Misconceptions Related to COVID 19 Vaccines Among the Jordanian Population: Myth and Public Health

Alaa M. Hammad1, Walid Al-Qerem1, Alaa Abu Zaid2, Sawsan I. Khdair1 and F. Scott Hall3

1Department of Pharmacy, Faculty of Pharmacy, Al-Zaytoonah University of Jordan, Amman, Jordan; 2Applied Science Department, Al-Balqa Applied University, Aqaba, Jordan and 3Department of Pharmacology and Experimental Therapeutics, College of Pharmacy and Pharmaceutical Sciences, University of Toledo, Toledo, Ohio, USA

Abstract

Objective: This study assesses misconceptions about coronavirus disease 2019 (COVID-19) vaccine and the factors associated with misconception among Jordanians.

Methods: A cross-sectional online survey was conducted. The survey was formulated on Google Forms, and was hosted on an online platform. These questions were created based on extensive review of online information about the vaccines. Frequencies and percentages (%) were used for categorical variables, while means and standard deviations (SDs) were used for continuous variables. Stepwise binary logistic regression was conducted to evaluate variables associated with participant’s misconception questions.

Results: Of 1195 survey respondents who participated in the study, 41.3% had received the COVID-19 vaccine. The mean misconception score was (60.0 ± 19.1). The statement with the highest mean was “The vaccine hasn’t been tested on enough people” (3.6 ± 1.0). The statement with the lowest mean was “The COVID-19 vaccine includes a microchip to control us” (2.2 ± 1.1) in the conspiracy theory portion. Females, 18- to 29-age group, higher educational level, living in a city, the participants who took lectures about the COVID-19 vaccine and vaccinated participants had higher odds of being in the misconception level group.

Conclusion: Targeted campaigns and vaccine safety information should be part of a broader health education campaign to alleviate vaccination safety concerns.

The coronavirus disease 2019 (COVID-19) pandemic has posed huge problems and threats to human lives and health systems globally.1–4 COVID-19 is highly contagious, prompting prophylactic public health measures that have included lockdowns (the closing of businesses and schools to prevent most social contact), social distancing, mask-wearing, and immunizations, once they were available.5 Over 258 million COVID-19 cases have been reported worldwide and more than 5 million COVID-19 related deaths have been reported globally. According to the World Health Organization (WHO), a total of over 10 million cases and more than 120 thousand deaths had been reported in the Middle East and North African Region (MENA) (as of March 7, 2022).6 Jordan is considered one of the MENA countries with over 1.6 million cases documented in Jordan and more, with over 13,000 deaths in Jordan (on March 7, 2022).7 One of the most important instruments for reducing the impact of infectious illnesses on mortality, morbidity, and socioeconomic health status is the development of vaccines.8 Vaccination of even a small number of people in a community can help to prevent the spread of disease, although much higher vaccination rates are thought to be needed to produce herd immunity for COVID19, 70% or more,8 greatly lowering the incidence and spread of the disease, and speeding up eradication. Herd immunity is dependent on a high vaccination coverage rate,7 and thus, highly dependent on the public’s acceptance of the vaccine. Vaccines from Pfizer BioNTech, Moderna, and Oxford AstraZeneca, among others, have been approved and distributed worldwide.8 The main distinction between vaccines is whether they are manufactured from the entire virus (SARS-CoV-2 or a viral vector), the virus’s genetic material (DNA or mRNA), or portions of the virus (protein subunit).9 Until now, there have been no direct vaccination comparisons in clinical trials, and comparing vaccine efficacy based on individual placebo-controlled trials is not appropriate. Even among trials of the same vaccination, differences in study populations, circulating variant strains at study sites, outcomes evaluated, and evaluation timing could all lead to differing degrees of vaccine efficacy. Overall vaccination efficacy in phase 3 trials published in peer-reviewed publications ranges from 70% to 95%, with each vaccine tested preventing severe disease and COVID-19-related death.10–12

Despite the fact that 4.37 million Jordanians have been fully vaccinated against COVID-19 up to March 7, 2022, which represents approximately 36% of the total population, there are still
pockets of skepticism.12 “The main hurdle to getting a COVID-19 vaccine into enough people’s arms won’t be scientific, technical, or logistical; it will come from a lack of faith,” said Tom Frieden, former Director of the Centers for Disease Control and Prevention. Public trust will be determined by whether the vaccine works, is safe, and is widely available to the general public,13 but also by the extent to which the public understands and accepts these facts about the vaccine. Simply being effective, safe, and accessible is vital, but not sufficient for gaining public trust. The general population must believe that the immunizations meet those requirements.14 Moreover, disinformation regarding the virus has been rampant since the outbreak began, posing a threat to mass immunization.15,16 Similar disinformation problems also plague vaccination efforts. Indeed, exposing people to COVID-19 vaccination disinformation reduces self-reported vaccine willingness.17

Individuals being exposed to disinformation may unwittingly be persuaded to believe misinformation, lowering vaccination acceptance.18 As a result, and after an extensive review of publicly available information from a range of sources, the main misconceptions that might be associated with the COVID-19 vaccine were categorized into 5 categories according to the nature of the misconception. These misconceptions were categorized as related to vaccine manufacturing, effectiveness, side effects, or importance, as well as those that would be categorized as conspiracy theory beliefs.19,20 It was vital to assess these misconceptions because they impede the effectiveness of health-care organizations in Jordan, and around the world, to vaccinate the population, achieve herd immunity, and thereby halt the continued spread of the disease. We believe that by assessing the extent and nature of public misconceptions about the COVID-19 vaccine, targeted information campaigns can be developed to improve public understanding of the vaccine and awareness of the necessary public health actions that will help to reduce COVID-19’s impact.

To the best of our knowledge, this is the first study to investigate the misconceptions surrounding COVID-19 vaccine among Jordanians. Similar beliefs are expected to exist around the world, and many of the factors that drive the frequency of these myths will have an impact on people everywhere, maybe even more so in nations like the United States that have had substantial resistance from some parts of the population about COVID-19 measures, including vaccine.21 Indeed, a previous study that was conducted in several nations, including the United Kingdom, Ireland, the United States, Spain, and Mexico, found that increased exposure to disinformation has a negative impact on people’s self-reported compliance with COVID-19 public health guidelines, as well as their willingness to get vaccinated against the virus and promote it to vulnerable friends and relatives.24 Moreover, another study listed one of the possible reasons for COVID-19 vaccine hesitancy in Africa was the theories on social and traditional media that the African continent was “immune” to COVID-19 due to the climatic conditions present.25 In this study, we aim to measure the magnitude of misconceptions toward COVID-19 vaccine within the Jordanian population. Furthermore, the impact of misinformation on receiving the vaccine as well as the willingness to receive the vaccine. A further aim of this study is to investigate how exposure to misinformation differentially impacts individuals according to their sociodemographic characteristics (age, gender, social status, presence of children, home residence, and highest education level) as well as attending a lecture concerning COVID-19 vaccines.

Methods

Design and Ethics

This was a Web-based cross-sectional survey of the Jordanian population. Only people aged 18 years and over were included in the study. The goal of this study was to look at common misconceptions about COVID-19 vaccines.

Survey

The survey consisted of 2 sections. The first section consisted of 11 multiple-choice questions that asked for anonymous demographic information about the respondents. The second section included 29 questions measuring the respondents’ views of different misconceptions about COVID-19 vaccines. These questions were created based on extensive review of online information about the vaccines, including official sources such as the World Health Organization (WHO)22 and the United States Center for Disease Control and Prevention (CDC) (19), as well as falsehoods that have been spread about COVID-19 vaccines in news reports, in social media reports, and identified in fact-checking efforts about the myths surrounding COVID-19 vaccines.20,21 The misperceptions that we considered fit broadly into 5 categories: (1) Vaccine manufacturing, (2) Effectiveness, (3) Side effects, (4) Importance, as well as (5) Conspiracy theory beliefs (see Table 2) as shown in a previous study with some modifications.26 Participants were asked to rate their opinions on a 5-point Likert scale, from 1 (strongly disagree) to 5 (strongly agree), when the question involved agreeing with a correct statement. This represented the score for each question. The mean of the questions in each misconception category represented the category score. The final misconception score was the mean of the 29 questions included in the questionnaire. The survey took approximately 5-10 min to complete. Reliability was assessed for total misconceptions using Cronbach’s $\alpha$.

Procedure

The survey was formulated on Google Forms, and the participant information sheet was hosted on an online platform. Questions were formulated in Arabic as it is the main language for Jordan. Face validity was tested in a pilot study with 25 participants who evaluated the questionnaire’s clarity, and no substantial changes were necessary. The results of the pilot study were not included in the final analyzed data. The link to the survey was distributed through different social media sites, including different Jordanian all-purpose Facebook groups that included thousands of members, including coronavirus “COVID-19?”/Jordan. There was no maximum enrollment on the Google Form. To ensure the fulfillment of the inclusion criteria, questions about age and area of residence were included in the questionnaire. No financial incentives were offered. The survey was distributed, and data were collected, between May 2021 and August 2021.

Data Analysis

The data were analyzed using SPSS version 22. Frequencies and percentages (%) were used to represent categorical variables, while means and standard deviations (SDs) were used to represent continuous variables. Duplicate cases were examined by SPSS duplicate case tools and by visual examination, and confirmed duplicates were deleted. Reliability analysis was conducted to evaluate internal consistency and Cronbach’s $\alpha$ was computed.
for each domain in the questionnaire. The ceiling and floor effects were evaluated by measuring the frequencies of participants who scored the maximum possible or lowest possible scores, the acceptable percentage is less than 15%. The independent variables included in the model were age group (18-29, 30-39, ≥40), sex (male, female), social status (single, married), education level (high education [bachelor certificate and post graduate], low education), type of workplace (medical, nonmedical), home residence (village, city), “Did you attend a lecture about the COVID-19 vaccination?” and “Did you receive vaccination for COVID-19?”

Results

A total of 1195 subjects participated in the study. As shown in Table 1, 60.8% of the sample were between 18 and 29 y of age, and the majority were female (71.5%). More than half of the participants had high educational level (84.4%) and most of them were working in a nonmedical field (65.9%). The percentage of participants had high educational level (84.4%) and most of them were female (71.5%). More than half of the participants were between 18 and 29 y of age, with individual questions. Overall, there was more acceptance of misconceptions surrounding vaccine manufacturing than the other categories (mean overall score: 3.36), but there were high levels of acceptance of misconceptions regarding vaccine side effects (mean overall score: 2.74), effectiveness (mean overall score: 2.8), and importance (mean overall score: 2.85) as well. Although the level of acceptance of conspiracy theory beliefs were lower overall (mean overall score: 2.45), they were still common. In terms of the frequency of agreement (agreement or strong agreement), the range for the manufacturing subsection was 20.6 to 59.1%. Although somewhat lower, similar ranges were observed for the other subsections: importance (24.1 to 43.8%), effectiveness (14.1 to 55.4%), side effects (14.0 to 32.2%), and conspiracy theory beliefs (12.5 to 27.0%).

Table 2 also shows the frequencies of agreement (agreement or strong agreement) for each individual question and the mean scores for each question in the survey. For the vaccine manufacturing portion of the survey, the statement with the highest frequency of agreement (59.1%) was “The vaccine hasn’t been tested on enough people” (mean score: 3.6 ± 1.0), while the statement with lowest frequency of agreement (20.6%) was “COVID-19 vaccines were developed using fetal tissue” (mean score: 2.9 ± 1.0). In the vaccine effectiveness portion of the survey, the statement occurring with the highest frequency of agreement (55.4%) was “COVID-19 vaccination will not protect me from getting sick with COVID-19” (mean score: 3.5 ± 1.2), while the statement occurring with the lowest frequency of agreement (14.1%) was, “Once you receive the coronavirus vaccine, you’re immune for life” (mean score: 2.4 ± 1.0). In the vaccine side effects portion of the survey, the statement occurring with the highest frequency of agreement (32.2%) was “The COVID-19 vaccine is unsafe because it was developed so quickly” (mean score: 3.1 ± 1.0), while the statement occurring with the lowest frequency of agreement (14.0%) was “The COVID-19 vaccine causes infertility in women” (mean score: 2.5 ± 1.0). In the vaccine importance part of the survey, the statement occurring with the highest frequency of agreement (43.8%) was “If you’re confident in the vaccine then you shouldn’t worry about other people not getting it because the vaccine will protect you” (mean score: 3.3 ± 1.2), while the statement occurring with the lowest frequency of agreement (24.1%) was “I’m not at risk for severe complications of COVID-19 so I don’t need the vaccine” (mean score: 2.7). In the conspiracy theory portion of the survey the statement with the highest frequency of agreement (27.0%) was “The vaccine was approved after the manufacturing companies coerced the authorities” (mean score: 2.8 ± 1.2), while the statement occurring with the lowest frequency of agreement (12.5%) was “The COVID-19 vaccine includes a microchip to control us” (mean score: 2.2 ± 1.1).

Reliability for misconception questions in each subsection (manufacturing, effectiveness, side effects, importance, and conspiracy theory beliefs) were evaluated using Cronbach’s α, and the results indicated good reliability (0.96, 0.71, 0.84, 0.91, 0.90, and 0.91, respectively). The results indicated that none of the questionnaire domains violated the floor and ceiling effect, as the percentage of participants who scored the maximum possible and lowest possible scores for manufacturing, effectiveness, side effects, importance, conspiracy theory, and total misconception were (0.07%, 2.6%), (1.2%, 1.5%), (2.2%, 1.7%), (2.7, 4.2), (12.9, 3.2%), and (0%, 0%), respectively. For additional analysis, the sample was divided into sub-groups with low overall misconception levels and high overall misconception levels. The low misconception level group included participants who had scores less than the score’s mean, while the high misconception level group included participants who scored above
and equal to the mean. A total of 635 (53.1%) participants were included in the low misconception level group.

Stepwise binary logistic regression (Forward: conditional) was conducted to assess the association between the misconception level and different participant’s characteristics. As shown in Table 3, females had significantly higher odds of being in the low misconception level group when compared with male participants (odds ratio [OR] = 0.72; $P$ value = 0.02). Participants in the 18- to 29-age group had significantly higher odds of being in the low misconception level group when compared with the participants in the age group, and higher educational level increased the odds of having low misconceptions (OR = 3.17; $P$ value < 0.001). Participants who lived in a city had significantly higher odds of having low misconceptions when compared with those who lived in villages (OR = 2.56; $P$ value = 0.00). The participants who took lectures about the COVID-19 vaccine had significantly higher odds of having low misconceptions (OR = 0.31; $P$ value = 0.02), and the participants who were vaccinated had significantly higher odds of having low misconceptions (OR = 2.45; $P$ value = 0.00).

Table 3 also shows analyses for each subsection of the survey, which shows similar results to the overall scores.

Discussion

Despite the fact that vaccines help in improving public health worldwide, vaccine hesitancy to COVID-19 from the public in different ethnic groups remains 1 of the major barriers to achieve herd immunity. The achievement of herd immunity has long been

### Table 2. Misconception question and category mean scores

|                           | Frequency (%) | Strongly agree/ agree Mean ± SD |
|---------------------------|---------------|---------------------------------|
| **Manufacturing**         |               |                                 |
| The vaccine hasn’t been tested on enough people. | 706 (59.1) | 3.6 ± 1.0                     |
| It’s new, untested technology | 645 (54.0) | 3.5 ± 1.1                     |
| COVID-19 vaccines were developed using fetal tissue | 250 (20.6) | 2.9 ± 1.0                     |
| COVID-19 vaccines must be stored at extremely low temperatures because of preservatives in the vaccines | 705 (59.0) | 3.7 ± 1.0                     |
| The vaccines use a live version of the coronavirus | 584 (48.9) | 3.3 ± 1.2                     |
| **Effectiveness**         |               |                                 |
| COVID-19 vaccine can make me sick with COVID-19 | 405 (33.9) | 2.9 ± 1.3                     |
| After getting a COVID-19 vaccine, I will test positive for COVID-19 on a viral test | 439 (36.7) | 3.1 ± 1.2                     |
| If I have already had COVID-19 and recovered, I do not need to get vaccinated with a COVID-19 vaccine | 370 (31.0) | 2.7 ± 1.3                     |
| COVID-19 vaccination will not protect me from getting sick with COVID-19 | 662 (55.4) | 3.5 ± 1.2                     |
| I only need 1 dose of any vaccine to be protected against COVID-19 | 242 (19.2) | 2.5 ± 1.1                     |
| Once you receive the coronavirus vaccine, you’re immune for life | 168 (14.1) | 2.4 ± 1.0                     |
| Once I receive the COVID-19 vaccine, I no longer need to wear a mask | 287 (24.0) | 2.6 ± 1.2                     |
| **Side effects**          |               |                                 |
| COVID-19 vaccine will alter my DNA | 218 (19.2) | 2.6 ± 1.1                     |
| The COVID-19 vaccine causes infertility in women | 168 (14.0) | 2.5 ± 1.0                     |
| The COVID-19 vaccine is unsafe because it was developed so quickly | 385 (32.2) | 3.1 ± 1.0                     |
| The COVID-19 vaccine causes severe problems with any future pregnancies | 287 (24.0) | 2.9 ± 1.0                     |
| If I receive the COVID-19 vaccine, I am at a greater risk to become sick from another illness, especially autoimmune diseases | 292 (24.4) | 2.8 ± 1.1                     |
| I am allergic to eggs so I shouldn’t get the COVID-19 vaccine | 151 (18.7) | 2.7 ± 1.0                     |
| More people will die as a result of a negative side effects of the COVID-19 vaccine than would actually die from the virus | 299 (25.0) | 2.7 ± 1.2                     |
| **Importance**            |               |                                 |
| I’m not at risk for severe complications of COVID-19 so I don’t need the vaccine | 290 (24.1) | 2.7 ± 1.2                     |
| I isolate myself from society so do not need to take the vaccine | 299 (25.0) | 2.6 ± 1.2                     |
| Certain blood types have less severe COVID-19 infections, so getting a vaccine isn’t necessary | 335 (28.1) | 2.9 ± 1.1                     |
| COVID-19 has a survival rate of 99% so you don’t need to get the vaccine | 298 (24.9) | 2.6 ± 1.2                     |
| I should wait for a vaccine that is more effective | 440 (36.8) | 3.1 ± 1.2                     |
| If you’re confident in the vaccine then you shouldn’t worry about other people not getting it because the vaccine will protect you | 513 (43.8) | 3.3 ± 1.2                     |
| **Conspiracy theory**     |               |                                 |
| The COVID-19 vaccine includes a tracking device. | 152 (12.7) | 2.3 ± 1.1                     |
| The COVID-19 vaccine includes a microchip to control us | 149 (12.5) | 2.2 ± 1.1                     |
| The vaccine was accepted after the manufacturing companies coerced the authorities | 322 (27.0) | 2.8 ± 1.2                     |
| The vaccine is designed to decrease number of human populations | 281 (23.5) | 2.6 ± 1.2                     |
| **Total misconception**   |               | **2.84 ± 0.9**                 |

Note: Strongly disagree = 1; disagree = 2; neutral = 3; agree = 4; strongly agree = 5.
Table 3. Multiple predictor analysis of variables associated with level of COVID19 vaccine misconceptions

| Total misconception                           | B   | P-Value | Odds ratio | Confidence interval of 95% | Lower | Upper |
|----------------------------------------------|-----|---------|------------|---------------------------|-------|-------|
| Sex                                          | -0.33 | 0.02   | 0.72      | 0.54 | 1.00          |
| Females compared to males                    | -0.73 | 0.00   | 0.48      | 0.35 | 0.68          |
| Age                                          | 1.20  | 0.00   | 3.17      | 2.13 | 4.72          |
| Education level                              | 0.93  | 0.00   | 2.56      | 1.80 | 3.63          |
| Home Residence                               | 0.31  | 0.02   | 0.73      | 0.56 | 0.95          |
| Did you attend a lecture about COVID-19 vaccines? | 0.90  | 0.00   | 2.45      | 1.90 | 3.20          |
| Did you receive the vaccine against COVID-19? | -0.41 | 0.00   | 0.66      | 0.48 | 0.89          |
| 18-29 y compared to 30-39 y                  | 0.75  | 0.00   | 2.14      | 1.53 | 2.98          |
| Village compared to city                     | 0.52  | 0.00   | 1.68      | 1.30 | 2.13          |
| Did you receive the vaccine against COVID-19? | 0.45  | 0.00   | 0.56      | 0.40 | 0.80          |
| 18-29 y compared to 30-39 y                  | -5.88 | 0.00   | 0.56      | 0.40 | 0.77          |
| Home residence                               | 1.09  | 0.00   | 3.00      | 2.04 | 4.40          |
| Village compared to city                     | 0.95  | 0.00   | 2.59      | 1.84 | 3.65          |
| Did you take a lecture about COVID-19 vaccines? | 0.30  | 0.01   | 0.73      | 0.56 | 0.95          |
| Yes compared to No                           | 0.62  | 0.00   | 1.84      | 1.42 | 2.40          |
| No compared to Yes                           | -0.32 | 0.02   | 0.72      | 0.55 | 1.00          |
| 18-29 y compared to 30-39 y                  | -0.59 | 0.00   | 0.55      | 0.39 | 0.76          |
| Education level                              | 0.91  | 0.00   | 2.48      | 1.70 | 3.61          |
| High education compared to low education     | 0.77  | 0.00   | 2.15      | 1.53 | 3.01          |
| Home residence                               | 0.76  | 0.00   | 2.14      | 1.66 | 2.76          |
| Did you receive the vaccine against COVID-19? | -0.45 | 0.00   | 0.64      | 0.47 | 0.91          |
| Females compared to males                    | -0.42 | 0.01   | 0.66      | 0.47 | 0.91          |
| Age                                          | 1.13  | 0.00   | 3.10      | 2.11 | 4.54          |
| Education level                              | 0.77  | 0.00   | 2.16      | 1.54 | 3.03          |

(Continued)
thought to be the primary solution for ending the COVID-19 pandemic.\textsuperscript{28,29} Herd immunity is not expected to be achieved until 66.7\% or more of the overall population receives the COVID-19 vaccine.\textsuperscript{28} In Jordan, around 42.5\% of the population is fully vaccinated against COVID-19. By contrast, it is around 2 times lower in the MENA region, that is, around 20\% is fully vaccinated. There are significant vaccine discrepancies across the MENA area, with immunization rates ranging from 68.8\% in Saudi Arabia and 63.1\% in Morocco to fewer than 2\% in Yemen and 7\% in Syria, 16.9\% in Iraq, and 29.3\% in Egypt.\textsuperscript{4} In this study, we created a questionnaire to assess and highlight the most common misconceptions about the COVID-19 vaccine among Jordanians. According to the nature of the misconceptions, we categorized them into 5 categories: manufacturing, effectiveness, side effects, importance, and conspiracy theory beliefs. The high reliability score evaluated by Cronbach’s $\alpha$ was used to include all items in the study, which did not change if any individual question was removed. Our results showed that misconceptions regarding vaccine manufacturing were connected with the highest overall mean was of COVID-19 vaccine misconceptions, this may refer to that many Jordanians consistently underestimate the extent of the COVID-19 vaccination research trials and lack the necessary knowledge of the manufacturing aspects of the vaccines, making them open to accepting common misperceptions about the safety, efficacy, and quality of vaccines. Previous research has found that Emergency Use Authorization (EUA), which is a system that makes medicinal countermeasures, such as vaccines, more accessible and usable during public health emergencies like the present COVID-19 pandemic, reduces vaccine willingness,\textsuperscript{32,33} with the magnitude of this effect perhaps increasing over time,\textsuperscript{34} apparently due to the perception that an “emergency” measure means that standards were lowered to produce the vaccine more quickly. Our data suggest that negative opinions toward the quickly developed COVID-19 vaccines influence immunization willingness. Education activities that stress the importance and benefit of vaccines, more accessible and usable during public health emergencies, might, therefore, alleviate worries, particularly among those who are less educated in general and unfamiliar with the specifics of the clinical trials, and might, therefore, believe that the trials were too small to find potentially major side effects of vaccination.\textsuperscript{13}

For instance, according to estimates from a study conducted in the West African sub-region, herd immunity would require 261 billion cases and approximately 5 million deaths (at a case fatality rate of 2\%).\textsuperscript{17} If herd immunity from disease exposure alone is pursued, the worldwide proportion of cases and deaths cannot be controlled. COVID-19 vaccine research has been done to combat the rising morbidity and mortality caused by the virus, and COVID-19 vaccinations are already available in most countries,\textsuperscript{25} although not at the necessary rates in many less-wealthy countries.\textsuperscript{25} Despite the potential benefits of the COVID-19 vaccination, anecdotal information suggests that many people are unwilling to accept the vaccine, reducing the efficiency of COVID-19 vaccination efforts as a

---

Table 3. (Continued)

| Total misconception | B    | P-Value | Odds ratio | Confidence interval of 95% |
|--------------------|------|---------|------------|---------------------------|
| Did you attend a lecture about COVID-19 vaccines? | 0.35 | 0.01    | 0.70       | 0.54 - 0.91              |
| Yes compared to No |      |         |            |                           |
| Did you receive the vaccine against COVID-19? | 0.82 | 0.00    | 2.29       | 1.76 - 2.98              |
| No compared to Yes |      |         |            |                           |
| Conspiracy theory |      |         |            |                           |
| Age                | -0.69| 0.00    | 0.50       | 0.36 - 0.69              |
| 18-29 y compared to 30-39 y | | |            |                           |
| Education level    | 0.82 | 0.00    | 2.28       | 1.56 - 3.33              |
| Low education compared to high education | | |            |                           |
| Home residence     | 0.84 | 0.00    | 2.32       | 1.65 - 3.26              |
| Village compared to city | | |            |                           |
| Did you receive the vaccine against COVID-19? | 0.72 | 0.00    | 2.05       | 1.59 - 2.64              |
| No compared to Yes |      |         |            |                           |
public health response to the pandemic. Thus, campaigns toward the education of the benefits, safety, and efficacy of the vaccine should be an important part of public health efforts.

Testing, border closures, school closures, recommendations for physical separation, use of face masks, hand hygiene in public areas, and public health advertising on the existence of COVID-19 have all been part of public health efforts so far. Although the effectiveness of such efforts to combat gender differences in similar traits. Women, for example, have not contributed to gender differences in COVID-19 vulnerability. Behavior could have a significant impact on the pandemic, as well related issues. Social media sites are beginning to issue notifications to quickly spreading falsehoods spread through online channels. The WHO to step up its communication efforts to provide accurate content of the lectures about COVID-19 vaccine. Moreover, this study also found that individuals in the age category 30-39, have lower educational level or have not taken the vaccine have higher likelihood of misconception about COVID-19 vaccine. The same factors that contribute to misconceptions about COVID-19 likely paly a similar role in misconceptions surrounding vaccination. Of interest, individuals who did not receive the COVID-19 vaccine or who are individuals with misconceptions toward COVID-19 vaccination, which is likely a major contributor to vaccine hesitancy. At the time of the study, the cases of COVID 19 are rising, especially among the individuals who did not receive the COVID-19 vaccine or who are reluctant to take the third dose (booster dose) for COVID-19. Thus, the present findings emphasize the importance of targeted campaigns to combat misconceptions, and given the rates of vaccine hesitancy, indicate that additional efforts are needed in Jordan. Furthermore, vaccine safety information should be part of a broader health education campaign to alleviate vaccination safety concerns. Various sectors, particularly health authorities, should undertake persistent education programs for nonpandemic infectious diseases such as influenza to enhance general vaccine uptake and public compliance in the event of future pandemics. To combat vaccine hesitancy, the community should be included as much as possible in the structure and delivery of vaccines. To enhance community acceptance of the COVID-19 vaccination, feedback methods for acknowledging community efforts in past health programs should be improved. Furthermore, increased multi-sectoral collaboration would boost COVID-19 vaccination acceptability by providing additional resources to solve COVID-19 vaccine hesitancy. In addition, incorporating the potential COVID-19 vaccine into the standard immunization schedule would strengthen the health system and increase COVID-19 vaccination rates.

In conclusion, despite the thousands of people that have been vaccinated in Jordan, we still have a substantial number of individuals with misconceptions toward COVID-19 vaccination, which is likely a major contributor to vaccine hesitancy. At the time of the study, the cases of COVID 19 are rising, especially among the individuals who did not receive the COVID-19 vaccine or who are reluctant to take the third dose (booster dose) for COVID-19. Thus, the present findings emphasize the importance of targeted campaigns to combat misconceptions, and given the rates of vaccine hesitancy, indicate that additional efforts are needed in Jordan. Furthermore, vaccine safety information should be part of a broader health education campaign to alleviate vaccination safety concerns. Various sectors, particularly health authorities, should undertake persistent education programs for nonpandemic infectious diseases such as influenza to enhance general vaccine uptake and public compliance in the event of future pandemics. To combat vaccine hesitancy, the community should be included as much as possible in the structure and delivery of vaccines. To enhance community acceptance of the COVID-19 vaccination, feedback methods for acknowledging community efforts in past health programs should be improved. Furthermore, increased multi-sectoral collaboration would boost COVID-19 vaccination acceptability by providing additional resources to solve COVID-19 vaccine hesitancy. In addition, incorporating the potential COVID-19 vaccine into the standard immunization schedule would strengthen the health system and increase COVID-19 vaccination rates.

Acknowledgments. The authors thank AlZaytoonah University of Jordan for funding this work through fund number (26/12/2019-2020).

Author Contributions. A.H. participated in study design and conceptualization, drafted and revised the manuscript and approved the final version of the manuscript. W.Q. performed data analysis and revised the manuscript and approved the final version of the manuscript. A.Z. helped in collecting data, writing the manuscript and revised the manuscript and approved the final version of the manuscript. F.H. conceptualized and designed the study, critically revised the manuscript for intellectual content, and approved the final version of the manuscript.

Funding statement. The work was supported by fund provided by AlZaytoonah University of Jordan number (26/12/2019-2020).

Conflicts of interest. The authors declare no conflict of interest.

References
1. Abbas J, Wang D, Su Z, et al. The role of social media in the advent of COVID-19 pandemic: crisis management, mental health challenges and implications. Risk Manag Healthc Policy. 2021;14:1917-1932.
2. Mas-Coma S, Jones MK, Marty AM. COVID-19 and globalization. One Health. 2020;9:100132.
3. Thu TPB, Ngoc PNH, Hai NM. Effect of the social distancing measures on the spread of COVID-19 in 10 highly infected countries. Sci Total Environ. 2020;742:140430.
4. Worldometer. Coronavirus. 2021. Accessed June 26, 2022. https://www.worldometers.info/coronavirus/
5. Andre FE, Booy R, Bock HI, et al. Vaccination greatly reduces disease, disability, death and inequity worldwide. Bull World Health Organ. 2008;86:140-146.
6. Kwok KO, Lai F, Wei WI, et al. Herd immunity - estimating the level required to halt the COVID-19 epidemics in affected countries. J Infect. 2020;80(6):e32-e33.
7. Clemente-Suárez VJ, Hormeño-Holgado A, Jiménez M, et al. Dynamics of population immunity due to the herd effect in the COVID-19 pandemic. Vaccines. 2020;8(2):236.
8. Costanzo M, De Giglio MAR, Roviello GN. Anti-coronavirus vaccines: past investigations on SARS-CoV-1 and MERS-CoV, the approved vaccines from BioNTech/Pfizer, Moderna, Oxford/AstraZeneca and others under Development Against SARS-CoV-2 Infection. Curr Med Chem. 2022;29(1):4-18.
9. Dong Y, Dai T, Wei Y, et al. A systematic review of SARS-CoV-2 vaccine candidates. Signal Transduct Target Ther. 2020;5(1):237.
10. Sissoko MS, Healy SA, Katile A, et al. COVID-19 vaccine hesitancy: misinformation and perceptions of vaccine safety. Hum Vaccin Immunother. 2021;17(5):498-509.
11. De Serres G, Skowronski D, Wu X, et al. The test-negative design: validity, accuracy and precision of vaccine efficacy estimates compared to the gold standard of randomised placebo-controlled clinical trials. Euro Surveill. 2013;18(37):20585.
12. Al-Qerem WA, Jarab AS. COVID-19 vaccination acceptance and its associated factors among a Middle Eastern population. Front Public Health. 2021;9:34.
13. Kreps SE, Goldfarb JL, Brownstein JS, et al. The relationship between US adults’ misconceptions about COVID-19 vaccines and vaccine preferences. Vaccines. 2021;9(8):901.
14. Fisher KA, Bloomstone SJ, Walder J, et al. Attitudes toward a potential SARS-CoV-2 vaccine: a survey of US adults. Ann Intern Med. 2020;173(12):964-973.
15. Kouzy R, Abi Jaoude J, Kraitem A, et al. Coronavirus goes viral: quantifying the COVID-19 misinformation epidemic on Twitter. Cureus. 2020;12(3):e7255.
16. Hammad AM, Hamed R, Al-Qerem W, et al. Optimism bias, pessimism bias, magical beliefs, and conspiracy theory beliefs related to COVID-19 among the Jordanian population. Am J Trop Med Hyg. 2021;104(5):1661-1671.
17. Loomba S, de Figueiredo A, Piatek SJ, et al. Measuring the impact of COVID-19 vaccine misinformation on vaccination intent in the UK and USA. Nat Hum Behav. 2021;5(3):337-348.
18. Lee JJ, Kang K-A, Wang MP, et al. Associations between COVID-19 infectious behavior and vaccine-related knowledge and preventive behaviors: cross-sectional online study. J Med Internet Res. 2020;22(11):e22205.
19. CDC. Myths and facts about COVID-19 vaccines. 2021. Accessed June 26, 2022. https://www.cdc.gov/coronavirus/2019-ncov/vaccines/facts.html
20. MU Health Care. The COVID-19 vaccine: myths vs. facts. Accessed June 26, 2022. https://www.muhospital.org/our-stories/covid-19-vaccine-myths-vs-facts
21. MayoClinic. 2020. Accessed June 26, 2022. https://www.mayoclinichealthsystem.org/hometown-health/featured-topic/covid-19-vaccine-myths-debunked
22. WHO. Covid-19 vaccines and vaccination explained. Accessed June 26, 2022. https://www.who.int/vaccines/ measles
23. Kricorian K, Civen R, Equils O. COVID-19 vaccine hesitancy: misinformation and perceptions of vaccine safety. Hum Vaccin Immunother. 2022;18(1):1950504.
24. Roozenbeek J, Schneider CR, Dryhurst S, et al. Susceptibility to misinformation about COVID-19 around the world. R Soc Open Sci. 2020;7(10):201199.
25. Afolabi AA, Ilesanmi OS. Dealing with vaccine hesitancy in Africa: the prospective COVID-19 vaccine context. Pan Afr Med J. 2021;38:3.
26. Abbas Q, Mangrio F, Kumar S. Myths, beliefs, and conspiracies about COVID-19 vaccines in Sindh, Pakistan: an online cross-sectional survey. Authorea. 2021. doi:10.22541/au.161519250.03425961/v1
27. McHorney CA, Tarlov AR. Individual-patient monitoring in clinical practice: are available health status surveys adequate? Qual Life Res. 1995;4(4):293-307.
28. Altmann DM, Douek DC, Boyton RJ. What policy makers need to know about COVID-19 protective immunity. Lancet. 2020;395(10236):1527-1529.
29. Ilesanmi OS, Akande A, Afolabi AA. Overcoming COVID-19 in West African countries: is herd immunity an option? Pan Afr Med J. 2020;33(Suppl 2):103.
30. Hamdan MB, Singh S, Polavarapu M, et al. COVID-19 vaccine hesitancy among university students in Lebanon. Epidemiol Infect. 2021;149:e242.
31. Al-Qerem W, Jarab AS, Qarqaz R, et al. Attitudes of a sample of Jordanian young adults toward different available COVID-19 vaccines. Vaccines. 2022;25:556-563.
32. Kreps S, Prasad S, Brownstein JS, et al. Factors associated with US adults’ likelihood of accepting COVID-19 vaccination. JAMA Netw Open. 2020;3(10):e202594.
33. Quinn SC, Jamison AM, Freimuth V. Communicating effectively about emergency use authorization and vaccines in the COVID-19 pandemic. Am J Public Health. 2021;111(3):355-358.
34. Kreps S, Dasgupta N, Brownstein JS, et al. Public attitudes toward COVID-19 vaccination: the role of vaccine attributes, incentives, and misinformation. NPJ Vaccines. 2021;6(1):73.
35. Pregowska A, Masztalerz K, Garińska M, et al. A worldwide journey through distance education—from the post office to virtual, augmented and mixed realities, and education during the COVID-19 pandemic. Educ Sci. 2021;11(3):118.
36. Pogue K, Jensen JL, Stancil CK, et al. Influences on attitudes regarding potential COVID-19 vaccination in the United States. Vaccines. 2020;8(4):582.
37. Young S. Addressing vaccination hesitancy. U Miami Int’é Comp L Rev. 2020;28:375.
38. Galasso V, Pons V, Profaeta P, et al. Gender differences in COVID-19 attitudes and behavior: panel evidence from eight countries. Proc Natl Acad Sci U S A. 2020;117(44):27285-27291.
39. Liu R, Li GM. Hesitancy in the time of coronavirus: temporal, spatial, and sociodemographic variations in COVID-19 vaccine hesitancy. SSM Popul Health. 2021;15:100896.
40. Bouchard TJ, Loehlin JC. Genes, evolution, and personality. Behav Genet. 2001;31(3):243-273.
41. Torgerl B. Tax Compliance and Tax Morale: A Theoretical and Empirical Analysis. Edward Elgar Publishing; 2007.
42. Zarocostas J. How to fight an infodemic. Lancet. 2020;395(10225):676.
43. Xue J, Chen J, Hu R, et al. Twitter discussions and emotions about the COVID-19 pandemic: machine learning approach. J Med Internet Res. 2020;22(11):e20550.
44. Fenner Y, Garland SM, Moore EE, et al. Web-based recruiting for health research using a social networking site: an exploratory study. J Med Internet Res. 2012;14(1):e1978.
45. Cantrell MA, Lupinacci P. Methodological issues in online data collection. J Adv Nurs. 2007;60(5):544-549.
46. UCHHealth. COVID-19 vaccine. Vaccine safety, distribution & FAQs. Accessed November 22, 2021. https://www.uchealth.org/services/infectious-diseases/coronavirus-covid-19/covid-19-vaccine
47. Ilesanmi O, Afolabi A. Time to move from vertical to horizontal approach in our COVID-19 response in Nigeria. SciMedicine J. 2020;2:28-29.