

# Acceptance to take COVID-19 vaccine and its relation to COVID-19 infection

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## ABSTRACT

One of the biggest global health threats is vaccine hesitancy and it remains a global issue. The speed at which vaccines are developed and media misinformation contribute to vaccine reluctance. This study examined the relationship between vaccine acceptance and COVID-19 infection. A cross-sectional study was used with a sample of 1388 subjects including students and academic staff. Data were collected using the self-administered COVID-19 Vaccine Acceptance Behavior questionnaire, which has nine dimensions and 42 items and asks about COVID-19 infection frequency and timing. The mean COVID-19 vaccine behavior scores of hesitant subjects were low. Low trust in COVID-19 vaccines (25.4%) was the main reason for hesitancy. COVID-19 vaccine hesitancy is positively correlated with increased infection rates ( $P \leq 0.001$ ). Acceptance of the COVID-19 vaccine can reduce infection rates, protect vulnerable populations, and aid public health efforts to control the virus.

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## Introduction

The ongoing COVID-19 pandemic has brought significant challenges to public health and has had a profound impact on nearly every aspect of society. Despite widespread efforts to control the spread of the virus, the development and administration of vaccines have emerged as a crucial tool in combating the spread and impact of COVID-19.<sup>1</sup> However, the successful containment of the virus relies heavily on the public's willingness to accept and receive the vaccination. This paper aims to explore the factors influencing acceptance of COVID-19 vaccination and its relationship with COVID-19 infection rates.<sup>2</sup>

Coronavirus poses a global health risk to millions worldwide. In 2019, COVID-19 first appeared in China and quickly expanded around the world. According to the WHO, over 251 million confirmed positive cases and approximately five million fatalities have been caused by COVID-19.<sup>3</sup> The WHO classified COVID-19 citing the infection's alarmingly high degrees of spread and severity.<sup>4</sup> A wide range of illnesses, from mild to severe or even fatal, have been linked to SARS-CoV-2 infection.<sup>5</sup> Frequent clinical manifestations of COVID-19 comprise fever, fatigue, dry cough, dyspnea, pneumonia, and anosmia<sup>6</sup>.

COVID-19 is transmitted by respiratory droplets and/or physical contact between people. The intensity of the sickness is increased by medical comorbidities such as cardiovascular, immunodeficiency, diabetes mellitus, and hypertension.<sup>7</sup> However, individuals without these conditions may still have severe COVID-19 and need intensive inpatient care.<sup>8</sup> COVID-19 has major adverse impacts, including social and economic ones, in addition to its substantial impact on people's health and the health of societies worldwide.<sup>9</sup>

Vaccines have been a vital tool in the fight against infectious illnesses including smallpox, polio, and plague, helping to improve health outcomes and lengthen life expectancy.<sup>10</sup> The creation of a reliable COVID-19 vaccination is essential to stopping the pandemic because of the increased morbidity and death linked to the virus. There were 172 potential vac-

cines undergoing preclinical review and 61 COVID-19 vaccine candidates awaiting clinical evaluation as of December 23, 2020.<sup>11</sup>

Apart from the apparent consequences this illness has on the world's health, it has also been shown to be detrimental to people's social and economic standing. According to reports, a number of factors influence how quickly new vaccines are accepted.<sup>12</sup> The factors that determine the actual vaccination rate include: age and work status; disease-specific factors like risk perception and exposure to COVID-19 information; vaccine-specific factors like vaccination attitudes and confidence in efficacy and safety; the presence of chronic disease; perceptions of infection; the severity of potential long-term effects; the effectiveness of vaccines; the negative side effects of vaccines (such as headache, diarrhea, mild flu-like symptoms, feeling achy, and myocarditis); and general impediments to vaccination.<sup>13</sup>

Thus, vaccination acceptance refers to the population's level of agreement or disagreement with vaccination. Therefore, it affects both the rate of vaccine absorption and the effectiveness of vaccination distribution.<sup>14</sup> While the hesitant population described a poor response rate to take the vaccine, postponement of the appointment regardless of the accessibility of vaccination services, may also hinder future attempts to vaccinate against COVID-19.<sup>11</sup>

The main arguments against vaccination were the idea that the immune system is strong enough to fight off the infection and the unreliability of clinical trials. According to Nguyen *et al.*, COVID-19 vaccination hesitancy has been linked in the United States to younger age (<60 years old), lower levels of education, lower household income, living in a rural area, and lack of health insurance. A few researchers have looked at the factors that influence vaccine acceptance locally in Saudi Arabia. The Saudi community exhibits significant levels of resistance and low acceptance rates which may pose a risk to public health.<sup>15</sup>

In order to overcome vaccine hesitation and rejection, vaccination efforts have attempted to take the target population's characteristics into account. It is anticipated that a person's decision regarding the COVID-19 vaccine may be influenced by their sociodemographic traits, prior vaccination history, the quantity of knowledge about the vaccine, accessibility to the vaccine, and other factors.<sup>16</sup> The willingness rate varied from 60% to 86%, based on the outcomes of COVID-19 immunization programs in several nations.<sup>17</sup> Furthermore, research on the COVID-19 vaccine's acceptability revealed that people frequently trust the advice of scientists.<sup>18</sup>

Acceptance of COVID-19 vaccination is influenced by a myriad of factors, including individual beliefs, attitudes, and perceptions, as well as socio-economic, cultural, and demographic variables. One of the key determinants of vaccine acceptance is the level of trust in the safety and efficacy of the vaccines. Misinformation and concerns about potential side effects can significantly impact individuals' willingness to get vaccinated. Moreover, accessibility and convenience of vaccination services, as well as structural barriers, such as lack of insurance or transportation, can also affect vaccine uptake.<sup>19</sup>

Additionally, cultural and religious beliefs, political ideologies, and experiences with previous vaccinations can influence an individual's decision to accept the COVID-19 vaccine. Public health communication, community engagement, and the role of healthcare providers play a crucial role in addressing these factors and fostering vaccine acceptance.<sup>20</sup>

## The significance of the study

A vaccination that can fight COVID-19 and be a dependable, affordable preventive measure. Furthermore, the assessment of overall effectiveness is heavily influenced by public acceptance. Ensuring widespread vaccination acceptability is crucial, even if a safe and effective COVID-19 vaccine is a crucial component in managing and ending the epidemic.<sup>1</sup> Therefore, in order to combat the widespread disinformation and conspiracy theories regarding COVID-19 vaccines, public health tactics are desperately needed. Furthermore, open communication regarding the efficacy and safety of vaccines will help to boost public confidence in upcoming COVID-19 immunization campaigns. Therefore, the current study aimed to better inform and comprehend public health authorities by analyzing factors that affect the general adult population's acceptance of a prospective COVID-19 vaccination and evaluating vaccine acceptance.<sup>21</sup>

## The gap in research

To exacerbate the situation, erroneous information about the COVID-19 vaccination is spreading via social media and other media outlets, causing public opinion to change often. There is currently little study on population intentions to receive the COVID-19 vaccine and how to maintain this behavior change to guarantee that the vaccination series is completed. Furthermore, little study has been done on the use of theory-based methods to determine the COVID-19 vaccine's determinants.<sup>17</sup>

The aim of this research was to explore the association between acceptance in taking the vaccine and COVID-19 infection.

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## Materials and Methods

### Study design and participants

This study used an online cross-sectional study design using Google Forms with a self-administered questionnaire. Data were collected between December 2023 and March 2024 using a convenient sampling approach from students and academic staff. The online poll was disseminated through social media (Facebook, LinkedIn, Twitter, and Instagram), web-based applications (such as Telegram and WhatsApp), and emails to individual contacts. Participants had to be at least eighteen years old. By using settings that permit one response per user, they were reminded to reply just once and to create a single account using a unique identification. Finally, in order to reduce the possibility of bias resulting from self-reported data, participant replies were kept private and confidential.

This study was performed at Prince Sattam Bin Abdulaziz University in Al-Kharij Governorate. Study participants consisted of 1388 students and academic staff of both genders and different ages and had to have received at least one dose of COVID-19 vaccine. The total population of students and academic staff in the university were contacted to complete the online questionnaire but the response rate was 60.1% of the total. Subjects with incomplete responses were deleted.

## Instrumentations

Data were collected for this research project through the usage of the COVID-19 vaccine acceptance behavior questionnaire, a self-administered questionnaire that aimed to assess the intention of initiating and sustaining the behavior of COVID-19 vaccination that expressed and did not express hesitancy towards the vaccine.<sup>22</sup> This questionnaire consisted of three parts. The first part asked about the sociodemographic characteristics including age, marital state, gender, and educational level. The second part asked about the response toward the COVID-19 vaccine including 7 items. The third part was divided into nine dimensions: i) benefits of the vaccine (3 items); ii) expected risks including side effects (3 items); iii) behavioral confidence (3 items); iv) accessibility of vaccine (5 items); v) initiation intention (one item); vi) emotional transformation (6 items); vii) overcoming barriers (5 items); viii) changes in the social environment (3 items); and xi) intention to take booster doses (1 item). The total items of the survey were 42 items, plus a main question asking about frequency and times for infection with COVID-19. Each item was measured on a scale from never = 0 to always = 4. Items of each dimension were added together and the mean score was calculated.

The internal reliability of the questionnaire was measured using Cronbach's alpha coefficient test resulted in 0.81 which indicated good internal consistency. Clearance of tools for subjects was assured through the pilot study. A pilot study was conducted on a group of 50 students. It was conducted in November 2023 prior to data collection to assess the feasibility, duration, and cost of a full-scale research project. No modification was carried out on the tool, so their responses were included in the study.

## Data collection

This phase started from December 2023 until March 2024, it involved students and academic staff working in the selected setting using Google Forms. They also received an information guide on the study that covered its objectives, methodology, informed consent form, and right of withdrawal at any moment without consequence. The informed consent and questionnaire were completed by the interested parties, who then returned them in an anonymous manner. Only complete data was included. A total of 1388 out of 2309 individuals provided final responses or a 60.1% response rate. A written agreement was obtained from each participant prior to the completion of the questionnaire, which was designed to address the study questions. In addition, the researcher promptly examined the questionnaires upon receiving them from the subjects to prevent any potential data omissions.

## Statistical analysis

Data were sorted, classified, and the results are shown in the tables. The participants' demographic characteristics were described using numbers and percentages with mean and standard deviation. The independent sample t-test and ANOVA test (F) were used to compare means of different categories regarding personal characteristics and different study variables. Cronbach alpha test was used to measure the reliability of the study variables. The Pearson correlation analysis was conducted to examine the correlation matrix among different

variables and subscales. We performed the analysis using IBM SPSS statistics 23 with the significance level at  $P < 0.001$ .

## Ethical considerations

This study was ethically accepted by Prince Sattam bin Abdulaziz University's institutional review board with reference number (SCBR-193-2023). Anonymity was guaranteed, informed consent was completed, and participation in the study was entirely voluntary. The study sample was given the assurance that their comments would not have an impact on their pay, employment status, or performance reviews. Nobody was forced to fill out the questionnaire by the researchers, nor were they lured in. The survey was completed anonymously, and the information was kept private and utilized exclusively for study.

## Results

The majority of age groups ranged from 30 to 40 years (32.8%). Moreover, about (51.6%) of the studied patients were male. While about 39.3% of the studied group had a bachelor's degree. Also, (35.5%) of the studied patients had a COVID-19 infection between (3-5) times. Finally, there was a relation between acceptance to take the vaccine and the educational level ( $F=20.072$ ,  $P=0.001$ ), moreover with COVID-19 infection times ( $F=19.864$ ,  $P=0.001$ ) as presented in Table 1.

Table 2 showed a statistically significant relation between acceptance to take the vaccine and the response toward the COVID-19 vaccine in all items except "Have you already completed the COVID-19 vaccine series" ( $F=0.072$ ,  $P=0.789$ ).

Table 3 illustrates that COVID-19 vaccine acceptance behavior mean scores were higher among the non-hesitant than the hesitant studied group within all dimensions of COVID-19 vaccine behavior. Also, there was a statistically significant difference between the non-hesitant and hesitant studied group within all dimensions of COVID-19 vaccine behavior except accessibility of vaccine ( $t=0.008$ ,  $P=0.929$ ), overcoming barriers ( $t=0.701$ ,  $P=0.403$ ), and intention to take booster doses ( $t=2.894$ ,  $P=0.089$ ).

Table 4 shows that there is a significant positive correlation between acceptance to take the vaccine with all dimensions of COVID-19 vaccine behavior except expected risks including (side effects) and hesitancy to take the COVID-19 vaccine respectively ( $r=-0.360$ ,  $P=0.001$  and  $r=-0.386$ ,  $P=0.001$ ). While COVID-19 infection times have a negative significant correlation with all dimensions of COVID-19 vaccine behavior except expected risks including (side effects) and hesitancy to take the COVID-19 vaccine respectively ( $r=0.556$ ,  $P=0.001$ ) & ( $r=0.242$ ,  $P=0.001$ ).

## Discussion

Acceptance of the COVID-19 vaccine and its relation to COVID-19 infection is a crucial topic shaping the ongoing global vaccination efforts; the acceptance of the COVID-19 vaccine plays a vital role in achieving herd immunity and controlling the spread of the virus.<sup>23</sup> So, this study aimed to investigate the relationship between acceptance of the vaccine and COVID-19 infection.

**Table 1.** Number and percent of the studied group according to personal characteristics and their relationship with acceptance to take vaccine (n=1388).

Personal characteristics	Total	Percent	Mean±SD	F/(P)
Age				
Less than 20 years	219	15.8	66.46±10.9	0.575 (0.681)
20-<30 years	356	25.6	67.22±10.4	
30-<40 years	455	32.8	66.79±10.4	
40-50 years	262	18.9	66.16±10.8	
More than 50 years	96	6.8	67.60±10.3	
Marital status				
Single	386	27.8	69.80±10.2	3.565 (0.091)
Married	746	53.7	64.52±10.1	
Divorced- separated	136	9.8	64.77±8.2	
Widowed	120	8.6	73.48±11.1	
What is your gender?				
Male	716	51.6	66.98±10.4	0.519 (0.472)
Female	672	48.4	66.58±10.6	
Educational level				
Less than high school	330	23.8	64.16±11.3	20.072 (0.001*)
High school	332	23.9	66.78±9.4	
Bachelor degree	545	39.3	66.79±10.5	
Master degree or more	181	13.0	71.56±9.3	
COVID-19 infection times				
Not infected before	103	7.4	66.89±7.1	19.864 (0.001*)
1-2 times	422	30.4	69.07±9.6	
3-5 times	493	35.5	67.28±11.4	
More than 5 times	370	26.7	63.49±10.3	

\*Significant (P<0.05); F, ANOVA test; SD, standard deviation.

**Table 2.** Description of studied group's response toward COVID-19 vaccine and its relation with acceptance to take the vaccine (n=1388).

Response toward COVID-19 vaccine	Total	Percent	Mean±SD	F/(P)
Do you currently have any hesitancy in taking (completing) the COVID-19 vaccine?				
No	872	62.8	69.91±9.3	5.500 (0.019*)
Yes	516	37.2	61.51±10.2	
Have you already completed the COVID-19 vaccine series?				
No	481	34.7	66.68±9.4	0.072 (0.789)
Yes	907	65.3	66.84±11.1	
Do you have health insurance?				
No	322	23.2	68.93±11.8	17.568 (0.001*)
Yes	1066	76.8	66.14±10.03	
Do you have a medical provider you trust to provide you with information about the COVID-19 vaccine?				
No	452	32.6	65.81±8.6	5.783 (0.016*)
Yes	936	67.4	67.26±11.3	
Have you been encouraged by a medical provider to take the COVID-19 vaccine?				
No	377	27.2	65.62±11.3	6.365 (0.012*)
Yes	1011	72.8	67.22±10.2	
What is the best protective practice behavior for COVID-19?				
Wearing mask	365	26.3	65.35±11.2	27.873 (0.001*)
Get vaccinated	837	60.3	67.27±9.9	
Practice social distance	119	8.6	62.58±10.5	
Stay away from large groups	67	4.8	76.01±7.9	
What is the reason for hesitancy regarding taking COVID-19 vaccine?				
I am concerned about possible side effects of a COVID-19 vaccine	134	9.7	75.02±9.3	25.148 (0.001*)
I don't know if a COVID-19 vaccine will work	185	13.3	67.46±11.6	
I don't believe I need a COVID-19 vaccine	312	22.5	65.94±9.6	
I don't like vaccines	137	9.9	68.60±9.6	
I plan to wait and see if it is safe and may get it later	267	19.2	65.97±11.2	
I don't trust COVID-19 vaccines	353	25.4	63.97±9.2	

\*Significant (P<0.05); F, ANOVA test; SD, standard deviation.

Regarding the sociodemographic characteristics and acceptance to take the vaccine, this study found a statistically significant association between acceptance to take the vaccine with educational level and COVID-19 infection times, this is compatible with the study of Salman *et al.*<sup>1</sup> who found an association between the acceptance to take the vaccine and educational level. A higher level of education can improve the beliefs and attitudes of the population and increase the awareness to take and complete doses of vaccine.

Moreover, this study found that COVID-19 vaccine acceptance behavior mean scores were higher among the non-hesitant than the hesitant studied group within all dimensions of COVID-19 vaccine behavior. Also, there was a statistically significant difference between the non-hesitant and the hesitant studied group within all dimensions of COVID-19 vaccine behavior, except for the accessibility of vaccine, overcoming barriers, and intention to take booster doses. These results guided us toward addressing vaccine hesitancy and providing accurate information about the safety, efficacy, and importance of COVID-19 vaccines are essential in promoting higher acceptance rates. Education and communication campaigns can help build trust in vaccines and encourage more individuals to get vaccinated.

Agreeing with these findings, it was stated that the hesitation to take the vaccine among the population resulted in a decreasing number of vaccinated people resulting from low

trust of the vaccine and incomplete information regarding the process of vaccination.<sup>20</sup> While Yasmin *et al.*<sup>24</sup> concluded that the occurrence of side effects following the vaccine can lead to hesitancy and another corrective action is needed to improve public confidence in the vaccine. Analyzing the data on vaccine acceptance and its association with COVID-19 infection rates over the long term will provide insights into the sustainability of population immunity and the potential need for booster doses or updated vaccines to address new variants of the virus.<sup>25</sup>

To determine the direction of the relationship, the study found a significant positive correlation between acceptance of the vaccine with all dimensions of COVID-19 vaccine behavior except expected risks including (side effects) and hesitancy to take the COVID-19 vaccine respectively. COVID-19 infection times have a negative significant correlation with all dimensions of COVID-19 vaccine behavior except expected risks including (side effects) and hesitancy to take the COVID-19 vaccine respectively. High vaccine acceptance rates lead to increased population immunity, reducing the overall infection rate and severity of the disease. Acceptance of the vaccine not only protects the vaccinated individual but also contributes to reducing virus transmission within communities. This can help in curbing the spread of COVID-19 and preventing new infections.

Along the same line, the findings of a study summarized

**Table 3.** COVID-19 vaccine acceptance behavior among the studied group (n=1388).

COVID-19 vaccine behavior	Total mean±SD	Non-hesitant	Hesitant	t/(P)
Benefits of the vaccine	7.02±2.74	7.63±2.5	5.99±2.7	11.687 (0.001*)
Expected risks including (side effects)	6.12±3.17	5.24±2.9	7.60±3.0	17.08 (0.001*)
Behavioral confidence	7.02±2.89	7.70±2.4	5.87±3.2	27.092 (0.001*)
Accessibility of vaccine	11.24±2.99	11.72±2.9	10.44±2.8	0.008 (0.929)
Initiation intention	2.60±1.26	2.80±1.2	2.26±1.3	12.894 (0.001*)
Emotional transformation	12.70±3.65	13.08±3.7	12.07±3.4	6.635 (0.010*)
Overcoming barriers	10.88±3.61	11.76±3.3	9.37±3.4	0.701 (0.403)
Changes in the social environment	7.11±2.84	7.83±2.6	5.87±2.8	13.601 (0.001*)
Intention to take booster doses	2.11±1.13	2.15±1.1	2.04±1.1	2.894 (0.089)
Total	66.79±10.53	69.91±9.4	61.51±10.2	5.500 (0.019*)

\*Significant (P<0.05); t, independent sample t-test; SD standard deviation.

**Table 4.** Correlation between COVID-19 vaccine acceptance behavior and COVID-19 infection.

COVID-19 vaccine behavior	Acceptance to take vaccine	COVID-19 infection times
Benefits of the vaccine	r=0.289, P=0.001*	r=-0.225-, P=0.001*
Expected risks including (side effects)	r=-0.360-, P=0.001*	r=0.556, P=0.001*
Behavioral confidence	r=0.306, P=0.001*	r=-0.126-, P=0.001*
Accessibility of vaccine	r=0.307, P=0.001*	r=-0.103-, P=0.001*
Initiation intention	r=0.207, P=0.001*	r=-0.199-, P=0.001*
Emotional transformation	r=0.133, P=0.001*	r=-0.114-, P=0.001*
Overcoming barriers	r=0.321, P=0.001*	r=-0.205-, P=0.001*
Changes in the social environment	r=0.334, P=0.001*	r=-0.254-, P=0.001*
Intention to take booster dose	r=0.046, P=0.089	r=-0.075-, P=0.005*
Hesitancy to take the COVID-19 vaccine	r=-0.386-, P=0.001*	r=0.242, P=0.001*

\*Significant (P<0.05).

that higher vaccination rates among populations provide a shield of protection not just for individuals who are vaccinated but also for those who cannot receive the vaccine due to medical reasons or other constraints. This concept of “herd immunity” is crucial for protecting vulnerable populations.<sup>26</sup> Moreover, a study has shown a clear correlation between vaccine uptake and COVID-19 infection rates. Areas with high vaccination rates have demonstrated lower infection and mortality rates, while regions with low vaccine acceptance have experienced higher case numbers and strain on healthcare systems. These findings underscore the importance of achieving high vaccination coverage to effectively control the spread of COVID-19 and mitigate its impact on public health.<sup>27</sup>

Similar studies have approved those findings and illustrated that monitoring vaccine acceptance and its impact on COVID-19 infection rates in real-world settings is essential. Observing how vaccination influences infection rates, severity of illness, hospitalizations, and mortality rates provides valuable data on the effectiveness of vaccination campaigns.<sup>28</sup> However, high vaccine coverage within a population can lead to herd immunity, which reduces the overall transmission of the virus and thereby protects vulnerable individuals who cannot be vaccinated. Conversely, low vaccine acceptance can prolong the duration of the pandemic and increase the risk of ongoing transmission and outbreaks.<sup>29</sup>

## Conclusions

The successful control of the COVID-19 pandemic relies on widespread acceptance and uptake of vaccines. Understanding the factors that influence vaccine acceptance and addressing barriers to vaccination are critical steps in achieving high population coverage. Additionally, the relationship between vaccine acceptance and COVID-19 infection rates highlights the necessity of promoting vaccination as a key strategy in controlling the spread of the virus and protecting public health. As efforts continue to promote COVID-19 vaccination, it is essential to consider the diverse factors that influence individuals’ decision-making and to implement targeted strategies to enhance vaccine acceptance and uptake.

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