

## Original Research Article

# An observational study of post-vaccination symptoms of inactivated virus vaccine versus mRNA COVID-19 vaccine

Jumanah D Al-Shawabkeh\*, Nidal MF Abu Laban, Diya Hasan, Ali Ata Alsarhan, Abeer Abdullah Alzayyat, Sajeda Al-Smadi, Suha Khayri Ababneh, Rima Saed Taha

Department of Allied Medical Sciences, Zarqa University College, Al-Balqa Applied University, Al-Salt, Jordan

\*For correspondence: **Email:** [jumanah-dawood@bau.edu.jo](mailto:jumanah-dawood@bau.edu.jo); **Tel:** +962795748626

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### Abstract

**Purpose:** To determine the safety, effectiveness, and post-vaccination side effects of inactivated virus (Sinopharm) and mRNA (Pfizer/BioNTech's) vaccines which are the most frequently used in Jordan. The study focuses on students' experiences of adverse reactions and symptoms after immunization.

**Method:** The cross-sectional survey included 3,903 students at Al-Balqa Applied University. Questionnaires on sociodemographic factors, symptoms, and immunization history were administered over the Internet. Distinct variations were identified by statistical analysis.

**Results:** Most university students (43.6 %) learned about COVID-19 vaccination from social media. The most significant health factor among participants was smoking, with 29.8 % having a history of COVID-19 infection. It was evident that 38.7 % of mRNA-vaccinated people developed moderate systematic side effects. Furthermore, 2.5 % of mRNA-vaccinated participants developed serious side effects that required hospitalization. The most frequently used post-vaccination medications were antipyretics (63.7 %), muscle relaxants (15.6 %), and vitamins (5.1 %) for both vaccines.

**Conclusion:** This study reveals that both vaccine types are effective in preventing symptomatic infections. SinoPharm vaccine has mild and non-life-threatening side effects compared to Pfizer vaccine. The risk of hospitalization for Pfizer recipients is related to their health status and the mechanism of action of nanoparticle-coated mRNA, which is still unclear.

**Keywords:** COVID-19, Jordan, Inactivated virus vaccine, mRNA vaccine, Post-vaccination side effects

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## INTRODUCTION

The extraordinary Coronavirus COVID-19 epidemic has affected people from all walks of life, racial and ethnic origins, and continents [1]. This worldwide issue has had a significant impact on healthcare systems throughout the world, including Jordan. [2], thus it is crucial to discover

novel strategies to control it and stop it from spreading in the future. Vaccines, a crucial defense line in the fight against the pandemic, have been produced and distributed in a worldwide effort.

Numerous COVID-19 vaccines, including inactivated SARS-CoV-2 virus and mRNA varieties, have been manufactured and

disseminated over the world. Experts have been thoroughly investigating the effectiveness and safety of these vaccinations because of their growing importance in public health initiatives [3]. According to El-Shitany *et al*, the majority of those who have had any adverse responses to COVID-19 vaccination have reported mild to moderate side effects that do not persist for more than a few days [4]. When it comes to common side effects, different vaccinations have different chances of causing things like injection site discomfort, fever, exhaustion, headache, muscular soreness, chills, and diarrhea.

Compared to inactivated viral vaccines, adverse effects from mRNA injections seem to be more frequent and more severe, according to experimental studies. Trougakos *et al*, found that injection site edema, localized soreness, and muscular aches were the most common side effects of mRNA vaccines [5]. Referring to the data presented by Klugar *et al*, the systemic side effects that were reported by patients who received the mRNA immunization were fever (9.9 %), chills (13.9 %), joint pain (14.3 %), malaise (18.8 %), muscular soreness (28.1 %), and headache/fatigue (48.1 %) [6]. By narrowing down on the Jordanian population, this study hopes to bolster what is already known about the COVID-19 vaccine's safety and effectiveness.

This study aims to assess the safety and effectiveness of the inactivated virus vaccine BBIBP-CorV (Sinopharm) and the mRNA vaccine BNT162b2 (Pfizer/BioNTech) - two widely used vaccines in Jordan. The study will use a web-based reporting system to monitor symptoms after vaccination and determine the frequency and severity of adverse effects. The results will contribute to the current worldwide pandemic efforts and provide important information that might influence the management of public health and production policies for monitoring vaccination and hospitalization status for populations affected by pandemic diseases.

## METHOD

### Study design and participants

This cross-sectional study was carried out in July 2021 by students at Al-Balqa Applied University in Jordan to collect data on adverse events related to the inactivated COVID-19 virus vaccination (BBIBP-CorV, made by Sinopharm/Beijing®, China) and mRNA COVID-19 vaccine (BNT162b2, made by Pfizer/BioNTech®, US). Approximately 50,604 undergraduates enrolled at the university, which is a public educational institution in Jordan. A

total of 3,903 students participated in this study by filling out an online self-assessment questionnaire (SAQ) made available via targeted e-learning platforms. The survey was created and sent out using Google Forms (Google®, Menlo Park, CA, USA) to university students in Jordan who had received either COVID-19 vaccination or an adjuvant shot. Involvement in this study was entirely discretionary.

### Ethical considerations

The university's Scientific Research Committee approved the research at Al-Balqa Applied University (no. 71/29/5). An informed consent form was included at the beginning of the online survey to ensure that participants were fully informed and gave their voluntary permission. The privacy of all information gathered was guaranteed.

### Participants and sample size

Al-Balqa Applied University data informed the determination that a minimum representative sample size of 655, with a 5 % margin of error, a 99 % confidence interval, and a 50 % response distribution, was needed. This determination was based on Raosoft online sample size calculator [1,2]. There was a strong and representative sample since 3,903 people filled out the survey as of July 18, 2021. This is about six times the minimum number of people needed for a sample. It's worth mentioning that the A-Balqa Applied University campus is distributed all over the area in Jordan, therefore, the participants involved in this study represented university students in Jordan.

### Questionnaire

Concerning possible adverse effects after administration of inactivated virus and mRNA COVID-19 vaccines, the questionnaire was painstakingly constructed following a comprehensive evaluation of PubMed publications [5,7,8]. Validation was then accomplished by consulting with a group of subject-matter experts. The questionnaire had 64 questions and was divided into an interface and three major sections. The first section described the socio-demographic details of participants, and the second section of the questionnaire requested information on participants' history of COVID-19 vaccines, including the type of vaccines and the number of doses. The third section of the survey addressed participants' medical history and post-vaccination medical complications and side effects of COVID-19 vaccinations. Participants were reassured of their

anonymity and given an overview of the study's goal via the interface. The level of fear regarding COVID-19 vaccines authorized for use in Jordan rated on a 1-5 scale. 1 - Not afraid, 3 - Moderate fear, 5 - High fear.

### Data analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 28.0 (SPSS Inc. Chicago, IL, USA, 2021). Categorical variables were reported in frequency and percentage. Continuous variables were presented as mean and standard deviation (SD). Inferential statistics, including the chi-squared test ( $\chi^2$ ) and Fisher's test, were used to assess the relationship between variables at a 95 % confidence level with a two-tailed p-value of  $\leq 0.05$  for significance.

## RESULTS

### Sociodemographic characteristics of the study subjects

The analysis of the study comprised the responses of 3,903 participants to the online survey. The results indicated that the average age of the study group was  $21 \pm 3.7$  years, a slight majority of the participants (59.8 %) were female (Table 1). The educational level of the participants were diverse; however, majority of them (65.9 %) were studying for their bachelor's degree (Table 1).

### Health-related information

Notable health-related characteristics among the participants included 29.8 % being smokers, 28.5 % having a history of COVID-19 infection, 5.9 % having allergies, and 2.4 % using immunosuppressants (Figure 1 A). The highest proportion of participants had blood group O<sup>+</sup> followed by those with blood group A<sup>+</sup>, and B<sup>+</sup> with 33.4, 31.1 and 14.1 %, respectively (Figure 1 B). The most commonly mentioned sources of information about COVID-19 treatments were; social media (46.3 %; n = 1,805), the Jordanian Ministry of Health, (17.6 %; n = 687), and television; (12.5 %; n = 489). Other sources are shown in Figure 1 C. It is worth mentioning that 10.7 % of students, or 418 individuals, expressed ignorance of COVID-19 vaccines (Figure 1 C).

### Vaccination information

The study participants showed confidence in the vaccinations and the technologies utilized. The type of vaccine was also an important component of the trust rating. In contrast to the

inactivated viral technology, which participants rated with a low of 2.39, the mRNA vaccine technique was rated with a high of 2.74. Moreover, among those who took part, 63.6 % obtained the inactivated COVID-19 vaccines from SinoPharm (n = 2,483), whereas 36.4 % were vaccinated with the mRNA COVID-19 from Pfizer-BioNTech (n = 1,420), which were accessible in Jordan at the time of the study (Figure 2 B). A distribution of vaccination types among participants indicated that an inactivated virus Sinopharm vaccine was administered. Further information on vaccination indicated nearly 49.7 % of the individuals got the required dosage of vaccination, and about 50.3 % got both doses. Nonetheless, there was a notable difference in the second dose completion rates between SinoPharm and Pfizer vaccines. In particular, 34.7 % (n = 1,355) of those who received SinoPharm vaccination were able to finish the second dose, compared to only 15.6 % (n = 607) of those who received the Pfizer vaccine (Table 2).

### Post-vaccination side effects

The study indicated adverse post-vaccination side effects associated with inactivated virus and mRNA vaccination. The highest proportions of both vaccinations were associated with mild side effects 42.5 and 43.6 % for SinoPharm and Pfizer (Figure 3 A). Furthermore, the incidence of adverse effects was reported by participants after the delivery of the first and second doses of the COVID-19 vaccine. Conjunctivitis (19.0 %), skin color changes (16.0 %), and muscular soreness (22.7 %) were among the many symptoms encountered by subjects after the first dosage.

**Table 1:** Socio-demographic details of Questionnaire Participants (n = 3903)

Parameter		Mean ( $\pm$ SD)	N (%)
Age in years	18-24	21.29 ( $\pm$ 3.697)	3580 (91.7)
	$\geq 25$		323 (9.3)
Gender	Female		2334 (59.8)
	Male		1569 (40.2)
Education level	Middle		1301 (33.3)
	Diploma		
	Bachelor		2572 (65.9)
	Postgraduate		30 (0.8)
What is your specialty?	Medical student		833 (21.3)
	Non-medical student		3070 (78.7)
Place of residence	Amman		1698(43.5)
	Middle area		983(25.2)
	North area		906(23.2)
	South area		316(8.1)

**Note:** In terms of majors, 21.3 % were studying medicine, and 78.7 % were a nonmedical course

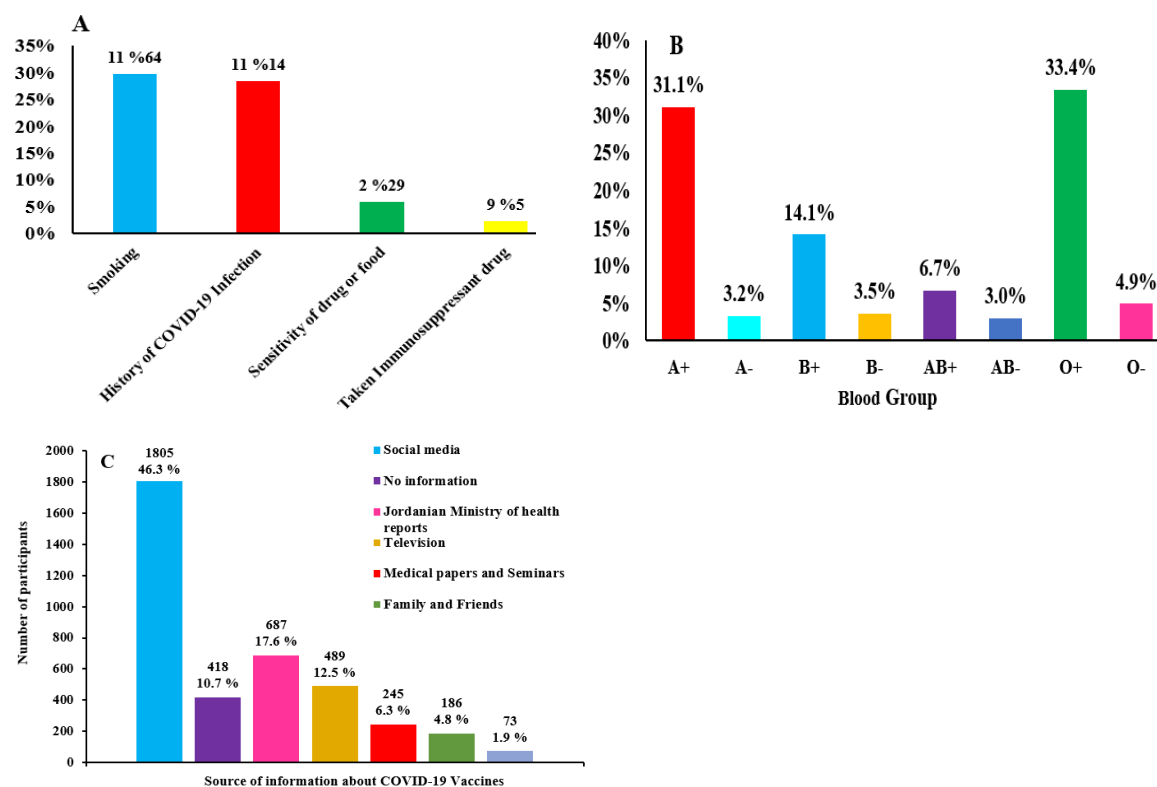


Figure 1: Participant's health status indicators and their perception towards COVID-19 vaccines before receiving a COVID-19 vaccine. Chart (A) Represents the most significant health factors of participants who are smokers, have food and drug allergies, have experienced COVID-19 infection, and have experienced COVID-19 vaccine hesitancy and related fears, respectively. (B) Shows blood group distribution among university participants. (C) Shows the sources of information about COVID-19 vaccines

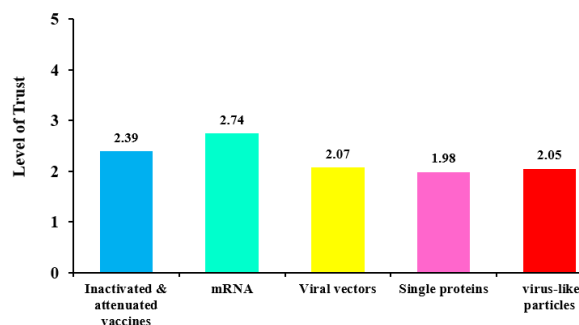


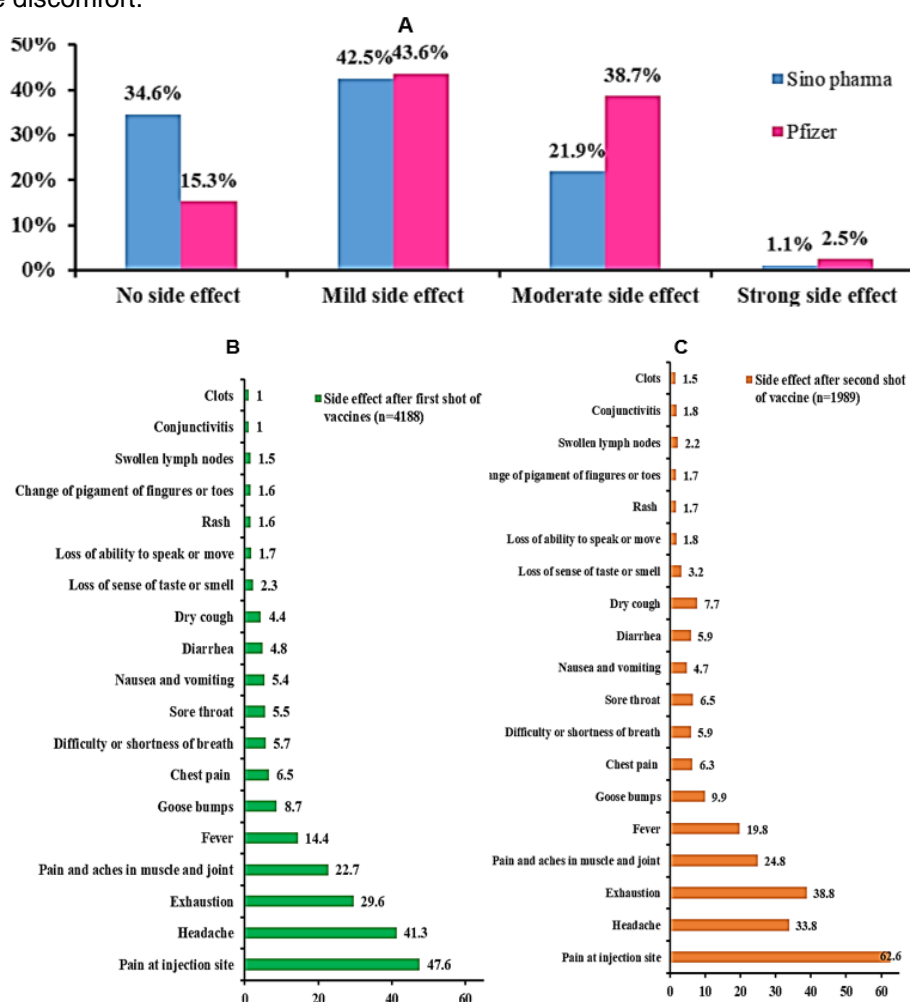
Figure 2: Vaccination information of study's participants, the general level of trust (evaluated using a 5-point Likert-type scale) in vaccines in relation to their technology

Table 2: Classification of participants based on types of COVID-19 vaccines, gender and number of doses (n = 3,903)

Vaccine	Participants N, (%)		Dose N, (%)	
	Female	Male	One	Two
Pfizer-Bio N Tech	841(21.5)	579(14.8)	813(20.8)	607(15.6)
Sinopharm	1493(38.3)	990(25.4)	1218(28.9)	1355(34.7)
Total (N = 3903)	2494(59.8)	1638(40.2)	2170(49.7)	1962(50.3)

Nausea and vomiting (5.4 % of cases) and fever (14.4 % of cases) were also common. Fever (19.8 %), exhaustion (38.8 %), and headache (33.8 %) were some of the systemic effects that subjects experienced following the second dose (Figure 3 B). Notable was the 62.6 % increase in

the occurrence of localized responses, especially injection site discomfort.



**Figure 3:** Post-vaccination side effects of study's participants. (A) The level of side effects for the inactivated virus (Sinopharm) and mRNA (Pfizer) vaccines and (B & C) The side effects seen in participants after the first and second shot of the COVID-19 vaccination

Table 3 shows COVID-19-related variables among 3,903 college students who received either an inactivated virus or mRNA vaccination against the virus. Gender distribution is an important finding; more females than males got both vaccination types (59.8 vs 40.2 %) and there was no statistically significant difference in the distribution of the two vaccines. Among the age groups surveyed, those between the ages of 18 and 24 were more likely to have received the inactivated virus vaccination (92.5 %) than the mRNA vaccine (90.4 %). Those studying for a bachelor's degree favored the mRNA vaccination (67.9 % of the time), whereas those studying for a middle diploma were more likely to obtain the inactivated virus vaccine (34.7 % of the time). In terms of smoking, food and medication sensitivities, and immunosuppressant use, there was no discernible difference between the two vaccination groups. Statistically speaking, there was a substantial difference between the two

vaccines in terms of the proportion of those with a history of COVID-19 infection who received the mRNA vaccination (31.1 vs 27 %). There was no discernible difference between the two vaccine types in terms of the time it took for COVID-19 infection to begin before inoculation. There was a significant difference in the number of doses given between the two groups; 34.7 % of those who received the inactivated virus vaccination took two doses while only 15.6 % of those receiving the mRNA vaccine received two doses ( $p < 0.001$ ).

The side effects reported by university students receiving COVID-19 vaccinations (n = 3,903) are summarized in Table 4. Inactivated viral vaccines were associated with a higher rate of localized adverse effects, such as injection site discomfort and edema, after the first dose (99.4 % vs 84.3 % for mRNA vaccines). Following the first dosage of the inactivated viral vaccine, the most

common systemic adverse effects were headache (94.0 %) and tiredness (69.1 %).

**Table 3:** COVID-19-related factor of university students receiving COVID-19 vaccines (n = 3903)

Variable	Response	Inactivated virus vaccine (N=2483, %)	m-RNA vaccine (N=1420, %)	Total (N=3903, %)	P-value*
Gender	Male	990(25.4)	579(14.8)	1569(40.2)	0.580
	Female	1493(38.3)	841(21.5)	2334(59.8)	
Age	18-24	2297(92.5)	1283(90.4)	2483(63.6)	0.130
	≥25	186(7.5)	137(9.6)	1420(36.4)	
Education level	Middle Diploma	861(34.7)	440(30.9)	1301(33.3)	0.030*
	Bachelor	1607(64.7)	965(67.9)	2572(65.9)	
	Postgraduate	15(0.6)	15(1.2)	30(0.8)	
Specialty	Medical student	515(20.7)	318(22.4)	833(21.3)	0.225
	Non-medical student	1968(79.3)	1102(77.6)	3070(78.7)	
Place of residence	Amman	1110(44.7)	588(41.4)	1698(43.5)	0.047*
	Middle area	628(25.3)	355(25)	983(25.2)	
	North area	542(21.8)	364(25.6)	906(23.2)	
	South area	203(8.2)	113(8)	316(8.1)	
Smoking	Yes	749(30.2)	415(29.2)	1164(29.8)	0.537
	No	1734(69.8)	1005(70.8)	2739(70.2)	
Sensitivity of drug or food	Yes	146(5.9)	83(5.8)	229(5.9)	0.964
	No	2337(94.1)	1337(94.2)	3674(94.1)	
Taken immunosuppressant	Yes	56(2.3)	39(2.7)	95(2.4)	0.338
	No	2427(97.7)	1381(97.3)	3808(97.6)	
COVID-19 Infection	Yes	671(27)	443(31.1)	1114(28.5)	0.005*
	No	1812(73)	977(68.8)	2789(71.5)	
Onset of COVID-19 infection	Before Vaccination	647(26.1)	425(29.9)	1072(27.5)	0.380
	After the first dose	24(0.9)	18(1.3)	42(1.1)	
	After the second dose	49(1.97)	34(2.4)	83(2.1)	
Number of doses	One dose	1128(28.9)	813(20.8)	1941(49.7)	<0.001*
	Two doses	1355(34.7)	607(15.6)	1962(50.3)	

**Note:** \*Chi-squared test ( $\chi^2$ ) had been used with a significance level  $p \leq 0.05$ ; \* $p < 0.05$

On the other hand, following the second dose of the mRNA vaccine, the same symptoms were reported at greater rates (70.5 % for headache and 62.1 % for exhaustion). Discomfort, muscular and joint aches and pains, and hormonal changes were more common in those who received the inactivated viral vaccination. After the second injection, mRNA vaccination group also had a higher incidence of some adverse effects, such as a shift in the menstrual cycle. Only 35 participants (2.5 %) reported severe side effects that required hospital admission within four weeks of receiving the Pfizer COVID-19 vaccine.

### Post-vaccination medications

Table 5 shows the drugs that university students (n = 3903) got after getting the inactivated viral or mRNA COVID-19 vaccine. Notably, 64.7 % of inactivated virus vaccine recipients and 61.97 % of mRNA vaccine recipients reported using antipyretics, making it the most often used drug overall. Among those who received the inactivated viral vaccination, 14.7 % used muscle

relaxants, whereas 16.6 % used muscle relaxants among those who received the mRNA vaccine. There were no statistically significant changes between the two immunization groups when it came to the reporting of vitamins, painkillers, and aspirin. The reporting frequencies varied. Notably, natural herbs and cortisone were found to be infrequently utilized, but antihistamines, antibiotics, and cold medicines were seldom used.

## DISCUSSION

This study showed that the most significant health factor of participants was smoking with 29.8 % followed by 28.5 % having a history of COVID-19 infection. The study revealed a connection between smoking and COVID-19, with smoking potentially exacerbating the severity of the disease. Smoking triggers inflammation in the respiratory tract and increases the risk of COVID-19 infection by affecting nicotine receptors in the body, leading to cardiovascular and pulmonary diseases and

facilitating the entry of the SARS-CoV-2 virus [11]. Therefore, the high proportion of smokers in Jordan might increase the susceptibility to COVID-19 infection. The ABO blood group system might be considered as another factor

linked with the side effects of vaccines, however, the results showed no significant association between ABO blood-type groups and COVID-19 side effects.

**Table 4:** Side effects reported by University students receiving COVID-19 vaccines (n = 3903)

Variable	Outcome	Inactivated virus vaccine (N =2483, %)		mRNA vaccine (N = 1420, %)		Total (N = 3903, %)	P-value*
		First shoot	Second shoot	First shoot	Second shoot		
Local Side effects	Injection site pain and Swelling	994	657	843	437	2931	0.024
	Sore arm at the site of injection	20	10	4	2	36	0.190
	Headache	940	387	705	452	2484	0.028
	Exhaustion	691	405	621	530	2247	< 0.001
	Discomfort	690	200	268	262	1152	< 0.001
Systemic Side effects	Pain and aches in muscle and joint	548	276	488	376	1688	0.007
	Fever	268	178	300	138	884	0.005
	Goosebumps	164	89	171	131	555	< 0.001
	Chest pain /pressure	120	62	69	133	384	< 0.001
	Sore throat	119	58	90	84	351	< 0.001
	Difficulty or shortness of breath	74	56	102	111	343	0.023
	Diarrhea	110	65	79	41	295	< 0.001
	Change of hormone	107	55	138	189	489	0.012
	Nausea and vomiting	95	34	113	67	309	0.210
	Swollen lymph nodes	90	12	46	21	169	< 0.001
	Dry cough	84	68	72	51	275	< 0.001
	Change of Menstrual cycle	45	13	150	98	306	0.023
	Loss in the sense of taste or smell	34	23	38	48	143	0.005
	Loss of ability to speak or move	30	11	31	22	94	0.039
	Tachycardia	30	11	20	85	146	0.017
	Rash	24	16	18	16	74	0.449
	Change of pigment of fingers or toes	24	16	18	15	73	0.190
Conjunctivitis and eye pain	15	10	14	9	48	0.285	
Clots	13	9	15	7	44	0.179	
Hair Loss	12	5	19	9	45	0.285	
Onset	12h	608	777	509	366	2260	0.006
	≥12	520	578	304	241	1643	<0.001
Duration	24 h	251	327	138	108	824	< 0.001
	2-3 days	315	386	359	289	1349	< 0.001
	4-7days	164	194	202	131	691	< 0.001
	More than weak	398	448	114	79	1039	< 0.001

**Note:** \*Chi-squared test ( $\chi^2$ ) had been used with a significance level  $p \leq 0.05$

**Table 5:** Post-vaccination medications received by university students (n = 3903)

Variable	Inactivated virus vaccine (N =2483; %)	mRNA vaccine (N = 1420; %)	Total (N = 3903; %)	P-value*
Antipyretics	1606(64.7)	880(61.97)	2486(63.7)	0.100
Muscle relaxant	364(14.7)	236(16.6)	600(15.4)	0.100
Vitamins	109(4.4)	89(6.3)	198(5.1)	0.540
Painkillers	105(4.2)	59(4.2)	164(4.2)	0.920
Aspirin	74(2.98)	54(3.8)	128(3.3)	0.160
Antihistamine	9(0.36)	2(0.1)	11(0.3)	0.210
Antibiotic	6(0.24)	0(0)	6(0.15)	0.060
Cold drug	6(0.24)	0(0)	6(0.15)	0.060
Natural herbs	5(0.2)	2(0.1)	7(0.18)	0.670
Cortisone	4(0.16)	3(0.2)	7(0.18)	0.720

\*Chi-squared test ( $\chi^2$ ) had been used with a significance level  $p$ -value  $\leq 0.05$

The majority of university students learned about COVID-19 vaccination from social media and Jordan Ministry of Health reports. Another study in Jordan found that social media and the internet provided a wide range of information about COVID-19 knowledge and prevention practices [1].

Consistent with previous studies, this result highlights the need to increase people's knowledge of COVID-19 vaccinations so that they are more likely to participate in and complete immunization programs. Conversely, concerns regarding safety and inaccurate information are long-standing issues that our study brings to light. To counteract misinformation and build public trust, targeted educational initiatives are essential in light of these challenges. Because of the growing importance of education as a factor, the study findings highlight the need for focused educational campaigns to increase vaccination knowledge. We should focus on educating university students and providing authentic information through scientific lectures, seminars, and local conferences to convey the right information to the community. Also, this study indicated that the technologies utilized and the kind of vaccine were considered the main components of trust in vaccines. The mRNA technology (Pfizer-BioNTech) which is a new technique was rated with a high level of trust compared to the inactivated virus (Sinopharm). Similarly, the Pfizer-BioNTech vaccine was most trusted as reported in an earlier study [12]. However, the majority of participants were vaccinated with SinoPhram. This might be related to the available vaccine type and application program that was applied by the Jordanian Ministry of Health during the COVID-19 outbreak. Concerns about vaccine safety and post-vaccination side effects were the top reasons for hesitancy or refusal of vaccines. This study provided details on the local and systematic side effects and post-vaccination risk factors associated with mRNA and inactivated virus vaccines in Jordan. The results revealed

that about half of the vaccinated participants suffered from mild local and systematic side effects including pain at the injection site, headache, exhaustion, pain and aches in muscles, fever, respiratory difficulty, and less than 5 % had diarrhea, dry cough, loss of sense of taste and smell after the first or second dose of vaccination. Contrarily, Omeish *et al* [13] reported that the side effects of COVID-19 vaccines in Jordan were more frequent and more severe after the first dose. It's worth mentioning, that the observed variation in side effects of the first and second doses of vaccines might be related to the history of COVID-19 infection and viral load, personal healthcare and immunity, type of vaccines, and duration between doses. The participants who suffered from allergies, or chronic pulmonary diseases might have significantly higher post-vaccination side effects [10]. Vaccine reactions are complex, and this was highlighted by the fact that side effects varied in both their onset and persistence.

After comparing the side effects of mRNA and inactivated virus vaccines, it was found that 38.7 % of mRNA-vaccinated individuals experienced moderate systemic side effects that required different medication compared to those who received the inactivated virus vaccine. These side effects included exhaustion ( $p < 0.001$ ), muscle pain and aches ( $p = 0.007$ ), fever ( $p = 0.005$ ), tachycardia ( $p = 0.017$ ), chest pain ( $p < 0.001$ ), difficulty breathing or shortness of breath ( $p < 0.001$ ), loss of taste ( $p = 0.005$ ), and loss of ability to speak or move ( $p = 0.039$ ). These effects were observed in participants who received two doses of the mRNA vaccine. These findings have been reported in several studies in which cases of acute myocarditis and myocarditis were reported in mRNA vaccine recipients, particularly young males receiving second doses [8]. The results also showed that there is an imbalance in several hormones ( $p = 0.012$ ) after vaccination with mRNA vaccine, especially sex hormones, many females in this study noticed a change in menstrual cycle ( $p =$



0.023) after taking two doses of mRNA vaccines. A previous study found that irregular and long menstrual cycles are associated with a higher risk of premature mortality. Additionally, infrequent or absent menstruation may indicate reduced fertility [14]. Vaccination alters the menstrual cycle by affecting hormone secretion and stability, including estrogen, progesterone, follicle-stimulating hormone, and luteinizing hormone [15]. With regards to SinoPharm, pain at the injection site was the most significant reported adverse effect ( $p = 0.024$ ), followed by fever ( $p = 0.005$ ), and swelling of lymph nodes ( $p < 0.001$ ). These reported results were in agreement with the report that fever was the most frequent side effect after both doses of SinoPharm vaccine in Pakistan [16]. Therefore, this study suggests that SinoPharm COVID-19 vaccine had mild and non-life-threatening side effects. Further, 2.5 % of mRNA-vaccinated participants developed severe side effects that required hospitalization, while less than half of these proportions were noticed with the people vaccinated with an inactivated virus. However, this is contrary to Munamm *et al*, who reported no significant differences in hospitalization cases between people vaccinated with either the mRNA vaccine or the inactivated virus vaccine [17]. Nevertheless, data from this study suggest that Pfizer-BioNtech vaccine might increase the risk of hospitalization twice as much as SinoPharm vaccine. The risk of Pfizer-BioNtech might be related to the health status of recipients and the mechanism of action of nanoparticle-coated mRNA which is still not clear. mRNA leads to the accumulation of lipid nanoparticles in cytosol, nonsilencing transposable elements (TEs), and activating foreign RNA and cytosolic DNA sensors, which enhances the expression of proinflammatory cytokines and type-I IFN [8]. It is worth mentioning that the side effects of mRNA recipients generally emerged after more than 12 h of vaccination compared to the side effects of inactivated virus recipients which showed within 12 h. This variation might be related to variations on mechanisms of actions between mRNA and inactivated virus vaccines, while Sinopharm directly activates innate immunity upon vaccination, Pfizer-BioNtech uptake has to go through cellular uptake, endosomal escape, and translation to antigen expression in different cell types.

With regards to post-vaccination medications, there were no significant differences in medications used by mRNA and inactivated virus-vaccinated participants. Most of the medications were used to reduce the symptoms associated with mild side effects of vaccines like antipyretics, muscle relaxants, vitamins to induce

and support immunity, and painkillers. Similar findings were observed in Iraq where 57.2 % of vaccinated health care workers took antipyretics (Paracetamol) to manage side effects of mRNA and AstraZeneca recipients [18], thus confirming the mildness of side effects. Lastly, this study contributes to the ongoing discussion by exploring students' perspectives on COVID-19 vaccination in a fresh and relevant manner. Consistent with other studies, this study's findings highlight the importance of knowledge, positive experiences, and strategic communication in increasing vaccine confidence and uptake. The results of this study should be used to guide the creation of more specific plans to prevent the spread of COVID-19 and boost immunization rates among students and the general public.

### Limitations of this study

This study is limited by self-reporting and its cross-sectional design, which may lead to over- or underestimation of self-reported side effects by participants. Furthermore, the interpretation of side effects was based on two shots of vaccinations used during the period of study.

## CONCLUSION

This study supports the safety and efficacy of both mRNA and inactive virus COVID-19 vaccines in Jordan. The web-based reporting system used in this study is a valuable tool for monitoring post-vaccination side effects and symptoms and understanding the effectiveness of different vaccine types. Concerns about vaccine safety and post-vaccination side effects were the top reasons for hesitancy and refusal of vaccines in Jordan. The study indicated that the main sources of information about vaccines were social media followed by the Ministry of Health, therefore, awareness programs will be required at the level of schools, universities, and public sectors to increase the acceptance of vaccines.

## DECLARATIONS

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### Ethical approval

The university's Scientific Research Committee approved the study at Al-Balqa Applied University (no. 71/29/5).

### Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

### Conflict of Interest

No conflict of interest associated with this work.

### Contribution of Authors

We declare that Jumanah Al-Shawabkeh, Nidal Abu Laban, Ali Alsarhan, Suha Ababneh, Ali Ata Alsarhan, Abeer Abdullah Alzayyat, Sajeda Al-Smadi, and Rima Saed Taha did this work. The authors will bear all liabilities about claims relating to the content of this article. All authors have participated sufficiently in all the different aspects of this work.

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