

Lack of access to COVID-19 vaccines could be a greater threat than vaccine hesitancy in low-income and conflict nations: the case of Yemen

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Summary: Although vaccine hesitancy is a global phenomenon, the immediate threat and a contributing factor to hesitancy towards COVID-19 vaccines in low-income and conflict countries could be the severe shortage and lack of access to vaccines.

Abstract

Background

Vaccine hesitancy and vaccine inequity are two major hurdles towards achieving population immunity to COVID-19. Although several studies have been published on vaccine hesitancy among numerous populations, there is inadequate information on any potential correlation between vaccine acceptance and lack of access to vaccines. Our cross-sectional study in a low-income country aimed to fill this gap.

Methods

We conducted a nation-wide cross-sectional survey among the general population in Yemen, a low-income conflict country. Participants from all the provinces in Yemen were included in the study. We evaluated factors influencing agreement to accept a COVID-19 vaccine and any potential correlation between vaccine hesitancy and lack of access to vaccines.

Results

Overall, 50.1% of the 5329 respondents agreed to accept a COVID-19 vaccine. Only 39.9% of the participants agreed to having access to a COVID-19 vaccine, with females indicating lower access than males. Potential determinants of vaccine acceptance included being male, updating self on the development of vaccines against COVID-19, opinion about severity of COVID-19, anxiety about contracting COVID-19, concerns about the safety of COVID-19 vaccines and lack of access to vaccines.

Conclusions

our results indicate that the immediate threat in Yemen towards achieving population immunity is the severe shortage and lack of access to vaccines, rather than vaccine hesitancy.

Keywords: Vaccine acceptance; Low-income country; Yemen; Lack of access; COVID-19

INTRODUCTION

The SARS-CoV-2 virus that causes coronavirus disease-19 (COVID-19) has been responsible for millions of deaths worldwide and a huge socio-economic burden. The introduction of effective vaccines and implementation of robust immunization campaigns worldwide has led to a global decline in morbidity and mortality from COVID-19.¹ However, in order to achieve the threshold immunization coverage necessary to attain population immunity, policymakers will need to address two concerns: the phenomenon of ‘vaccine hesitancy’, the reluctance or refusal to vaccinate despite the availability of vaccines, and equitable global vaccine distribution.²

Early studies on vaccine acceptance among the adult population have suggested acceptance rates ranging from as low as 23.6% in Kuwait to as high as 97% in Ecuador.³ A more recent systematic review also showed wide variations in COVID-19 vaccine acceptance rates, ranging from 15.37% in Cameroon to 98.06% in China.⁴ Apart from geographic variations, global hesitancy to COVID-19 vaccines has also been shown to be time dependent, with hesitancy rates ranging from 21% in April 2020, increasing to 36% in July 2020 and later declining to 16% in October 2020.⁵

Current statistics suggest that, as of 4 December 2021, more than 44% of the world’s population have been fully vaccinated against COVID-19.⁶ Although it seems like a great achievement, a country-wise break-up of the numbers indicate that at least 68% of those fully vaccinated are from high-income countries (HIC), while those in low-income countries (LIC) account for a grim 3.1%, a result of large-scale vaccine inequity.⁶ This extreme discrepancy could have serious implications for global population immunity, as it could allow the virus to mutate into newer variants. This has been proven by the recent discovery of the ‘Omicron’ variant in South Africa (where only about 24% of the population has been fully vaccinated against COVID-19), in addition to the eight variants that have

been already identified until early November 2021, causing renewed worry among health experts and policymakers.⁷⁻⁸

Apart from LICs, vaccine inequity could be particularly crippling in conflict countries that are already facing difficulties associated with logistic constraints and the near collapse of their healthcare systems.⁹ Since Yemen started its vaccination campaign in mid-April 2021, as of 4 December 2021, it has received less than a million COVID-19 vaccine doses through the COVAX, for a population of more than 30 million.¹⁰ Currently, only about 1.2% of the Yemeni population has been fully vaccinated against COVID-19, while the neighboring countries of Oman and Saudi Arabia have fully vaccinated more than 54% and 63% of their populations respectively.⁶ The huge discrepancy in access to vaccines could be a greater threat than vaccine hesitancy in LICs and conflict countries and could even be a cause for vaccine hesitancy.¹¹

Currently there is inadequate information on the determinants of vaccine hesitancy in conflict countries and any potential correlation between vaccine hesitancy and lack of access to vaccines. Our nation-wide cross-sectional exploratory study aimed to identify determinants of vaccine acceptance and any correlation between access to COVID-19 vaccines and its acceptance in Yemen, a low-income conflict country.

METHODS

Study Design

A cross-sectional self-administered survey was conducted among the adult general population in Yemen between 4 and 28 October 2021. The 'Report of the SAGE working group on vaccine hesitancy' was used as a guide in preparing the questionnaire.¹¹ As part of the validation of the study, a pilot study was initially carried out on 10 participants, after which expert opinions were taken from specialists in the field. The bilingual (English and Arabic) survey questionnaire developed on Google

Forms required less than 5 min to complete. Participation was voluntary and the participants provided informed consent on the survey platform before proceeding to the survey items. The participants' anonymity was guaranteed during the data collection process. The survey form was designed in such a way that only complete forms would qualify for submission.

This study was approved by the Research Committee of College of Dentistry, Dar Al Uloom University, Riyadh, Saudi Arabia (COD/IRB/2020/2).

Sample

Sample size was calculated using Open Source Epidemiologic Statistics for Public Health–OpenEpi (http://www.openepi.com/Menu/OE_Menu.htm, accessed on 25 October 2021). We use 50% as the hypothesized % frequency of outcome factor in the population, which is recommended for unknown frequency, and 2% as absolute precision. The result was a sample size of 4130 to get 99% confidence interval. We added 20% to overcome the possibilities of receiving missing data. Our final sample size was 4,956, which was our target for the current study.

Participants were invited to complete the questionnaire through the Whatsapp platform. This was done by forming a group of carefully selected students and faculty of Al Razi University, Sana'a, Yemen hailing from different parts of Yemen to share the questionnaire in their Whatsapp groups. However, due to the high population concentration in the Azal region (due to massive population displacement from other parts of Yemen to Sana'a) and it being the point of distribution of the questionnaire, maximum participation was expected from this region. Participants below the age of 18 years were not included in the study.

Measures

Trust in COVID-19 Vaccines, Health Authorities and the International Community, and Access to Vaccines

General attitudes towards vaccines were measured using a set of 2 items. First, participants were asked if vaccines were really necessary to overcome the pandemic. Participants were asked if they thought vaccine manufactures followed recommended development and production guidelines. Responses were rated on a five-point Likert scale from 1 “strongly agree” to 5 “strongly disagree”. Participants’ attitudes towards the health authorities were measured using a set of 4 items. Participants were asked if they were happy with the health authorities’ handling of the pandemic, and their management of vaccination campaigns. Participants were then asked if they were happy with the NGOs and the international community in helping Yemen vaccinate its population. Responses were rated on a five-point Likert scale from 1 “strongly agree” to 5 “strongly disagree”. Participants were then asked if they had access to COVID-19 vaccines. Responses were rated on a five-point Likert scale from 1 “strongly agree” to 5 “strongly disagree”.

Intention to Vaccinate

This was measured using a set of 7 items. First, participants were asked if vaccines should be made mandatory and if the participant intended to be vaccinated against COVID-19. Further questions included concern for others who would be in greater need for the vaccine, intention to protect others with weaker immunity, fear of possible side effects of the vaccine and if the participant would take the vaccine only if it was free of cost. Responses were rated on a five-point Likert scale from 1 “strongly agree” to 5 “strongly disagree”.

Predictor Variables

Socio-demographic factors included age group, sex, nationality, region, and employment.

Participants' reports on chronic medical conditions (e.g., asthma, diabetes, hypertension, heart disease, and/or cancer) were used to indicate the presence or absence of pre-existing co-morbidity.

Other variables included participants' self-updating on COVID-19 vaccine development, prior infection with COVID-19, perception of COVID-19 severity, compliance with government COVID-19 guidelines, and anxiety towards contracting COVID-19.

Statistical Analysis

Descriptive statistics were expressed as percentages and numbers for each item/survey question. The main outcome of this study was the intention to vaccinate. The current study considered any participant to have an intention to vaccinate if he/she agreed or strongly agreed on the item "I will get vaccinated with the Covid-19 vaccine", or if they had already taken the vaccine. Bivariate statistical analysis of the relationship between the main outcome "intention to vaccinate" and predictors was performed using the Chi-squared test for trend for ordinal factors, and the Chi-squared test for categorical variables. A multivariate binary logistic regression model was used to determine the predictors for intention to vaccinate. The following factors were examined as potential predictors for intention to vaccinate: age group, sex, nationality, presence of any medical condition, following updates on the development of vaccines against COVID-19, opinion about the severity of COVID-19, compliance with COVID-19 preventive guidelines, and anxiety about contracting COVID-19, previous COVID-19 infection, concerns about side effects of COVID-19 vaccines and access to COVID-19 vaccines. We used the Bonferroni correction to overcome the possibilities of false positive results as a result of multiple comparisons. Based on this adjustment, the significance level was set at $p < 0.0056$. All statistical analyses were performed using IBM SPSS Statistics version 25.0 (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY, USA: IBM Corp).

RESULTS

Overall, 5329 out of the 8220 invited adult subjects completed the survey questionnaire (response rate 64.83%). Of the participants, 50.1% expressed their agreement to get vaccinated against COVID-19. Characteristics and demographics of the participants are shown in Table 1. Data regarding participants' awareness about COVID-19 are presented in Table 2. It can be noted that only 15.6% took the COVID-19 vaccine.

Concern about the side effects of vaccines was apparent among a high proportion of the participants (66.4%). Less than half of the participants (47.2%) were happy with the health authorities' management of the pandemic and the vaccination campaigns. Similarly, just a little more than a half of the participants expressed their satisfaction with the support provided by non-governmental organizations (NGO) (57.3%) and the international community (53.9%). Unfortunately, only 39.9% of the participants agreed that they have access to a COVID-19 vaccine. The abovementioned results are summarized in Table 3.

The bivariate statistical analysis indicated an association between participants' intention to vaccinate and 10 factors ($p < 0.05$) (Table 4). Interestingly, access to COVID-19 vaccine was associated with a high intention to vaccinate.

The logistic regression analysis indicated six determinants of agreement to get vaccinated against COVID-19 among the study population. These include being male, those following the updates about COVID-19 vaccines, those who believed COVID-19 to be a severe disease, those with greater anxiety about contracting COVID-19, those concerned about the side effects of COVID-19 vaccines and those who have access to a COVID-19 vaccine ($p < 0.05$) (Table 5).

DISCUSSION

The current study looked for the determinants of COVID-19 vaccine acceptance and its potential correlation with access to vaccines, in a low-income country devastated by a seven-year-long conflict. Our findings in Yemen indicate a COVID-19 vaccine acceptance rate (50.1%) comparable to that of a similar study we conducted in neighboring Saudi Arabia (56.2%), a high-income country.¹² The acceptance rate is also significantly higher than that of a large study conducted among Arabs, in which only one in eight respondents reported their willingness to accept a vaccine.¹³ A survey conducted during the first two weeks of the COVID-19 outbreak in Yemen in April 2020 reported a higher vaccine acceptance rate of 61%. This however was only if the vaccine was offered free of cost. The acceptance rate was however shown to decrease to 43% if they were required to pay for it.¹⁴ Studies in neighboring conflict countries have indicated varying results. For example, a study in Somalia indicated a higher acceptance rate of 76.8%, whereas two studies in Syria indicated lower acceptance rates of 37% and 36%.¹⁵⁻¹⁷

Not much is known about the SARS-CoV-2 transmission trajectory in Yemen. However, considering the difficulties in imposing preventive measures like lockdowns, social distancing, etc., the total case count of 10,025 infections and 1954 deaths (as of 6 December 2021) as indicated in the World Health Organization (WHO) dashboard is a huge underestimation.⁹ This is evident from the results of a study in Aden governorate conducted during November – December 2020, which indicated a seroprevalence of 27.4%.¹⁸ Nonetheless, the agreement of at least 63% of the participants on COVID-19 being a public health threat in Yemen, and a good percentage (66%) of the population updating themselves on the development of vaccines against COVID-19 indicates the high level of awareness of the Yemeni population on COVID-19 and the vaccines against it. The challenge now lies in supplying enough doses to fill the gap between supply and demand.

Apart from demographic factors, our results indicate determinants of vaccine acceptance, similar to studies in other low as well as high-income countries.^{15-16,19} These include opinion on the severity of COVID-19, anxiety of contracting COVID-19, concerns on the side-effects from COVID-19 vaccines, etc. (Table 5). The logical finding that individuals who perceive COVID-19 to be a severe disease and are anxious about contracting it being more likely to accept a vaccine have been reported in other Arab and conflict countries like Syria. A study in four Middle Eastern countries, including Iraq, also indicated similar results.²⁰ Although fear of side effects of COVID-19 vaccines has been shown to be dropping globally, it is still a cause for concern as demonstrated in several studies.²¹ A large multi-country study among Arabs concluded that one of the most cited reason for rejecting COVID-19 vaccines is concerns about their side effects.¹³ Similar findings were reported in two studies in Syria.¹⁶⁻¹⁷ These results highlight the responsibility of policymakers in addressing the critical issue of educating the public on the safety of vaccines.

Trust in authorities and policies have been shown to have a positive impact on vaccine acceptance.²² A large multi-country study on more than 36,000 Arab participants revealed that one of the most cited reasons for not agreeing to accept a COVID-19 vaccine was distrust in healthcare policies.¹³ Shifting front lines, sudden flare-ups in violence, attacks on aid workers, non-unified governing systems, administrative and movement restrictions, etc. could compromise the work of humanitarian agencies and NGOs in conflict settings.²³ Unfortunately, trust in NGOs and the international community was low among the participants in our study. The extreme inequity and delay in vaccine supply in Yemen, coupled with the lack of transparency could be one of the reasons for this mistrust. Further studies will shed more light on this.

The strongest determinant of vaccine acceptance in our study was access to vaccines, meaning, an increase in supply could lead to an increase in demand/acceptance. Only 39.9% of the participants in our study definitely agreed that they have access to a COVID-19 vaccine. Unfortunately, due to the extreme shortage in vaccine supply, even after almost a year since the approval of COVID-19

vaccines by regulatory bodies, less than 2% of the Yemeni population is fully vaccinated against COVID-19, while most of the high-income countries have fully vaccinated almost 70% of their populations.⁶ The current campaign of administering booster doses in high income-countries at the expense of limiting access to the recommended two doses in low-income countries has only compounded this challenge.²⁴ Policymakers should consider limiting booster doses to the vulnerable so that the excess doses can be diverted to low-income countries. But this seems highly unlikely.

Apart from vaccine inequity, residents of conflict nations, especially women and children, are faced with the additional challenge of difficulty in accessing vaccination facilities. For example, a study in 2018 revealed that nearly 30.6% of the Yemeni population lived more than 30-min travel time from the nearest fully or partially functional public primary health-care facility, and more than 42.4% lived more than 1 h from the nearest fully or partially functional public hospital, assuming access to motorised transport.²³ Additionally, access to vaccination and healthcare facilities can also be severely compromised during flare-ups of the conflict. As expected, results of our study indicated that females had significantly lower access to COVID-19 vaccines than males. This highlights the need for NGOs like the WHO, MSF, UNICEF, etc. to coordinate with the Yemeni authorities to ensure that vaccination campaigns are conducted in locations that provide safe and convenient access to both males and females alike. One feasible solution would be to provide single dose vaccines to residents of areas with compromised access to vaccination facilities.

In conclusion, our results suggest that the immediate threat in Yemen towards achieving population immunity is the severe shortage and lack of access to vaccines, rather than vaccine hesitancy. Under the current circumstances, a possible solution to accelerate vaccine coverage in Yemen could be to increase distribution of single dose vaccines (Yemen has already received 151,000 doses of the J&J/Janssen single dose vaccine through the COVAX facility) and those that do not require critical storage conditions.¹⁰ The first step towards achieving sufficient vaccination coverage in Yemen

remains ensuring adequate supply of vaccines to meet the demand. The WHO, other NGOs operating in Yemen, the COVAX and donor nations should work determinedly and inclusively with all parties in Yemen to ensure that no one is left behind in the pursuit to achieve optimum vaccine coverage.

Although Azal province has been overrepresented partly due to the greater population concentration there, the fact that our study could cover respondents spanning over all the provinces of Yemen, representing different demographic characteristics, and the large sample size are notable strengths. Moreover, this is the first study on vaccine acceptance in Yemen following vaccine rollout, and the first study examining any potential correlation between vaccine acceptance and lack of access to vaccines. The major limitation of our study is the mode of the study. Since we used a web-based self-administration mode of survey, there could be potential bias among the participants in responding to the survey questions. Moreover, since participants in our study included only those with access to internet facilities, there is a possibility that they represent those with higher socio-economic status and greater and easier access to healthcare and vaccination facilities. This could be another potential source of bias. However, due to the restrictions related to the pandemic and the conflict, the web based questionnaire distribution was the best mode currently available. Future studies with wider penetration, especially covering rural and underserved areas in Yemen will provide further information on the attitudes of Yemenis towards vaccines against COVID-19.

CONCLUSIONS

Our results in Yemen, a low-income conflict country suggests vaccine acceptance comparable to those of neighboring countries. The potential correlation between vaccine acceptance and access to vaccines however indicates that a potential increase in supply could lead to an increase in demand.

Notes

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Data Availability Statement. The questionnaire used in the current study is not publicly available due to certain restrictions. However, it is available from the corresponding author (Mohammed Noushad) on reasonable request.

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Potential Conflicts of interest. None

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Table 1: Sample characteristics: Data are presented as n (%)

Number of participants	5329
Age	
18-29 years	4193 (78.7%)
30-49 years	995 (18.7%)
>= 50 years	141 (2.6%)
Sex	
Male	2331 (43.7%)
Female	2998 (56.3%)
Nationality	
Yemeni	5227 (98.1%)
Non-Yemeni	102 (1.9%)
Place of living	
Aden Province	202 (3.8%)
Azal Province	3445 (64.6%)
Hadhramout Province	149 (2.8%)
Jund Province	423 (7.9%)
Sheba Province	543 (10.2%)
Tihama Province	567 (10.6%)
Work	
Unemployed	2690 (50.5%)
Employed	2639 (49.5%)
Comorbidity	
No	4706 (88.3%)
Yes	623 (11.7%)

Table 2: Awareness about COVID-19. Data are presented as n (%)

Have you been updating yourself on the development of vaccine?	
No	1810 (34%)
Yes	3519 (66%)
In your opinion, how would you rate the severity of COVID-19 disease:	
Mild	631 (11.8%)
Moderate	2261 (42.4%)
Severe	2437 (45.7%)
How would you rate your compliance with COVID-19 preventive guidelines?	
Good	2272 (42.6%)
Moderate	2393 (44.9%)
Poor	664 (12.5%)
To what extent are you anxious about contracting (getting infected with) COVID-19?	
Low	2030 (38.1%)
Moderate	2348 (44.1%)
High	951 (17.8%)
Have you had COVID-19?	
No	4034 (75.7%)
Yes	1295 (24.3%)
COVID-19 is a threat to public health in my country	
Agree	3478 (65.3%)
Not sure	1346 (25.3%)
Disagree	505 (9.5%)
Have you taken the COVID-19 vaccine?	
No	4497 (84.4%)
Yes	832 (15.6%)

Table 3: Trust in COVID-19 Vaccines and Health Authorities. Data are presented as n (%)

Vaccines are necessary to overcome the COVID-19 pandemic and get back to normal life	3217 (60.4%)
I am concerned about the possible side effects of COVID-19 vaccines	3537 (66.4%)
I will delay taking the COVID-19 vaccine, as I feel there are others who deserve it more than me	3257 (61.1%)
Getting myself vaccinated for COVID-19 is important because I can also protect people with a weaker immune system	3505 (65.8%)
I will take the COVID-19 vaccine only if it is free	1966 (36.9%)
I think that vaccines against COVID-19 have been produced in a hurry without following recommended clinical trials and approval guidelines	2468 (46.3%)
I am happy with the way the health authorities have been managing the COVID-19 pandemic so far	2514 (47.2%)
I am happy with the health authorities' organization of the COVID-19 vaccination campaigns.	2514 (47.2%)
I am happy with the way the Non-governmental organizations like the World Health Organization, Medicines Sans Frontiers, etc., have been helping my country in vaccinating its population	3051 (57.3%)
I am happy with the way the international community is helping my country in vaccinating its population	2870 (53.9%)
I support a mandatory vaccination program for COVID-19	2981 (55.9%)
I have access to the COVID-19 vaccine	2127 (39.9%)

Table 4: Bivariate statistical analysis of the relationship between the main outcome “intention to vaccinate” and potential influencing factors.

	Intention to vaccinate % (n)	Exact 95% confidence interval for the proportions^{***}
Intention to vaccinate, among all participants	50.1% (2671/5329)	(48.8%-51.5%)
Age		
18-29 years	49.5% (2074/4193)	(47.9%-51%)
30-49 years	52% (517/995)	(48.8%-55.1%)
>= 50 years	56.7% (80/141)*	(48.1%-65%)
Sex		
Male	56.3% (1313/2331)	(54.3%-58.4%)
Female	45.3% (1358/2998)**	(43.5%-47.1%)
Nationality		
Yemeni	50% (2611/5227)	(48.6%-51.3%)
Non-Yemeni	58.8% (60/102)	(48.6%-68.5%)
Place of living		
Aden Province	54% (109/202)	(46.8%-61%)
Azal Province	47.5% (1635/3445)	(45.8%-49.1%)
Hadhramout Province	56.4% (84/149)	(48%-64.5%)
Jund Province	53.9% (228/423)	(49%-58.7%)
Sheba Province	49.4% (268/543)	(45.1%-53.6%)
Tihama Province	61.2% (347/567)**	(57.1%-65.2%)
Work		
Unemployed	45.9% (1235/2690)	(44%-47.8%)
Employed	54.4% (1436/2639)**	(52.5%-56.3%)
Comorbidity		
No	49.6% (2333/4706)	(48.1%-51%)
Yes	54.3% (338/623)**	(50.2%-58.2%)
Updating self on the development of vaccines against COVID-19		
No	33.3% (603/1810)	(31.1%-35.5%)
Yes	58.8% (2068/3519)**	(57.1%-60.4%)
Opinion about the severity of COVID-19		
Mild	31.7% (200/631)	(28.1%-35.5%)
Moderate	41.5% (938/2261)	(39.4%-43.5%)
Severe	62.9% (1533/2437)*	(61%-64.8%)
Compliance with COVID-19 preventive guidelines		
Good	62.1% (1411/2272)	(60.1%-64.1%)
Moderate	43% (1029/2393)	(41%-45%)
Poor	34.8% (231/664)*	(31.2%-38.5%)
Anxiety about contracting COVID-19		
Low	36.3% (737/2030)	(34.2%-38.4%)
Moderate	53.4% (1254/2348)	(51.4%-55.4%)
High	71.5% (680/951)*	(68.5%-74.4%)
Previously infected with COVID-19		

No	51% (2057/4034)	(49.4%-52.5%)
Yes	47.4% (614/1295)**	(44.7%-50.2%)
Concerned about the possible side effects of COVID-19 vaccines		
No	56.9% (1020/1792)	(54.6%-59.2%)
Yes	46.7% (1651/3537)**	(45%-48.3%)
I have access to the COVID-19 vaccine		
No	31.4% (1004/3202)	(29.7%-33%)
Yes	78.4% (1667/2127)**	(76.6%-80.1%)

*: p was calculated using chi-square test for trend. Significance difference was set at $p < 0.05$

** : p was calculated using chi-square test. Significance difference was set at $p < 0.05$

***: 95% confidence intervals of the proportions are the exact intervals and were calculated based on Clopper & Pearson.

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Table 5: Predictors of intention to vaccinate. Results of multivariate logistic regression

	Odds ratio (95% OR)	p
Age		
18-29 years	Ref	
30-49 years	1.11 (0.94-1.31)	0.22
>= 50 years	1.12 (0.75-1.66)	0.59
Sex		
Male	Ref	
Female	0.82 (0.72-0.94)*	0.004
Nationality		
Yemeni	Ref	
Non-Yemeni	0.95 (0.6-1.51)	0.84
Work		
Unemployed	Ref	
Employed	1.06 (0.93-1.21)	0.37
Comorbidity		
No	Ref	
Yes	1.01 (0.83-1.24)	0.91
Updating self on the development of vaccines against COVID-19		
No	Ref	
Yes	1.85 (1.61-2.12)*	<0.001
Opinion about the severity of COVID-19		
Mild	Ref	
Moderate	1.39 (1.11-1.73)*	0.004
Severe	2.23 (1.77-2.81)*	<0.001
Compliance with COVID-19 preventive guidelines		
Poor	Ref	
Moderate	0.86 (0.7-1.07)	0.17
Good	1.12 (0.9-1.4)	0.31
Anxiety about contracting COVID-19		
Low	Ref	
Moderate	1.53 (1.32-1.77)*	<0.001
High	2.13 (1.73-2.61)*	<0.001
Previously infected with COVID-19		
No	Ref	
Yes	0.86 (0.74-1)	0.05
Concerned about the possible side effects of COVID-19 vaccines		
No	Ref	
Yes	0.57 (0.5-0.65)*	<0.001
I have access to the COVID-19 vaccine		
No	Ref	
Yes	6.18 (5.4-7.08)*	<0.001

Odds ratio and 95% confidence interval was calculated by a binary logistic model.

*Significant difference at $p < 0.05$