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ORIGINAL RESEARCH

COVID-19 Vaccines Breakthrough Infections and Adverse Effects Reported by the Birzeit University Community in Palestine

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Background: Coronavirus disease (COVID-19) vaccines play an essential role in boosting immunity, preventing severe diseases, and alleviating the Covid-19 health crisis.

Objective: This study aimed to explore the type and severity of short-term adverse reactions associated with BNT162 (Pfizer-BioNTech), mRNA 1273 (Moderna), and viral vector vaccines and to compare the incidence of post-vaccination Covid-19 infection among the Birzeit University community in Palestine.

Methods: This questionnaire-based retrospective cross-sectional study was conducted among individuals who were vaccinated with at least one dose of any COVID-19 vaccine offered in Palestine during the COVID-19 pandemic. The study included participants aged 18 years and older who were vaccinated with Pfizer, Moderna, Sputnik Light, or Sputnik v.

Results: A total of 558 participants who were administered COVID-19 vaccine were included in the study. Sputnik (239), Pfizer vaccine recipients (236), and Moderna vaccine recipients (83). Of the viral vector vaccine recipients, 57 (23.8%) had a post-vaccination infection, compared to 30 (12.7%) for Pfizer and seven (8.4%) for Moderna. Furthermore, the reported adverse effects in the viral victor group were higher than those in the Moderna and Pfizer groups (71.7, 66.3, and 61.9%, respectively). Chills, headache, fatigue, abdominal pain, and joint pain were significantly higher in the Viral Vector vaccine group than the Moderna and Pfizer vaccine. Vomiting, tiredness, and fatigue were significantly less likely to be complained of by Pfizer vaccine recipients compared to Moderna and Viral Vector vaccine recipients ($p < 0.05$).

Conclusions: Breakthrough infections were associated with both viral vectors and mRNA; however, the mRNA vaccine had less reported post-vaccine infection. Furthermore, the Pfizer/BioNTech COVID-19 vaccine group reported fewer commonly reported side effects (fever, chills, headache, fatigue, muscle pain, joint pain, nausea, and dizziness), followed by the Moderna and viral vector vaccines. Females and underweight participants experienced more adverse effects with both vaccines, and fewer common side effects were reported by all participants.

Keywords: Covid-19 vaccine, viral vector vaccine, Sputnik, Moderna, Pfizer, breakthrough infection, adverse effects, Palestine

Background

The COVID-19 pandemic has disrupted people's normal living and taken many people's lives, resulting in extensive economic closures and curfews in many countries at the beginning of 2020.[1] As of May 2024, there have been over 7 million cases and 7.5 million deaths caused by COVID-19 worldwide.[2,2] This health crisis has caused a greater responsibility for the medical research community to race for both a cure and vaccine to halt this pandemic. Furthermore, governments have introduced laws and regulations allowing for the rapid development of new COVID-19 vaccines to halt the spread of the virus and save human lives.[3,4] Furthermore, rapid global pharmaceutical collaboration and effective

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medical technology were necessary to introduce vaccines to provide protection and immunization against the SARS-CoV virus, leading to rapid advances in vaccine development virology, molecular biology, and vaccinology.[5,6]

SARS-Cov-2 vaccines have been granted an Emergency Use Listing (EUL) worldwide by the WHO or Emergency Use Authorization by the Food and Drug Administration, allowing for the use of unapproved vaccination in an emergency or critical situation.[4,7,8] Vaccines were manufactured to enhance body immunity using different technologies such as mRNA (Pfizer-BioNTech, Moderna), viral vector (Johnson & Johnson, and Sputnik V), protein subunit (Novavax), and whole or inactivated virus (Sinopharm, COVAXIN, and Sinovac) vaccines.[3,9]

Each COVID-19 vaccine has specific handling, dosage, storage, administration instructions, efficacy rates, and side effect profiles. Adverse effects associated with COVID-19 vaccines include mild-to-moderate symptoms such as redness, swelling, and pain at the injection site, as well as fatigue, chills, fever, myalgia, headache, diarrhea, and nausea.[10–12] In addition to severe reactions such as myocarditis, pericarditis, deep vein thrombosis, transverse myelitis, and even anaphylactic shock.[13,14] Furthermore, a rare and serious side effect has been reported with viral vector vaccines, including Guillain-Barre syndrome (GBS), an immune disorder of the nervous system, and thrombocytopenia syndrome (TTS), a fatal blood clotting disorder, and myocarditis, which is cardiac inflammation has been reported with mRNA vaccines.[15] As reports of adverse effects about the safety and efficacy of vaccines continue to evolve, information about the safety and efficacy of the COVID-19 vaccines via media has caused considerable anxiety and worries.[4] Worldwide, there is a need to continue monitoring and reporting adverse effects associated with COVID-19 vaccines. In addition to adverse effects, breakthrough infections pose a major challenge to COVID-19 vaccination, and it has been established that they are caused by a declining humoral response.[16,17] Furthermore, the emergence of SarsCov2 variants has increased the chances of breakthrough infections owing to their increased transmissibility and immune-invasive characteristics. A recent study in Palestine explored the adverse effects associated with Pfizer-BioNTech vaccine. To the best of our knowledge, no study has explored the effectiveness and associated adverse effects of different vaccines used in Palestine during the pandemic.[18]

This study's objective is to compare the adverse effects and post-vaccination rates for SARS-CoV-2 infection among individuals vaccinated with various COVID-19 vaccines, including BNT162 (Pfizer-BioNTech), mRNA 1273 (Moderna), Sputnik V, and Sputnik Light (Gamaleya), in Palestine. This study will evaluate the occurrence, extent, type, and severity of adverse reactions associated with vaccinations. Furthermore, this study compared the incidence of Post-vaccination Covid-19 infection among BNT162 (Pfizer-BioNTech), mRNA 1273 (Moderna), and viral vector vaccines.

Materials and Method

Study Design and Sample

A retrospective cross-sectional analytical study was performed among the Birzeit University community in Palestine between December 13, 2021, and March 29, 2022. A Google platform link to a self-administered questionnaire was distributed online through a university website (Ritaj), social media platforms (eg, Facebook and Telegram), and in-person interviews. The study targeted employees, academics, postgraduates, and undergraduates aged 18 years and older who received at least one dose of COVID-19 vaccines, including Pfizer, Moderna, Sputnik Light, or Sputnik v.

Questionnaire (Survey)

The questionnaire was prepared through a standardized method, based on a literature review of similar studies,[13,18] and by revising the reports from WHO and Center for Disease Control and Prevention (CDC) websites to review the globally registered adverse effects.[19,20]

The research team developed, reviewed, evaluated, and rephrased the questionnaire during several meetings to assess content validity. A pilot study was conducted with 32 vaccinated individuals. They were requested to fill out the questionnaire and provide feedback regarding its clarity, consistency, and appropriateness. Based on the pilot response, the final draft was published in Arabic, the respondents' original language. It must also be noted that the final questionnaire comprised five sections with 27 questions structured as open- and closed-ended multiple-choice questions, and two short essay questions. The first section included sociodemographic data. The second was regarding the infection

status of SARSCov-2 before vaccination. Third, the COVID-19 vaccine type and number of doses received. And the fourth section is "COVID-19 vaccines adverse effects", consisting of 23 possible side effects registered in WHO and CDC leaflets and reports published by randomized control trials on the different COVID-19 vaccines.[18,21,22] A space was provided at the end to report any other adverse effects that respondents complained about and were not mentioned. Other questions in this section included the onset and duration of side effects, the participant's attitude after vaccination, and any doctor visits or hospital admissions due to severe side effects. The last section included four questions regarding the infection status of SARS-Cov-2 after vaccination. (Supplementary file)

Statistical Analysis

Data were analyzed using IBM Statistical Package for the Social Sciences (SPSS) version 22. A descriptive analysis was performed to present the data. Data were imported into SPSS, cleared, categorized, and recoded as needed. BMI was computed from height and weight and classified as underweight (<18.5), normal weight (18.5–24.9), overweight (25.0–29.9), and obese (≥30.0). Age was recoded into two subgroups: <20 years and ≥20 years. Next, vaccine adverse effects were categorized into less common and more common adverse effects according to the CDC classification. Categorical data are presented as frequencies and percentages, whereas means and standard deviations were measured for continuous data. The number of adverse effects reported by each patient was counted to form a new continuous not normally distributed variable, according to the Shapiro–Wilk normality test results. Chi-square ($\chi 2$) tests with 95% CI were performed to compare the incidence of COVID-19 infection post-vaccination between viral vector, Pfizer, and Moderna vaccines. Chi-square ($\chi 2$) tests with 95% CI were also performed to compare the 23 post-vaccination side effects incidence for the Viral vector, Pfizer, and Moderna vaccines. Mann–Whitney and Kruskal–Wallis *H*-tests were conducted to establish the association between participant demographics and the counts of the most and least common post-vaccination side effects of COVID-19, respectively. Statistical significance was set at $P < 0.05$.

Ethical Considerations

The ethical committee of the Faculty of Pharmacy, Nursing, and Health Professions at Birzeit University approved this study (reference number: BZU-PNH-2103). The study complied with the ethical guidelines of the Declaration of Helsinki. Informed consent was obtained from the participants prior to participation in the study.

Results

Demographic Characteristics

In total, 558 participants met the inclusion criteria. The mean age of the patients was 24.547 ± 10.184 years, and the majority 72.2% were 20 years or older. In addition, more than half of them were female (60.8%) and free from chronic diseases (89.6%). 28.3% of the respondents were smokers and 15.2% had drug/food allergies. (Further information on each vaccine is provided in Table 1).

COVID-19 Infection

The Covid-19 infection status of participants both before and after they received the COVID-19 vaccination is shown in Figure 1. A total of 158 (28.3%) participants were infected with SARS-CoV-2 before COVID-19 vaccination and 94 (16.9%) patients were infected post-vaccination. Depending on the type of vaccination, 57 (23.8%) viral vector vaccine recipients were infected post-vaccination at a time ranging from less than one month to six months after receiving the vaccine. However, the percentage is lower in mRNA-based vaccines, which are 30 (12.7%) for Pfizer and 7 (8.4%) for Moderna. (Figure 2)

Post-Vaccination Side Effects

BioNTech, Pfizer vaccine

The most frequently reported side effects after administration of the initial dose of the BioNTech Pfizer vaccine were fever (41.9%), headache (38.1%), tiredness and fatigue (32.2%), muscle pain (31.4%), pain, redness, or swelling at the

Table 1 Demographic Characteristics of Covid-19 vaccines recipients (N= 558)

Variable	CATEGORY	Viral Vector Vaccine (N= 239) n (%)	Pfizer Vaccine Recipients (N= 236) n (%)	Moderna Vaccine Recipients (N= 83) n (%)	Total (N= 558) n (%)
Gender	Male	102 (42.7)	86 (36.4)	31 (37.3)	219(39.2)
	Female	137 (57.3)	150 (63.6)	52 (62.7)	339(60.8)
Age	(mean ± SD)	27.519±12.3849	21.837±6.5020	23.699±9.4891	24.547±10.184
	Less than 20	56 (23.4)	81 (34.3)	18 (21.7)	155(27.8)
	20 and more	183 (76.6)	155 (65.7)	65 (78.3)	403(72.2)
Participants	University employee	73 (30.5)	16 (6.8)	9 (10.8)	98(17.6)
	Student	166 (69.5)	220 (93.2)	74 (89.2)	460(82.4)
BMI	Underweight (<18.5)	15 (6.3)	19 (8.1)	7 (8.4)	41(7.3)
	Normal (18.5-24.9)	115 (48.1)	139 (58.9)	57 (68.7)	311(55.7)
	Overweight (25.0-29.9)	79 (33.1)	64 (27.1)	12 (14.5)	155(27.8)
	Obese (≥30)	30 (12.6)	14 (5.9)	7 (8.4)	51(9.1)
Smoking	Smoker	78 (32.6)	63 (26.7)	17 (20.5)	158(28.3)
Comorbidities	Yes	33 (13.8)	12 (5.1)	13 (15.7)	58(10.4)
Allergies	Drug / food	32 (13.4)	39 (16.5)	14 (16.9)	85(15.2)
	Post-Vaccine	33 (13.8)	45 (19.1)	15 (18.1)	93(16.7)
Number of vaccine doses	One dose	143 (59.8)	18 (7.6)	40 (48.2)	201(36.0)
	Two doses	79 (33.1)	188 (79.7)	36 (43.4)	303(54.3)
	Three doses	17 (7.1)	30 (12.7)	7 (8.4)	54(9.7)

site of the vaccine injection (30.9%), chills (28.4%), joint pain (23.7%), and dizziness (19.1%). Other side effects that are reported less commonly (<15%) are persistent cough, shortness of breath, menstrual cycle changes in females, increased heart rate, nausea, sleep disturbances, chest pain, hoarseness of the voice, diarrhea, ear tinnitus, abdominal pain, increase in blood pressure, vomiting, armpit swelling, and knee swelling (Figures 3 and 4). However, 38.1% of the participants who received the BNT162 vaccine did not experience any side effects. As shown in Figure 5, side effects began to manifest within 12 h of vaccination, according to 50% of the participants who received the Pfizer vaccine, and in 39.8% of those people, the side effects that appeared after vaccination continued for one–three days.

Figure 3 shows how different vaccines affected the recipients' daily activities; less than one-fifth of the participants had experienced post-vaccination allergic reactions or shoulder injuries. Furthermore, over 95% of the respondents revealed that they had overcome the adverse effects either by rest or painkiller administration, and approximately three-fourths of the participants did not miss any working days.

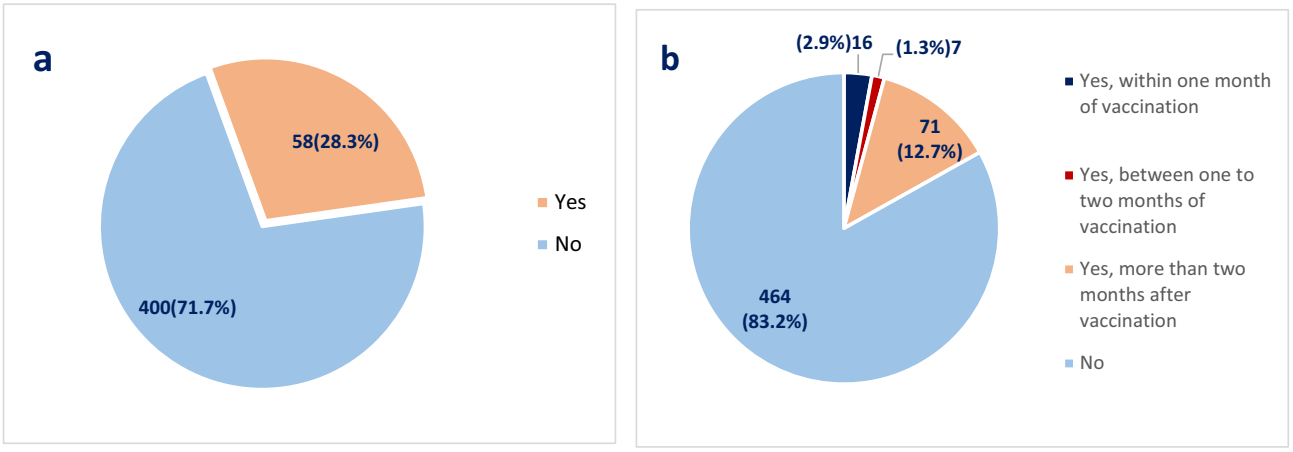

Figure 1 Covid-19 infection Status (N= 558). (**a**) Pre-vaccination, (**b**) post-vaccination.

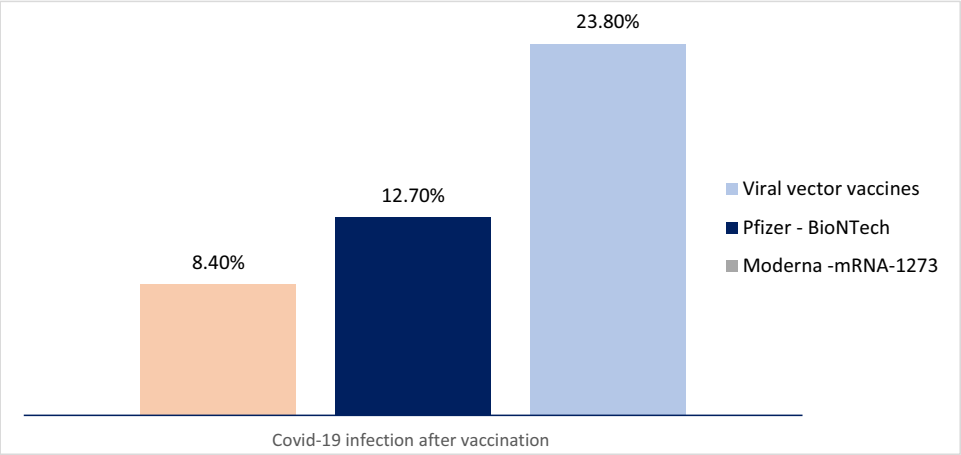

Figure 2 Comparison of Post-vaccination Covid-19 infection between viral vector, Pfizer, Moderna vaccines (N= 94), chi-square test (p-value <0.001).

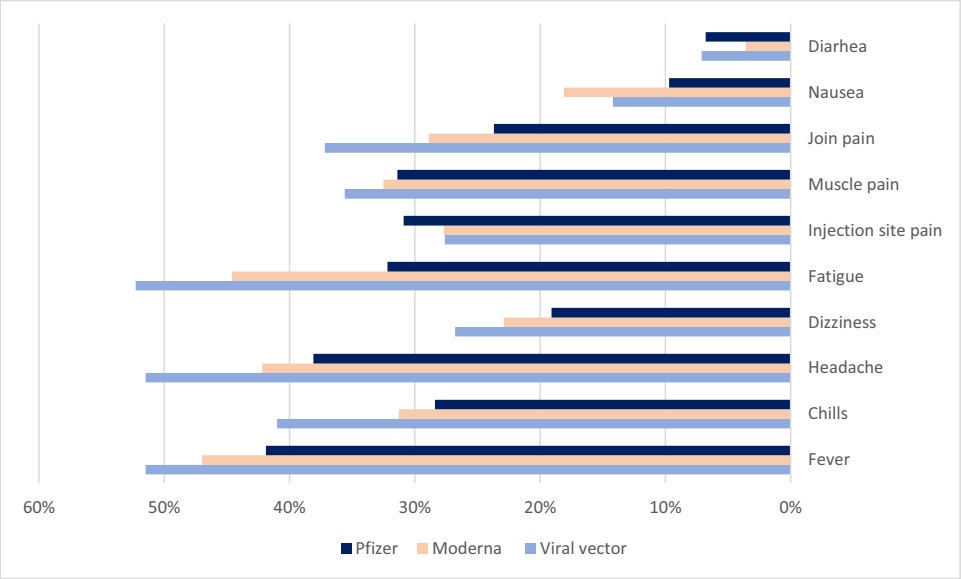

Figure 3 Comparison of the frequencies of the most common side effects of Pfizer, Moderna, and viral vector COVID-19 vaccines.

Moderna's mRNA-1273

The most frequent side effects reported after administration of the Moderna vaccine were fever (47.0%), fatigue (44.6%), headache (42.2%), muscle pain (32.5%), chills (31.3%), joint pain (28.9%), pain, redness, or swelling at the site of vaccine injection (27.7%), dizziness (22.9%), shortness of breath (19.3%), and nausea (18.1%). Other side effects that are reported less commonly (<15%) are menstrual cycle changes in females, an increase in heart rate, chest pain, sleep disturbances, ear tinnitus, persistent cough, increased blood pressure, vomiting, abdominal pain, hoarseness of the voice, diarrhea, armpit swelling, and knee swelling (Figures 3 and 4). However, 33.7% of the participants who received the mRNA-1273 vaccine did not experience any side effects. As shown in Figure 5, side effects began to manifest within 12 h of vaccination, according to 53% of the participants who received the Moderna vaccine. In 48.2% of the participants, the side effects that appeared after vaccination continued for one–three days.

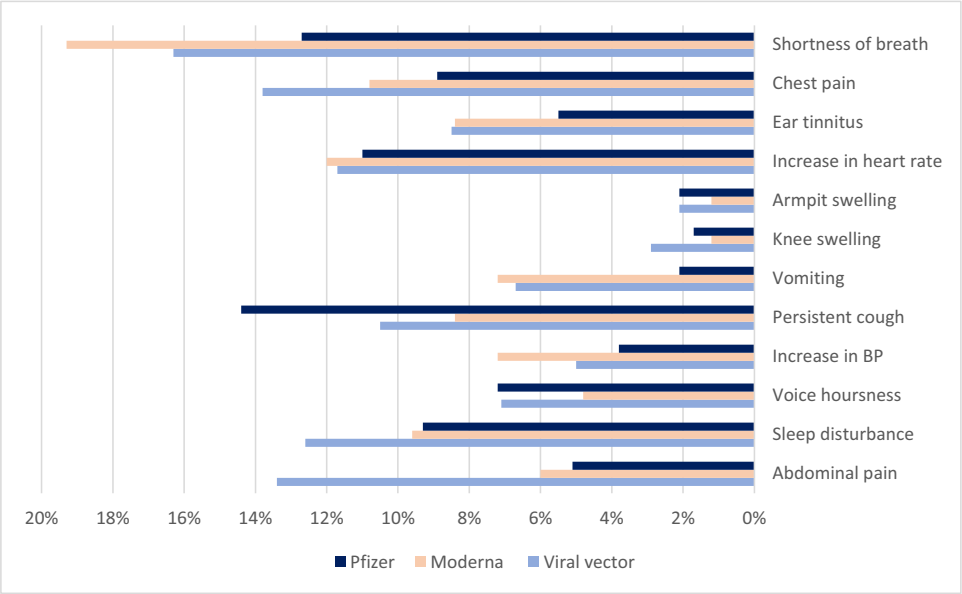

Figure 4 Comparison of the frequencies of less common side effects between Pfizer, Moderna, and viral vector COVID-19 vaccines.

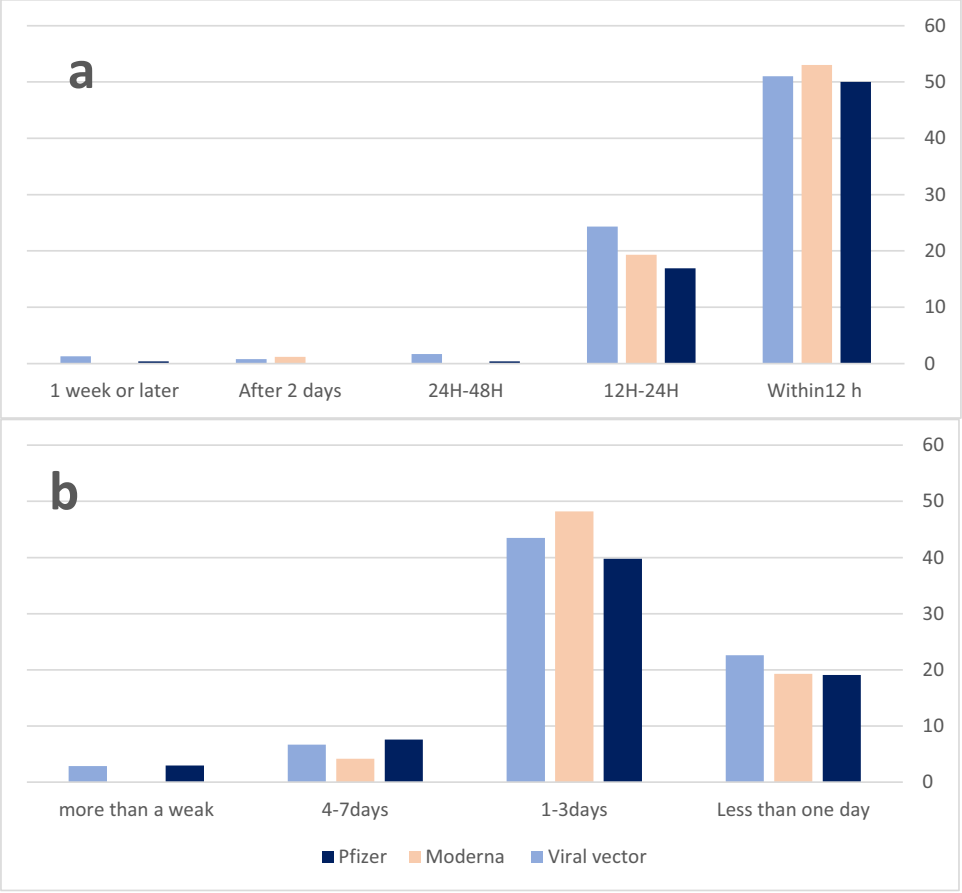

Figure 5 Side effects after Covid-19 vaccination (**a**) Onset of side effects, (**b**) Duration of side effects.

Viral Vector Vaccines (Sputnik V and Light; Gam-COVID-Vac)

The most frequently reported side effects of viral vector vaccines were tiredness and fatigue (52.3%), fever and headache (51.5%), chills (41.0%), joint pain (37.2%), muscle pain (35.6%), redness, swelling, and pain at the site of the vaccine injection (27.6%), dizziness (26.8%), menstrual cycle changes (17.5%), and shortness of breath (16.3%). Other side effects that are reported less commonly (<15%) are nausea, chest pain, abdominal pain, sleep disturbances, increased heart rate, persistent cough, ear tinnitus, hoarseness of the voice, vomiting, diarrhea, increased blood pressure, armpit swelling, and knee swelling (Figures 4 and 5). However, 29.3% of the participants who received the Sputnik vaccine did not experience any side effects. As shown in Figure 3, the side effects began to manifest within 12 h of vaccination, according to 51% of the participants who received the Sputnik vaccine, and in 43.2% of those participants, the side effects that appeared after vaccination continued for one–three days.

Variation in Post-Vaccination Side Effects Among Vaccinations

Table 2 presents the variation of side effects reported among the three vaccines; chills, headache, fatigue, abdominal pain, and joint pain were significantly reported by participants who received the Viral Vector vaccine than by Moderna and Pfizer vaccine recipients. Vomiting, tiredness, and fatigue were significantly less likely to be complained of by Pfizer vaccine recipients compared to Moderna and Viral Vector vaccine recipients ($p < 0.05$). However, there were no significant differences among the other reported side effects.

Table 2 Post-vaccination side effects reported by Viral vector, Pfizer, and Moderna vaccine recipients (N= 558)

Side Effects	Viral Vector Vaccine (N= 239) n (%)	Pfizer Vaccine Recipients (N= 236) n (%)	Moderna Vaccine Recipients (N= 83) n (%)	P-value
No symptoms	70 (29.3)	90 (38.1)	28 (33.7)	0.125
Fever	123 (51.5)	99 (41.9)	39 (47.0)	0.115
Chills	98 (41.0)	67 (28.4)	26 (31.3)	0.013
Headache	123 (51.5)	90 (38.1)	35 (42.2)	0.013
Increased blood pressure	12 (5.0)	9 (3.8)	6 (7.2)	0.422
Increased heart rate	28 (11.7)	26 (11.0)	10 (12.0)	0.950
Shortness of breath	39 (16.3)	30 (12.7)	16 (19.3)	0.297
Persistent Cough	25 (10.5)	34 (14.4)	7 (8.4)	0.240
Chest pain	33 (13.8)	21 (8.9)	9 (10.8)	0.237
Voice hoarseness	17 (7.1)	17 (7.2)	4 (4.8)	0.737
Dizziness	64 (26.8)	45 (19.1)	19 (22.9)	0.136
Ringing in the ears (Tinnitus)	20 (8.4)	13 (5.5)	7 (8.4)	0.429
Nausea	34 (14.2)	23 (9.7)	15 (18.1)	0.109
Vomiting	16 (6.7)	5 (2.1)	6 (7.2)	0.023
Diarrhea	17 (7.1)	16 (6.8)	3 (3.6)	0.516
Abdominal pain	32 (13.4)	12 (5.1)	5 (6.0)	0.004
Tiredness and fatigue	125 (52.3)	76 (32.2)	37 (44.6)	0.000

(*Continued*)

Table 2 (Continued).

Side Effects	Viral Vector Vaccine (N= 239) n (%)	Pfizer Vaccine Recipients (N= 236) n (%)	Moderna Vaccine Recipients (N= 83) n (%)	P-value
Pain or swelling at the injection site	66 (27.6)	73 (30.9)	23 (27.7)	0.699
Muscle pain (myalgia)	85 (35.6)	74 (31.4)	27 (32.5)	0.614
Joint pain	89 (37.2)	56 (23.7)	24 (28.9)	0.006
Swollen ankles and feet	7 (2.9)	4 (1.7)	1 (1.2)	0.666
Swollen armpit glands	5 (2.1)	5 (2.1)	1 (1.2)	1.000
Sleep disturbances	30 (12.6)	22 (9.3)	8 (9.6)	0.492
Menstrual cycle changes	24 (17.5)	18 (12.0)	7 (13.5)	0.404

Note: Bold font P Value (p≤0.05).

Most Common Side Effects Intensity and Patient Characteristics

Table 3 shows the patterns of the intensity of the side effects reported by the participants for the different vaccines, based on patient characteristics. Females, underweight participants, and participants without chronic diseases who received viral vectors experienced significantly more common side effects. Females, underweight, patients who complained of at least one chronic disease, participants with a history of allergy, or had a history of COVID-19 infection and received Pfizer vaccine reported significantly more common side effects. Furthermore, Moderna vaccine recipients, who were younger or had a history of allergies, had significantly more common side effects.

Fewer Common Side Effects Intensity and Patient Characteristics

Table 4 shows the patterns of fewer common side effects reported by different vaccine recipients based on patient characteristics. Male and overweight participants who received viral vectors were significantly less likely to report fewer

Table 3 Association between post-vaccination most common side effects *reported by the participants and their predisposing factors. (N= 558)

Variable	Category	Viral vector n=239			Pfizer vaccine n=236			Moderna vaccine N=83		
		N	Mean rank	P value	n	Mean rank	P value	n	Mean rank	P value
Gender**	Male	102	105.17	**0.004**	86	96.52	**0.000**	31	34.24	0.20
	Female	137	131.04		150	131.10		52	46.63	
Age**	Less than20	56	111.12	0.264	81	126.31	0.194	18	55.22	**0.007**
	20 or more	183	122.72		155	114.42		65	38.34	
BMI***	Underweight	15	172.30	**0.000**	19	165.92	**0.014**	7	36.00	0.507
	Normal	115	130.91		139	113.29		57	44.61	
	Overweight	79	103.72		64	115.73		12	37.54	
	Obese	30	94.90		14	118.50		7	34.36	
CHRONIC DISEASES**	None	206	123.77	**0.032**	224	115.51	**0.003**	70	41.24	0.492
	At least one	33	96.44		12	174.25		13	46.12	
Allergy**	Yes	32	135.25	0.173	39	148.78	**0.002**	14	62.18	**0.000**
	No	207	116.64		197	112.51		69	37.91	
Smoking**	Smoker	78	114.96	0.426	63	106.40	0.093	17	35.32	0.189
	Non-smoker	161	122.44		173	122.91		66	43.72	
Previous covid-19 infection**	Yes	69	125.09	0.462	66	132.48	**0.045**	23	48.09	0.114
	No	170	117.94		170	113.07		60	39.67	

Notes: *The most common side effects were fever, chills, headache, fatigue, muscle pain, joint pain, injection site pain, nausea, diarrhea, and dizziness. **Mann-Whitney U–test. ***Kruskal-Wallis H–test. Bold font P Value (p≤0.05).

Table 4 Association between post-vaccination fewer common side effects* Reported by the Participants and their predisposing factors. (N= 558)

Variable	Category	Viral Vector n=239			Pfizer Vaccine N=236			Moderna vaccine N=83		
		n	Mean rank	P value	N	Mean rank	P value	n	Mean rank	P value
Gender**	Male	102	107.52	0.006	86	103.66	0.002	31	36.53	0.058
	Female	137	129.29		150	127.01		52	45.26	
Age**	Less than20	56	122.70	0.702	81	123.41	0.336	18	50.58	0.042
	20 or more	183	119.17		155	115.93		65	39.62	
BMI***	Underweight	15	136.37	0.035	19	142.97	0.186	7	32.71	0.173
	Normal	115	129.05		139	111.83		57	45.12	
	Overweight	79	11.28		64	112.59		12	33.50	
	Obese	30	100.07		14	128.89		7	40.43	
CHRONIC DISEASES**	None	206	120.52	0.739	224	116.23	0.008	70	40.61	0.146
	At least one	33	116.76		12	160.83		13	49.50	
Allergy**	Yes	32	136.78	0.091	39	147.12	0.001	14	56.96	0.002
	No	207	117.41		197	112.84		69	38.96	
Smoking**	Smoker	78	116.84	0.573	63	111.21	0.234	17	36.88	0.243
	Non-smoker	161	121.53		173	121.15		66	43.32	
Previous covid-19 infection**	Yes	69	125.59	0.361	66	128.89	0.080	23	48.28	0.080
	No	170	117.73		170	114.47		60	39.59	

Notes: *Less common side effects: increased blood pressure, increased heart rate, shortness of breath, persistent cough, chest pain, voice hoarseness, ear tinnitus, vomiting, abdominal pain, knee swelling, and sleep disturbances. **Mann-Whitney test. ***Kruskal-Wallis H–test.

common side effects. Females, patients who complained of at least one chronic disease, or with a history of allergy and received Pfizer vaccine, reported significantly fewer common side effects. Moreover, younger participants with a history of allergies who received Moderna vaccine had significantly fewer common side effects.

Discussion

Several covid-19 vaccines have been authorized for human use to compact SARS-Cov2 infections. In this study, we explored and compared the prevalence of side effects and reinfection rates following the administration of three different types of Covid-19 vaccines BNT162 (Pfizer-BioNTech), mRNA 1273 (Moderna), and a viral vector. Both classes of vaccines have been effective in targeting SARS Cov2 viruses. mRNA vaccines do not use a live virus, whereas the viral vector vaccine uses a modified version of the non-replicating virus and does not cause the disease.

A breakthrough COVID-19 infection is defined by the Centers for Disease Control and Prevention (CDC) as a positive COVID-19 test 14 days or more after completing all recommended doses of an FDA-approved COVID-19 vaccine. However, the World Health Organization (WHO) states that vaccinations certified for emergency use or allowed for use by regulatory agencies in various countries are very effective in reducing the risk and severity of infection, particularly serious disease and death. The effectiveness of a vaccine can vary based on the vaccine, the viral variations in circulation, and the period since inoculation.[23]

Vaccine efficacy deterioration over time is a major concern that calls for further research to improve vaccine effectiveness.[22,24] In This study, 71% of breakthrough infections developed within 2–6 months of the full vaccination date. Another study found that 52.9% of those who received the second dose of vaccine experienced a breakthrough infection after 28 days.[25] The frequency of breakthrough infections in vaccine recipients differed significantly based on the type of vaccine administered, as our study revealed that viral vector vaccines displayed a higher breakthrough rate than mRNA vaccines. Interestingly, a similar observation was made in a prospective cohort study conducted in Belgium.[26] Furthermore, a systemic meta-analysis concluded that mRNA vaccines had the highest likelihood of being effective against systemic COVID-19 infections compared to other types of vaccines.[27]

Breakthrough infections post-vaccination are still an area of research, and no COVID-19 vaccine has demonstrated 100% effectiveness. As a result, despite full immunization, a subset of the population remains susceptible to SARS CoV-2.[28]

Possible explanations include a rise in the number of vaccinated people, a decline in vaccine-induced antibody levels, the emergence of variations with reduced sensitivity to vaccine-induced antibodies, and a reduction in preventive recommendations for the community.[29]

In addition to vaccine efficacy, side effects are another major factor that can be considered when selecting or comparing vaccines. Transient side effects are expected during or after vaccine administration owing to immune system activation and trauma to the injection site. The CDC reports that the most frequent side effects of COVID-19 immunization include swelling, pain, and redness at the injection site, as well as fatigue, chills, fever, muscle aches, headaches, and nausea.[20]

In this study, the commonly reported side effects were lower in the Pfizer group, followed by the Moderna and viral vector vaccines. This is true for all the common side effects reported except for the injection site pain, which was more common with the Pfizer vaccine; diarrhea, which was least common in the Moderna vaccine; and nausea, which was more common in the Moderna group than in the other types of vaccines. This finding contradicts that of a recent comprehensive review conducted by Pordanjani. et, where the occurrence of local side effects was more common with mRNA-based vaccines, which includes Pfizer and Moderna vaccines, as compared to viral vector vaccines.[30] Furthermore, in a regional study in Saudi Arabia, viral vector recipient reported fewer side effects.[31] The Advisory Committee on Immunization Practices (ACIP) prefers mRNA over viral vector vaccines because mRNA vaccines have not been associated with the rare side effect, Guillain-Barre syndrome, which can occur with viral vector vaccines. Moreover, mRNA vaccines have proven to be more effective.[32]

Several factors may influence the prevalence of adverse effects. In this study, there was no statistically significant association between age and common adverse effects associated with the administration of Pfizer and viral vector vaccines. In contrast, Moderna vaccine recipients who were younger had significantly more common side effects. Different finding was reported by other studies, a British study by Menni et al, reported that people aged 55 and under had a significantly higher rate of side effects after both mRNA-based and viral vector-based vaccines.[33] A regional study in Saudi Arabia reported adults aged 60 years or older had a substantially higher level of local side effects, including injection site pain than their younger counterparts who received the BNT162b2 vaccine.[34]

Female patients showed significantly more common side effects for both the viral vectors and Pfizer vaccines. That completely different according to a study published in Jordan by Abu Hammad et al, there were no significant differences between males and females in the development of systemic adverse effects.[35] Where Alghamdi et al, 2021 discovered within a viral vector-based vaccine recipients group that the occurrence of post-vaccination side effects was substantially higher in females than males.[36] This study also showed that patient with Pfizer and Moderna vaccines with history of allergy experienced significantly more common side effects. Therefore, according to the Medicines and Healthcare Products Regulatory Agency (MHRA), it is recommended to provide the vaccine with caution to those who have any history of an adverse reaction to vaccination, drug, or food, especially people who have an adrenaline auto-injector in emergency situations.[37]

The three vaccines have reported fewer common side effects (<15%), including persistent cough, shortness of breath, increased heart rate, sleep disturbances, chest pain, hoarseness of the voice, ear tinnitus, abdominal pain, increase in blood pressure, vomiting, armpit swelling, and knee swelling. This is similar to the study by Abu Hammad et al, which found that a small number of patients reported gastrointestinal (nausea, vomiting, and diarrhea) and respiratory side effects (dyspnea). As well as ear complaints, facial pain, drowsiness, and diuresis.[35]

Underweight patients who were administered Pfizer and viral vector vaccines experienced more adverse effects after vaccination. A study in Spain which was published in 2021 studied the association between COVID19 vaccines side effects and body mass index (BMI) found that after controlling for sex and age, the majority of the substantial effects in the relationship between COVID-19 vaccination adverse effects and weight status were no longer significant.[38] Also a systemic review study published in China in 2023 discovered that newer coronavirus vaccinations may produce higher adverse effects in non-obese adults, providing some new recommendations for the design and emphasis of follow-up research.[39]

In this study, 39.8% of the participants experienced adverse effects one–three days after vaccination. This is comparable to the study conducted among healthcare workers in Germany indicating good safety findings for both forms of vaccinations.[40]

Strengths and Limitations

This is the first study conducted in Palestine during the covid-19 pandemic that compares mRNA vaccines and viral vectors among higher education communities. The data collected were self-reported based on participant perception of side effects and were not evaluated by healthcare providers due to the retrospective nature of the study, which might have led to information bias. The questionnaire was distributed online; therefore, there was a possibility of selection bias. Furthermore, most participants were younger, which might have affected the results because elderly participants might have had different comorbidities that might affect vaccine efficacy and toxicity. Further research is needed to extrapolate these results to the general population.

Conclusion

As the pandemic of Sars Cov-2 is unfolding, post-vaccine long-term immunity and adverse effects continue to be challenging for the medical and research community; therefore, continuous research, long-term studies, and reporting of adverse effects that might be associated with covid −19 vaccines are essential to ensure vaccine safety and efficacy.

In this study, breakthrough infection was associated with both viral victors and mRNA; however, the mRNA vaccine had fewer reported post-vaccine infections. Furthermore, the Pfizer/BioNTech COVID-19 vaccine group reported fewer commonly reported side effects (fever, chills, headache, fatigue, muscle pain, joint pain, nausea, and dizziness), followed by the Moderna and Viral Vector vaccines. Females and underweight participants experienced more adverse effects with both vaccines, and fewer common side effects were reported by all participants. The findings of this study can be used to inform the general population about the adverse effects of the Sars-Cov-2 vaccine.

Disclosure

The authors report no conflicts of interest in this work.

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