



Determinants of the willingness of the general population to get vaccinated against COVID-19 in a developing country

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Received: January 31, 2021
 Accepted: May 26, 2021

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No potential conflict of interest relevant to this article was reported.

The datasets generated and analyzed during the current study are available with the corresponding author.



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Purpose: Vaccination is a cost-efficient intervention to slow the spread of the coronavirus disease 2019 (COVID-19) pandemic. This study aims to assess the population's willingness to take the COVID-19 vaccine in Jordan and investigate potential determinants of their acceptance.

Materials and Methods: This study used an online survey distributed in November 2020, before introducing the vaccine, with items investigating socio-demographic characteristics, seasonal flu vaccination history, COVID-19 vaccine acceptance once available, and factors affecting their decision-making. Also, "COVID-19 risk perception" and beliefs toward COVID-19 vaccine benefits and barriers were assessed.

Results: A total of 2,208 participants completed the survey with a participation rate of 13.1%. The mean \pm standard deviation age was 33.2 ± 13.5 , and 55.7% were females. Study participants were almost equally distributed between willingness, unwillingness, and indecision to take the COVID-19 vaccine (30.4%, 36.4%, and 31.5%, respectively). Younger adults, males, and those who were not married, do not have children, have a bachelor or higher education, employees or being students, healthcare workers, and those who reported receiving flu vaccine had higher rates of COVID-19 vaccine acceptance compared to their counterparts ($p < 0.001$ for each category). COVID-19 risk perception, and perceived vaccine benefits, and barriers were significant predictors of intention. Among those undecided or unwilling to take the COVID-19 vaccine, its safety and side effects were the most common concerns.

Conclusion: The low rate of COVID-19 vaccine acceptance in a developing country is alarming, and a significant proportion are indecisive. Interventions to elevate vaccine acceptance by addressing its safety and efficacy and targeting vulnerable groups are recommended.

Keywords: COVID-19, Coronavirus, Vaccine, Acceptance, Risk perception, Benefits, Barriers, Jordan, Developing country

Introduction

While the coronavirus disease 2019 (COVID-19) pandemic has spread quickly worldwide, and imposed an unprecedented global disease burden, and caused more than 2 million deaths by late-January of 2021 [1,2], there are many potential COVID-19 vaccine candidates currently in development [3,4]. Until today, the best method to stem the spread of COVID-19 is by applying strict outbreak response measures include national lockdown and adopting precautionary measures such as social distancing, mask-wearing, and frequent handwashing [5-7]. With COVID-19-related socio-eco-

nomic burden, along with strict measures, and as vaccination is one of the most cost-efficient and successful health interventions to prevent infectious diseases, a vaccine against COVID-19 is, perhaps, the best hope for ending this burden [3].

Providing an acquired immunity against COVID-19 by an approved vaccine is required to decrease disease mortality, severity, and complications as much as possible, to open-up societies worldwide on a more permanent basis, and to preserve societies functional state [8]. Once vaccines are proven effective and safe, they must be approved by national regulators, manufactured to exacting standards, and distributed. As of January 2021, more than 320 vaccine candidates were in clinical research, with several in phase III clinical trials [9,10]. However, on December 11, 2020, the U.S. Food and Drug Administration issued the first emergency use authorization for the Pfizer-BioNTech COVID-19 vaccine to be distributed in the United States for the prevention of COVID-19 infection in individuals 16 years of age and older [11].

As misinformation and infodemic about COVID-19 vaccines have spread rapidly across media, public health officials, and politicians, especially in developing countries, need to begin planning for effective messaging and policies while the vaccine is introducing. Previous reports on the acceptance of the H1N1 vaccine in 2009, during the H1N1 flu pandemic, have shown unsatisfying results as the willingness to get the 2009 H1N1 pandemic vaccine among the general population ranged from 17% to 67% across studies from the United States, Australia, France, Greece, and the United Kingdom [12-16]. To be successful, vaccination programs require high acceptance and coverage rates and may be mandatory in some situations [17]. This study aims to assess the Jordanian population's willingness to take the COVID-19 vaccine before it was available in the country and investigate potential determinants of their acceptance. Moreover, this study provides public health officials with the data to develop appropriate vaccination strategies and immunization programs against COVID-19.

Materials and Methods

Study design, population, and ethical approval

In November 2020, an anonymous cross-sectional electronic survey was conducted online using the Google Form tool. The researchers shared the e-survey form via social media, e.g., Facebook groups, WhatsApp, and messenger, during the month of November 2020. Our sampling goal was to repre-

sent the general Jordanian population based on age, gender, and residence area. Participants were eligible if they were Jordanian, 16 years of age or older, and living in Jordan. Participants did not receive any compensation or rewards for their participation in the study.

Institutional Review Board of Jordan University of Science and Technology's Clinical Research Ethics committee approved the study (IRB no., 19/138/2021). This study was conducted following the 1975 Helsinki declaration, as revised in 2008 and its later amendments or comparable ethical standards. Informed consent for participation was obtained at the beginning of the questionnaire from all participants. Participants could terminate the survey at any time desired. The survey was anonymous, and information confidentiality was assured.

Sample size

The population of Jordan is approximately 11 million. The country was affected by the COVID-19 pandemic since March 2, 2020 [18,19]. Assuming the Jordanian population (16 years and older) to be 7,250,000 at the time of conducting this study with a vaccine acceptance of 50% and margin of error of 4% (99% confidence interval, 46%–54%) [18], we calculated a sample size of 1,040 individuals. To increase the power of our study, we aimed to include +2,000 participants.

Measures

The questionnaire was designed based on previous studies' frameworks to assess a new vaccine acceptance [20-27]. All questions were close-ended, with tick boxes provided for responses except for age. The contents of the questionnaire included: (1) an introducing statement providing a piece of information about the aim of this study and a consent to participate; (2) demographic characteristics, including age, gender, area of living in Jordan, marital status, having children, education level, employment status, and health status as well as a previous diagnosis of COVID-19; (3) seasonal flu vaccination history in the past 8 months; (4) the importance of identified impact factors on the respondents' COVID-19 vaccination decision-making, such as the national origin of vaccine, age, health status, vaccine price, potential side effects, convenience, doctors' recommendations, and so forth. (5) For those who did not intend or did not decide to accept COVID-19 vaccination, the reasons of no such intention were asked in a multiple-choice question and included a choice of "others, please specify" with an open-ended question.

Participants responded to each of the items described below using a 5-point Likert scale that was ranging from “1=strongly disagree” to “5=strongly agree” except for two questions about the worriedness about COVID-19, and the perceived likelihood of catching the virus in the “COVID-19 risk perception” domain, which 1=not at all worried/not at all likely, and 5=very worried/very likely. (6) The code was also reversed in the question “The coronavirus/COVID-19 will not affect very many people in the country I am currently living in” acceptance of taking the COVID-19 vaccine for themselves, their children, and the elderly once available [20]. (7) The “COVID-19 risk perception” scale included six items capturing participants’ perceived seriousness of the COVID-19 pandemic, perceived likelihood of catching the virus themselves and their family and friends over the next 6 months, and their present level of worry about the virus [21]. The scores of the six items were summed as an overall measure of COVID-19 risk perception. The greater the score a participant receives on this scale, the greater their perceived risk of COVID-19. This scale was previously conducted on national samples of 6,991 participants from ten countries across Europe, North America, Australia, and Asia [21] and designed following previous studies on risk perception [22-24]. (8) Perceived benefits of a COVID-19 vaccine were measured using three items focused on the benefits of a COVID-19 vaccine, which included [25,26]: “Vaccination will decrease my chance of getting COVID-19 or its complications”; “Vaccination is a good idea because I feel less worried about catching COVID-19”; “if I get vaccinated for COVID-19, I will decrease the frequency of having to consult my doctor.” The mean of the sum scores of three items was calculated as an overall measure of perceived benefits. (9) Perceived clinical barriers to the COVID-19 vaccine were measured using four items focused on having side effects, getting sick or dying from the COVID-19 vaccine, and “the COVID-19 vaccine will be painful” as possible barriers for taking the COVID-19 vaccine [27]. The sum of these four items’ scores was calculated for each participant, and the mean was reported. (10) Finally, participants were asked about their reliability and confidence in information sources about the COVID-19.

Statistical analysis

The IBM SPSS software for Windows ver. 25.0 (IBM Corp., Armonk, NY, USA) was used for data processing and analysis. The sample demographic characteristics, their COVID-19 vaccine acceptance for themselves, their children, and the elderly, the reported seasonal flu vaccination status, the factors

associated with vaccination decision-making, and the reasons for no such intention were described using descriptive statistics (frequencies and percentages). Continuous variables were presented as mean±standard deviation (SD). A chi-square test or Fisher’s exact test was used to assess the categorical variables, whereas continuous variables were analyzed via the Student t-test or one-way analysis of variance. Reliability analyses were conducted for each of the three belief scales, and Cronbach’s α was reported.

To assess the predictors of COVID-19 vaccine acceptance, a binary logistic regression analysis was used. The dependent variable was the participants’ willingness to take the COVID-19 vaccine [20], which was collapsed into “0=strongly disagree/disagree/neutral” and “1=agree/strongly agree.” Model selection using stepwise backward selection with a cutoff p-value of 0.2 was used to select the final, most parsimonious model where age, gender, residence area, social status, having children, education, employment status, working in medical fields, having chronic diseases, history of COVID-19 infection, seasonal flu vaccination status, COVID-19 risk perception, and perceived benefits and barriers to vaccination were included as explanatory variables. Adjusted odds ratios (OR) and their 95% confidence intervals (95% CI) were reported. Statistical significance was considered at a p-value of 0.05.

Results

A total of 2,208 participants completed the survey and were

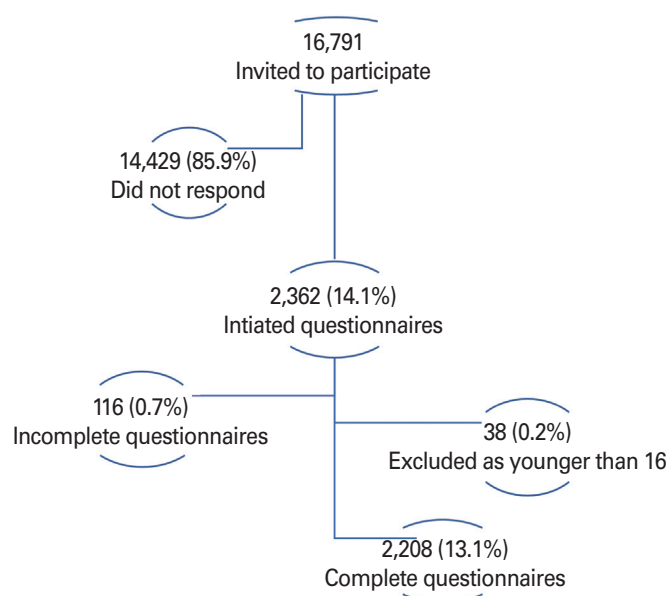


Fig. 1. Study participants.

included in this study with a participation rate of 13.1% (Fig. 1). The mean ±SD age was 33.2 ± 13.5 years, ranging between 16 and 89 years, and 1,230 (55.7%) were females. About half of the participants live in Amman (capital of Jordan), and most

participants (85%) have bachelor’s degrees or higher, and 14.5% reported a previous infection with COVID-19. Table 1 shows the study participants’ demographics characteristics.

Out of the 2,208 participants surveyed, 672 (30.4%) report-

Table 1. COVID-19 vaccine acceptance rates and risk perception across demographic characteristics

Characteristic	Total (n=2,208)	COVID-19 vaccine acceptance rate ^{a)}	p-value	Risk perception score (out of 30)	p-value
Age (yr)			<0.001		<0.001
≤24	856 (38.8)	307 (35.9)		20.34±4.078	
25–34	475 (21.5)	170 (35.8)		20.30±4.365	
35–44	363 (16.4)	80 (22.0)		19.48±4.151	
45–54	328 (14.9)	73 (22.3)		20.25±4.223	
55–64	132 (6.0)	31 (23.5)		18.77±4.584	
≥65	54 (2.4)	11 (20.4)		18.83±4.343	
Gender			<0.001		0.080
Male	978 (44.3)	391 (40.0)		19.87±4.54	
Female	1,230 (55.7)	281 (22.8)		20.19±3.98	
Residence area			0.062		0.072
Amman (Jordan capital)	1,219 (55.2)	380 (31.2)		20.11±3.96	
North	798 (36.1)	236 (29.6)		20.10±4.56	
Middle	131 (5.9)	46 (35.1)		19.74±4.40	
South	60 (2.7)	10 (16.7)		18.72±4.63	
Social status			<0.001		0.003
Single	1,171 (53.0)	421 (36.0)		20.30±4.12	
Married	1,037 (47.0)	251 (24.2)		19.76±4.35	
Having children			<0.001		0.227
Yes	825 (37.4)	196 (23.8)		19.90±4.39	
No	1,383 (62.6)	476 (34.4)		20.13±4.14	
Educational level			<0.001		<0.001
High school or lower	331 (15.0)	64 (19.3)		19.01±4.62	
Bachelor’s student or degree	1,561 (70.7)	498 (31.9)		20.15±4.03	
Master or doctoral degree	316 (14.3)	110 (34.8)		20.63±4.64	
Employment status			<0.001		<0.001
Unemployed or retired	618 (28.0)	124 (20.1)		19.39±4.19	
Employed	871 (39.4)	277 (31.8)		20.18±4.40	
Student	719 (32.6)	271 (37.7)		20.45±4.01	
Currently or previously working in medical fields			<0.001		<0.001
Yes	649 (29.4)	326 (50.2)		21.04±4.13	
No	1,559 (70.6)	346 (22.2)		19.63±4.21	
Having chronic diseases			0.096		0.784
Yes	307 (13.2)	81 (26.4)		19.98±4.60	
No	1,901 (81.8)	591 (31.1)		20.06±4.18	
Previously infected with COVID-19			0.401		0.011
Yes	320 (14.5)	91 (28.4)		19.49±4.60	
No	1,888 (85.5)	581 (30.8)		20.14±4.17	

Values are presented as number (%) or mean ± standard deviation, unless otherwise stated. Statistical test used was chi-square test. Bold type is considered statistically significant.

COVID-19, coronavirus disease 2019.

^{a)}Acceptance includes those who agreed and strongly agreed to take a COVID-19 vaccine versus those disagreed or strongly disagreed to take a such vaccine versus those undecided.

ed that they would take a COVID-19 vaccine if available and recommended for them (42.1% strongly agreed and 57.9% agreed). On the other hand, 803 (36.4%) reported that they would not take the COVID-19 vaccine (51.3% strongly disagreed 48.7% disagreed). About one-third of the participants, 733 (31.5%), were not decided yet if they will take the COVID-19 vaccine or not.

The vaccine acceptance rate significantly differed by the demographic characteristics with younger adults ($p < 0.001$), males ($p < 0.001$), not married ($p < 0.001$), who do not have children ($p < 0.001$), those with a bachelor or higher educational level ($p < 0.001$), employees or being students ($p < 0.001$), and workers in medical fields ($p < 0.001$) being more likely to

accept the COVID-19 vaccine if available and recommended for them compared to their counterparts in each category (Table 1). The mean \pm SD age of those willing to take the COVID-19 vaccine was 30.6 ± 12.6 as compared to 35.4 ± 13.8 for ones who were undecided and 41.1 ± 13.7 for the unwilling group ($p < 0.001$). Fig. 2 represents the COVID-19 acceptance rates by age groups. There was no significant difference in COVID-19 acceptance rates according to having previous COVID-19 infection or the presence of chronic diseases ($p > 0.05$ for comparison).

The mean \pm SD of the “COVID-19 risk perception” score was 20.1 ± 4.2 with internal consistency reliability of 0.723. The mean COVID-19 risk perception score amongst those who would accept the vaccine was 21.7 ± 3.9 compared to 18.5 ± 4.6 amongst those who would not accept the vaccine ($p < 0.001$). Those who reported intentions to take the COVID-19 vaccine had higher perceived benefits of the vaccine and scored lower on clinical barriers to the vaccine scale than those who were undecided or unwilling to take the COVID-19 vaccine ($p < 0.001$) (Table 2).

A total of 920 participants (41.7%) agreed/strongly agreed to encourage the elderly (≥ 64 years old) to receive the COVID-19 vaccine, and 467 (20.1%) agreed/strongly agreed to vaccinate their children against COVID-19 (Fig. 3). Half of the participating health care workers (50.2%) were willing to take the COVID-19 vaccine, and 62.4% would encourage other people to do so, although only 32% had received the influenza vaccine. Moreover, most healthcare workers who intend to take the COVID-19 vaccine for themselves would encourage

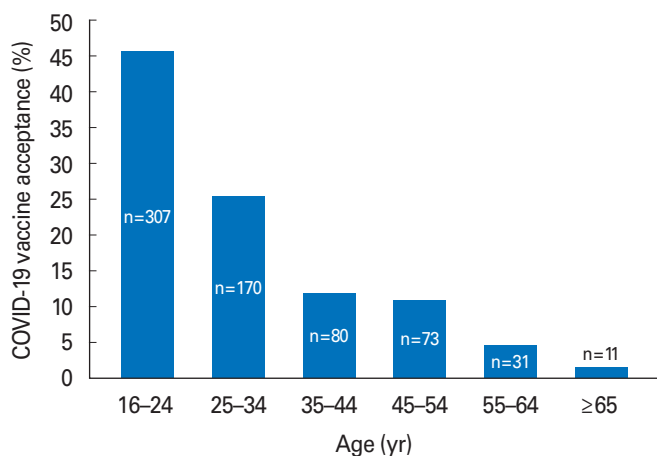


Fig. 2. Comparison of coronavirus disease 2019 (COVID-19) acceptance by age groups for individuals who reported acceptance of COVID-19 vaccine ($p < 0.001$).

Table 2. COVID-19 risk perception, perceived benefits, and barriers to vaccination and their associations with the willingness to get COVID-19 vaccine

	Cronbach's α	Range	Total sample	Willingness to get COVID-19 vaccine			p-value
				Yes	Undecided	No	
COVID-19 risk perception scale ^{a)}	0.723	6-30	20.05 \pm 4.24	21.68 \pm 3.85	20.20 \pm 3.59	18.54 \pm 4.55	<0.001
Perceived benefits of a COVID-19 vaccine scale ^{b)}	0.888	3-15	8.81 \pm 3.04	11.58 \pm 2.16	8.85 \pm 1.94	6.46 \pm 2.50	<0.001
Perceived clinical barriers to COVID-19 vaccine scale ^{c)}	0.777	4-20	11.55 \pm 2.70	10.06 \pm 2.38	11.53 \pm 1.94	12.83 \pm 2.89	<0.001

Values are presented as range or mean \pm standard deviation, unless otherwise stated. COVID-19, coronavirus disease 2019.

^{a)}How worried are you personally about coronavirus/COVID-19 at present? (1=not at all worried, 5=very worried); How likely do you think it is that you will catch the coronavirus/COVID-19 in the next 6 months? (1=not at all likely, 5=very likely); How likely do you think it is that your friends and family in the country you are currently living in will catch the coronavirus/COVID-19 in the next 6 months? (1=not at all likely, 5=very likely); How much do you agree or disagree with “The coronavirus/COVID-19 will NOT affect very many people in the country I am currently living in?” (1=strongly agree, 5=strongly disagree); How much do you agree or disagree with “I will probably get sick with the coronavirus/COVID-19?” (1=strongly disagree, 5=strongly agree); How much do you agree or disagree with “Getting sick with the coronavirus/COVID-19 can be serious?” (1=strongly disagree, 5=strongly agree). ^{b)}How much do you agree or disagree with the following statements? (1=strongly disagree, 5=strongly agree): “Vaccination will decrease my chance of getting COVID-19 or its complications.”; “Vaccination is a good idea because I feel less worried about catching COVID-19.”; “If I get vaccinated for COVID-19, I will decrease the frequency of having to consult my doctor.” ^{c)}How much do you agree or disagree with the following statements? (1=strongly disagree, 5=strongly agree): “I will have side effects from the COVID-19 vaccine.”; “I will get sick from the COVID-19 vaccine.”; “I will die from the COVID-19 vaccine.”; “The COVID-19 vaccine will be painful.”

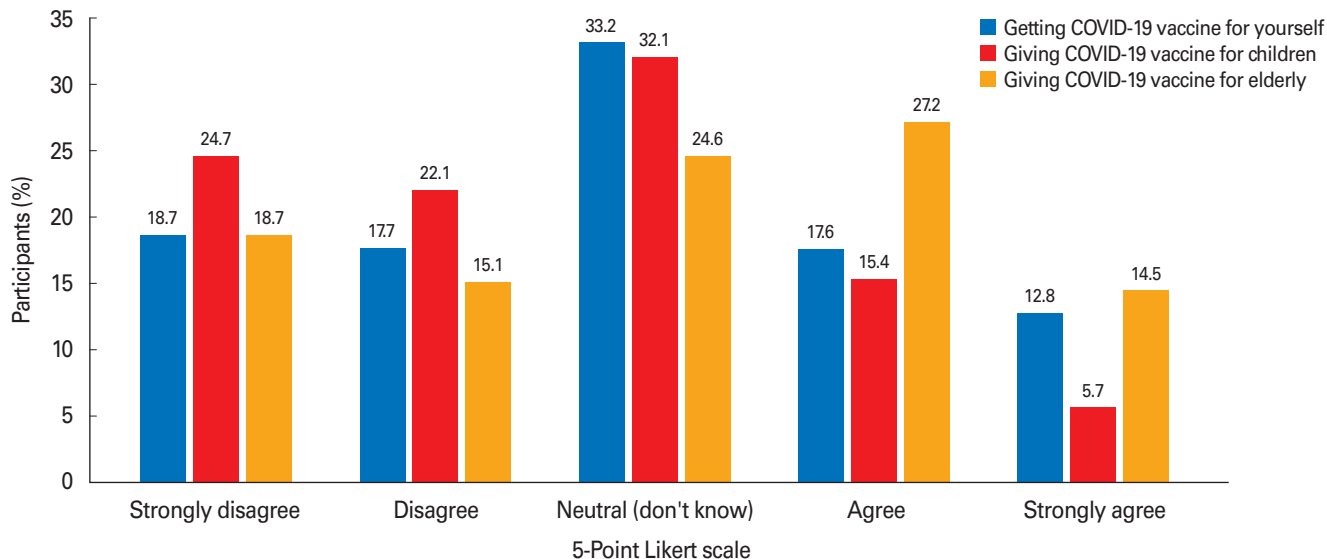


Fig. 3. Coronavirus disease 2019 (COVID-19) acceptance rates (%) for self, children, and the elderly.

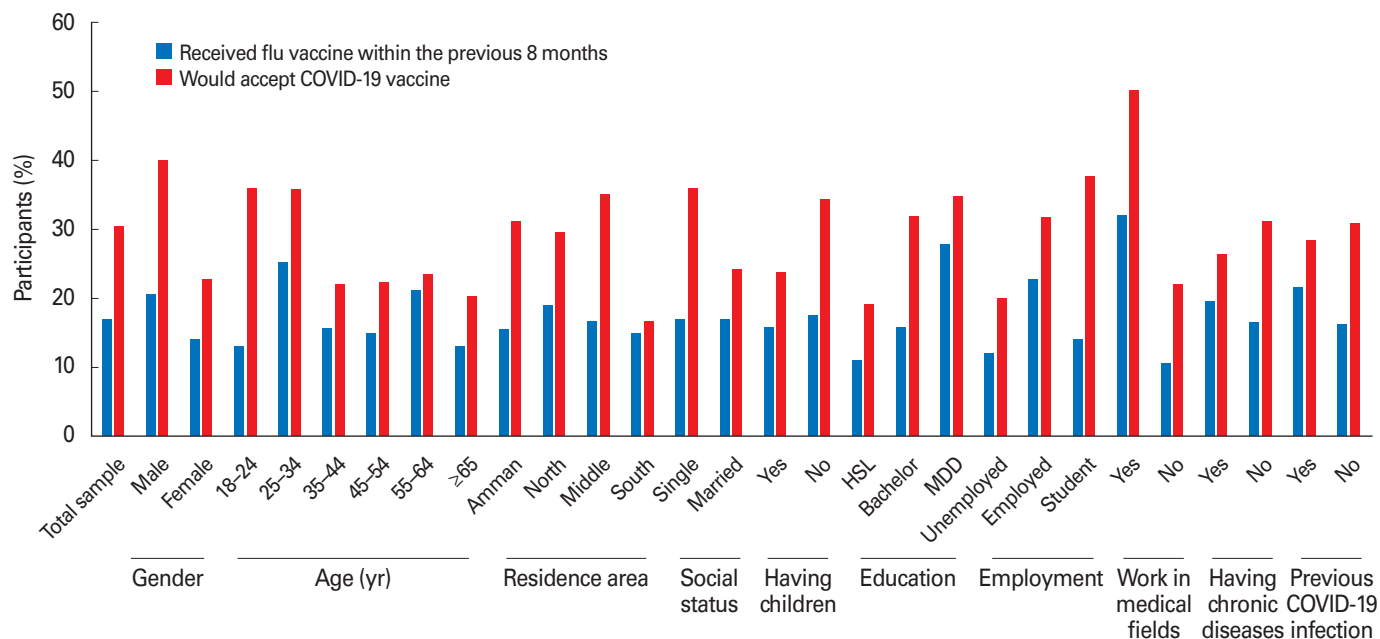


Fig. 4. Percentages of participants who reported receiving the influenza vaccine and who reported acceptance of coronavirus disease 2019 (COVID-19) vaccine by demographic characteristics. HSL, high school or lower; MDD, master or doctoral degree.

others to receive it (313/326, 96%).

COVID-19 vaccine acceptance rates also differed compared to the seasonal flu vaccination rates. Among 374 (16.9%) of the participants who reported receiving the seasonal flu vaccine in the last 8 months, 243 (65%) were willing to take a COVID-19 vaccine ($p < 0.001$). Notable demographic differences present when comparing reported seasonal flu vaccine uptake to reported COVID-19 vaccine acceptance rates (Fig. 4). For example, males who would accept the COVID-19 vaccine

(40%) are two-folds of those who received the flu vaccine (20.6%). Another demographic difference finding is that participants in the young age group (18–24 years old) had a low seasonal flu vaccine uptake ($n = 113$, 13.2%), but of that same group, 35.9% ($n = 307$) reported acceptance of the COVID-19 vaccine. In comparison, those who were ≥ 65 years old had low seasonal flu vaccine rates and low COVID-19 vaccine acceptance rates (13%, 20.4%, respectively). Additionally, individuals who live in the south of Jordan, mostly rural areas, re-

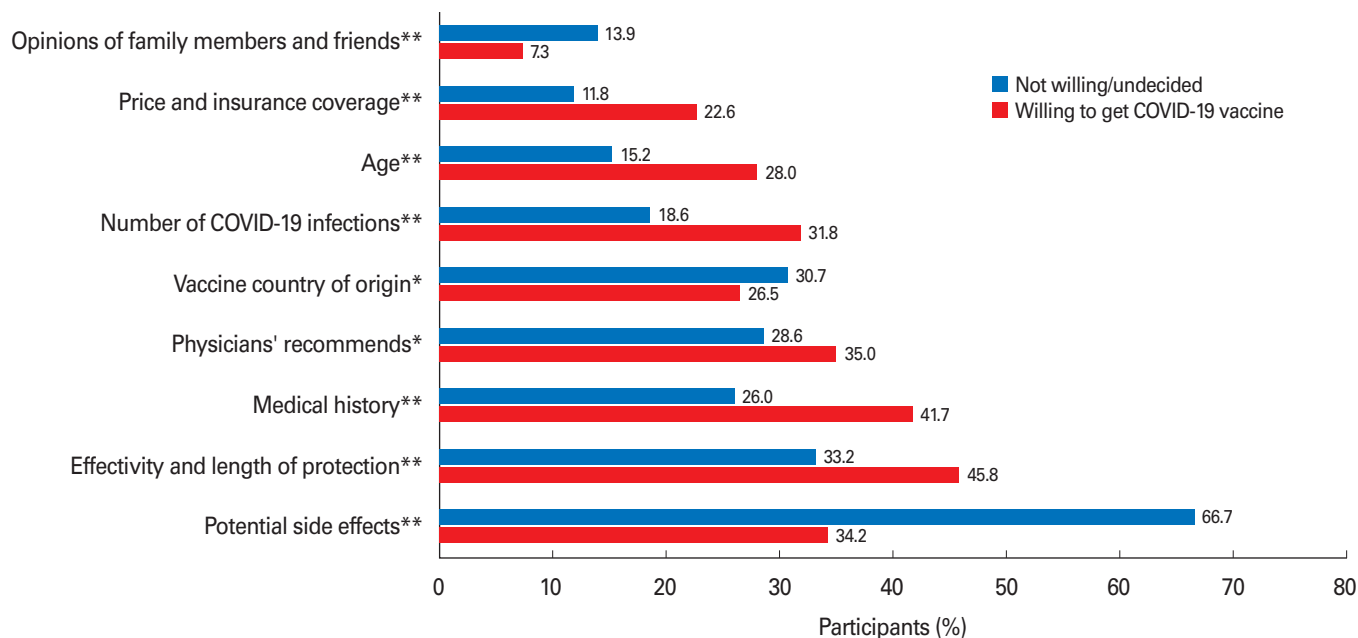


Fig. 5. Factors influencing coronavirus disease 2019 (COVID-19) vaccination decision-making. *Significant comparison with $p < 0.05$; **Significant comparison with $p < 0.001$, based on chi-square tests.

ported lower influenza vaccine uptake ($n=9$, 15%) and lower COVID-19 vaccine acceptance rates ($n=10$, 16.7%) than nearly all other Jordanian areas. Participants who had high school education or lower reported a lower influenza vaccination uptake and a lower COVID-19 vaccine acceptance rate than those with higher educational levels. A similar finding was observed among unemployed or retired participants in comparison to employed individuals and college students. A final interesting difference is that individuals who reported previous COVID-19 infection reported higher influenza uptake ($n=69$, 21.6%) but lower COVID-19 vaccine acceptance rate ($n=91$, 28.4%) than those who reported no previous COVID-19 history ($n=305$, 16.2%; $n=581$, 30.8%, respectively).

The 2,208 surveyed participants indicated that the following factors would matter in their vaccination decision-making: potential side effects of the vaccine ($n=1,255$, 56.8%) as the most essential factor, the effectiveness of the vaccine and length of protection it provides ($n=818$, 37%), their health history (e.g., presence of an underlying medical condition) ($n=679$, 30.8%), if a physician recommends me to get the vaccine ($n=675$, 30.6%), the national origin of vaccine ($n=650$, 29.4%), the number of people getting infected with COVID-19 ($n=500$, 22.6%), their age ($n=421$, 19.1%), vaccine price and health insurance coverage for the vaccine ($n=333$, 15.1%), and the least important factor in their vaccination decision-making was the opinions of family members and friends

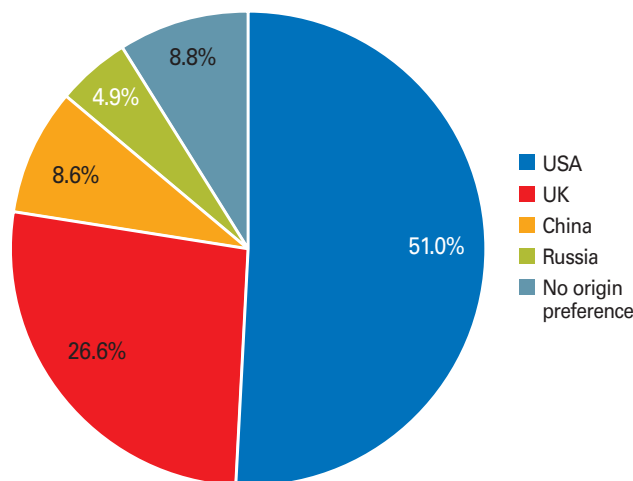


Fig. 6. The preferred national origin of coronavirus disease 2019 (COVID-19) vaccine among those who are willing to get COVID-19 vaccine ($n=672$).

($n=262$, 11.9%). Fig. 5 represents factors influencing vaccination decision-making among participants willing to take the COVID-19 vaccine and those not willing or undecided to do such yet (all $p < 0.05$). Regarding the national origin of the vaccine, most study participants who were willing to take the COVID-19 vaccine preferred the vaccine originating in the United States or United Kingdom (77.6%) over other countries (Fig. 6).

It is also essential to understand the reasons why people

Table 3. The reasons for indecision and rejection of COVID-19 vaccine

	Total ^{a)}	Intentions to accept COVID-19 vaccination when it is available		p-value
		Undecided (n=733)	Not accept (n=803)	
I do not think it can be reliable as it will be a new vaccine.	1,074 (69.9)	505 (68.9)	569 (70.9)	0.402
There is a lack of information about the COVID-19 vaccine, and we need to know more about it.	919 (59.8)	467 (63.7)	452 (56.3)	0.003
I am afraid of the side effects of the COVID-19 vaccine.	917 (59.7)	483 (65.9)	434 (54.0)	<0.001
COVID-19 vaccine may cause long-term health problems for me.	737 (48.0)	411 (56.1)	326 (40.6)	0.009
COVID-19 vaccine contains harmful substances.	460 (29.9)	142 (19.4)	318 (39.6)	<0.001
I do not trust vaccine companies in general.	409 (26.6)	133 (18.1)	276 (34.4)	<0.001
COVID 19 infection is a biological weapon, and I think that the vaccine will serve those who produce this virus.	352 (22.9)	95 (13.0)	257 (32.0)	<0.001
COVID-19 vaccine is not an effective way to prevent the disease.	227 (14.8)	58 (7.9)	169 (21.0)	<0.001
COVID-19 vaccine will be very expensive.	73 (4.8)	45 (6.1)	28 (3.5)	0.015
Religious reasons	15 (1.0)	3 (0.4)	12 (1.5)	0.037

Values are presented as number (%), unless otherwise stated. Bold type is considered statistically significant.

COVID-19, coronavirus disease 2019.

^{a)}Out of 1,536 participants who did not intend or not decide to accept COVID-19 vaccination for themselves.

do not want to get vaccinated. Among those who reported no intention or had no decision to accept COVID-19 vaccination, the most common reasons were “I do not think it can be reliable as it will be a new vaccine,” “There is a lack of information about COVID-19 vaccine, and we need to know more about it,” “I am afraid of the side effects of COVID-19 vaccine,” and “COVID-19 vaccine may cause long-term health problems for me.” The reasons for indecision and rejection of the COVID 19 vaccine are presented in Table 3. The differences in the reasons were further explored between those who did not intend to accept the COVID-19 vaccination and those who did not decide on the vaccination acceptance. Those who did not decide to accept the COVID-19 vaccination were more likely to have suspicion on the safety of the vaccine, such as its possible side effects, long-term health problems, and the lack of sufficient information about the vaccine. In contrast, they were less likely to believe that the COVID-19 vaccine contains harmful substances or that COVID-19 infection is a biological weapon.

Using binary logistic regression analysis, male gender (OR, 1.55; 95% CI, 1.19–2.01; p=0.001), living in the capital (OR, 2.54; 95% CI, 1.04–6.19; p=0.041), or in middle of Jordan (OR, 3.55; 95% CI, 1.27–9.91; p=0.016), being employee (OR, 1.62; 95% CI, 1.23–2.18; p=0.038), being a college student (OR, 1.41; 95% CI, 1.00–1.98; p=0.048), working in a medical field (OR, 2.37; 95% CI, 1.77–3.15; p<0.001), having history of seasonal influenza vaccine (OR, 1.66; 95% CI, 1.20–2.28; p=0.002),

Table 4. The predictors of COVID-19 vaccine acceptance

Variable	Adjusted odds ratios (95% confidence intervals)	p-value
Gender (male)	1.545 (1.191–2.005)	0.001
Residence area		
Amman (Jordan capital)	2.537 (1.040–6.187)	0.041
North	2.431 (0.991–5.964)	0.052
Middle	3.545 (1.269–9.906)	0.016
South	Ref	Ref
Employment status		
Unemployed or retired	Ref	Ref
Employed	1.620 (1.230–2.182)	0.038
College students	1.410 (1.003–1.981)	0.048
Working in medical fields	2.365 (1.774–3.151)	<0.001
History of COVID-19 infection	0.730 (0.502–1.062)	0.099
Influenza vaccine uptake during the past 8 months	1.655 (1.201–2.281)	0.002
COVID-19 risk perception score	1.069 (1.032–1.107)	<0.001
Perceived benefits of the vaccine score	1.933 (1.803–2.072)	<0.001
Perceived clinical barriers to vaccine score	0.815 (0.766–0.868)	<0.001

Bold type is considered statistically significant.

COVID-19, coronavirus disease 2019; Ref, reference.

having higher COVID-19 risk perception scores (OR, 1.07; 95% CI, 1.03–1.11; p<0.001), having higher perceived vaccine benefits (OR, 1.93; 95% CI, 1.80–2.07; p<0.001), and lower perceived vaccine barriers (OR, 0.82; 95% CI, 0.77–0.87; p<0.001) were independent predictors for intentions to accept COVID-

19 vaccination, rather than indecision or unwillingness to accept the COVID-19 vaccine (Table 4).

Participants reported that their own physician (63.1%) and healthcare professionals (51.3%) were the most reliable sources of COVID-19 information. Other reported reliable sources of information were world health institutions (34.3%) and governmental health institutions (29%). Comparatively, social media was reported as the least reliable source of information (5.7%).

Discussion

This study is one of the first to investigate both the willingness to take the COVID-19 vaccine as well as the predictors and determinants of its acceptance rate in a developing country. Overall, study participants were almost equally distributed between willingness, unwillingness, and indecision to take the COVID-19 vaccination when available. Participants reported more COVID-19 acceptance for the elderly than themselves than for their children. The COVID-19 vaccine acceptance rate significantly differed by socio-demographic characteristics, seasonal flu vaccination status, COVID-19 risk perception, and perceived benefits and clinical barriers of the COVID-19 vaccine. Willingness type and predictors of willingness are critical for public health decision making and vaccination campaign implementation.

Our findings indicated that COVID-19 vaccine acceptance could be predicted with relatively high accuracy by readily available demographic characteristics. One of the alarming findings that older-adults and elderly were less likely to be willing to take the COVID-19 vaccine; this represents an area of concern because this group is at higher risk for COVID-19 infection morbidity and mortality and will likely be a priority group to receive the COVID-19 vaccine [28,29]. Targeting this age group with proper interventions is crucial in reducing the burden of COVID-19 infection.

A staggering gender gap in COVID-19 vaccine willingness was noted as females were less likely than males to receive COVID-19 vaccination. This finding is concordant with other reports from China and the United States [30-32]. This finding could be attributed to the fact that women usually tend to be more worried and careful about themselves and their families' health.

Our study also found that the COVID-19 vaccine acceptance rate differs by education, employment, and residence. Educational level is proportional to the COVID-19 vaccine

acceptance rate. On the other hand, unemployed participants and those who live in rural areas reported lower COVID-19 vaccine acceptance rates. This was previously reported by Malik et al. [20] that found as years of education increase, so does COVID-19 vaccine acceptance rate, and unemployed participants reported a lower COVID-19 vaccine acceptance rate. Our study found that working in the healthcare field independently predicted COVID-19 acceptance as half of the healthcare workers were willing to take the COVID-19 vaccine. Similar findings were reported among nurses, where 40.0% of them were willing to take a COVID-19 vaccine [33].

Our study demonstrated a significant correlation between several beliefs and the COVID-19 vaccine acceptance rate. As the COVID-19 risk perception and the vaccine's perceived benefits increased, so did the reported COVID-19 vaccine acceptance rate. Also, perceived clinical barriers to the COVID-19 vaccine were associated with a lower COVID-19 acceptance rate. Importantly, future interventions could target these modifiable beliefs to encourage COVID-19 vaccine uptake. Past interventions that have included components targeting such beliefs were successful in improving knowledge, attitudes/beliefs, and uptake of other vaccines [34-37].

Overall, the potential side effects of the COVID-19 vaccine, its effectiveness, and the duration of protection it provides were the most critical factors in vaccination decision-making. Therefore, planning for a COVID-19 vaccination should be comprehensive, focusing on its efficacy and safety. Moreover, our study highlights that certain factors in vaccination decision-making may differ depending on a person's willingness to get vaccinated and demonstrates the common reasons for no intentions or no decisions to accept COVID-19 vaccination. Therefore, we suggest that future communications about a COVID-19 vaccine should be individualized based on the person's readiness to get vaccinated. Among those undecided or unwilling to take the COVID-19 vaccine, communications should focus more on the safety of the COVID-19 vaccine and reduce concerns about its side effects. In comparison, communications for people who were willing to take the COVID-19 vaccine may need to focus more on other issues such as COVID-19 vaccine efficacy and its protection duration against COVID-19 infection, their medical health status, and physicians' recommendation. While assurance of safety is critical for the first group, the latter groups should be addressed with efficacy evidence. Such distinction is vital for a proper vaccination campaign.

Our study shows a low COVID-19 vaccine acceptance rate

among the general population in a developing country. Based on some estimates, the herd immunity threshold for SARS-CoV-2 (severe acute respiratory syndrome coronavirus-2) was estimated between 55% and 82% [38]. Hence, this low level of acceptance absolutely may not be sufficient to achieve COVID-19 herd immunity. With many COVID-19 vaccines under development and substantial vaccination levels needed to achieve herd immunity, evidenced-based interventions and messages are needed to build confidence, encourage trust in a COVID-19 vaccine and minimize misinformation, especially among vulnerable groups. Also, how these messages are made available to the public should be considered. Our study found that healthcare professionals were the most reliable sources of information on COVID-19 infection, and 30.6% reported the physicians' vaccine recommendation as an essential factor in their vaccination decision-making. Hence, strong healthcare professionals' vaccine recommendations will be critical to promoting vaccine uptake, and they should be engaged in community vaccination messaging to enhance trust in a COVID-19 vaccine and encourage its uptake. Also, messaging and education should target the general population and focus on those who are undecided or unwilling to take a COVID-19 vaccine, such as females, elderly, uneducated, and unemployed individuals, and those who live in underdeveloped areas and low-income communities.

Our study's strengths include timeliness prior to introducing any COVID-19 vaccines in Jordan and a large sample size from different areas throughout the country. The study also examined a wide range of demographic factors and health beliefs to predict COVID-19 vaccine acceptance. Most vitally, this is one of the first studies that examined detailed COVID-19 vaccine acceptance. However, several limitations should be mentioned. A selection bias may influence our study because participants needed access to a smartphone/computer to participate, limiting our sample's generalizability. This may have also excluded poor people and the elderly, which are groups vulnerable to COVID-19. Besides, approximately 13% of all invited individuals completed the e-survey and were included in the analysis; however, a previous study has shown that the average response rate of internet-based surveys is low but is better than paper questionnaires in terms of data completeness [39]. The lack of available data on non-respondents and the cross-sectional design of the study could also affect the interpretation of results. Additionally, because this is an online survey-based study, we could not

check if participants' responses were real (e.g., whether the participants had really received an influenza vaccine is unknown). Given that data collection occurred during the early stages of developing a COVID-19 vaccine and before its distribution, we could not provide participants with detailed information about the COVID-19 vaccine that could affect their acceptance rate, such as the dosing schedule. Lastly, our survey assessed COVID-19 vaccine acceptance rates under the condition that the vaccine was free, and acceptability might be lower if there would be out-of-pocket costs associated with the vaccine.

In conclusion, this study sets the stage for public health stakeholders to develop tailored COVID-19 vaccination interventions. While the COVID-19 vaccine acceptance rate was low, a significant proportion of participants reported being indecisive. This necessitates swift interventions to elevate vaccine acceptance by addressing its safety and efficacy. Targeting vulnerable groups is also crucial for implementing these interventions. The influence of socio-demographics on acceptance rate, along with perceived risks, benefits, and barriers should be used to fine-tune the intervention campaign. A one-size fits all national campaign may not suffice. Utilizing healthcare professionals as gatekeepers and social norms is crucial in any public health campaign for immunization.

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