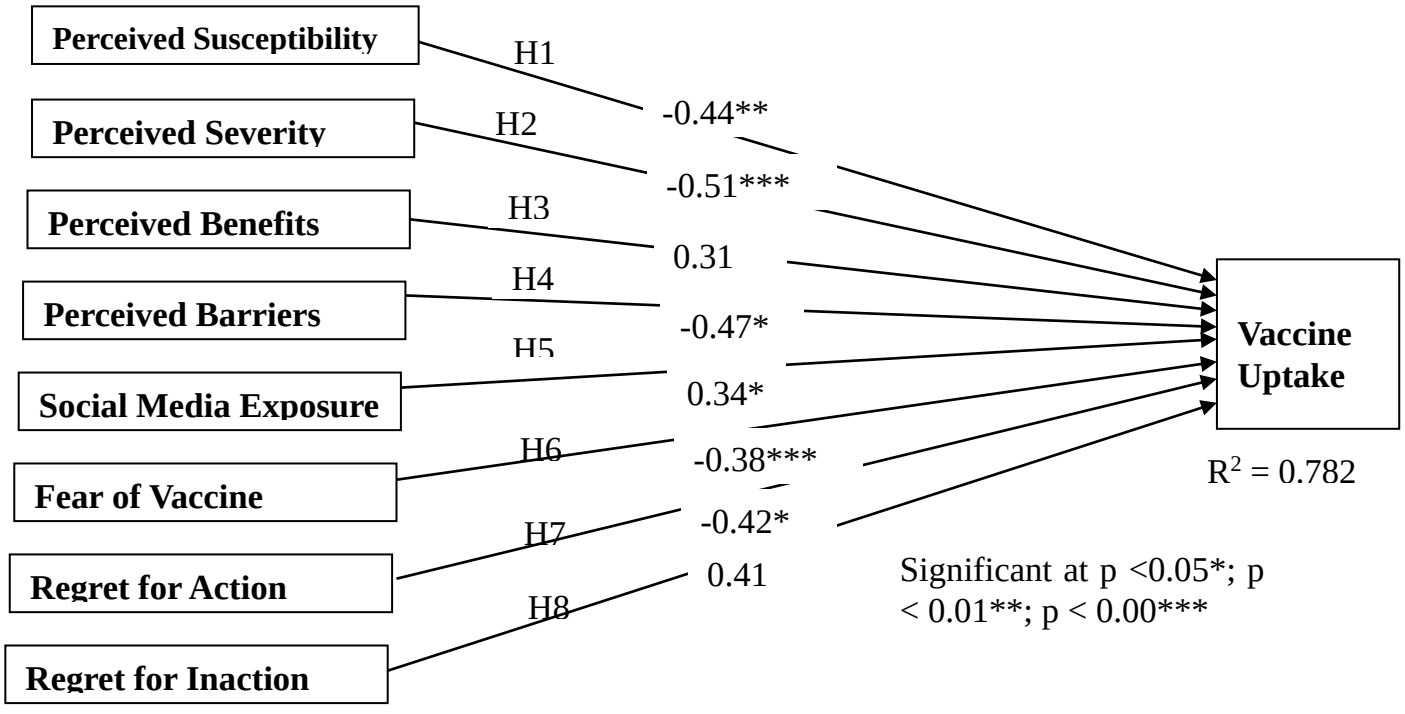

Figure 2. Final structural model for COVID-19 vaccine uptake

5. Discussion of Findings

Vaccines are widely considered the most effective tool for containing infectious diseases, and their level of uptake could determine the success of public health-related initiatives. Our study sought to offer a clearer insight into the main predictors of vaccine uptake in the COVID-19 pandemic era using empirical data collected from social media users in Nigeria. We essentially sought to know if exposure to vaccine-critical posts on social media, perceived vaccine risk, and discrete emotions (particularly fear and anticipated regret) would significantly predict COVID-19 vaccine uptake among the sampled Nigerian social media users. In agreement with previous research (Apuke & Tunca, 2021; NPHCDA, 2022; Olomofe et al., 2021), the outcome showed a generally low level of COVID-19 vaccine uptake among the study sample, with about 55.5% of the study participants still unvaccinated.

On the fore, we found that perceived susceptibility to and perceived severity of COVID-19 vaccine risk significantly predicted the respondents' vaccine uptake. Specifically, our study showed that perceived susceptibility to the likely risk inherent in taking COVID-19 vaccines was negatively linked with the uptake of the vaccines among the study sample, thereby supporting our first hypothesis. This finding agrees with the HBM construct and aligns with previous evidence that suggests that perceived susceptibility toward certain health risks would motivate health behaviour, including vaccine uptake (Choi et al., 2017; Oyeoku et al., 2021; Panchapkesan et al., 2018).

Overall, the strongest predictor of COVID-19 vaccine uptake among the study sample was the perceived severity of the potential negative consequences arising from vaccination. Thus, people with high perceived severity of COVID-19 vaccine risks (such as harsh side effects, gene mutation, morbidity, and mortality) would show a greater unwillingness to receive the vaccine than those who perceive the inherent risk of the vaccine (if any) would be less severe. This finding supports the assumptions of our second hypothesis and lends credence to previous studies that found that the perceived severity of a potential risk would significantly influence people's response to recommended preventive/containment actions, including vaccines uptake (Deng et al., 2020; Suleiman et al., 2015; Shmueli, 2021).

Although previous studies suggest that people's perceived susceptibility and severity toward COVID-19 disease may not significantly determine their health-related behaviour toward the disease (Apuke & Tunca, 2022; Wong et al., 2021), our study indicates that individuals' self-judgment concerning the seriousness of the likely negative effect of COVID-19 vaccine would predict their decision toward its uptake or otherwise. A possible reason for this outcome is the belief of Nigerians toward COVID-19 disease on the one hand and COVID-19 vaccines on the other. For instance, whereas many Nigerians doubt the existence and acclaimed potential consequences of COVID-19 infection, they nonetheless strongly believe that recommended COVID-19 vaccines are potentially harmful, underwent little medical/scientific rigour, are politically promoted, and targeted at population control in Africa (Apuke & Omar, 2021).

In furtherance of the HBM constructs, the results of the current study indicated that the perceived benefit of COVID-19 vaccines did not significantly influence the uptake of the vaccine among the study sample, contrary to our third hypothesis. However, COVID-19 vaccine uptake was negatively associated with perceived barriers to vaccination as postulated in our fourth hypothesis. This outcome refutes previous research that found perceived benefits as a significant predictor of COVID-19 vaccine uptake (Wong et al., 2021). However, it agrees with the conclusion of other studies that perceived barrier is significantly associated with health behaviour, including the uptake of vaccines (Oyeoku et al., 2021).

Generally, while the perceived benefits of certain public health actions (such as accepting COVID-19 vaccines) are expected to trigger appropriate behavioural change (Panchapakesan et al., 2018), the nature of such change would be influenced by an individual's self-assessment of the actions' utilitarian value (including the perceived efficacy and safety of vaccines in this case). In this guise, people would judge the perceived benefits of an action against the potential barriers to taking such actions; where perceived barriers outweigh perceived benefits, the willingness to engage in recommended health actions would be severely impacted (Cheney & John, 2013; Kim & Lee, 2011; Yuen & Tarrant, 2014). Observably, the potential barriers of inconvenient time and place for vaccination, negative recommendations from significant others, anti-vaccine religious beliefs, and limited trust in vaccine safety could dwarf the potential benefits of vaccination and discourage people from accepting the vaccine. Therefore, the promoters of vaccination programmes need to pay critical attention to these discouraging factors.

Regarding social media influence, the results showed that increased exposure to vaccine-critical posts on social media platforms was significantly associated with decreased COVID-19 vaccine uptake among the respondents. This is in agreement with our fifth hypothesis and previous research (Betsch et al., 2010; Wilson & Wiysonge, 2020). Evidence has shown that social media conversations on vaccines and vaccination schemes are inundated with critical opinions that are inimical to public health promotion efforts (Jamison et al., 2019; Smith & Graham, 2019). If poorly managed, such adverse comments on social media can significantly hamper netizens from adopting recommended health behaviours, including vaccine uptake (Erubami et al., 2021; Han & Liu, 2018). For this reason, stakeholders in the

public health sector must pay adequate attention to what goes on across these platforms and counter any detected falsehood with credible information.

Observably, the negative influence of social media exposure on COVID-19 vaccine uptake goes hand-in-hand with the study participants' fear of COVID-19 vaccines, which is also negatively associated with vaccine uptake in line with hypothesis six. Social media debates on infectious diseases are often enveloped in negative and pessimistic emotions like fear (Galistiani et al., 2021; Oh et al., 2021), and people's increased exposure to these posts can decrease their perceived efficacy and volitional control, making them doubt their ability to engage in recommended behaviours (Broche-Pérez et al., 2020; Erubami et al., 2021). Expectedly, as people become more regularly exposed to multiple anti-vaccination posts and their vaccine-related fear soars, there will be a concomitant surge in their vaccine resistance level, leading to a suboptimum vaccination reach.

Finally, we found anticipated regret for action to be a significant predictor of COVID-19 vaccine uptake among the study sample in line with previous research (Brewer et al, 2016). However, the respondents' uptake of recommended COVID-19 vaccines was not significantly related to their anticipated regret for inaction contrary to the assumption of hypothesis eight and previous findings (Brewer et al., 2016; WHO, 2020). The result, thus, suggests that the study participants were more interested in the immediate outcome of their action than what may happen in the future should they fail to act.

6. Limitations and Conclusion

To understand the impact of our findings, it is germane to state the likely limitations of this study. First, our study adopted an online survey, which has the drawback of unequal sampling opportunity for all members of a survey population; hence, future research should adopt a more robust probability sampling technique to account for possible sampling bias. Future research should also increase the size of the study sample to accommodate more participants and increase generalisability of findings. Nevertheless, the survey results for this study reflected the online stratification of Nigerian netizens, and the model variance is substantial enough for informed policymaking. Second, the current study did not investigate the influence of some control variables like gender, age, education, and previous vaccination experience, among others. Therefore, we encourage the inclusion of such variables in future research.

Despite the above-mentioned limitations, the current study has contributed to our understanding of the HBM by showing how its constructs explain the variations in people's uptake of recommended vaccines. Specifically, the study has established that the main predictors of COVID-19 vaccine uptake among Nigerian social media users include perceived susceptibility and perceived severity of vaccination risk, perceived barriers to vaccination, exposure to vaccine-critical posts on social media, fear of vaccination risk, and anticipated regret for vaccine uptake. However, we conclude that the perceived benefits of COVID-19 vaccine uptake and anticipated regret for inaction related to vaccination do not predict COVID-19 vaccine-related decisions. These findings are useful for understanding people's uptake of public health-related initiatives as well as in the planning and execution of public health-related policies and programmes in Nigeria.

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