

Factors associated with COVID-19 vaccine intention in Benin in 2021: A cross-sectional study



Elias Martinien Avahoundje^{a,*}, Jean-Paul Dossou^a, Armelle Vigan^a, Ibrahima Gaye^b, Christian Agossou^a, Christelle Boyi^a, Kéfilath Bello^a, Joël Mikponhoue^a, Mouhamadou Faly Ba^b, Adama Faye^{b,c}, Valéry Ridde^{b,d}

^a Centre de Recherche en Reproduction Humaine et en Démographie (CERRHUD), Cotonou, Benin

^b Institute of Health and Development (ISED), Cheikh Anta Diop University, Dakar, Senegal

^c Faculty of Medicine, Pharmacy and Odontology Cheikh Anta Diop University, Dakar, Senegal

^d Université Paris Cité, IRD, Inserm, Ceped, F-75006 Paris, France

ARTICLE INFO

Article history:

Received 10 July 2022

Received in revised form 1 November 2022

Accepted 2 November 2022

Available online 3 November 2022

Keywords:

Benin
COVID-19
Intention
Vaccine

ABSTRACT

Introduction: The development of COVID-19 vaccines has brought considerable hope for the control of the pandemic. With a view to promoting good vaccine coverage, this study aimed to measure vaccine intention against COVID-19 and to understand the factors that promote it.

Method: In April 2021, we conducted a cross-sectional and analytical study at the national level through a telephone survey of Beninese aged 18 years or older. We used a marginal quota sampling method (n = 865) according to age, gender, and department. We constructed the questionnaire using a theoretical framework of health intention. We determined the factors associated with intention to vaccinate against COVID-19 in Benin using a multinomial logistic regression at the 5 % significance level.

Results: The intention to vaccinate was 64.7 %; 10.9 % of the population were hesitant, and 24.4 % did not want to vaccinate. Thinking that it was important to get vaccinated (AOR = 0.274; CI = 0.118–0.638) or that getting vaccinated will help protect loved ones from the virus (AOR = 0.399; CI = 0.205–0.775) increased the intention to vaccinate. Having a high level of education (AOR = 1.988; CI = 1.134–3.484), thinking that the vaccine could put one's health at risk (AOR = 2.259; CI = 1.114–4.578), and hearing something negative about the vaccine (AOR = 1.765; CI = 1.059–2.941) reduced intention to vaccinate. In addition, believing that the creators of the vaccine had ensured its safety (AOR = 0.209; CI = 0.101–0.430), and believing that it was unlikely to be infected after vaccination (AOR = 0.359; CI = 0.183–0.703) decreased hesitancy in favour of the intention to vaccinate.

Conclusion: In April 2021, vaccine intention was high, but maintaining this high rate requires building confidence in the vaccine and combating misinformation about the vaccine.

© 2022 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

In response to the coronavirus pandemic, countries developed and implemented measures to ensure better case management and to attempt to control the spread of the virus (hand washing, social distancing, curfew, etc.) [1]. Despite these measures, the mortality and morbidity linked to the disease as well as the collateral effects remain considerable. Indeed, more than 1.4 million deaths were already recorded in 220 countries around the world in November 2020, one year after the appearance of the 1st cases [2]. By December 2021, there were more than 4.7 million deaths

due to COVID-19 recorded [3]. These facts justify the need, among the multiple prevention tools available, to rapidly develop an effective vaccine and to ensure its rapid deployment in all countries [4]. Research has shown that herd immunity can be achieved if a theoretical threshold of 66 % of the population is immune, either naturally or by vaccination [5,6]. Significant funding has been put in place to support rapid vaccine development [7]. The first vaccination campaigns began one year after the onset of the pandemic (December 2020). By December 2021, 21 vaccines against COVID-19 were on the market [8]. The COVID-19 Vaccines Global Access (COVAX) scheme was established to promote equity in vaccine distribution. The goal of COVAX was to achieve 20 % immunization coverage by the end of 2021 by promoting the distribution of 2 billion doses worldwide [9]. This initiative has

* Corresponding author.

E-mail address: avahoundjeelias@gmail.com (E.M. Avahoundje).

been disrupted by difficulties in the supply of delivered doses. These difficulties are due to the late delivery of less than promised by donors and manufacturers [9]. As of December 2021, only 907 million of the planned 2 billion doses of vaccine had been distributed worldwide [10]. Also in the beneficiary countries, there is a fragility of the health systems, logistical challenges that do not facilitate the transport and proper storage of vaccines, the lack of qualified health personnel, and the slow mobilization of the population [11,12]. In addition to these problems, vaccine hesitancy is a factor that hinders vaccination.

After the launch of the vaccine, some hesitation was noted in the US, Europe, and Asia [13–15]. In Africa, the intention to vaccinate (defined as being absolutely certain or very likely to be vaccinated [16]) could be dampened by rumours about the efficacy and dangers of vaccines [17,18]. As early as December 2020, rumours of adverse events such as Bell's palsy, allergic reactions, and an elevated risk of HIV infection were noted largely on online social media [19]. Several research studies have sought to identify factors that inhibit the acceptance of vaccines against diseases that existed prior to COVID-19 in Africa. These results highlighted the high burden of post-vaccination adverse effects, parental religious beliefs, and dysfunctional immunization services [20,21]. In the case of COVID-19, little research has been done on the underlying factors associated with vaccine intention in Africa. According to the results of a recent study conducted in 42 countries, 12 of which were in Africa, the most common reasons influencing the decision to vaccinate were uncertainty and mistrust of the vaccine, side effects, and vaccine safety [22]. In Cameroon during the first 30 days of COVID-19 vaccination, the most common side effects reported with Sinopharm and Covishield vaccines were headache, fever and myalgia (muscle pain) [23]. In Ethiopia and Egypt, injection site pain, headache, fatigue, fever, joint and muscle pain and chills were experienced by more than 40 % of people after receiving the Oxford AstraZeneca vaccine [24,25].

On March 29th, 2021, the government of Benin launched the COVID-19 vaccination campaign with Astra Zeneca vaccine [26]. In order to carry out a more successful and objective campaign, it was necessary to understand the factors that would encourage the population's support for this initiative. Studies have shown that the intention to be vaccinated is a crucial element that leads to the vaccination of individuals [27]. It was, therefore, urgent to measure the intention to vaccinate in Benin to understand the factors that contributed to the intention to vaccinate of the Beninese in order to better fight against the pandemic. Thus, the objective of this study was to identify the determinants of the Beninese population's intention to vaccinate with the COVID-19 vaccine.

Material and method

Benin demographics and health system

Benin is a country in West Africa with an area of 114,763 km². Benin has 12 departments and 77 communes. In 2018 its population was estimated at 11,496,140, of which 50.9 % are women. 44.6 % of the population lives in urban areas. The dominant religions are Catholicism (25.5 %) and Islam (27.7 %) [28]. Benin remains a low-income country with a GDP per capita of US \$1,428.4 according to World Bank estimates for 2021 [29]. Benin has two types of climate: in the south, an equatorial climate with high humidity. Alternating dry and rainy seasons. In the centre and north, a tropical climate. The harmattan, a hot and dry wind from the Sahara, blows over the entire country during the dry season. Benin has a three-tiered pyramid-shaped health system based on territorial division: the central or national level, the intermediate or departmental level and the peripheral level. In the public

sector, health care is provided by the Hubert Koutougou Maga National University Hospital Centre (CNHU-HKM), University Hospitals, Departmental Hospitals, District Hospitals, hospitals, health centres, and infirmaries. In the private sector, there are clinics, polyclinics, community medical centres, dispensaries, medical offices, specialised hospitals, humanitarian centres and religious centres. Benin has 561 doctors, or 21,137 inhabitants per doctor, and an estimated health coverage rate of 96.0 % in 2019 [30]. According to the WHO, the health coverage index is 45 and the health service utilisation rate is 30 % in 2020 [31].

COVID-19 vaccines available in Africa and Benin

Janssen, Pfizer-BioNTech, Oxford AstraZeneca, Sinopharm BBIBP, Sinovac and Moderna are the COVID-19 vaccines most received by African countries. In Benin, more than half of the doses received are Janssen vaccine (Table 1).

Type and period of study

We conducted a cross-sectional, descriptive, and analytical study through a nationwide telephone survey. The survey was conducted from March 30, 2021 to May 15, 2021. Only AstraZeneca vaccine was available in this period in Benin.

Study population

The study population consisted of Beninese aged at least 18 years, with a mobile phone, and able to answer a phone call. Individuals whose telephone numbers were unavailable and those who did not give oral informed consent were excluded.

Sampling

We performed marginal quota sampling on 865 individuals. In an emergency situation such as that of COVID-19, the marginal quota sampling method is considered relevant when the sample size is less than 3000 [32]. The variables used to define the quotas were age, gender, and department of origin. Quotas for each subgroup are proportional to the distribution of the population according to the latest 2013 General Census of Population and Housing [28]. Telephone numbers were randomly generated, which allowed for a balanced survey [33]. Of the 1000 people initially planned, 865 people were able to complete the questionnaire.

Data collection

We administered a digitized tablet-based questionnaire to the participants via Open Data Kit. A second Zoiper application installed on the tablets allowed the interviewer to receive the calls. The Zoiper application was networked with a computer complex consisting of a server, a gateway, and telephone call management software. This software made it possible to contact randomly generated numbers that were tested by a computer program beforehand to verify that the number was assigned to an individual and was active. After validation of the numbers, the list obtained was imputed into another computer program which automatically triggered the calls [34]. When a call was picked up, the respondent was put in touch with one of the interviewers to have the questionnaire administered. An audio greeting was placed between the time the call was picked up and the call was redirected to the interviewer's tablet. The system allowed up to four interviews to be conducted simultaneously between interviewers and respondents. Interviewers were trained and monitored by trained supervisors.

Table 1
Information on COVID-19 vaccines received by Benin.

name	Research name	Manufacturer/developer	Type	Percentage of doses received (Total = 6,541,590 doses)
Janssen (Johnson & Johnson)	JNJ-78436735 (Ad26.COV2.S)	Janssen Pharmaceutical Companies	Non-replicable viral vector	55 %
Sinovac	–	Chinese company Sinovac Biotech.	Inactivated	19 %
Pfizer-BioNTech	BNT162b2	BioNTech, Fosun Pharma, Pfizer	mRNA	11 %
Moderna	mRNA-1273	American company Moderna, the United States National Institute of Allergy and Infectious Diseases, and the Biomedical Advanced Research and Development Authority	mRNA	8 %
Oxford AstraZeneca	AZD1222 (ChAdOx1)	AstraZeneca, University of Oxford	Non-replicable viral vector	5 %
Others	–	–	–	2 %

¹ WHO, 2022 Africa COVID-19 Vaccination dashboard <https://app.powerbi.com/view?r=eyJrIjoIOTI0ZDlhZWEtMjUxMC00ZDhhLWFjOTYtYjZlMGYzOWI4NGlwiwidCl6l-mY2MTBjMG13LWJkMjQtNGl3OS04MTBiLTNkYzI4MGFmYjU5MCIsImMiOj9h9> (accessed November 01, 2022).

² DRUGBANK Online: <https://go.drugbank.com/>.

Ethical considerations

The study was authorized by the Local Ethics Committee for Biomedical Research of the University of Parakou in Benin under the number: 0308/CLERB-UP/P/SP/R/SA. The questionnaire was administered to each participant after oral informed consent.

Theoretical models

To identify factors that may influence vaccine intention, the questionnaire (Supplementary material 1) was based on two theoretical models of intention regarding health behaviours. On the one hand, the theory of planned behaviour (TPB) postulates that attitudes, subjective norms, and perceived behavioural control are the determinants of an individual's actual health behaviour [35]. On the other hand, the Health Belief Model (HBM) argues that health behaviour is based on perceived susceptibility to a particular health problem, perceived severity of disease, belief in the efficacy of the new behaviour, cues to action, perceived benefits of preventive action, perceived barriers to action (perceived risks, perceived difficulties, etc) [36]. Some studies have used one of these frameworks to understand people's intentions to vaccinate against influenza [37] or HPV [38]. In COVID-19, the TCP or HBM were also used to understand vaccination intention [39,40]. A few studies combined the two methods in understanding vaccine intention on COVID-19 [41]. We collected data on themes from the different theoretical models, and also data on socio-demographic characteristics, health profile of participants, knowledge about COVID-19, confidence, and emotions about the epidemic. Indeed, research had shown that negative emotional reactions to vaccination events are an important factor in the decision to vaccinate [42]. Fear may be a more direct predictor of vaccine intention than perceived susceptibility [43]. Also, trust in the government or in the vaccine is a factor strongly associated with intention to vaccinate [44,45]. Knowledge is also an important element influencing decision making [46].

Dependent variable

To measure intention to vaccinate, we asked the following question: "I intend to be vaccinated against COVID-19". The possible answers were proposed according to a 5-point Likert scale ("Strongly agree = 5" to "Strongly disagree = 1"; they also had the option to choose "Don't know". For the analyses, we recoded the answers given by the respondents into 3 categories: "1 = Yes" for those who had chosen "Strongly agree" or "Agree"; "2 = Hesitate" for those who had chosen "Neither disagree nor agree" or

"Don't know" and "3 = No" for those who had chosen "Disagree" or "Strongly disagree". Intention to vaccinate is the dependent variable.

The independent variables

Factors measured from theoretical models

We asked a series of questions to assess attitude towards the vaccine, subjective norms, behavioural control, perception of the severity of the disease, perceived efficacy of vaccination, incentive to act, perceived benefits, perceived risks, and availability of vaccination-related information. All the items in these themes were formulated through simple questions to the respondents. They could give their opinion using a 5-point Likert scale as defined above. We gave users the possibility of choosing "Don't know". The variables were recoded in two categories: "Yes = 1" corresponding to the choices "completely agree; or agree" and "No = 0" corresponding to the others.

Socio-demographic characteristics and health profile

We collected information on the age, gender, department, level of education, marital status and people's opinion of their financial situation. This last variable has 4 modalities and has been recoded into two: "0 = Poor or very poor" which corresponds to the choice "You are very poor" or "You are poor" and "1 = Modest or rich" which corresponds to the choice "Your income is sufficient" or "You are very comfortable". We recoded the level of education variable into two modalities "0 = Less educated" which corresponds to the choice "No education" or "primary" and "1 = More educated" which corresponds to the choice "secondary school" or "higher education". We also constructed a composite variable representing a proxy for the respondent's standard of living. To do this, we calculated an overall score for each individual, taking into account household equipment (fridge, television, radio) and access to basic services such as water and electricity. An individual who had one of the above-mentioned assets had one point. If he or she had two, he or she had two points, and so on. This assumes that the score varied from 0 to 5. The composite variable is called the overall socio-economic well-being score. After assigning the scores, we recoded the variable into two categories (0 to 3 = 0 "Low", 4 to 5 = 1 "High"). We also asked respondents whether or not they had any chronic illnesses and whether they had ever received any vaccinations as an adult.

Knowledge of COVID-19

We measured the knowledge of the respondents about the signs and modes of transmission of COVID-19. Respondents were asked

to list the three main signs they were familiar with. With the answers given, we created a variable that takes the response “yes” if the respondent knew the three main signs as defined by the World Health Organization [47]. The same procedure was carried out at the level of the survey. The same procedure was used for the modes of transmission.

Confidence around immunization

Confidence in vaccination was comprised of three variables that measured confidence in the government to fight the pandemic, confidence in health care providers, and confidence in the vaccine itself. The first variable was measured on a scale of 0–10 and then recoded into two categories “6–10 = More confident” and “0–5 = Less confident”. The other variables were measured on the same Likert scale as above. They were recoded using the same procedure as in the theoretical model.

Emotions

In our study, negative emotions included fear, anxiety, and worry. The positive emotions were related to hope, optimism, enthusiasm, and self-confidence in the face of the epidemic. The emotion variables were measured on a Likert scale and then recoded into two categories: “Yes = 1” which corresponds to the choice “strongly agree; or agree” and “No = 0” which corresponds to the other choices made. The level of concern was measured on a scale of 0 to 10 and recoded into two categories: “6–10 = More concerned” and “0–5 = Less concerned”.

Analysis

We performed a description of the population according to the socio-demographic characteristics on some variables of interest, and calculated frequencies. We performed chi-square tests of independence between vaccine intention and all other explanatory variables. The variables that had a p-value lower than 0.25 in the bivariate analysis with vaccine intention were retained to estimate an initial multinomial logistic regression model according to the recommendations of Hosmer LemerShow [48]. We used a top-down stepwise selection method that retained variables with p-values < 0.10 to create a final model. The final model produced adjusted odds ratios (AOR) and 95 % confidence intervals (CI). To reduce the effects of multicollinearity, we excluded some variables from the initial model by analysing variance inflation factors (VIF). A VIF greater than 2.5 was indicative of multicollinearity [49]. We excluded some variables with the highest VIF in order to have a VIF lower than 2.5 for all variables retained for the initial model. We tested the goodness of fit of the model for multinomial logistic regression models [50]. All analyses were performed with STATA 17 software.

Results

Characteristics of the study population and health profile

Of the 865 opinions received, the majority of respondents were under 25 years of age (57.6 %) with a predominance of men (59.2 %) and 63.1 % had either secondary school or higher education. People in unions (57.4 %) and single people (40.3 %) were the most represented. Only 2.3 % of the population was divorced or widowed. More than 8 out of 10 people (85.8 %) have a low socio-economic level and 96.1 % of respondents said they did not have a chronic disease. Slightly more than half of the population had received any kind of vaccine as an adult (50.9 %) (Table 2).

Presentation of some variables of interest

Vaccination intention was 64.7 %. It was higher in the central regions (Zou and Collines) and in almost all the northern regions, but in almost all the southern regions (Atlantique, Littoral, Ouémé, Mono), the intention to vaccinate was below the average 64.7 % (see Fig. 1). The results also show that 74.5 % of the population trusted the government to fight the pandemic. Only 3.8 % were aware of the main signs of the pandemic and 0.7 % knew the main modes of transmission. Six out of 10 people (59.9 %) said they would trust the vaccine if it was available (Table 2).

Determinants of vaccine intention

The results of the bivariate analysis showed that there was no significant association at the 5 % level between marital status, age, chronic disease, having received a vaccine in adulthood, having tested positive, or knowledge of another person who tested positive. Vaccination intention was also not associated with being optimistic or confident about the COVID-19 epidemic. There was also no association between knowledge of the three main symptoms or knowledge of the main modes of transmission and vaccine intention. Also at the behavioural control level, there was no significant association between vaccine intention and the variable “it is up to me to decide whether I want to get a coronavirus vaccine” (Supplementary material 2).

The results of the multivariate analysis showed that vaccination intentions were higher among respondents who thought it was important to be vaccinated (AOR = 0.274; CI = 0.118–0.638). They were also less likely to be hesitant about vaccination than to have a positive opinion (AOR = 0.230; CI = 0.090–0.589). Also, those who were confident about the COVID-19 vaccine were less likely to be negative (AOR = 0.144; CI = 0.085–0.245) or hesitant (AOR = 0.183; CI = 0.099–0.340). Respondents who agreed that people whose opinion was important to them approved of getting vaccinated were more likely to intend to vaccinate than to be hesitant about taking a COVID-19 vaccine (AOR = 0.435; CI = 0.245–0.773) and were also more likely to intend to vaccinate than to have a negative opinion (AOR = 0.244; CI = 0.148–0.401). Those who thought it was desirable to get vaccinated (AOR = 0.347; CI = 0.179–0.675) and those who thought getting vaccinated will help protect their loved ones from the virus (AOR = 0.399; CI = 0.205–0.775) were more likely to intend to get vaccinated against COVID-19 than to have a negative opinion. People who think the COVID-19 vaccine could put their health at risk (AOR = 2.259; CI = 1.114–4.578) and those who had heard something negative (AOR = 1.765; CI = 1.059–2.941) about the COVID-19 vaccine were more likely to not want the vaccination. The same was true for people with higher levels of education (AOR = 1.988; CI = 1.134–3.484). However, other socio-demographic variables such as sex, marital status, age, or financial status did not have a significant effect on vaccination intention. Respondents who believed that the creators of the vaccine had ensured its safety compared to those who did not were less likely to hesitate than to want to vaccinate (AOR = 0.209; CI = 0.101–0.430). The same was true for those who thought they were unlikely to be infected after vaccination (AOR = 0.359; CI = 0.183–0.703) (Table 3).

Discussion

The results show that a large proportion of the Beninese population had the intention to vaccinate (64.7 %) when the vaccination campaign had just started. Similar results were found in other countries such as Nigeria with a vaccination intention of 74.6 % in August 2020 [51] and in Senegal (54.4 %) in June 2020 [52]. In

Table 2
Study population according to socio-demographic characteristics and some variables of interest.

		Descriptive statistics		
		no.	%	N
Age group	Under 25 years old	498	57.6	865
	25 years –59 years	319	36.9	
	60 years and over	48	5.5	
Gender	Men	512	59.2	865
	Women	353	40.8	
Level of education	Less educated	319	36.9	865
	More educated	546	63.1	
Marital status	Married	495	57.4	862
	Divorced/Widowed	20	2.3	
	Single	347	40.3	
Overall socio-economic well-being score	Low	742	85.8	865
	High	123	14.2	
Existence of a chronic disease	Yes	34	3.9	865
	No	827	96.1	
Confidence in the government to fight the pandemic	Less confident	221	25.5	865
	More confident	644	74.5	
Confidence in the new COVID-19 vaccine if it were available	No	346	40.1	864
	Yes	518	59.9	
Received any kind of vaccine as an adult	No	440	50.9	864
	Yes	424	49.1	
Knowledge of the three main signs	No	832	96.2	865
	Yes	33	3.8	
Knowledge of the main modes of transmission	No	859	99.3	865
	Yes	6	0.7	

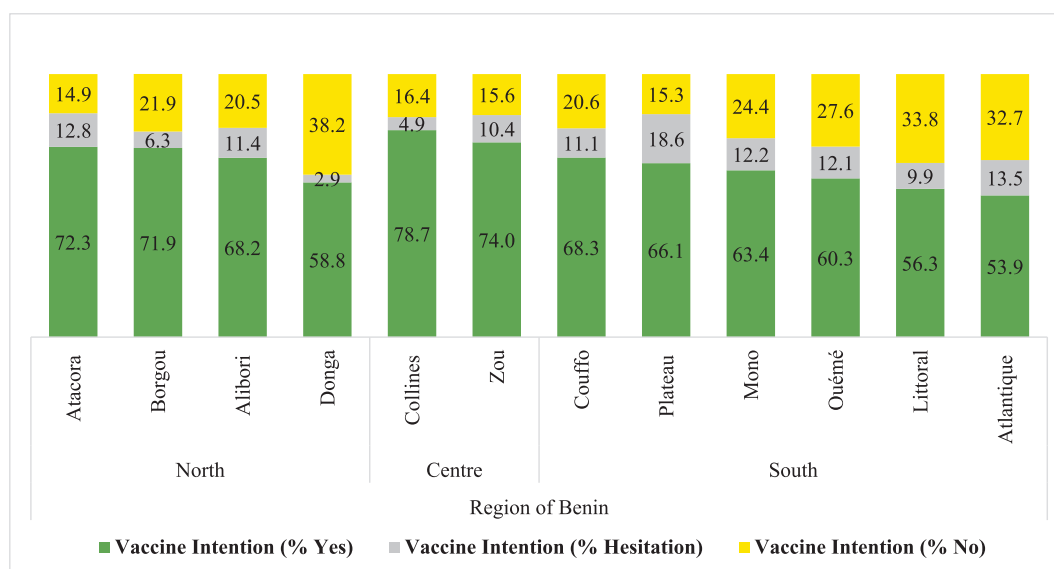


Fig. 1. Evolution of vaccination intention according to regions in Benin. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

a study including 22 Arab League countries, the intention was 62.4 % in January 2021 [53]. The intention to vaccinate is much lower in the southern regions, particularly in the Littoral and Atlantique, which are the most urbanised areas of the country and where the population is better educated and has better access to social media [28], which exposes them to the various rumours surrounding the vaccine. A study in Egypt found that rural residents had low levels of hesitancy and high levels of acceptance of COVID-19 vaccine [54]. Similar results were also observed in Senegal [55]. It should also be noted that the northern region is located in the African meningitis belt. Several adult meningitis vaccination campaigns are often conducted in this region. Adults had much more experience with vaccination, which probably had a positive effect on their intention to be vaccinated against COVID-19.

Confidence in the government to fight the pandemic was 74.5 % and confidence in the vaccine was 59.9 %. These results represent favourable indicators for vaccine promotion in Benin. Although these rates are satisfactory, it should be noted that a significant portion of the population did not yet have confidence in the vaccine and did not intend to be vaccinated.

The results also show that high levels of confidence in the vaccine led to high levels of vaccine intention. The same observations were obtained in two recent studies conducted in India [56] and the United States [57]. One of the determinants of vaccine confidence is the confidence conditioned by the vaccine itself, taken as a medical product [52,58]. Confidence in the product is influenced by vaccine safety issues (quality control, speed of development, potential side effects, and controversies) [14,58] perceived effectiveness of the vaccine, and perceived importance or benefit

Table 3
Multivariate analysis between vaccine intention and dependent variables.

Vaccination intention	Hesitation vs Yes(ref)			No vs Yes (ref)		
	AOR	P > z	IC-95 %[inf-sup]	AOR	P > z	IC-95 %[inf-sup]
High level of education.						
More educated	1.573	0.143	[0.859–2.880]	1.988*	0.016	[1.134–3.484]
Less educated	1.00	–	–	1.00	–	–
It is important to get vaccinated.						
Yes	0.230**	0.002	[0.090–0.589]	0.274**	0.003	[0.118–0.638]
No	1.00	–	–	1.00	–	–
It is advisable to be vaccinated.						
Yes	0.605	0.187	[0.287–1.277]	0.347**	0.002	[0.179–0.675]
No	1.00	–	–	1.00	–	–
Getting vaccinated will help protect my loved ones from the virus.						
Yes	0.787	0.523	[0.377–1.643]	0.399**	0.007	[0.205–0.775]
No	1.00	–	–	1.00	–	–
I believe that the creators of the vaccine made sure it was safe.						
Yes	0.209**	<0.001	[0.101–0.430]	0.695	0.189	[0.404–1.196]
No	1.00	–	–	1.00	–	–
The covid-19 vaccine could put my health at risk.						
Yes	1.160	0.726	[0.505–2.667]	2.259*	0.024	[1.114–4.578]
No	1.00	–	–	1.00	–	–
COVID-19 vaccine may have side effects.						
Yes	0.679	0.375	[0.288–1.597]	1.662	0.126	[0.867–3.188]
No	1.00	–	–	1.00	–	–
I am unlikely to be infected with COVID-19 after vaccination.						
Yes	0.359**	0.003	[0.183–0.703]	0.713	0.286	[0.383–1.327]
No	1.00	–	–	1.00	–	–
Faced with the coronavirus, I am afraid.						
Yes	0.736	0.383	[0.370–1.464]	1.708	0.102	[0.899–3.246]
No	1.00	–	–	1.00	–	–
People whose opinions are important to me approve of getting vaccinated.						
Yes	0.435**	0.005	[0.245–0.773]	0.244**	<0.001	[0.148–0.401]
No	1.00	–	–	1.00	–	–
Have heard something bad about the covid-19 vaccine.						
Yes	1.187	0.577	[0.649–2.170]	1.765*	0.029	[1.059–2.941]
No	1.00	–	–	1.00	–	–
I would need to know as much as possible about the coronavirus vaccine.						
Yes	1.364	0.737	[0.224–8.316]	0.295	0.099	[0.069–1.261]
No	1.00	–	–	1.00	–	–
Confidence in Government.						
More confident	1.363	0.340	[0.722–2.572]	0.699	0.175	[0.416–1.174]
Less confident	1.00	–	–	1.00	–	–
Confidence in the new covid-19 vaccine.						
Yes	0.183**	<0.001	[0.099–0.340]	0.144**	<0.001	[0.085–0.245]
No	1.00	–	–	1.00	–	–
_cons	8.056	0.046	[1.041–62.331]	19.526	0.001	[3.513–108.532]

AOR: Adjusted Odds Ratio.

Model fit: chi-squared statistic = 11.561 Prob > chi-squared = 0.774.

* Significant at the 5% level only;

** Significant at the 1% level.

of the vaccine. The results reported that respondents who were confident in the efficacy of the vaccine, mainly those who thought it was unlikely that they would still be infected with COVID-19 after vaccination, were more likely to want to be vaccinated. We also saw that people who believed that the vaccine developers had ensured the safety of the vaccine were more likely to want to be vaccinated. These results are similar to those obtained in a study in Zimbabwe in May 2021 on vaccination intention against COVID-19 [59]. Thus, communication strategies aimed at clarifying and explaining the efficacy and safety of the vaccine to the population are needed to reduce doubt and maintain high levels of confidence in the vaccine. We saw that people who thought that the COVID-19 vaccine could endanger their health were quite reluctant to take the vaccine. This makes sense, in that it is very difficult to buy into a health intervention knowing that it may have negative health impacts. Developing highly effective vaccines with minimal side effects against COVID-19 is one of the challenges in this pandemic context. It should be noted, however, that this perceived risk associated with the COVID-19 vaccine may be rooted in misinfor-

mation about the vaccine. This idea is also confirmed by the results of this study, as we have seen that hearing something negative about the vaccine negatively influences the intention to vaccinate. A study conducted in Cameroon between May and August 2020 showed that 84.6 % of respondents had shown hesitant behaviours towards COVID-19 vaccines due to the proliferation, misinformation, and fake news, mainly in social media [17]. Similar results were obtained respectively in Benin and in a study including 194 countries worldwide [18,60]. Rumours that Africa is a testing ground, that the vaccine may adversely affect the immune system, that the vaccine may cause infertility and that it has caused the death of children in Senegal, Benin and Guinea have been discussed at length [19]. In South Africa, a respondent in a study said: “This virus was created by man to kill. What makes you think the vaccine is safe? It’s a conspiracy of some assholes trying to control the world.” [61]. Other arguments against vaccination are based on distrust of the mRNA-based technology used by some COVID-19 vaccines [62]. Misinformation had a huge impact on vaccine intention. We must work to reduce the spread of negative rumours

about the vaccine. Limiting the effect of rumours can lead to more objective public support for efforts to achieve good immunization coverage in the country.

Efforts should be made to ensure that the most listened-to sources (radio, television, social networks, etc.) circulate reliable information. Health professionals must also play their part in this fight, especially first-contact health workers (at the primary care level) who are closest to the population and are more likely to be listened to. It has been shown that health professionals are the most reliable source of information on immunization [63], and can contribute to overall confidence in the vaccine [52,58].

At the attitude level, more specifically, the results show that the more the population thought it was important to get vaccinated, the more likely they were to be favourable to vaccination. In terms of subjective norms, those whose significant others approved of getting vaccinated were more likely to be in favour of getting vaccinated. Several studies aimed at predicting vaccine intentions had found similar results [39,41]. These results show that the Beninese population's decision to vaccinate was more related to the perceived importance of the vaccine, and this population is very much influenced in its decisions by the opinions of their significant others. What is needed, then, are initiatives by decision-makers to emphasize the importance of the vaccine through large-scale sensitization on the benefits of COVID-19 vaccines. We also need to work to improve the experience of those who agree to be vaccinated through good reception, good follow-up, and good listening to help them manage side effects so that they become ambassadors for the vaccines and not detractors.

We found no significant association between vaccine intention and variables aimed at measuring the knowledge of populations about the epidemic. These findings are not in line with those obtained by some studies showing the positive effect of a high level of knowledge on vaccine acceptance for COVID-19 [64]. But similar results were obtained in a study in the United States in May 2020, which showed that the level of knowledge about COVID-19 infection was not associated with a high level of acceptance of the COVID-19 vaccine [65]. Research has shown that knowledge is one of the most important factors in the fight against pandemics [46] but efforts to promote knowledge about the virus alone will not result in high vaccination rates in Benin. We have also noticed that more educated citizens tend not to intend to be vaccinated. In Egypt, high rates of hesitation were observed among the more educated [54]. Also, a study in Senegal in 2020 showed that the most educated people were the least likely to accept government measures [66]. But this is not in line with findings elsewhere [64]. A study of household heads in Zimbabwe showed that the higher their level of education, the higher their intention to vaccinate [59]. The same finding was also made in Israel [41]. This is a possible paradox for Benin, but it can be explained by the fact that these better-educated populations have a broader view of what is happening with COVID-19 vaccination. These are people who have easier access to information through the various audio-visual and digital information and communication channels. They are also people who do more research in order to have a broad knowledge of vaccines. In the presence of all the information, both false and true, that circulates around COVID-19 vaccines, their critical spirit has certainly taken over, without them having the possibility of independently accessing the methodology of production of the various information put forward by both sides. The sheer volume of work and the amount of evidence produced in such a short time on COVID-19 has not allowed for clear, consistent, and transparent communication. Between 2020 and 2021, some 140,780 publications were classified under the keyword "COVID-19" in the US National Library of Medicine. Of these publications, 2744, or barely 2 %, are classified as relating to Africa [67]. The lack of

participation of African intellectuals, the lack of contextualization of the research done on COVID-19 and ultimately the lack of ownership of this evidence by the educated did not necessarily help in the fluidity of communication and the building of strong confidence on this subject. Apart from the level of education, other socio-demographic characteristics did not have a significant impact on vaccination intention. There was no significant difference between the intention to vaccinate of men and women. A study based on a systematic review and meta-analysis conducted between November 2020 and January 2021 showed that women were more willing to be vaccinated than men [68]. A recent study in Saudi Arabia in February 2021 found that people aged 50 years were more likely to intend to vaccinate than younger populations, but there was no significant association between education level, gender or region and vaccine intention [39]. The same observation was made in the United Kingdom [69]. In Egypt, men are more likely than women to accept vaccination against COVID-19 [54].

One of the major findings of our study is that although vaccine intention was high at the beginning of the vaccination campaigns, the actual vaccination rate, after nine months of vaccination campaign, was low (11.4 %), a rate close to the average in Africa (9.1 %) [70]. The same observation was made in Senegal, where the intention to vaccinate was quite high in June 2020, i.e. 54.4 %, but the actual vaccination rate remains low (5.6 % in December 2021 [70]). This low vaccination rate in Africa can be attributed to the delay of COVAX in reaching its objectives. Other factors such as the availability and distribution of the vaccine, misinformation, the experience of side effects after vaccination can lead to a drop in confidence in the vaccine, in the government and in the health professionals. Other factors include the use of alternative methods of fighting against COVID-19 (homemade recipes based on plants or bark, grigris) and religious beliefs. Indeed, a recent study in Benin showed that the COVID-19 pandemic is perceived as a divine punishment by some believers. For them, human behaviour such as homosexuality, laws allowing abortion and others do not respect morality. Prayer and fasting are needed to implore the mercy of benevolent spirits to find a solution to the crisis. This category of people also uses antiviral plant species such as horned melon, which has a physical appearance similar to that of the virus, and the chilacayote or *Cucurbita ficifolia*, which is hung at the main entrance of the house to prevent the entry of the virus into the house [71]. In a survey in South Africa (n = 10,618, January 2021), some respondents linked the vaccine to supernatural phenomena: "People say it is infused with 666" and "I am a Christian, the vaccine is from the devil" [61]. Research is needed to understand the reasons for low vaccination rates in Africa in general, and in Benin in particular, when vaccination intentions were high.

This study has some limitations. First, the study was conducted in a context where the vaccine had only recently become available in Benin. Thus, participants' responses may change over time and with the scale of the vaccination campaign. In addition, the perceived severity of the virus may change vaccine intent as new variants emerge. In addition, this is a telephone survey carried out with quotas and some information on the socio-demographic characteristics used to verify the achievement of quotas and household assets is difficult to verify, which may impact the representativeness of the sample and the analysis of the predictive effect of these factors on vaccination intention. The fact that the sampling does not offer the possibility of disaggregating according to place of residence (urban and rural) is also a limitation. However, this study has the merit, in a context of physical distance, of being based on a methodology that makes it possible to contact populations throughout the country, and of producing data that remain useful for decision-making and, above all, for monitoring trends.

Conclusion

The purpose of this study was to find out the determinants of vaccine intention in Benin after the launch of the vaccine campaign. Indeed, about two-thirds of the population declared their intention to be vaccinated against COVID-19 in the first days of the vaccine launch. This high intention to vaccinate was accompanied by high confidence in the government's actions and in the vaccine. Similarly, confidence in the vaccine, perceived efficacy, and vaccine safety were associated with high rates of vaccine intention. Yet, vaccination coverage remains very low and shows the gaps between intentions and their realization. Communication efforts to highlight the vaccine's efficacy, benefits, and safety are needed to maintain high levels of acceptability. Work is also needed to address negative rumours about COVID-19 vaccination. These results can help guide public health policies and efforts, which should not be limited to vaccinating the majority of the population. They should also try to ensure a good relational experience for the vaccinated subject and adequate follow-up of the latter after vaccination, especially in the present pandemic context of COVID-19.

Funding

This research was funded by the French Development Agency through the initiative "COVID-19 - Health in common". It is conducted within the framework of the ARIACOV program (Support to the African Response to the COVID-19 epidemic).

Authors' contributions

All authors attest that they meet the ICMJE's criteria for authorship.

Data availability

Data will be made available on request.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

We would like to thank all the investigators who participated in the data collection: Boris Denakpo, Fahadou Ali, Fiacre Anato, Joséphine Dotou, and Rachelle Fagbohoun. We would also like to thank our partner AFRICASYS for its technical support in setting up the technological device that enabled us to conduct the telephone survey.

Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jvaxc.2022.100237>.

References

- [1] ACAPS. COVID-19 - Government measures | ACAPS 2021. <https://www.acaps.org/projects/covid19/data> (accessed September 26, 2021).
- [2] World Health Organisation. Coronavirus disease 2019 pandemic n.d. <https://www.who.int/emergencies/diseases/novel-coronavirus-2019> (accessed March 1, 2022).
- [3] WHO. WHO Coronavirus (COVID-19) Dashboard | WHO Coronavirus (COVID-19) Dashboard With Vaccination Data n.d. <https://covid19.who.int/> (accessed September 26, 2021).
- [4] Heymann DL, Aylward RB. Mass Vaccination: When and Why. Mass Vaccin. Glob. Asp. — Prog. Obstacles, vol. 304, Springer Berlin Heidelberg; 2006, p. 1–16. https://doi.org/10.1007/3-540-36583-4_1.
- [5] Fine P, Eames K, Heymann DL. "Herd Immunity": A Rough Guide 2011;52:911–6. <https://doi.org/10.1093/cid/cir007>.
- [6] The Royal Society. Herd immunity in the epidemiology and control of COVID-19. Sage 2020;11:1–8. <https://royalsocietypublishing.org/doi/10.1098/rsos.200671>.
- [7] Echos L. Covid : 5 chiffres fous sur le financement des vaccins 2021. <https://www.lesechos.fr/industrie-services/pharmacie-sante/covid-5-chiffres-fous-sur-le-financement-des-vaccins-1269170> (accessed September 26, 2021).
- [8] Gavi. The COVID-19 vaccine race 2021. <https://www.gavi.org/vaccineswork/covid-19-vaccine-race> (accessed September 26, 2021).
- [9] de Bengy PA, Storeng KT. COVAX, vaccine donations and the politics of global vaccine inequity. Glob Health 2022;18:1–14. <https://doi.org/10.1186/s12992-022-00801-z>.
- [10] UNICEF. COVID-19 Vaccine Market Dashboard 2021. <https://us20.campaign-archive.com/?u=40658b1a132cdc263e35b5b97&id=479b2344ed> (accessed March 2, 2022).
- [11] Massinga Loembé M, Nkengasong JN. COVID-19 vaccine access in Africa: Global distribution, vaccine platforms, and challenges ahead. Immunity 2021;54:1353–62. <https://doi.org/10.1016/j.immuni.2021.06.017>.
- [12] INTERNATIONAL C. Déception.Covax, enquête sur un échec 2021. <https://www.courrierinternational.com/article/deception-covax-enquete-sur-un-echec> (accessed March 2, 2022).
- [13] Barello S, Nania T, Dellafiore F, Graffigna G, Caruso R. 'Vaccine hesitancy' among university students in Italy during the COVID-19 pandemic. Eur J Epidemiol 2020;35:781–3. <https://doi.org/10.1007/s10654-020-00670-z>.
- [14] Dror AA, Eisenbach N, Taiber S, Morozov NG, Mizrahi M, Zigran A, et al. Vaccine hesitancy: the next challenge in the fight against COVID-19. Eur J Epidemiol 2020;35:775–9. <https://doi.org/10.1007/s10654-020-00671-y>.
- [15] Cascini F, Pantovic A, Al-Ajlouni Y, Failla G, Ricciardi W. Attitudes, acceptance and hesitancy among the general population worldwide to receive the COVID-19 vaccines and their contributing factors: a systematic review. EclinicalMedicine 2021;40:. <https://doi.org/10.1016/j.eclim.2021.101113>.
- [16] Nguyen KH, Srivastav A, Razzaghi H, Williams W, Lindley MC, Jorgensen C, et al. COVID-19 vaccination intent, perceptions, and reasons for not vaccinating among groups prioritized for early vaccination — United States, September and December 2020. MMWR Morb Mortal Wkly Rep 2021;70:217–22. <https://doi.org/10.15585/mmwr.mm7006e3>.
- [17] Dinga JN, Sinda LK, Titanji VPK. Assessment of vaccine hesitancy to a COVID-19 vaccine in cameroonian adults and its global implication. Vaccines 2021;9:1–14. <https://doi.org/10.3390/vaccines9020175>.
- [18] Hounghinih R, Dahèou G, Cadja-dodo E, Kpatinvoh A. Guide Pratique d'informations sur les vaccins et la vaccination contre la COVID-19 en Afrique. Cotonou, Bénin; 2021. https://www.ariacov.org/wp-content/uploads/2021/10/Guide_HD.pdf.
- [19] Olivia T. Data synthesis: covid-19 vaccine perceptions in Africa: social and behavioural science data. SSHAP Social Science in Humanitarian Action Platform; 2021. https://opendocs.ids.ac.uk/opendocs/bitstream/handle/20.500.12413/16580/Data%20Synthesis_Covid19%20Vaccine%20Perceptions%20Africa_Social_Behavioural%20Science%20Data%20Mar%202020-Mar%202021.pdf?sequence=3&isAllowed=y.
- [20] Streefland PH, Chowdhury AM, Ramos-Jimenez P. Quality of vaccination services and social demand for vaccinations in Africa and Asia. Bull World Health Organ 1999;77:722–30. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2557734/>.
- [21] Fourn L, Haddad S, Fournier P, Gansey R. Determinants of parents' reticence toward vaccination in urban areas in Benin (West Africa). BMC Int Health Hum Rights 2009;9:S14. <https://doi.org/10.1186/1472-698X-9-S1-S14>.
- [22] Asadi Faezi N, Gholizadeh P, Sanogo M, Oumarou A, Mohamed MN, Cissoko Y, et al. Peoples' attitude toward COVID-19 vaccine, acceptance, and social trust among African and Middle East countries. Health Promot Perspect 2021;11:171–8. <https://doi.org/10.34172/hpp.2021.21>.
- [23] Amani A, Djossaya D, Njoh AA, Fouda AAB, Ndoula S, Abba-kabir HM, et al. The first 30 days of COVID-19 vaccination in Cameroon: achievements, challenges, and lessons learned. Pan Afr Med J 2022;41. <https://doi.org/10.11604/pamj.2022.41.201.30218>.
- [24] Yesuf EA, Riad A, Sofi-Mahmudi A, Sudhakar M, Mekonnen A, Endalkachew S, et al. Self-reported side effects of the Oxford AstraZeneca COVID-19 vaccine among healthcare workers in Ethiopia, Africa: a cross-sectional study. Front Public Health 2022;10. <https://doi.org/10.3389/fpubh.2022.937794>.
- [25] Orebi HA, Emara HE, Alhindi AA, Shahin MR, Hegazy AH, Kabbash IA, et al. Perceptions and experiences of COVID-19 vaccines' side effects among healthcare workers at an Egyptian University Hospital: a cross-sectional study. Trop Med Health 2022;50:37. <https://doi.org/10.1186/s41182-022-00427-2>.
- [26] OMS. Lutte contre la pandémie du coronavirus (COVID-19) : La campagne nationale de vaccination officiellement lancée | Regional Office for Africa 2021. <https://www.afro.who.int/fr/news/lutte-contre-la-pandemie-du-coronavirus-covid-19-la-campagne-nationale-de-vaccination> (accessed September 26, 2021).

- [27] daCosta DM, Chapman GB. Moderators of the intention-behavior relationship in influenza vaccinations: intention stability and unforeseen barriers. *Psychol Health* 2005;20:761–74. <https://doi.org/10.1080/14768320500183368>.
- [28] INSAE. Principaux Indicateurs Socio-Démographiques Et Economiques (Rgph-4, 2013). 2016. <https://instad.bj/images/docs/insae-statistiques/demographiques/population/Principaux%20Indicateurs%20avec%20projections%20RGPH4/Principaux%20indicateurs%20socio%20d%C3%A9mographiques%20et%20C3%A9conomiques%20RGPH-4.pdf>.
- [29] Banque Mondiale. Produit Intérieur Brute par habitant. Tous les pays et leurs économie 2019. <https://donnees.banquemondiale.org/indicateur/NY.GDP.PCAP.CD?view=chart> (accessed August 25, 2022).
- [30] Hounnakan AC, Vissoh Ayadi AP, Vodungbo V, Hounkpe E, Gbeken P, Wadochedohoun R, et al. Annuaire des statistiques sanitaires 2019. Ministère de la santé-République du Bénin 2020. https://files.who.int/afahobckpcontainer/production/files/Annuaire_Statistique_2019.pdf.
- [31] OMS. Rapport annuel OMS Bénin 2020. Cotonou, Bénin: Organisation Mondiale de la Santé; 2020. https://www.afro.who.int/sites/default/files/2021-08/RAPPORT%20ANNUUEL%20OMS%20BENIN%202020%20Final_0.pdf.
- [32] Deville J-C. Une théorie des enquêtes par quotas. *Tech Enq Stat Can* 1991;12:177–95. <https://www150.statcan.gc.ca/n1/fr/pub/12-001-x/1991002/article/14504-fra.pdf?st=a165SGXA>.
- [33] Riandey B, Isabelle B-W. Introduction aux sondages à l'usage du plus grand nombre. 2009. <https://hal.archives-ouvertes.fr/hal-01272371>.
- [34] Anne Marie. Processus de réalisation d'enquêtes téléphoniques informatisées en suivant une approche d'échantillonnage aléatoire. Cloudly Yours 2020. <https://www.cloudlyyours.com/2020/11/05/processus-de-realisation-denquetes-telephoniques-informatisees-en-suivant-une-approche-dechantillonnage-aleatoire/> (accessed October 3, 2021).
- [35] Conner M, Norman P. Health Behavior. Ref Module Neurosci Biobehav Psychol 2021. <https://doi.org/10.1016/B978-0-12-818697-8.00060-1>.
- [36] Green EC, Murphy EM, Gryboski K. The health belief model. *Wiley Encycl Health Psychol* 2021;2:211–4. <https://doi.org/10.1002/9781119057840.ch68>.
- [37] Lau JTF, Yeung NCY, Choi KC, Cheng MYM, Tsui HY, Griffiths S. Factors in association with acceptability of A / H1N1 vaccination during the influenza A / H1N1 pandemic phase in the Hong Kong general population. *Vaccine* 2010;28:4632–7. <https://doi.org/10.1016/j.vaccine.2010.04.076>.
- [38] Wheldon CW, Buhi ER, Daley EM. Gay and bisexual men's human papillomavirus vaccine intentions: a theory-based structural equation analysis. *J Health Psychol* 2013;18:1177–86. <https://doi.org/10.1177/1359105312459875>.
- [39] Mahmud I, Kabir R, Rahman MA, Alradie-Mohamed A, Vinnakota D, Al-Mohameed A. The health belief model predicts intention to receive the COVID-19 vaccine in Saudi Arabia: results from a cross-sectional survey. *Vaccines* 2021;9:864. <https://doi.org/10.3390/vaccines9080864>.
- [40] Drązkowski D, Trepanowski R. Reactance and perceived disease severity as determinants of COVID-19 vaccination intention: an application of the theory of planned behavior. *Psychol Health Med* 2021;1–8. <https://doi.org/10.1080/13548506.2021.2014060>.
- [41] Shmueli L. Predicting intention to receive COVID-19 vaccine among the general population using the health belief model and the theory of planned behavior model. *BMC Public Health* 2021;21:1–13. <https://doi.org/10.1186/s12889-021-10816-7>.
- [42] Sun R, Wang X, Lin L, Zhang N, Li L, Zhou X. The impact of negative emotional reactions on parental vaccine hesitancy after the 2018 vaccine event in China: a cross-sectional survey. *Hum Vaccines Immunother* 2021;17:3042–51. <https://doi.org/10.1080/21645515.2021.1907149>.
- [43] Slovic P, Finucane ML, Peters E, MacGregor DG. Risk as analysis and risk as feelings: some thoughts about affect, reason, risk, and rationality. *Risk Anal* 2004;24:311–22. <https://doi.org/10.1111/j.0272-4332.2004.00433.x>.
- [44] Khosravi M. Perceived risk of COVID-19 pandemic: the role of public worry and trust. *Electron J Gen Med* 2020;17:em203. <https://doi.org/10.29333/ejgm/7856>.
- [45] Dubé E, Vivion M, MacDonald NE. Vaccine hesitancy, vaccine refusal and the anti-vaccine movement: influence, impact and implications. *Expert Rev Vaccines* 2015;14:99–117. <https://doi.org/10.1586/14760584.2015.964212>.
- [46] Li J-B, Yang A, Dou K, Wang L-X, Zhang M-C, Lin X-Q. Chinese public's knowledge, perceived severity, and perceived controllability of COVID-19 and their associations with emotional and behavioural reactions, social participation, and precautionary behaviour: a national survey. *BMC Public Health* 2020;20:1589. <https://doi.org/10.1186/s12889-020-09695-1>.
- [47] OMS. Maladie à coronavirus 2019 (COVID-19): ce qu'il faut savoir 2020. <https://www.who.int/fr/news-room/q-a-detail/coronavirus-disease-covid-19> (accessed October 8, 2021).
- [48] Hosmer DW, Lemeshow S. *Applied Logistic Regression*, 3rd Edition. 3rd ed. New York (USA): Wiley-Interscience Publication; 2000.
- [49] Midi H, Sarkar SK, Rana S. Collinearity diagnostics of binary logistic regression model. *J Interdiscip Math* 2010;13:253–67. <https://doi.org/10.1080/09720502.2010.10700699>.
- [50] Fagerland MW, Hosmer DW, Bofin AM. Multinomial goodness-of-fit tests for logistic regression models. *Stat Med* 2008;27:4238–53. <https://doi.org/10.1002/sim.3202>.
- [51] Adebisi Y, Alaran A, MedRxiv OB-. 2020 U. When it is available, will we take it? Public perception of hypothetical COVID-19 vaccine in Nigeria n.d. <https://doi.org/10.1101/2020.09.24.20200436>.
- [52] Ridde V, Ba MF, Gaye I, Diallo AI, Bonnet E, Faye A. Participating in a vaccine trial for COVID-19 in Senegal: trust and information. *Hum Vaccines Immunother* 2021;17:3907–12. <https://doi.org/10.1080/21645515.2021.1951097>.
- [53] Kaadan MI, Abdulkarim J, Chaar M, Zayegh O, Keblawi MA. Determinants of COVID-19 vaccine acceptance in the Arab world: a cross-sectional study. *Glob Health Res Policy* 2021;6:23. <https://doi.org/10.1186/s41256-021-00202-6>.
- [54] Omar DI, Hani BM. Attitudes and intentions towards COVID-19 vaccines and associated factors among Egyptian adults. *J Infect Public Health* 2021;14:1481–8. <https://doi.org/10.1016/j.jiph.2021.06.019>.
- [55] Ba MF, Faye A, Kane B, Diallo AI, Junot A, Gaye I, et al. Factors associated with COVID-19 vaccine hesitancy in Senegal: a mixed study. *Hum Vaccines Immunother* 2022;18:2060020. <https://doi.org/10.1080/21645515.2022.2060020>.
- [56] Mir HH, Parveen S, Mullick NH, Nabi S. Using structural equation modeling to predict Indian people's attitudes and intentions towards COVID-19 vaccination. *Diabetes Metab Syndr Clin Res Rev* 2021;15:1017–22. <https://doi.org/10.1016/j.dsx.2021.05.006>.
- [57] Latkin CA, Dayton L, Yi G, Konstantopoulos A, Boodram B. Trust in a COVID-19 vaccine in the U.S.: a social-ecological perspective. *Soc Sci Med* 2021;270:. <https://doi.org/10.1016/j.socscimed.2021.113684>.
- [58] Larson HJ, Clarke RM, Jarrett C, Eckersberger E, Levine Z, Schulz WS, et al. Measuring trust in vaccination: a systematic review. *Hum Vaccines Immunother* 2018;14:1599–609. <https://doi.org/10.1080/21645515.2018.1459252>.
- [59] McAbee L, Tapera O, Kanyangara M. Factors Associated with COVID-19 Vaccine Intentions in Eastern Zimbabwe: A Cross-Sectional Study. *Vaccines* 2021;9:1109. <https://doi.org/10.3390/vaccines9101109>.
- [60] Awijen H, Ben Zaied Y, Nguyen DK. Covid-19 vaccination, fear and anxiety: evidence from Google search trends. *Soc Sci Med* 2022;297:. <https://doi.org/10.1016/j.socscimed.2022.114820>.
- [61] Runciman C, Roberts B, Alexander K, Bohler-Muller N, Bekker M. UJ-HSRC COVID-19 DEMOCRACY SURVEY: Willingness to take a Covid-19 vaccine: A research briefing. University of Johannesburg; Human Sciences Research Council(HSRC); 2021. [https://hsrc.ac.za/uploads/pageContent/1045085/2021-01-25%20Vaccine%20briefing%20\(final\).pdf](https://hsrc.ac.za/uploads/pageContent/1045085/2021-01-25%20Vaccine%20briefing%20(final).pdf).
- [62] Kasozi KI, Laudisoit A, Osuwa LO, Batiha G-E-S, Al Omairi NE, Aigbogun E, et al. A descriptive-multivariate analysis of community knowledge, confidence, and trust in COVID-19 clinical trials among healthcare workers in Uganda. *Vaccines* 2021;9:253. <https://doi.org/10.3390/vaccines9030253>.
- [63] Badur S, Ota M, Öztürk S, Adegbola R, Dutta A. Vaccine confidence: the keys to restoring trust. *Hum Vaccines Immunother* 2020;16:1007–17. <https://doi.org/10.1080/21645515.2020.1740559>.
- [64] Bono SA, de Moura F, Villela E, Siau CS, Chen WS, Pengpid S, et al. Factors affecting COVID-19 vaccine acceptance: an international survey among low- and middle-income countries. *Vaccines* 2021;9:515. <https://doi.org/10.3390/vaccines9050515>.
- [65] Reiter PL, Pennell ML, Katz ML. Acceptability of a COVID-19 vaccine among adults in the United States: how many people would get vaccinated? *Vaccine* 2020;38:6500–7. <https://doi.org/10.1016/j.vaccine.2020.08.043>.
- [66] Ridde V, Kane B, Gaye I, Ba MF, Diallo A, Bonnet E, et al. Acceptability of government measures against COVID-19 pandemic in Senegal: a mixed methods study. *PLOS Glob Public Health* 2022;2:e0000041.
- [67] National Library of Medicine. Advanced Search Results - PubMed 2022. <https://pubmed.ncbi.nlm.nih.gov/advanced/> (accessed May 7, 2022).
- [68] Zintel S, Flock C, Arbogast AL, Forster A, von Wagner C, Sieverding M. Gender differences in the intention to get vaccinated against COVID-19: a systematic review and meta-analysis. *J Public Health* 2022;1–25. <https://doi.org/10.1007/s10389-021-01677-w>.
- [69] Sherman SM, Smith LE, Sim J, Amlôt R, Cutts M, Dasch H, et al. COVID-19 vaccination intention in the UK: results from the COVID-19 vaccination acceptability study (CoVAccS), a nationally representative cross-sectional survey. *Hum Vaccines Immunother* 2021;17:1612–21. <https://doi.org/10.1080/21645515.2020.1846397>.
- [70] Our World in Data. Coronavirus (COVID-19) Vaccinations 2022. <https://ourworldindata.org/covid-vaccinations> (accessed April 7, 2022).
- [71] Jean-Paul D, Armelle V, Eric A, Marlène G, Christelle B, Gisèle H. Influence des perceptions, savoirs populaires et pratiques sociales liés à la COVID-19 sur les comportements de recours aux soins post-partum et du planning familial dans la commune d'Allada: une recherche formative. Cotonou, Bénin: Centre de Recherche en Reproduction Humaine et en Démographie (CERRHUD); 2021.