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Factors associated with COVID-19 vaccine hesitancy in Senegal: A mixed study

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ABSTRACT

This study was an explanatory, sequential, mixed-methods design conducted in Senegal. We collected quantitative data from December 24, 2020, to January 16, 2021, and qualitative data from February 19 to March 30, 2021. We conducted a telephone survey among a marginal quota sample of 607 people over 18 years old. We performed descriptive, bivariate, and multivariate analyses with R software for the quantitative phase; and performed manual content analyses for the qualitative phase. We surveyed 607 people for the quantitative phase and interviewed 30 people for the qualitative phase. Individuals who hesitated or refused to be vaccinated represented 12.9% and 32.8%, respectively. Vaccine hesitancy was related to gender, living in large cities, having a poor attitude toward the vaccine, thinking that the vaccine would not help protect them from the virus, being influenced by people important to them, and lacking information from health professionals. Vaccine refusal was related to living in large cities, having a poor attitude toward the vaccine, thinking that the vaccine would not help protect them from the virus, thinking that the vaccine could endanger their health, trusting opinions of people who were important to them, and lacking information from health professionals. The results of the study show that the factors associated with COVID-19 vaccine hesitancy and refusal are diverse and complex. Addressing these factors will help to ensure better vaccination coverage. Governments and health authorities should intensify their efforts to promote vaccine confidence and reduce misinformation.

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Introduction

Coronavirus disease 2019 (COVID-19) remains a significant public health concern. Although much effort worldwide has been devoted to implementing control strategies—including travel bans, isolation of confirmed cases and close contacts, social distancing, and hygiene measures—virus transmission is likely to rebound when these strategies are lifted.[1] Among multiple possible strategies to control this pandemic is mass vaccination.[2] Achieving effective results from vaccination depends not only on accessibility, which remains a major challenge in Africa, but also on the acceptance and willingness of the population to be vaccinated.[3] Thus, one of the major obstacles to achieving high immunization coverage is vaccine hesitancy.[4] Beyond the long-standing debates on the concept and its scope,[5] the World Health Organization (WHO) defines vaccine hesitancy as the delay in acceptance or refusal of vaccination despite the availability of immunization services.[6]

Worldwide, studies show very high variability in acceptability of the COVID-19 vaccine, with rates ranging from 29.4% to 86.0%.[7–13] In the majority of studies of the public stratified by country, acceptance of COVID-19 vaccination showed a level ≥70%.[14] A survey of 15 African countries showed that approximately 80% of people are willing to accept the COVID-19 vaccine once it is available and is considered safe (harmlessness) and effective (protection from infection). Although the overall results are encouraging, there are significant regional differences in Africa.[15] A meta-analysis showed that the proportion of individuals reporting that they would refuse a COVID-19 vaccine was 14.3% [95% CI: 11.4% to 17.9%], and the proportion reporting uncertainty was 22.1% [95% CI: 17.8% to 27.1%].[16] The latter also showed that intentions to vaccinate have decreased over time while refusals have increased.[16] Several factors can influence acceptance or refusal of the vaccine (professional status, politics, gender, age, education, income, etc.).[17] In addition, the novelty of the disease, concerns about the safety and efficacy of the vaccine, and distrust of governments have resulted in a significant proportion of people indicating a reluctance to be vaccinated against COVID-19.[17]

Senegal launched its vaccination campaign against COVID-19 on 23 February 2021. Vaccines were offered free of charge through the regular immunization services of the expanded programme on immunization. Vaccinations was mainly carried out as a fixed strategy at the level of the vaccination units.[18] As of 2 February 2022, 1.4 million people have received at least one dose, including 1.0 million people who have received two doses, representing a complete coverage of 6.0% of the total population.[19] This coverage is far from the objective set by the authorities, which was to ensure vaccination of at least 20% of the general population before June 2021.[18] At the same time, the virus continues to spread. As of 2 February 2022, Senegal

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had 85,072 cases including 1,949 deaths—a case-fatality rate of 2.2%.[20] The number of cases in Africa was 1.1 million with a similar case fatality (2.2%). One of the important components of this challenge, despite its multifaceted nature, is vaccine hesitancy and refusal. Thus, assessing its scope and magnitude is necessary to guide interventions to build and sustain responses to this epidemic. Understanding and responding to the determinants is necessary to achieve a high vaccine coverage. This study aims to assess and identify factors associated with hesitancy toward the COVID-19 vaccine in Senegal.

Methodology

Research specifications, data collection, and study population

This study is a sequential, explanatory, mixed-methods design where qualitative data should help understand the results of the analysis of the previously collected quantitative data.[21] The writing of the article followed the quality criteria proposed by the Mixed Methods Appraisal Tool.[22] The quantitative data were collected from 24 December 2020, to 16 January 2021, before the vaccine campaign; and the qualitative data were collected during the vaccine campaign—from February 19 to 30 March 2021.

Sampling

The study population consisted of individuals from the general population living in Senegal aged 18 years and older with a mobile phone number. In June 2020, we conducted an initial nationwide telephone survey of 813 people to measure the social acceptability of governmental measures to control COVID-19.[23] The study used a marginal quota sampling strategy.[24] In order to have a representative population sample, we carried out a stratification according to the weight of the population by region, gender, and age group. We organized a second survey concerning vaccine aspects among these same people. The final quantitative sample size was 607 (74.6%). A comparison of the characteristics of the quotas chosen to constitute the sample between the two surveys shows that while they are not statistically different for region ($p = .99$) or age ($p = .08$), they are for gender ($p = .04$).

The qualitative sample was composed of 30 individuals drawn at random from the quantitative sample and according to this stratification from those who said they were reluctant ($n = 15$) or unwilling ($n = 15$) to be vaccinated, nested within the final quantitative sample ($n = 607$) (Table A1). Individuals were replaced if they refused to participate or could not be reached.

Data collection

The quantitative data collection tool was a structured and closed questionnaire (supplementary material). Five female interviewers speaking six languages (French, Diola, Wolof, Sérére, Pulaar, Soninké) collected the data by telephone. The interviewers used tablets equipped with an Open Data Kit (ODK) software to administer the questionnaire.[25] We performed data quality control by training interviewers, pretesting the tools, scanning the questionnaire, collecting the data on a tablet, and recruiting a supervisor to monitor data collection in real-time daily.

Intention to be vaccinated, the dependent variable, was measured with a 5-point Likert scale (strongly agree = 5 to strongly disagree = 1). Following the WHO definition, we moved the results to a 3-mode variable:

- Strongly agree and agree = intention to be vaccinated
- Neither agree nor disagree = reluctant to get vaccinated
- Disagree and strongly disagree = refusal to be vaccinated

The independent variables collected in the quantitative survey were conceptualized according to the WHO vaccine hesitancy model.[6] They concerned:

- Contextual factors: age, gender, region, wealth quintile, education, belief in the safety of the pharmaceutical industry, belief in the accessibility of health personnel to get vaccinated, the perception that there is something wrong with the vaccines, and total trust in the government to fight the epidemic.
- Individual and group influences: perceived importance of getting vaccinated, the usefulness of getting vaccinated, responsibility of getting vaccinated, safety of future vaccines, desirability of getting vaccinated, benefits and risks of the vaccine, social influence for receiving the vaccine, trust in health care providers for receiving the vaccine, getting regular information about the vaccine in the coming months, and perceived need for health care workers to provide information about the vaccine.
- Vaccine-specific factors: free vaccines for the entire population

The independent variables composed of a 5-point Likert scale were transformed into binary variables (Yes = Strongly agree and agree; No = Other). For the variable "Confidence in the government in the fight against COVID-19," which was in the form of a score ranging from 0 to 10, the person was considered to have had complete confidence when he/she had the maximum score. Using principal component analysis (PCA), we obtained the wealth quintile on durable asset ownership and housing characteristics. This approach ranked individuals from the poorest (1) to the least poor (5) to capture the socio-economic differences.

All this made it possible to determine the level of refusal and reluctance to be vaccinated and identify the associated factors.

The quantitative analyses guided the qualitative survey by seeking to understand more deeply the reasons for hesitation or refusal. Using an open-ended guide, the interviewers conducted individual interviews over the telephone for an average of 30 minutes.

Data analysis

We performed quantitative analyses with R software version 4.0.5. Categorical variables were described by numbers and percentages. We used the Chi2 test to compare proportions with a 5% alpha risk. We modeled vaccine hesitancy and

Table 1. Results of the multivariate analysis.

	Intention (Ref) vs Hesitation			Intention (Ref) vs Refusal		
Features	ARO [1]	95% CI [1]	p-value	ARO [1]	95% CI [1]	p-value
Sex						
Male	1.00	-		1.00	-	
Female	**2.49**	**1.20, 5.17**	**0.014**	1.77	0.90, 3.50	0.099
Region						
Remainder	1.00	-		1.00	-	
Dakar-Diourbel-Thiès	**2.16**	**1.04, 4.48**	**0.040**	**2.03**	**1.04, 3.96**	**0.038**
I think it's important to get vaccinated						
Yes	1.00	-		1.00	-	
No	**2.72**	**1.16, 6.39**	**0.022**	2.07	0.93, 4.61	0.075
I think it is advisable to get vaccinated against COVID-19						
Yes	1.00	-		1.00	-	
No	**16.49**	**6.72, 40.59**	**<0.001**	**17.00**	**7.42, 39.00**	**<0.001**
Getting the COVID-19 vaccine will help protect me from the virus						
Yes	1.00	-		1.00	-	
No	**20.10**	**8.06, 50.00**	**<0.001**	**19.30**	**8.49, 44.00**	**<0.001**
The coronavirus vaccine could put my health at risk						
Yes	1.00	-		1.00	-	
No	0.56	0.20, 1.62	0.299	**0.20**	**0.09, 0.49**	**<0.001**
Coronavirus vaccine may have side effects						
Yes	1.00	-		1.00	-	
No	1.66	0.71, 3.90	0.199	0.67	0.32, 1.40	0.299
When the vaccine is offered, most of the people important to me (family, friends) would think that I need to be vaccinated against COVID-19						
Yes	1.00	-		1.00	-	
No	**4.97**	**2.34, 10.50**	**<0.001**	**5.61**	**2.83, 11.1**	**<0.001**
I think it will be easy for me to access the health professional to get the coronavirus vaccine if I want it						
Yes	1.00	-		1.00	-	
No	**0.33**	**0.13, 0.84**	**0.020**	**0.22**	**0.09, 0.51**	**<0.001**
Health workers should provide appropriate and necessary information and support for immunization						
Yes	1.00	-		1.00	-	
No	**22.4**	**1.71, 293**	**0.018**	**26.2**	**2.29, 301**	**0.009**

[1]AOR = Adjusted Odds Ratio, CI = Confidence Interval, $p < 0.05$ in bold.

refusal using multinomial logistic regression in the multivariate analysis. We included all variables with *p*-values less than .25 in the bivariate analysis in the initial model.[26] To construct the final model, we used the stepwise top-down selection procedure in each model. We individually removed variables that did not improve the model.[27] We used the likelihood ratio test to compare the nested models.[27] We used this multivariate analysis to determine adjusted Odds Ratios and estimated the corresponding 95% confidence intervals (CIs) for all variables.

For the qualitative data, we transcribed the interviews in full in French. Then, we performed a manual content analysis.[28] We have organized these results according to the 6 dimensions conceptually based on the model of Huijts et al.[29] to understand the results of the quantitative analysis. According to the mixed methods approach, divergences and convergences are highlighted in the presentation of the results.[30] Explanatory elements for vaccine refusal or hesitation that were not considered in the quantitative survey emerged in the qualitative survey. The integration of the results is described in the discussion.

Results

Quantitative study

In the study, 67.1% of the individuals were between 25 and 59 years of age. Males accounted for 60.3%. The proportion of respondents with no education was 41.7% (Table A2).

Individuals who hesitated or refused to be vaccinated were 12.9% and 32.8%, respectively (Table A2).

The proportion of vaccine-hesitant who thought it was not useful to be vaccinated was 23.3% compared to 9.0% who thought it was useful ($p < .001$). The proportion of individuals who refused to be vaccinated because the vaccine could endanger their health was higher than the proportion who said the vaccine would not endanger their health (67.9% vs 22.8%, $p < .001$) (Table A3).

The results of the multivariate analysis showed that females (ORa = 2.49 [95% CI: 1.20–5.17]), individuals living in Senegal's major cities (ORa = 2.16 [CI95%: 1.04–4.48]), individuals who thought it was not important or not desirable to get vaccinated (OR = 2.72 [CI95%: 1.16–6.39]; OR = 16.49 [CI95%: 6.72–40.59]), individuals who said that getting vaccinated would not help protect them from the virus (OR = 20.10 [CI95%: 8.06–50.00]) and individuals who thought that most people important to them would not think they should be vaccinated against COVID-19 when the vaccine was offered (OR = 4.97 [95% CI: 2.34–10.50]) were more likely to be reluctant to be vaccinated. individuals living in Senegal's major cities (ORa = 2.03 [CI95%: 1.04–3.96]), individuals who thought it was undesirable to be vaccinated against COVID-19 (ORa = 17.00 [CI95%: 7.42–39.00]), individuals who said that getting vaccinated would not help protect them from the virus (ORa = 19.30 [CI95%: 8.49–44.00]), individuals who thought that the vaccine might endanger their health (OR = 5.00 [95% CI: 2.04–11.11]) and individuals who thought that most people important to them would not think they should be vaccinated against COVID-19 when the vaccine was offered (ORa = 5.61 [95% CI: 2.83–11.10]) were more likely to refuse the vaccine (Table 1).

Qualitative study

The deductive content analysis was used to explain the results found in the quantitative survey.

Attitudes

The qualitative research indicates that a poor attitude toward the COVID-19 vaccine could be explained by rumors: "*I hesitate because of the rumors I heard about the vaccine; that's the first aspect, the second aspect is that I am confused about the time it takes to create it. That is why I am hesitating for the moment and I am waiting for some time to understand how it will manifest itself in the country*" (Male, 37 years old, hesitant).

Individuals spoke of concern to reduce the African population with this vaccine: "*I have heard that some people want to harm Africa because they see a very high birth rate in the population. It is also said that those who control the world consider that Africa has many more people because some men marry four women and have 10 children or each woman gives birth to five children. They demand for each couple to have one or two children and if they don't manage to prohibit the large number of births, they do everything to decrease the size of our population through vaccines.*" (Male, 21 years old, refusal). On another note, one person said that it was not advisable to talk about COVID-19 vaccination in Africa when the epidemic is taking a greater toll in northern countries: "*They should start with them first. If they had done that until they were cured, until they were stable, then they would say, there is still the part of the Africans, I would have understood*" (Male, 36 years old, refusal).

Perceived benefits

Even though the individuals in the qualitative survey think that there could be a benefit, they address the fact that the vaccine only makes it possible to reduce the risk of seriousness once the person is infected by the virus: "*Ah, as we said about vaccination, today if you vaccinate yourself at least, maybe this disease even if it affects you, it won't be serious. I can't say that you won't get Covid-19. Today, no one can guarantee that this disease will not affect you after vaccination*" (Female, 30 years old, refusal).

> *There can be advantages because it's the last resort, it's the last solution. When you get the vaccine, even if you have the disease, you can have the strength to fight it and it won't harm you. Now we have hope.*(Male, 36 years old, hesitant).

Perceived risks

Individuals refusing the vaccine cited adverse effects of some vaccines and deaths observed in some countries after the start of the vaccination campaign as explanations: "*You know, when you follow the news closely, there are certain things about which you can have doubts. I saw on France 2, in their 8 o'clock news, that in Norway they started to vaccinate retired people and most of those who were vaccinated died and it was the French television that showed it. There are some things we have doubts about. Yes you know that this information, the television, if it was another television I can not believe it but France TV TF1 or LCI, han? Yes, the side effects, we have to say so because there are side effects, they have to tell us about the side effects*" (Male, 34

years old, refusal). This situation creates doubt in the respondents and leads them to adopt a precautionary principle to observe the possible positive or negative effects of the vaccine before taking the plunge: "*If people who are vaccinated stay 3 to 4 months without anything happening to them or if they don't have any undesirable effects, I'll get vaccinated*" (Female, 38 years old, hesitant).

Subjective standards

The qualitative survey showed that for most individuals hesitating and refusing to be vaccinated, the opinion of their family member would not affect their decision in any way: "*No, if I have to be vaccinated, I will do it willingly, but not under the influence of anyone*" (Female, 33 years old, Hesitant). For others, the opinion of people who have expertise in this field can be a determining factor in changing their behavior: "*For me, only doctors can influence us because they know it better than us. But for the others, even if they have knowledge, for me, maybe what they say is true, but I trust the doctors more, they know the job better*. (Female, 34 years old, refusal).

Information and conspiracy

Hesitancy and refusal to be vaccinated were related to the failure of health workers to provide appropriate and necessary information and support for vaccination (Table 1): "*I am hesitant to be vaccinated because I have not yet received relevant information about the vaccine*" (Male, 20 years old, hesitant). In addition, the communication offered by the health staff, but also the example given, seems to have a strong influence on the behavior to be vaccinated:

- "*We need medical personnel to communicate with the population. They could have confidence if, for example, a doctor who is a specialist in his or her field communicates about the vaccine*. (Female, 24 years old, hesitant).
- *"The state should communicate widely through doctors and not through politicians. Health personnel should be vaccinated and the population should be encouraged to do the same. For me, this is the best thing to do*. (Female, 24 years old, refusal).

Communication by health professionals is important because it reassures the population: "The day I am reassured, I will vaccinate myself" (Female, 33 years old, hesitant).

The quality of information was also highlighted in the qualitative interviews, and the conspiracy theories were prominent: "*The day before yesterday, I was shown someone who works in this field explaining that the vaccines sent to Africa are not the best and that they carry undesirable risks*" (Male, 62 years old, refusal). Some even went so far as to question whether the vaccine received by the state authorities is the same as the one that the population will use: "*There is no proof that the vaccine received by the health authorities and the state authorities are the same vaccines used for the population. For me, it is only a decoy because we saw on Whatsapp, a shot used in Germany that shows a person vaccinated with a fake syringe containing nothing and making people believe that the person was vaccinated"* (Male, 27 years old, hesitant).

Perceived effectiveness

Respondents thought that possible variants could complicate vaccination: "*The vaccine may be risky because it has been said that the Covid-19 virus can mutate. But how can you find your vaccine so quickly? If we find the cure and the virus takes another form too . . . I am not convinced of the effectiveness of this vaccine"*. (Female, 20 years old, refusal).

> *They won't be as effective as they should be because the vaccine was designed for the variant that was here first. But if another variant comes along, this vaccine won't be able to do anything about it because the virus has changed*(Female, 20 years old, hesitant).

On the other hand, some people have reservations about certain vaccines: "From *what people are saying about the Chinese vaccine and the Russian vaccine, they have a lot more confidence in those two vaccines than the others. I don't know if that's the reality, but that's from what I hear people say on both sides*." (Male, 41 years old, hesitant).

Discussion

The international public health and economic impact of COVID-19 has prompted private and governmental organizations to work together to address the pandemic. Significant investments have been made in developing vaccines against COVID-19.[31] Nevertheless, hesitation in addition of accessibility about the COVID-19 vaccine, may limit global efforts to control the pandemic and its adverse health and socioeconomic effects.[14] In this sense, we conducted a study adopting a sequential explanatory mixed method with the results of the quantitative phase being explained by those of the qualitative phase. It showed that 12.9% of individuals hesitate to be vaccinated, and 32.8% would not take the vaccine when it became available in Senegal. These results are similar to those of a study conducted in New Zealand and those of a systematic review and meta-analysis including 13 countries.[16,32] However, compared to these studies conducted in the USA, Portugal, and Great Britain, the proportion of refusals is higher in our study.[4,16,32–34] Senegal is classified as a heavily indebted poor country and has a very young population with an average age of 19 years.[35] This demographic makes young people generally less likely to die from COVID-19 and therefore less concerned about vaccination compared to developed countries where also the disease burden is high.[36] One study showed that regions and countries with high human development index have higher cases and deaths per million population due to COVID-19. This is due to international connectedness and mobility of their population related to trade and tourism, and their vulnerability related to older populations and higher rates of non-communicable diseases.[37] This result is even more worrying as the systematic review and meta-analysis of Robinson et al.[16] showed that the percentages of vaccine refusals and hesitation increased as the pandemic progressed. This could be due to media coverage of misinformation about the safety of the vaccine and a belief in sufficient immunity to combat COVID-19.[38] This situation could be confirmed by the disposal of thousands of doses of expired COVID-19 vaccine in October 2021 because the number of people vaccinated

was quite small.[19] Successful strategies to address hesitancy require an understanding of regional, cultural, and economic factors, and tailored training of health-care professionals.[39]

Vaccine hesitancy was associated with female gender in our study in Senegal. This result is similar to those found in New Zealand, Israel, China, the UK, the USA, Qatar, and Portugal.[3,4,32,34,40,41] This disparity could be explained by the fact that women perceive a lower risk of the disease.[3] In addition, several reports and medias have shown higher risks of complications, infectiousness, and death from COVID-19 in men.[42] Therefore, women may be less likely to be affected by this disease. In addition, the finding in this study that women are more likely to show reluctance to be vaccinated is of concern as women play a central role in the vaccination of children.

Hesitancy and refusal to be vaccinated were related to living in large cities (Dakar, Thiès, and Diourbel). These same perceptions were noted in our previous study, which showed that the more regions are affected by the pandemic, the less confidence respondents have in the government and the less effective they perceive the measures to be.[23] As of 2 December 2021, these three most populated regions of Senegal will account for more than 80% of the cases of COVID-19 in the entire country.[19] One might have thought that vaccination intentions would be greater in these areas because of the burden of the pandemic. However, these results could be explained by the belief in a certain natural immunity, by a greater exposure to misinformation encountered on social networks, or by their higher standard of living than elsewhere in the country. The results of the first national seroprevalence survey in November 2021 may help us understand this perception.

The study showed that a bad attitude (thinking that it was not desirable and important to be vaccinated) toward vaccination was linked to hesitating and refusing vaccination. This adverseness was mainly explained in the qualitative survey by rumors circulating—particularly on social networks—about the vaccine and the length of time it took to manufacture it. These reasons were consistent with the findings of several studies.[3,17,43] One report showed that the main topics of conversation related to vaccine hesitancy on Facebook and Twitter included posts about "dropouts," people not showing up for their second injection, and parents resisting vaccinating their children "because of the low risk of COVID infection in their home."[44]Not surprisingly, there is a growing focus on the role of the media and in particular social media in shaping public opinion around COVID-19 and the vaccine. Social media, with its instant communication and access to a large audience, when combined with the ability to express oneself anonymously, offers immense potential for the spread of unverified and uncontrolled information.[41] Public health organizations, health professionals, and media platforms should collaborate to ensure the accuracy of information, provide programs to improve health literacy levels to enable the target population to make an informed decision. Furthermore, the impact of these actions implies that strategies to overcome hesitancy can be framed in models that take into account these multi-faceted and multi-level factors.[3]

The fact that individuals thought that vaccination would not help protect them from the virus was associated with reluctance and refusal to be vaccinated. Furthermore, individuals who thought that the coronavirus vaccine could put their health at risk were more likely to refuse the vaccine. Indeed, several studies show that concerns about vaccine safety and efficacy appear to be important in vaccine intention.[3,4,12,17,34,41] This concern transcends socio-demographic aspects and countries. This concern led to some respondents to the survey wanting to "wait and see" whether vaccination was safe before getting vaccinated. Thus, effective communication about safety and efficacy, and greater transparency about vaccine development and distribution, including financial aspects, should be the cornerstone of all other strategies to ensure equitable mass immunization programs related to COVID-19.[45–47]

The hesitancy and refusal to vaccinate was also related to the fact that individuals thought that most people important to them would not think they should be vaccinated against COVID-19, and that health workers do not provide the appropriate and necessary information and support for vaccination. Several studies have examined the role of these factors consistent with our study.[47–55] Health professionals appeared to be a reliable source of information. Their recommendations[48,52,53,55]and support from family and friends[49,53]play an important role in influencing their perceptions and behaviors toward vaccination. These results suggest that health professionals (especially general practitioners and pediatricians) need to be better involved in vaccination campaigns to support people and help them make informed decisions.

Significantly, in our study, education and economic well-being quintile were not associated with reluctance or refusal to be vaccinated. This result was similar to a study conducted in Nigeria and a rapid systematic review.[16,36] However, it was different in other studies.[3,32] This mixed result is important to note to ensure that the components of a comprehensive and effective COVID-19 vaccination strategy are properly targeted and do not exacerbate health inequalities.

This study is not without its limitations. It only involved people with mobile phones, thus excluding the most marginalized populations. In addition, the cross-sectional nature of the data limits our ability to draw conclusions about causal links. However, the sample is representative of the Senegalese population and the use of mixed methods allowed for a better understanding of the results and the organization of the arguments.

Conclusion

The results of the study show that the factors related to hesitation and refusal to be vaccinated against COVID-19 in Senegal are diverse and complex. Addressing these factors will help to ensure better vaccination coverage. Governments and health authorities should intensify their efforts to encourage vaccine confidence and reduce misinformation. It is critical to continue to monitoring COVID-19 vaccine hesitancy and refusal, and adjust measures to address these factors. The low vaccination rate in Africa shows that there are still many challenges to vaccine uptake for which the international community must act urgently. Finally, there is a need for further studies to

understand the low rates of vaccination coverage in relation to the high rates of intention to vaccinate.

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Authors' contributions

VR, AF and AJ designed the study. IG, AID, BK and MFB participated in the data collection. MFB and BK analyzed the data. MFB, BK, AF and VR interpreted the data. MFB wrote the article. All authors critically reviewed the article for intellectual content. All authors gave final approval to the submitted version.

Ethical approval statement

The study received approval from the National Health Research Ethics Committee of Senegal (SEN/20/23).

Disclosure statement

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Appendix

Table A1. Socio-Demographic characteristics of individuals in the qualitative survey (N = 30).

Features	Hesitant	Refusal
Sex		
Male	9	9
Female	6	6
Age		
<25 years	3	3
25–59 years old	10	10
≥60 years	2	2
Education		
Without instruction	6	6
Primary	3	3
Secondary	4	4
Superior	2	2
Region		
Dakar	5	5
Outside Dakar	10	10
Total	**15**	**15**

Table A2. Distribution of individuals by characteristics (N = 607).

	n (%)
Age:	
Under 25 years old	140 (23.1)
25-59 years old	407 (67.1)
60 years and over	60 (9.9)
Sex:	
Female	241 (39.7)
Male	366 (60.3)
Quintile:	
Poorer	81 (13.3)
Poor	78 (12.9)
Medium	131 (21.6)
Rich	161 (26.5)
Richer	156 (25.7)
Region:	
Other regions	257 (42.3)
Dakar-Diourbel-Thiès	350 (57.7)
Education:	
Without instruction	253 (41.7)
Primary	122 (20.1)
Secondary	153 (25.2)
Superior	79 (13.0)
Have you ever received a vaccine as an adult?	
Yes	173 (28.5)
No	434 (71.5)
I think it is important to get vaccinated:	
Yes	444 (73.1)
No	163 (26.9)
I think it is useful to get the vaccine to protect against COVID-19:	
Yes	377 (62.1)
No	230 (37.9)
I think it's responsible to get vaccinated against COVID-19:	
Yes	510 (84.0)
No	97 (16.0)
I believe that the future COVID-19 vaccine will not pose a health risk:	
Yes	203 (33.4)
No	404 (66.6)

(*Continued*)

Table A2. (Continued).

	n (%)
I think it is advisable to get the COVID-19 vaccine:	
Yes	408 (67.4)
No	197 (32.6)
Intention to be vaccinated:	
Yes	330 (54.4)
Hesitates	78 (12.9)
Refusal	199 (32.8)
Getting the COVID-19 vaccine will help protect me from the virus:	
Yes	357 (58.8)
No	250 (41.2)
Getting vaccinated will help fight the spread of the coronavirus:	
Yes	358 (59.0)
No	249 (41.0)
Getting the COVID-19 vaccine will help protect my loved ones from the virus:	
Yes	349 (57.5)
No	258 (42.5)
I think the people who are going to create the COVID-19 vaccine are going to make sure it's safe:	
Yes	330 (54.4)
No	277 (45.6)
The coronavirus vaccine could put my health at risk:	
Yes	134 (22.1)
No	473 (77.9)
The coronavirus vaccine may have side effects:	
Yes	226 (37.2)
No	381 (62.8)
When the vaccine is offered, most of the people important to me (family, friends) would think I need to get the COVID-19 vaccine:	
Yes	324 (53.4)
No	283 (46.6)
I think it will be easy for me to access the health care provider to get the coronavirus vaccine if I want it:	
Yes	470 (77.4)
No	137 (22.6)
How much would you trust the health care providers who would give you a COVID-19 vaccine? Would you say you trust them:	
Yes	441 (72.7)
No	166 (27.3)
Over the next few months, I will be learning about the COVID-19 vaccine on a regular basis:	
Yes	521 (85.8)
No	86 (14.2)
Have you seen or heard anything bad about COVID-19 vaccines?	
Yes	348 (57.4)
No	258 (42.6)
Health workers will need to provide appropriate and necessary information and support for immunization:	
Yes	586 (96.5)
No	21 (3.5)
Free for all Senegalese:	
Yes	517 (85.2)
No	90 (14.8)
Do you have confidence in the government of Senegal to fight the coronavirus epidemic?	
Yes	170 (28.0)
No	437 (72.0)

Table A3. Distribution of individuals by characteristics and intention to be vaccinated (N=607).

	Intention to be vaccinated			
	Yes	Hesitates	Refusal	p-value
Age:				0.406
60 years and over	38 (63.3%)	8 (13.3%)	14 (23.3%)	
25-59 years old	222 (54.5%)	49 (12.0%)	136 (33.4%)	
Under 25 years old	70 (50.0%)	21 (15.0%)	49 (35.0%)	
Sex:				0.075
Female	132 (54.8%)	39 (16.2%)	70 (29.0%)	
Male	198 (54.1%)	39 (10.7%)	129 (35.2%)	
Quintile:				0.103
1. Poorer	53 (65.4%)	12 (14.8%)	16 (19.8%)	
2. Poor	41 (52.6%)	9 (11.5%)	28 (35.9%)	
3. Medium	79 (60.3%)	14 (10.7%)	38 (29.0%)	
4. Rich	75 (46.6%)	25 (15.5%)	61 (37.9%)	
5. Richer	82 (52.6%)	18 (11.5%)	56 (35.9%)	
Region:				0.249
Remainder	149 (58.0%)	28 (10.9%)	80 (31.1%)	
Dakar-Diourbel-Thiès	181 (51.7%)	50 (14.3%)	119 (34.0%)	
Education:				0.227
1. Without instruction	145 (57.3%)	32 (12.6%)	76 (30.0%)	
2. Primary	69 (56.6%)	12 (9.8%)	41 (33.6%)	
3. Secondary	79 (51.6%)	26 (17.0%)	48 (31.4%)	
4. Superior	37 (46.8%)	8 (10.1%)	34 (43.0%)	
Have you ever received a vaccine as an adult?				0.422
Yes	100 (57.8%)	18 (10.4%)	55 (31.8%)	
No	230 (53.0%)	60 (13.8%)	144 (33.2%)	
I think it is important to get vaccinated:				**<0.001**
Yes	302 (68.0%)	40 (9.0%)	102 (23.0%)	
No	28 (17.2%)	38 (23.3%)	97 (59.5%)	
I think it is useful to get the vaccine to protect against COVID-19:				**<0.001**
Yes	300 (79.6%)	27 (7.2%)	50 (13.3%)	
No	30 (13.0%)	51 (22.2%)	149 (64.8%)	
I think it's responsible to get vaccinated against COVID-19:				**<0.001**
Yes	314 (61.6%)	52 (10.2%)	144 (28.2%)	
No	16 (16.5%)	26 (26.8%)	55 (56.7%)	
I believe that the future COVID-19 vaccine will not pose a health risk:				**<0.001**
Yes	148 (72.9%)	10 (4.9%)	45 (22.2%)	
No	182 (45.0%)	68 (16.8%)	154 (38.1%)	
I think it is advisable to get the COVID-19 vaccine:				**<0.001**
Yes	313 (76.7%)	29 (7.1%)	66 (16.2%)	
No	15 (7.6%)	49 (24.9%)	133 (67.5%)	
Getting the COVID-19 vaccine will help protect me from the virus:				**<0.001**
Yes	304 (85.2%)	20 (5.6%)	33 (9.2%)	
No	26 (10.4%)	58 (23.2%)	166 (66.4%)	
Getting vaccinated will help fight the spread of the coronavirus:				**<0.001**
Yes	294 (82.1%)	25 (7.0%)	39 (10.9%)	
No	36 (14.5%)	53 (21.3%)	160 (64.3%)	
Getting the COVID-19 vaccine will help protect my loved ones from the virus:				**<0.001**
Yes	286 (81.9%)	24 (6.9%)	39 (11.2%)	
No	44 (17.1%)	54 (20.9%)	160 (62.0%)	
I think the people who are going to create the COVID-19 vaccine are going to make sure it's safe:				**<0.001**
Yes	249 (75.5%)	22 (6.7%)	59 (17.9%)	
No	81 (29.2%)	56 (20.2%)	140 (50.5%)	
The coronavirus vaccine could put my health at risk:				**<0.001**
Yes	32 (23.9%)	11 (8.2%)	91 (67.9%)	
No	298 (63.0%)	67 (14.2%)	108 (22.8%)	
The coronavirus vaccine may have side effects:				**<0.001**
Yes	89 (39.4%)	22 (9.7%)	115 (50.9%)	
No	241 (63.3%)	56 (14.7%)	84 (22.0%)	
When the vaccine is offered, most of the people important to me (family, friends) would think I need to get the COVID-19 vaccine:				**<0.001**
Yes	259 (79.9%)	25 (7.7%)	40 (12.3%)	
No	71 (25.1%)	53 (18.7%)	159 (56.2%)	
I think it will be easy for me to access the health care provider to get the coronavirus vaccine if I want it:				0.984
Yes	255 (54.3%)	61 (13.0%)	154 (32.8%)	
No	75 (54.7%)	17 (12.4%)	45 (32.8%)	
How much would you trust the health care providers who would give you a COVID-19 vaccine? Would you say you trust them:				**<0.001**
Yes	296 (67.1%)	58 (13.2%)	87 (19.7%)	
No	34 (20.5%)	20 (12.0%)	112 (67.5%)	
Over the next few months, I will be learning about the COVID-19 vaccine on a regular basis:				**<0.001**
Yes	305 (58.5%)	62 (11.9%)	154 (29.6%)	
No	25 (29.1%)	16 (18.6%)	45 (52.3%)	

(*Continued*)

Table A3. (Continued).

	Intention to be vaccinated			
	Yes	Hesitates	Refusal	p-value
Have you seen or heard anything bad about COVID-19 vaccines?				**0.017**
Yes	176 (50.6%)	42 (12.1%)	130 (37.4%)	
No	154 (59.7%)	36 (14.0%)	68 (26.4%)	
Health workers will need to provide appropriate and necessary information and support for immunization:				**<0.001**
Yes	329 (56.1%)	73 (12.5%)	184 (31.4%)	
No	1 (4.8%)	5 (23.8%)	15 (71.4%)	
Free for all Senegalese:				**0.038**
Yes	289 (55.9%)	69 (13.3%)	159 (30.8%)	
No	41 (45.6%)	9 (10.0%)	40 (44.4%)	
Do you have confidence in the government of Senegal to fight the coronavirus epidemic?				**0.001**
Yes	108 (63.5%)	26 (15.3%)	36 (21.2%)	
No	222 (50.8%)	52 (11.9%)	163 (37.3%)	