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Jordanians' willingness to receive heterologous prime-boost COVID-19 vaccination and vaccine boosters

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Abstract. – OBJECTIVE: Coronavirus-2019 (COVID-19) vaccination is the game-changing approach that tops all other strategies to contain the pandemic spread. A growing interest has been raised to heterologous prime-boost and booster COVID-19 vaccination to tackle vaccine shortage and to increase the vaccine's immunogenicity. This study aimed to evaluate the willingness and acceptance of Jordanians to receive heterologous prime-boost COVID-19 vaccination and vaccine boosters.

MATERIALS AND METHODS: A web-based cross-sectional study was conducted using a validated online questionnaire. Adult Jordanian participants were recruited using several social media platforms. The questionnaire link was randomly posted by researchers on public groups in Jordan. Participant's demographics, medical history, knowledge of mixed and booster COVID-19 vaccination and their willingness to receive them were obtained and analyzed.

RESULTS: Approximately 50.5% and 49.3% of the respondents stated former knowledge of the mixed and booster COVID-19 vaccination, respectively. Approximately 50% of respondents acknowledged that the side effects could preclude them from taking mixed and booster vaccines, and 45.3% responded that taking a third dose of the vaccine would increase the side effects. The respondents with previous history of COVID-19 and influenza vaccination were more likely to agree on mixed vaccines compared to those not vaccinated (29.5% vs. 6.5%, $p<0.0001$; 38.0% *vs.* 24.5%, $p=0.0078$, respectively). Moreover, both previous history of COVID-19 and seasonal influenza vaccine was an encouraging response for acceptance of mixed and booster vaccines when compared to those who did not receive the vaccines (54.5% vs. 11.3%; $p<0.0001$, 69.0% vs. 45.5%; $p<0.0001$, respectively).

CONCLUSIONS: The current study showed that nearly half of the respondents were familiar with COVID-19 mixed and booster vaccine programs; however, a high percentage still expressed reticence to receive the mixed vaccines. We consider these results to emphasize the importance and need of awareness campaigns that accentuate the safety profile of such updated vaccination programs.

Key Words:
Willingness, COVID-19 vaccine, Miixed vaccine, Booster vaccine, Jordan.

Abbreviations

SARS-CoV-2: Severe Acute Respiratory Syndrome Coronavirus 2; COVID-19: Coronavirus Disease; WHO: World Health Organization.

Introduction

Since the emergence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infections in late 2019, the world has been trapped in a deadly race with a virus that has taken millions of lives across nearly 200 countries[1]. As of August 2021, over 203 million confirmed cases of novel coronavirus-2019 (nCOVID-19) and more than 4.3 million deaths have been reported worldwide[2]. The nCOVID-19 mitigation policies employed by various governments to control the pandemic included wearing masks, hand sanitization, closure of educational institutions and airports, self-isolation, and lockdowns. These measures effectively slowed the massive spread of the virus but imposed nearly unbearable implications on the healthcare system as well as the economy[3-5]. Additionally, the intensive search to find an effective treatment has been unsuccessful. The most promising candidate, the antiviral medication remdesivir, was issued a conditional recommendation against its use by the World Health Organization (WHO) at the end of 2020 due to lack of evidence regarding remdesivir's ability to reduce

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nCOVID-19 mortality[6,7]. Today, vaccination has become the game-changing approach that tops all other strategies to contain COVID-19 spread[8-10]. In spite of the well-known lengthy process of vaccine development, joint medical efforts between countries, institutions, and researchers have accelerated the launching of several COVID-19 vaccine[11]. In less than two years, seven vaccines have been approved under emergency use authorization as well as hundreds under clinical trials12. Furthermore, more than 4.4 billion vaccine doses have been administered worldwide[2].

Most available vaccination regimens involve a second homologous dose following a priming dose at a specified time interval dependent on the vaccine being administered[13,14]. To tackle vaccines shortage and to increase the vaccines immunogenicity, there is growing interest in the "Mix and Match" vaccination program[15,16]. Mix and match vaccination involves receiving two heterologous doses of COVID-19 vaccines and it has been adopted as early as January 2021 in the United Kingdom[17]. Many other countries have rushed to implement this approach including Canada[18], Germany[19], Denmark[20], and Norway[21]. The approach can include vaccines with the same technology, such as mixing those manufactured by Pfizer- BioNTech and Moderna, or using different technologies such as Pfizer- BioNTech and Oxford-AstraZeneca vaccines. The European and US regulatory instiutions are monitoring this approach's safety as there is currently limited evidence supporting this approach[22]. Clinical trials are running to investigate the safety of this approach and some are showing promising results[15,23]. A third dose booster vaccination program has also gained the spot light as clinical trials showing greater protection compared with the conventional licensed approach[24]. One clinical trial showed marked improvement in the immunogenicity of the vaccine after receiving third dose in solid organ transplant recipients[25]. Pfizer/BioNTech and Moderna vaccines have been authorized by the US food and drug administration to provide their COVID-19 boosters for certain patient populations. Despite WHO recommendation for a halt to vaccine boosters, Russia started implementing the approach using Sputnik V light as of July this year. By September, the United Kingdom and Germany will start offering booster vaccines in elderly and vulnerable patients[26]. Eventually, both mixed and booster vaccine approaches will become a reality to most countries including Jordan.

To date, only 2.3 million people have received the required two doses of the vaccine in Jordan. However, this is considered not enough as more than 70% of the population needs to be vaccinated to achieve herd immunity[27,28]. With the prediction of a third wave of the pandemic and the increased demand on COVID-19 vaccines in Jordan[29], mixed vaccination and booster vaccines may be needed in the near future. Vaccine hesitancy is a term described as "delay in acceptance or refusal of vaccination despite availability of vaccination services"[30]. Attitude toward vaccination can be explained by the "Three Cs" model which highlights three categories: complacency, convenience and confidence[31]. Vaccine hesitance is a global phenomenon and most reported reasons are related to religious beliefs, safety concerns and lack of knowledge[31]. Previously published studies showed low rates of COVID-19 vaccination acceptance among Middle East populations including Jordanians[32,33]. As described in previous literature, Jordanian hesitance is mostly related to safety concerns, lack of scientific knowledge, and trusted resources[34]. Thus, implementing the new strategies of mixed vaccination and vaccine boosters in Jordan requires addressing the measures that affect vaccination decision making. In this study, we aimed to evaluate the willingness and perception of Jordanians to receive mixed COVID-19 vaccines and vaccine boosters, and to assess the predictors behind their willingness.

Ethics Approval

This study followed the set of Ethical principles stated in The World Medical Association Declaration of Helsinki. The study was approved by the Institutional Review Board at Jordan University of Science and Technology (approval No. 11/143/2021; Irbid, Jordan). Participants' consent was inferred as participants agreed to join in and fill the online survey. The participation in the current study was voluntary participation with anonymity. Participants did not receive any compensation.

Materials and Methods

Study Design, Participants, and Data Collection

This is a web-based cross-sectional survey study, which was conducted using a self-administered, validated online questionnaire. The questionnaire was developed on Google Forms. Participants were recruited using several social media

platforms including Facebook, LinkedIn, Twitter, and WhatsApp. The questionnaire link was randomly posted by researchers on public groups in Jordan. The target population of the current study was composed of Jordanian adults aged 18 and older. Data collection was conducted during August 2021, and participants were encouraged to share the questionnaire to their contacts.

Questionnaire and Measures

The questionnaire was a revised version of a former one used to evaluate Jordanian acceptance of COVID-19 vaccination[33]. The questionnaire was reviewed by a biostatistician and two academic professors for face validity. A pilot test was performed on a sample of participants to ensure clarity of questions. Data from the pilot study was incorporated in the final analysis. The questionnaire was developed in English, then translated and shared in Arabic. It required five minutes to complete.

The questionnaire was composed of 27 items that were divided into four sections. The first section involved an introduction page stating the topic, the objectives of the survey and ensuring confidentiality and anonymity of participants as well as stating the time required to complete it. The second section was the sociodemographic characteristics and medical history section. Data collected included gender, age, marital status, smoking status, educational level, governorate, nationality, employment status and social insurance. Participants were asked about their history of chronic diseases, flu vaccine intake and history of COVID-19 infections. The third section was to investigate the participant's knowledge with mixed vaccination and vaccine boosters and their most trusted resources to gain this knowledge. Finally, in the fourth section participants were asked about their acceptance to receive mixed and third booster vaccination approach, responses for these questions were accept, neutral, don't accept. Furthermore, this section had seven statements expressing participants' perceptions and concerns regarding the new vaccination approaches. A five-point likert scale was used to answer these statements.

Statistical Analysis

The IBM SPSS (Statistical Package for the Social Sciences) version 24.0 software (IB Corp., Armonk, NY, USA) was used to analyze the data. The percentages and frequencies were used to describe all the variables. Chi-square test or Fisher's exact test was used to examine differences among respondents' willingness to receive mixed and booster COVID-19 vaccines. The significance of all results was determined using a p-value of less than 0.05.

Results

Baseline Demographics

In the current study, 475 participants filled out the web-based online survey. Table I represents the demographic characteristics of the respondents. About 40.4% of the participants were between the age of 18-29, 34.2% between 30-39, 12.8% between 40-49, 8.4% between 50-59 and 4.2% were ≥60 years old. The majority of the respondents were females (76%), married (61.5%), employed (57.5%), with low monthly income (≤ 599 JOD; 63.2%) and medically insured (76.8%) participants. Most respondents did not have chronic diseases (86.3%). Moreover, most of the participants had earned a bachelor degree (51.4%), and 33.9% finished their higher educational studies. In general, most of the participants located in the north (48.4%) and middle (49.7%) regions of Jordan, with 1.9% from the southern part of Jordan. Additional demographics are presented in Table I.

As presented in Figure 1, 36.2% declared that scientific research papers are a trusted source for valid information about COVID-19 vaccine. Approximately 25.9%, 9.9%, 3.8% and 3.4% of the respondents believed in the information provided by the healthcare providers, government sources, media, family, and friends respectively. Only 2.5% of the participants relied on the different reports provided by the pharmaceutical companies. However, 16.2% of the respondents did not trust any source of information.

Respondents' Willingness and Knowledge About Heterologous Prime-Boost COVID-19 Vaccination and Vaccine Boosters

Table II depicts the respondents' willingness and knowledge about heterologous prime-boost COVID-19 vaccination and vaccine boosters. Among the current study population group, 86.9% of the participants had received the COVID-19 vaccination and 14.9% had received or were planning to receive their annual influenza vaccine this year (Table II). Nearly half of the respondents (49.9%) were previously infected with COVID-19 with only 5.3% infected after being immunized with the COVID-19 vaccine (Table II).

Table I. Descriptive demographics for study respondents (n=475).

Variable	Frequency (n)	Percentage (%)
Gender	Female: 361	76.0%
	Male: 114	24.0%
Age, years	18-29: 192	40.4%
	30-39: 162	34.2%
	40-49: 61	12.8%
	50-59: 40	8.4%
	≥60: 20	4.2%
Marital status	Single: 172	36.2%
	Married: 292	61.5%
	Other: 11	2.3%
Education	Primary/secondary: 32	6. 7%
	Bachelor: 244	51.4%
	Diploma: 38	8.0%
	Graduate studies: 161	33.9%
Employment	Employed: 273	57.5%
	Unemployed: 178	37.5%
	Retired: 24	5.0%
Income (monthly, JD)	<300: 150	31.6%
	300-599: 150	31.6%
	600-1000: 100	21.1%
	>1000: 75	15.9%
Governorate (region)	North: 230	48.4%
	Middle: 236	49.7%
	South: 9	1.9%
Medical Insurance	Yes: 365	76.8%
	No: 110	22.2%
Chronic disease	Yes: 65	13.7%
	No: 410	86.3%

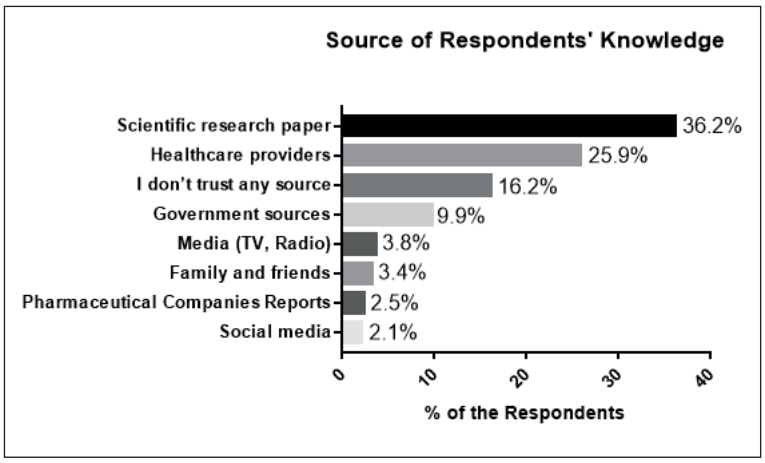

Figure 1. Representation of the Trusted Source of Information about COVID-19 Vaccines in Jordanian population.

About 249 respondents, namely 50.5% of the sample, reported having earlier knowledge about the mixed COVID-19 vaccination program (defined as receiving a second dose of vaccination with a different brand than the first dose). Moreover, 49.3% of the respondents stated that they were familiar with the COVID-19 booster vaccine (defined as receiving the third dose of COVID-19 vaccination after receiving the two-dose regimen). Among the 475 participants, only 126 (26.5%) agreed that they would receive a mixed COVID-19 vaccination program assuming they had not been previously vaccinated. Conversely, 40.9% and 32.6% refused receiving the mixed COVID-19 vaccination program and declared neutral responses respectively (Table II). Sur-

prisingly, the majority of the respondents (48.8%) were willing to receive the COVID-19 booster vaccine with only 29.1% disagreed (Table II)

Perspectives Toward COVID-19 Mixed and Booster Vaccination

In the current study, 114 (24%) of the public agreed that the mixed vaccine approach is beneficial to protect people from COVID-19, 42.3% did not agree and 33.7% responded neutral (Table III). Most of the respondents (44%) indicated that the booster vaccine is beneficial to protect people from COVID-19, 26.3% were not agreed and 29.7% provided a neutral response. The participants reported concern about different issues associated with the mixed COVID-19 vaccination and booster vaccines (Table III). For example, 44.4% of the respondents agreed and strongly agreed that mixed and booster vaccines protocols are promoted by drug companies to increase their profit while 16.4% did not agree and 39.2% provided neutral concern. The perception of the participants regarding the safety profile of the mixed and booster vaccination program is presented in Table III. Almost half of the respondents (48.2%) declared that the side effects would prevent them from taking mixed vaccination and booster vaccines and (45.3%) stated that taking a third dose of the vaccine would increase the side effects. Moreover, 36% of the respondents indicated that the second dose of a different brand of the vaccine would counteract the effect of the first dose when following the COVID-19 mixed vaccination approach, 27.8% were not agreed and 36.2% provided neutral response (Table III). Finally, the majority of the respondents chose the neutral response (42.9%) when they were asked a general statement about mixed vaccination and booster vaccines safety profile, 27.8% agreed about their safety and 29.3% declared disagreement (Table III).

The respondents with a previous history of COVID-19 and influenza vaccination were more likely to agree to mixed vaccines compared to those not vaccinated (29.5% *vs.* 6.5%, p <0.0001; 38.0% *vs.* 24.5%, p=0.0078, respectively; Table IV). Furthermore, the acceptance to receive a mixed dose of the vaccines was significantly different based on employment status as employed respondents had a higher rate of acceptance

Table II. Respondents' willingness and knowledge about heterologous prime-boost COVID-19 vaccination and vaccine boosters.

Variable	Frequency	Percentage %
Have you had or are you going to have the influenza vaccine?	Yes: 71 No: 404	14.9% 85.1%
Have you been infected with the Coronavirus?	Yes: 237 No: 238	49.9% 50.1%
Have you received the COVID-19 vaccine?	Yes: 413 No: 62	86.9% 13.1%
Have you been infected after receiving the vaccine?	Yes: 25 No: 450	5.3% 94.7%
Did you hear about the mixed COVID-19 vaccination program before (defined as receiving a second dose of vaccination with a different brand than the first dose)?	Yes: 249 No: 226	50.5% 49.5%
Did you hear about the COVID-19 booster vaccine before (defined as receiving the third dose of COVID-19 vaccination after receiving the two-dose regimen)?	Yes: 234 No: 241	49.3% 50.7%
If you have not been fully vaccinated or assuming that you haven't been vaccinated, do you accept to receive a mixed COVID-19 vaccination program? Do you accept receiving the COVID-19 booster vaccine?	Accept: 126 Do not accept: 194 Neutral: 155 Accept: 232 Do not accept: 138 Neutral: 105	26.5% 40.9% 32.6% 48.8% 29.1% 22.1%

Table III. Respondents' perspectives toward COVID-19 mixed and booster vaccination.

Perspectives Toward COVID-19 Mixed and Booster Vaccination	Strongly agree N(%)	Agree N(%)	Neutral N(%)	Disagree N(%)	Strongly disagree N (%)
A mixed vaccine is beneficial to protect people from COVID-19.	26 (5.5)	88 (18.5)	160 (33.7)	143 (30.1)	58 (12.2)
A booster vaccine is beneficial to protect people from COVID-19.	52 (10.9)	157 (33.1)	141 (29.7)	84 (17.7)	41 (8.6)
Mixed vaccination and booster vaccines are safe.	21 (4.4)	111 (23.4)	204 (42.9)	96 (20.2)	43 (9.1)
Mixed vaccination and booster vaccines are promoted by drug companies to increase their profit.	74 (15.6)	137 (28.8)	186 (39.2)	70 (14.7)	8 (1.7)
Concerns about side effects will prevent me from taking mixed vaccination and booster vaccines.	84 (17.7)	145 (30.5)	108 (22.7)	120 (25.3)	18 (3.8)
The second dose of a different brand of the vaccine will counteract the effect of the first dose when following the COVID-19 mixed vaccination approach.	45 (9.5)	126 (26.5)	172 (36.2)	113 (23.8)	19 (4.0)
Taking a third dose of the vaccine will increase its side effects.	63 (13.3)	152 (32.0)	137 (28.8)	112 (23.6)	11 (2.3)

31.5%, followed by retired 25%, and unemployed 19% (p=0.047). Regarding the booster dose of COVID-19 vaccines, both previous history of COVID-19 and seasonal influenza vaccine was a favorable response for acceptance when compared to those who did not receive the vaccines (54.5% *vs.* 11.3%; p<0.0001, 69.0% *vs.* 45.5%; p <0.0001, respectively; Table IV).

Discussion

The global pandemic of novel coronavirus-2019 (COVID-19) started in China is caused by severe-acute-respiratory syndrome coronavirus (SARS-CoV-2). Due to the high rate of human-human transmission of SARS-CoV-2, countries in the Middle East witnessed a rapid increase in the number of infected populations. Therefore, countries implemented a variety of strategies to restrict human-human transmission of which vaccination quickly became the main approach to contain COVID-19 spread. Most of the COVID-19 vaccination regimens include a second homologous dose following a priming dose at a specified time interval[13,14]. The present study sought to report the willingness and acceptance of Jordanians to receive heterologous prime-boost COVID-19 vaccination and vaccine boosters.

A previously published study inspected 13,426 participants from different countries to reveal their willingness to received the COVID-19 vaccine as well as the factors affecting public acceptance of COVID-19 vaccine[35]. The acceptance rates ranged from 90% to less than 55% (in China and Russia respectively). In the context of the ongoing COVID-19 crisis, several studies have been conducted to measure public attitude toward COVID-19 vaccines and have displayed high heterogeneity in acceptability between countries. When comparing published studies regarding the rate of willingness to receive COVID-19 vaccines, highest rates tend to be observed in Asian nations (China, Malaysia, Indonesia, South Korea and Singapore) while the lowest were observed in the middle- and low-income countries including Jordan[35]. A study with 2,925 participants from Jordan, Iraq, Lebanon and Saudi Arabia showed that Jordan was the least Arab country willing to receive COVID-19 vaccines[33]. Unfortunately, vaccine hesitancy in Jordan is not a novel phenomenon and is a concerning barrier controlling the spread of other infectious diseases; for example, low acceptability and coverage rates have also been observed in seasonal influenza vaccination[36,37]. This correlates with our findings that only 14.9% of participants have received or are planning to receive seasonal influenza vaccines.

At present, most studies available have investigated public acceptability of COVID-19 vaccines but none have investigated the acceptability of the public toward the updated approaches of heterologous prime-boost COVID-19 vaccination and vaccine boosters. This study is the first to report the extent of acceptance and willingness among Jordanians toward the new

COVID-19 vaccination regimens. Our current study showed low public acceptability and a hesitancy toward heterologous prime-boost COVID-19 vaccination as 40.9% refused and 32.6% are hesitant. This might be related to multiple factors. First, the lack of evidence regarding the safety and efficacy of mixing vaccines, even though this regimen has been implemented in multiple countries, is affecting its public acceptability. Currently, multiple clinical trials are ongoing to test the immunogenicity and safety of these vaccination techniques[23,38,39]. The current

Table IV. Comparison of different demographic and clinical features among the responses to receive mixed, or booster COVID-19 vaccines.

	Mixed		Booster	
Variable	Agree N(%)	*p*-value	Agree N(%)	*p*-value
Gender				
Male (n= 114)	30 (26.3)	0.6484	59 (51.8)	
Female (n= 361)	96 (26.6)		173 (47.9)	0.6673
Age				
18-29 (n= 192)	51 (26.6)	0.8858	95 (49.5)	0.5475
30-39 (n= 162)	39 (24.1)		77 (47.5)	
40-49 (n= 61)	18 (29.5)		31 (50.8)	
50-59 (n= 40)	14 (35.0)		16 (40.0)	
≥60 (n= 20)	4 (20.0)		13 (65.0)	
Marital status				
Single (n= 172)	48 (27.9)	0.3322	93 (54.1)	0.0533
Married (n= 292)	72 (24.7)		131 (44.9)	
Other (n= 11)	6 (54.6)		8 (72.7)	
Education				
Primary/secondary (n= 32)	5 (15.6)	0.6121	10 (31.3)	0.0748
Bachelor (n= 244)	65 (26.5)		116 (47.5)	
Diploma (n= 38)	8 (21.1)		15 (39.5)	
Graduate studies (n= 161)	48 (29.8)		91 (56.5)	
Governorate (region)				
Middle (n= 236)	63 (26.7)	0.1672	119 (50.4)	0.5087
North (n= 230)	60 (26.1)		109 (47.4)	
South (n= 9)	3 (33.3)		4 (44.4)	
Employment				
Employed (n= 273)	86 (31.5)		147 (53.9)	
Unemployed(n= 178)	34 (19.1)	0.047*	73 (41.0)	0.1048
Retired (n= 24)	6 (25.0)		12 (50.0)	
Income				
<300 (n= 150)	31 (20.7)	0.1086	58 (38.7)	0.0953
300-599 (n= 150)	43 (28.7)		52 (48.0)	
600-1000 (n= 100)	25 (25.0)		49 (49.0)	
>1000 (n= 75)	27 (36.0)		36 (48.0)	
Chronic disease				
Yes (n= 65)	18 (27.7)	0.6430	32 (49.2)	
No (n= 410)	108 (26.3)		200 (48.8)	0.9929
Flu vaccine				
Yes (n= 71)	27 (38.0)	0.0078*	49 (69.0)	< 0.0001
No (n= 404)	99 (24.5)		183 (45.3)	
COVID vaccine				
Yes (n= 413)	122 (29.5)	< 0.0001*	225 (54.5)	
No (n= 62)	4 (6.5)		7 (11.3)	< 0.0001

study has highlighted the Jordanians' safety concerns regarding such vaccination techniques as heterologous prime-boost vaccination as nearly 42% of the participants were hesitant and about 30% think that they are not safe. The vaccine safety dilemma is of global concern as shown in many studies and more efforts are needed to address the causes and establish solutions[40-42]. Another factor influencing vaccine acceptability is Jordanians' low vaccine literacy as displayed in the current study with nearly half of the participants being unknowledgeable of the mixed vaccination approach although it is being implemented in many countries. Therefore, knowledge and awareness is a major factor influencing vaccination decision making. Circulating conspiracy and accusation campaigns by non-experts and anti-vaccinationists also play a role in vaccine hesitancy. Conspiracy theories have been shown to account for the under-vaccination and delayed-vaccination waves in both the USA and Europe[43,44]. The effect of consipiracy theories can be also be seen in our study as about 45% of the participants agree that the new vaccination approaches are promoted by drug companies to increase their profit. Moreover, politicizing COVID-19 vaccines by drug companies and vaccine producing counties have raised people's skepticism and reduced the public's trust in the quality of information provided by the press, drug companies and social media[45]. This politicization of the vaccines also contributed to those who are amenable to vaccines racing to receive the most favored vaccine by the media. Conversely, 48.8% are accepting to receiving booster vaccines. This can be justified by the highly intensified awareness-raising campaigns and legal regulations led by the government to emphasize the necessity of the vaccine's third dose specially for those immunocompromised. Approximately 36.2% and 25.9% of our participants reported that their most trusted sources of information about COVID-19 vaccines are scientific research papers and healthcare providers, respectively. This result is supported by a cross-sectional study where young Jordanians had the highest willingness to receive the Pfizer/BioNTech vaccine, the vaccine with the highest publicized studies[46]. This is consistent with the result of a previous study taken place in Jordan and Kuwait which showed that most of the public relied on information from medical doctors and scientific journals[47]. Another cross-sectional study involved 845 adult participants in the US also correlations with our findings as they reported that 90% of respondents trusted doctors as a primary source of information[48]. This can be justified by the fact that the availability of numerous sources of conflicting information about COVID-19 vaccines has put the public in a position where only evidence-based information and front-line workers (doctors, nurses, pharmacists and others) are a trusted fount of information. Furthermore, the current study indicated a lack of trust in the government as only 9.9% of the participants trusted in the government as a source of knowledge. The public's lack of trust in the government as a scource of information may be associated with discontent with the government's handling of the COVID-19 crisis and the decisions that resulted in significant burdens on the health care system, education, and economy. These indications agree with reports showing high correlation between public COVID-19 vaccination hesitancy and distrust in the government[35]. Of note, the selection of scientific papers as the most trusted source may also been influenced by the high percentage of post-graduates among participants in this study.

One of the limitations of the present study is the inherent nature of cross-sectional study design as it cannot show cause-and-effect. This study was conducted using a web-based survey which makes it more prone to selection and recall biases. Furthermore, this methodology excludes the collection of data from populations that don't utilize social media such as the elderly and those in rural areas who do not have access to internet. Another limitation of this study is the utilization of a convenience sampling method which limits the generalizability of the study results. In addition, most participants were of the north and middle governorates of Jordan. The influence of the latter can be decreased by the fact that most of the Jordanian population density is distributed in north and middle governorates and that the south region only constitutes 9.5% of the population according to estimated census of 2016.

Conclusions

The current study reported 50.5% and 49.3% of the respondents declared earlier knowledge about the mixed and booster COVID-19 vaccination, respectively. However, 40.9% would refuse receiving the mixed COVID-19 vaccine while 48.8% were willing to receive the COVID-19 booster

vaccine. Moreover, respondents with a previous history of COVID-19 and influenza vaccination were more likely to agree to mixed or booster vaccines compared to those who had not received the influenza vaccine. It must be noted that there is still a need for an intensification of government-led awareness-raising campaigns and legal regulations in Jordan to emphasize the necessity of the mixed and booster COVID-19 vaccination schedule and accentuate the safety profile of such updated vaccination programs.

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Conflicts of Interest
The authors declare that they have no conflict of interest.

Data Availability Statement
The data that support the findings of this study are available from the corresponding author upon reasonable request.

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