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## Predictors of healthcare workers' intention to vaccinate against COVID-19: A cross sectional study from Saudi Arabia



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### ABSTRACT

**Background:** Vaccination is considered the best way to prevent the spread of COVID-19 and to prevent the complications of the disease. Nevertheless, no awareness campaigns were conducted in Saudi Arabia until March 1, 2021, when the Vaxzevria, or ChAdOx1 nCoV-19 (AZD1222), vaccine became available.

**Objectives:** This study aims to determine the factors that can predict healthcare workers' acceptance of the COVID-19 vaccine.

**Methods:** A cross-sectional study was conducted from July to September 2021, in our university tertiary hospital (King Saud University Medical City [KSUMC]), Riyadh, Saudi Arabia. The study targeted potential participants among healthcare workers at KSUMC. We assessed healthcare workers' perceptions and beliefs about the COVID-19 vaccine via a questionnaire that was distributed via social media applications such as WhatsApp, Twitter, and Google. Participants were informed about the questionnaire before they filled it out, and they were asked to respond to three screening questions before beginning the main questionnaire. These screening questions ensured that the participants met the inclusion criteria. Included participants were over the age of 18, agreed to answer the questions, and were residents of Saudi Arabia. The participants filled out the self-administered questionnaire.

**Results:** A total of 529 participants completed the questionnaires. All participants were vaccinated, 68% were female, 55% were married, 35% had been working for less than five years, and 65% had a bachelor's degree. More than half of participants had not previously been infected with COVID-19, and most did not interact with COVID-19 patients. More convenient access to the vaccine increased the odds ratio of participant vaccination by 0.39. An increase in the number of vaccinated friends and family members increased the odds ratio of participant vaccination by 0.30. However, COVID-19 vaccination mandates decreased the odds ratio of participant vaccination by 0.27. The fitted linear regression model explained 32% of the variation observed in the dependent variable, acceptance of the COVID-19 vaccine, and the

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adjusted R squared was 0.32. The fitted regression model was statistically significant at a 95% confidence interval; the p-value was 0.00001.

**Conclusion:** In Saudi Arabia, there is an immense need to increase uptake of the COVID-19 vaccine. This requires encouraging more positive beliefs and attitudes regarding vaccination in general and the COVID-19 vaccine in particular.

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## 1. Introduction

### 1.1. Background

Coronavirus disease 2019 (COVID-19) is highly contagious and is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (Lai et al., 2020). On January 30, 2020, the World Health Organization (WHO) declared the COVID-19 outbreak a public health emergency of international concern (Jee, 2020). During the first six months after the initial outbreak, more than ten million COVID-19 cases were confirmed worldwide; 20,000 of these were in Saudi Arabia (Awwad et al., 2021). Although several vaccines are now available and approved in many countries and although none of the underdevelopment COVID-19 vaccines have reached the market, vaccination is considered the most effective strategy for ending the pandemic and avoiding the complications associated with the disease (Thanh Le et al., 2020; Schaffer DeRoo et al., 2020). However, Larson et al. (2016) and Bankamp et al. (2019) have shown that the decision to take available vaccines is dependent on beliefs and perceptions. Therefore, worldwide concern about public acceptance of the COVID-19 vaccines has been increasing (Fu et al., 2020; Khan et al., 2020). A recently published review indicates varying levels of vaccine acceptance and hesitancy globally (Xiao and Wong, 2020). Most surveys of COVID-19 vaccination acceptance report low rates of acceptance in the Middle East, Russia, Africa, and several European countries (Almotaury et al., 2019; Alqahtani et al., 2017). Further studies are needed to address COVID-19 vaccine hesitancy, especially in the Middle East, North Africa, Sub-Saharan Africa, Eastern Europe, Central Asia, and Middle and South America. Addressing COVID-19 vaccine hesitancy is the first step of building trust in COVID-19 vaccination efforts (Sallam, 2021).

In Saudi Arabia, a COVID-19 vaccine is expected to face significant public hesitancy given the current public hesitancy toward seasonal influenza vaccination (Almotaury et al., 2019; Alqahtani et al., 2017). Although few studies have explored hesitancy toward COVID-19 vaccination, existing studies have found that acceptance and hesitancy rates towards any vaccine vary around the world (Xiao and Wong, 2020).

### 1.2. Research problem and significance

National health authorities have made significant efforts to improve awareness of the COVID-19 vaccines and their importance. In Saudi Arabia, COVID-19 vaccines have been made available in three priority stages; the first stage includes elderly people and all healthcare providers. Local awareness campaigns at our institution started after the arrival of the first batch of COVID-19 vaccines. Our study aimed to assess healthcare workers' beliefs about and barriers to COVID-19 vaccination.

### 1.3. Research aims and objectives

This study was conducted because misinformation disseminated via numerous sources may have a significant impact on COVID-19 vaccination uptake. The faster-than-usual speed of vac-

cine development has heightened public concern and may jeopardize vaccine uptake. Therefore, governments and communities must assess current levels of willingness to receive a potentially safe and effective COVID-19 vaccine and identify predictors of vaccination hesitation and/or adoption (Cornwall, 2020; Fadda et al., 2020). Therefore, the present study aims to identify factors that can predict healthcare workers' acceptance of the COVID-19 vaccine.

## 2. Methods

### 2.1. Study design and setting

The study is a cross-sectional, hospital-based online survey that was conducted between May 1 and September 30, 2021. This study was conducted in a tertiary care multi-site teaching hospital, King Saud University Medical City (KSUMC), in Riyadh, Kingdom of Saudi Arabia.

A validated, self-administered electronic questionnaire was published on Google Surveys and distributed online through social networking sites such as WhatsApp, Google, and Twitter. The questionnaire was distributed to employees and staff of KSUMC. Questionnaires/data sheets from other authors (copyrights or permission to use, or open access for academic and research purposes). The authors of this paper designed the questionnaire specifically for this study; therefore, copyright was not an issue. All participants were briefly informed about the objectives of the study and about the procedure; they could then opt to complete the questionnaire or not.

### 2.2. Sampling technique and sample size

Non-probability, a non-random sampling technique in the form of a convenient purposive sample, was used to select participants.

### 2.3. Sample size calculation

For this qualitative study, participants were selected via purposive sampling. With this method, it is not necessary to obtain a statistically representative sample; any number of participants (i.e., any sample size) can be used. The sample size is therefore determined by the facts, data, and available resources. The confidence level and margin of error are calculated based on the number of participants and complete responses received.

### 2.4. Target population

Administrative and non-administrative healthcare workers at KSUMC were invited to participate in the survey. Participants aged 18 years and older who reside in Saudi Arabia were included in this study. Participants who were unwilling to participate in the study were excluded.

## 2.5. Data collection

The study data were collected using a secure web-based platform, Google Forms. The one-time web survey link was sent to employees via e-mail or WhatsApp.

## 2.6. Inclusion and exclusion criteria

Participants who read the introductory information and subsequently completed the questionnaire were considered to have provided informed consent to participate in the study. Before they saw the main questionnaire, participants were asked three screening questions to ensure that they met the inclusion criteria (i.e., at least 18 years of age, resident of Saudi Arabia, and willing to share their responses). Eligible hospital staff at occupational health and safety clinic (OHSC) and KSUMC employees and staff members who were willing to participate completed the study voluntarily. Individuals not employed at KSUMC and those who were unwilling to participate were excluded from the study.

## 2.7. Questionnaire

The questionnaire was developed specifically for this study based on tools used in previous studies and discussions within the research team (Paul et al., 2021; El-Elimat et al., 2021). The final questionnaire was structured into three sections. The first section collected sociodemographic data, and the second section explored participants' beliefs and attitudes toward vaccination against COVID-19. The third section was designed to identify barriers to vaccination against COVID-19. The questionnaire was provided in English and Arabic. The Arabic version was translated into English using the backward-forward method, and the translation was double-checked by the authors (Paul et al., 2021; El-Elimat et al., 2021).

A pilot sample ( $n = 30$ ) was used to assess the reliability and validity of the questionnaire. We conducted statistical analysis to measure internal consistency. The Cronbach's alpha values were distinct. Values (individual and cumulative) for males and females who did not know about the vaccine were higher than for the other category. When all females were weighed, the alpha value was 0.83. The alpha value for each domain was 0.66, 0.81, and 0.92, respectively. The final test result was 0.90. Pearson's correlation coefficient was calculated based on respondents' ratings who answered the questionnaire to measure test-retest reliability. The correlation coefficients varied across the groups (ranging from 0.69 to 0.87). Total reliability was high ( $r = 0.90$ ,  $p < 0.001$ ).

### 2.7.1. Reliability and validity

We set up the construct validity for the questionnaire. Validity is the degree to which a questionnaire measures what it is intended to measure. One of the simplest ways to evaluate construct validity is to offer a metric to two parties, one of whom has more knowledge about vaccine than the other. We also measured the test's reliability, or precision, which is its consistency across repeated observations of the same phenomena. Internal consistency refers to the degree to which all objects on a scale evaluate various facets of a single element. Cronbach's alpha is often used to determine the efficacy of dietary awareness assessments for questions that have more than two correct answers. Cronbach's alpha ( $r$ ) can range from zero to one; a Cronbach's alpha of  $r = 0.7$  or higher is considered fairly accurate.

We measured test-retest reliability by administering the questionnaire to the same participants under the same circumstances on two separate occasions and comparing the scores. The reliability coefficient (or the Pearson correlation) shows the relationship between the results of the first and second measures. The Pearson

coefficient estimate may range from zero (no correlation) to one (ideal correlation).

### 2.7.2. Internal consistency

The Cronbach's alpha values (individual and cumulative) for males and females who did not know about the vaccine were higher than for the other category. When all females were weighed, the alpha values were 0.83. The alpha value of the final test was 0.90. For the test-retest reliability, reliability test Pearson's correlation coefficient was based on the ratings of respondents who answered the questionnaire. The correlation coefficients ranged across the parts and the groups (from 0.69 to 0.87). Total reliability was high ( $r = 0.90$ ,  $p < 0.001$ ).

## 2.8. Ethical considerations

The study commenced after ethical approval was received from the Institutional Review Board of King Saud University (#E-21-5871). Data confidentiality and participant anonymity were protected by assigning a code number to each participant for the data analysis. Participation in the study was completely voluntary. No rewards were given to the participants. They were also informed of their right to withdraw from the study at any time without obligation. Collected data were stored in a secure server that only members of the study team could access. The identity of all participants will remain anonymous in the published research.

## 2.9. Measures to reduce response bias

To avoid non-response bias, we sent a pre-notification email to potential participants informing them about the upcoming survey. We also sent personalized invitations and one reminder to potential participants. To avoid response bias, the survey questions were neutrally phrased, and the answer choices were not leading. The survey was conducted anonymously. We also reduced order bias by reducing the number of questions to the bare minimum and grouping survey questions by topic. Demographic questions were asked later in the survey. We also sought to ask question that would engage respondents and randomized our question and answer options.

## 2.10. Statistical analysis

Statistical Package for Social Sciences (SPSS, IBM Corporation, Armonk, New York, USA) v. 24.0 was used to clean and analyze the data. The study variables included: demographic characteristics, knowledge of COVID-19, perceptions of and attitudes toward COVID-19 vaccines, and attitudes toward local healthcare services. The descriptive statistics present the demographic data (including percentages and frequencies). In the second section (attitudes towards COVID-19 vaccines), possible responses were rated from zero to three. Responses with a value of zero were considered anti-vaccination (most negative attitude); responses rated three indicated the most positive attitude. The total score was calculated by averaging the values of the total responses. A score greater than two indicates a positive attitude, while a score less than two indicates a negative attitude. A chi-squared test was used to measure the impact of sociodemographic variables on COVID-19 vaccination acceptance. The odds ratio was calculated using logistic regression analysis. Variables that predict vaccine acceptance were calculated using 95% confidence intervals. A p-value greater than 0.05 is considered statistically significant.

### 3. Results

The demographic statistics are shown in Table 1. A total of 529 participants were included in the study. Of these, most (88.46%,  $n = 468$ ) had received a COVID-19 vaccine; the rest (11.53%,  $n = 61$ ) were vaccinated during the study. Most participants were Saudi (54.06%,  $n = 286$ ), female (68.43%,  $n = 362$ ), and married (54.82%,  $n = 290$ ); the largest cohort received a salary between 5,001 and 10,000 SR (46.88%,  $n = 248$ ).

Of the participants, 35.72% ( $N = 189$ ) had been working for less than five years, while about one-quarter had been working for ten to 15 years. Most participants (64.65%,  $N = 342$ ) had a bachelor's degree; 10.58% ( $N = 56$ ) had either a Ph.D. or a master's degree. Participants' demographic characteristics are presented in detail in Table 1.

Table 1 also shows the infection rate among participants. More than half of participants had not been infected with COVID-19. Table 1 also shows the number of participants who did and did

**Table 1**  
Demographics statistics.

		N	(%)	
Ever had a COVID19 vaccine	No	61	(11.53)	
	Yes	468	(88.47)	
Gender	Female -	362	(68.43)	
	Male -	167	(31.57)	
Monthly Income	10001–15000	90	(17.01)	
	15001–20000	52	(9.83)	
	5001–10000	248	(46.88)	
	less than 5000	104	(19.66)	
Marital Status	More than 20,000	35	(6.62)	
	Married	290	(54.82)	
	Separated/ Divorced /	13	(2.46)	
Hours Worked Per Week	Single	226	(42.72)	
	20	68	(12.85)	
	45	267	(50.47)	
Presence of a Long-term physical health condition	21–44	194	(36.67)	
	No	444	(83.93)	
Presence of a Long-term mental health condition	Yes	85	(16.07)	
	No	505	(95.46)	
Current Profession	Yes	24	(4.54)	
	Administrator	41	(7.75)	
	Allied health professional	23	(4.35)	
	EMS	1	(0.19)	
	Nurse	223	(42.16)	
	Other	109	(20.60)	
	Pharmacist	16	(3.02)	
	Physician	88	(16.64)	
No of Years Worked in Health Care Field	Technician (e.g. lab CSSD radiology anesthesia tech, etc.)	28	(5.29)	
	>15	94	(17.77)	
	10–Jun	140	(26.47)	
	15–Nov	106	(20.04)	
Education Level	5–Jan	189	(35.73)	
	Bachelor	342	(64.65)	
	Board/fellowship	21	(3.97)	
	Diploma	96	(18.15)	
	Master PhD	56	(10.59)	
Nationality	Other	14	(2.65)	
	Non-Saudi	243	(45.94)	
Current Department	Saudi	286	(54.06)	
	Critical Care Unit (ICU CCU. etc.)	72	(13.61)	
	Emergency Medicine	14	(2.65)	
	Fever /Flu clinic	2	(0.38)	
	General Ward	75	(14.18)	
	Isolation areas	8	(1.51)	
	Laboratory	23	(4.35)	
	Operating Room	35	(6.62)	
	Other	218	(41.21)	
	Outpatient Clinics	61	(11.53)	
	Radiology department	21	(3.97)	
	Living Arrangement	Live alone	85	(16.07)
		With others (including children)	243	(45.94)
With others (not children)		201	(38.00)	
Smoking Status	Current smoker	45	(8.51)	
	Never smoked	448	(84.69)	
	Past smoker	36	(6.81)	
Infection status	Infected	95	(18)	
	Non-infected	511	(82)	
Infection rate vs involvement in COVID-19 care	Infected and directly exposed	35	(6.61)	
	Infected not exposed	60	(11.34)	
	Not infected but exposed	130	(24.57)	
	Not infected not exposed	300	(56.7)	
Relative or friend who have died because of COVID	Yes	248	(46.8)	
	No	281	(53.2)	
Total		529	(100.0)	

not interact with COVID-19 patients. As the bar graph shows, most participants did not interact with COVID-19 patients. However, the infection rate was almost the same for those who worked with COVID-19 patients and those who did not. This indicates that healthcare workers exposed to COVID-19 patients did not have a greater risk of infection than their counterparts who did not work with COVID-19 patients.

As Table 1 shows, 52.78% of the participants know someone (a relative or friend) who has been infected with COVID-19 or who has died from COVID-19. The rest, 46.58% of the sample, had no previously infected relatives or friends. 52.86% is more than half of the participants.

Table 2 shows the chi-squared analyses, which were used to determine the relationship between COVID-19 vaccine acceptance and social demographic characteristics.

**Table 2**  
Chi Square Analysis between COVID-19 vaccine acceptance and socio demographic variables.

	N	%	Chi-Square Tests				
				Value	df	P value	
Gender	Female -	362	(68.43)	Pearson Chi-Square	21.016a	4	0.0003
	Male -	167	(31.57)	Likelihood Ratio	20.56218	4	0.0004
Monthly Income	10001–15000	90	(17.01)	Pearson Chi-Square	28.559a	16	0.0271
	15001–20000	52	(9.83)	Likelihood Ratio	30.76866	16	0.0144
	5001–10000	248	(46.88)				
	less than 5000	104	(19.66)				
	More than 20,000	35	(6.62)				
Marital Status	Married	290	(54.82)	Pearson Chi-Square	16.641a	8	0.0341
	Separated/ Divorced /	13	(2.46)	Likelihood Ratio	17.69153	8	0.0237
	Single	226	(42.72)				
Level of Education	Bachelor	342	(64.65)	Pearson Chi-Square	37.885a	16	0.0016
	Board/fellowship	21	(3.97)	Likelihood Ratio	42.83933	16	0.0003
	Diploma	96	(18.15)				
	Master PhD	56	(10.59)				
	Other	14	(2.65)				
Direct Involvement with COVID-19 Patients	Infected and directly exposed	35	(6.61)	Pearson Chi-Square	5.735a	4	0.2198
	Infected not exposed	60	(11.34)	Likelihood Ratio	5.816113	4	0.2133
	Not infected but exposed	130	(24.57)				
	Not infected not exposed	300	(56.7)				
Have relative or Friend with or died of COVID-19	Yes	248	(46.8)	Pearson Chi-Square	7.393a	4	0.1165
	No	281	(53.2)	Likelihood Ratio	7.469274	4	0.1131

**Table 3**  
Linear Logistic Regression of different variables.

Variables in the Equation	B	S.E.	Wald	df	Sig.	Exp (B)
Vaccine convenience is an important factor in vaccination decision-making	0.39	0.14	7.62	1	0.006	0.675
It is possible that I would take the vaccination if one of my family or friends has already taken it	0.30	0.15	3.88	1	0.049	1.353
The vaccine should be mandatory by the government Ministry of Health	-0.27	0.12	4.86	1	0.028	0.762
Have your children been vaccinated based on the pediatric vaccination schedule?	0.063	0.54	6.06	1	0.294	1.276
Have you been vaccinated against influenza in the past season?	0.260	0.76	2.28	1	0.473	1.554
I have refused vaccination of a certain type of vaccine in the past When will you get COVID-19 vaccine	0.500	0.73	3.73	1	0.652	2.823
Taking the COVID-19 vaccine will protect me, my family, and the community from contracting the virus.	0.177	0.99	8.94	1	0.831	1.118
Getting vaccinated is the best way to avoid infection with Covid-19 disease compared to other preventive measures (washing hands, wearing a muzzle and social distancing)	0.1745	0.12	4.54	1	0.119	3.333
Vaccination most of the community with the Covid-19 vaccine will eradicate the virus and make life return to normal.	0.1268	0.41	5.63	1	0.318	2.660
The vaccine should be mandatory by the employer (e.g., hospitals)	3.981	0.64	1.23	1	0.587	4.910
My acceptance of the vaccination depends on my doctor's recommendation.	4.062	0.53	1.18	1	0.766	2.294
My failure to take the Covid-19 vaccine depends on my concern about the side effects associated with the vaccine.	3.294	0.66	5.33	1	0.941	2.473
I will not take the new COVID-19 vaccine, as I think it is only propaganda or commercial profiteering.	2.473	0.41	7.60	1	0.112	4.652
I will not take the COVID-19 vaccine because I think it is not working well.	0.752	0.52	8.10	1	0.099	2.831
I will not take the COVID-19 vaccine because I prefer natural immunity	0.731	0.31	8.87	1	0.073	3.237
I think the benefits of the COVID-19 vaccines outweigh their harms or risks	0.619	0.37	4.66	1	0.276	4.189
Have you received the first dose or completed the COVID-19 vaccination (for any of the available vaccines)	1.276	0.89	2.41	1	0.554	2.330
I am confident our local healthcare services can handle the pandemic	1.354	0.30	2.12	1	0.823	4.602
I follow the national guidelines for COVID-19 issued by the Saudi Ministry of Health (SMoH) and the Saudi Center for Disease Prevention and Control (SCDC-Weqaya)	2.623	0.91	7.99	1	0.118	2.104
I follow the other international guidelines for COVID-19 (e.g., by World Health Organization)	1.218	0.60	3.73	1	0.333	2.876
I am satisfied with the preventive precautionary measures at my workplace	3.433	0.78	1.76	1	0.660	3.668
The covid-19 pandemic had a great impact on my daily life	8.745	0.86	4.54	1	0.910	4.410

Multiple Linear regression.

**Table 4**  
Multiple Linear regression Model Summary.

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.587a	0.34	0.32	1.10

The fitted logistic regression model explained 16% of the variation observed in the dependent variable, vaccine acceptance. Nagelkerke’s R squared was 0.16 and the  $-2$  log likelihood was 309.022a, supporting our conclusion. Only three predictor variables were statistically significant. Logistic regression was used to measure the impact of the three significant predictors of vaccine acceptance: vaccine convenience, number of vaccinated friends and family members, and vaccine mandates. As Table 3 shows, an increase in vaccine convenience (vaccination method, frequency, distance to vaccination sites, etc.) increased the odds ratio (O.R.) that a participant was vaccinated by 0.39. An increase in the number of friends or family members who were vaccinated increased the O.R. of vaccination acceptance by 0.30. However, vaccine mandates decreased the O.R. of vaccine acceptance by 0.27.

The dependent variable in the fitted linear regression was normally distributed; the mean was around zero, and the standard deviation was 0.98. This suggests that the results are reliable since the dependent variable is evenly distributed for all observations. As Table 4 shows, the fitted linear regression model explained 32% of the variation in the dependent variable, acceptance of the COVID-19 vaccine. The adjusted R squared was 0.32. The ANOVA (Table 5) shows that the fitted regression model was statistically significant at a 95% confidence interval with a p-value of 0.00001. Therefore, the results are explained by the significant predictor variables in the model. The regression results indicate that only three of the independent variables significantly predicted vaccine acceptance. Propaganda reduced vaccine acceptance by 0.18, while vaccine convenience increased vaccination acceptance by 0.17. Following the national guidelines increased vaccine acceptance by 0.13 (Table 6).

**4. Discussion**

This study has uncovered some important factors related to COVID-19 vaccine hesitancy and resistance. Although little research has explored COVID-19 vaccine hesitancy, acceptance and hesitancy rates for any vaccine vary across the globe (Xiao and Wong, 2020). The current study has described the predictors

**Table 5**  
Multiple Linear regression (ANOVA test).

	Sum of Squares	df	ANOVA Mean Square	F	Sig.
Regression	325.33	19	17.12	14.07	.000b
Residual	619.44	509	1.22		
Total	944.78	528			

**Table 6**  
Multiple Linear regression (Regression Results).

	Unstandardized Coefficients		t	Sig.
	B	Std. Error		
(Constant)	0.1342	0.1758	0.7633	0.4456
Propaganda or commercial profiteering	-0.1768	0.0444	3.9817	0.0001
Vaccine convenience	0.1745	0.0429	4.0629	0.0001
National guidelines for COVID-19	0.1268	0.0551	2.3001	0.0218

and factors influencing hesitancy and intention to receive COVID-19 vaccinations among healthcare workers in Saudi Arabia. Our findings showed that gender, income level, marital status, and level of education significantly impact COVID-19 vaccine acceptance. Vaccine convenience, the number of vaccinated family members or friends, and government COVID-19 vaccine mandates also significantly predicted vaccine acceptance. Of the included demographic variables, only gender, income level, marital status, and level of education had statistically significant relationships with COVID-19 vaccine acceptance.

This study found that more than half of Saudi healthcare professionals are open to vaccination against COVID-19. This aligns with a recent report that the majority of Chinese healthcare professionals were ready to receive a COVID-19 vaccine. However, reluctance to receive an influenza vaccination has previously been observed among Irish and Saudi healthcare personnel (Halpin and Reid, 2019; Alsuhaibani, 2020). In a randomized clinical study, Dempsey et al. (2018) highlight the beneficial impact of healthcare professionals on teenagers’ uptake of the human papillomavirus vaccination.

Our findings also indicate that the preventive measures to protect frontline healthcare workers in Saudi Arabia from contracting COVID-19 are effective. Therefore, healthcare workers who interact with COVID-19 patients should not face discrimination. COVID-19 has spread, and most participants in the present study have first-hand knowledge of the virus rather than only information from the media. Therefore, the Saudi government should continue to implement measures aimed at reducing the spread of the disease.

Other studies have identified several variables related to COVID-19 vaccine acceptance. We found that males were more likely than females to accept COVID-19 vaccination, which supports previous results (Wong et al., 2020; Malik et al., 2020). We also found that vaccine acceptance was highest among high-income individuals and lowest among low-income participants. These results align with those of another study in the United States; there, vaccine acceptance was also higher among high-income participants than among those with lower incomes (Reiter et al., 2020).

Other studies have also found a relationship between vaccine acceptance and marital status. These results may be explained by views and opinions regarding immunization, which vary across age groups. However, married participants should seek to increase COVID-19 vaccination acceptance among individuals who are more susceptible to COVID-19-related problems (Malik et al., 2020; Bonanad et al., 2020; Lazarus et al., 2021).

We also found that COVID-19 vaccine acceptance varied by level of education; highly educated participants were more likely

to accept the vaccine than those with lower levels of education, and doctors were more eager to be vaccinated than those in other healthcare professions. Public health initiatives should address these differences in vaccination acceptance based on demographic and socioeconomic factors in order to reduce inequalities and increase vaccine acceptance (Dror et al., 2020).

The proportion of people among our participants who have been vaccinated against COVID-19 was twice as high as those reported for China, the United States, and Egypt (Thunstrom et al., 2020; Thanh Le et al., 2020; Abdelhafiz et al., 2020). This may be explained by Saudi Arabia's diverse culture and by the impact of rumors and inaccurate information disseminated via social media platforms.

Our findings show that increased vaccine convenience (vaccination technique, frequency, distance to vaccination locations, etc.) enhanced vaccine acceptance. This finding is consistent with a recent study among healthcare workers in Turkey (Yilmaz et al., 2021). A systematic review has evaluated the variables impacting vaccination acceptance. In studies conducted in Turkey, Australia, the United Kingdom, and Malaysia, the authors found that participants' views on vaccination were significantly related to their desire to get vaccinated (Thanh Le et al., 2020).

According to MacDonald (2015), variables affecting vaccine reluctance may be linked to confidence, complacency, and/or convenience. This suggests that future research should use a different sampling technique to select participants, such as random sampling with appropriate stratification (Biddlestone et al., 2020; Georgiou et al., 2020).

Our findings indicate that when the COVID-19 vaccine is available, Saudi Arabia may see high rates of vaccination. Previous studies have found that individuals in the United States and France who have previously received the seasonal influenza vaccination have higher COVID-19 vaccine acceptance (Gidengil et al., 2012; Setbon and Raude, 2010). However, the self-reported rate of influenza vaccination in Saudi Arabia is extremely low in some regions. For example, in Saudi Arabia's Western area, only 18.5% of individuals received the influenza vaccination in 2015 (Korani, 2015). In 2011, the same rate was recorded in Saudi Arabia's Central area (Al-Khashan et al., 2011). Since COVID-19 is extremely infectious and has a high death rate, a large proportion of the community should be immunized to stop or slow the spread of the illness.

Female gender was another positive predictor of COVID-19 vaccine uptake in our findings; we found that women were more likely than men to take a COVID-19 vaccination. This finding contradicts those of previous studies. Furthermore, women are more likely than men to believe conspiracy theories related to COVID-19, which may help explain women's greater vaccine hesitancy (Gagneux-Brunon et al., 2021; Allington et al., 2021).

In our study, age was not a significant predictor of COVID-19 vaccine acceptance. Other studies, however, have found that younger individuals are more dissatisfied with the social constraints and curfews imposed to reduce the spread of COVID-19 and therefore more likely to get vaccinated. Younger people may also be more comfortable with and trusting of science and technology than their elders (Gagneux-Brunon et al., 2021; Allington et al., 2021). In addition, school lockdowns may have a detrimental impact on the academic performance of schoolchildren and university students. As a result, they may be more eager to end the spread of COVID-19 and, as a result, more willing to be vaccinated.

We found that being a member of a high-risk group did not increase vaccine acceptance. Therefore, the findings of the current study regarding COVID-19 vaccine acceptance among Saudi healthcare professionals is worrisome for several reasons. First, the psychological desire to explain the unexpected occurrences connected with the COVID-19 pandemic may contribute to the popularity of conspiracy theories (van Prooijen and Douglas,

2017). Second, belief in conspiracies has been noted to play a role in vaccination hesitancy, including hesitancy regarding the influenza vaccine, among Saudi people (Bangerter et al., 2012). In line with earlier studies in China, most vaccine refusers in our study said that more research is needed to demonstrate the safety and efficacy of COVID-19 vaccines. This suggests that their prior knowledge may influence their assessment of COVID-19 vaccines.

Interestingly, before the H1N1 influenza A pandemic, the public vaccination acceptance rate in the United States was 8.7% (Quinn et al., 2009). However, when a vaccine for H1N1 was brought to the market, self-reported vaccination uptake rose to 20% (Maurer et al., 2010). Given that vaccination is the cornerstone of reducing the healthcare burden of the COVID-19 pandemic, this study's findings may be used to design evidence-based immunization programs while a vaccine is being developed (Fadda et al., 2020). Enhancing public attitudes toward vaccination and identifying the obstacles to COVID-19 vaccination acceptance can increase vaccine acceptance, which may result in increased vaccine uptake when it becomes accessible.

#### 4.1. Strengths and limitations

The present study has several limitations. Due to the curfew and social distance limitations imposed due to COVID-19, data were collected through an online self-administered questionnaire rather than in face-to-face interviews. In addition, only healthcare professionals were included in our sample. Therefore, underrepresentation and reporting bias could be issues. Furthermore, this cross-sectional study explores popular acceptance and views about COVID-19 vaccines during the pandemic, before any vaccine was available. People's attitudes and views toward COVID-19 vaccination may alter over time, as documented in previous pandemic research (Almotairy et al., 2019; Alqahtani et al., 2017).

#### 4.2. Implications for health policy

The present study found that COVID-19 vaccine hesitancy among Saudi healthcare workers was twice that reported in China, the United States, or Egypt (Fu et al., 2020; Thunström et al., 2020; Abdelhafiz et al., 2020). This finding highlights the need for further efforts to promote future uptake of a COVID-19 vaccine in Saudi Arabia. This might include improving attitudes towards COVID-19 vaccination in particular and vaccination in general (Bish et al., 2011).

First, healthcare professionals have a significant risk of contracting and therefore spreading COVID-19. Second, healthcare professionals play an important role in persuading others to be vaccinated. This function will certainly be critical to boosting COVID-19 vaccine uptake. Future research should concentrate on evaluating the extent of vaccination hesitancy among Saudi healthcare professionals and on designing and testing interventions that may improve attitudes towards vaccination and increase vaccine uptake among Saudi healthcare workers.

## 5. Conclusion

Gender, income level, marital status, and level of education significantly impact COVID-19 vaccine acceptance among Saudi healthcare workers. Healthcare workers do not receive information about COVID-19 vaccines only from social media, and government efforts to promote COVID-19 vaccines are clearly effective. Therefore, the government should continue to encourage vaccine uptake, especially in light of the possible emergence of more variants of COVID-19 or of other infectious diseases. The findings of the present study have important implications for public health and

should drive public health initiatives to increase general acceptance of COVID-19 vaccines. Although developing efficient and safe vaccines against COVID-19 is critical to managing and ending the COVID-19 pandemic, guaranteeing vaccine acceptance is also critical. As a result, public health measures to address the widespread disinformation and conspiracy theories regarding COVID-19 vaccinations are urgently required. Furthermore, open information regarding vaccine efficacy and safety will help build public confidence in future COVID-19 immunization campaigns.

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## 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.

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