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RESEARCH ARTICLE

Assessing the Self-reported After Events Following Immunization of COVID-19 Vaccines in Turkey and Bangladesh

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Abstract

Though mass vaccination programs helped to reduce the severity of the ongoing pandemic, various unwanted effects were reported in Turkey and Bangladesh after taking vaccines. The purpose of this study was to evaluate and compare the adverse effects of several vaccines in Turkey and Bangladesh and how the population of both countries prioritizes the continuation of vaccination compared to the side effects. An online survey with a pretest was conducted to gather data over the research period from July 10, 2021 to December 10, 2021. Finally, the questionnaire was shared with the mass population of Turkey and Bangladesh who have received at least one or two doses of the COVID-19 vaccines. The quality of the questionnaire was evaluated with Cronbach's alpha test. The study consisted of 1508 respondents from Bangladesh and 602 respondents from Turkey. Among the total 2110 respondents, 50.0% were male 66.8% were from the 18–30 years age range, and 77.5% reported living in the city area. Among all the respondents, 64.99% of those vaccinated in Bangladesh and 67.28% of those vaccinated in Turkey reported side effects after vaccinations. Participants receiving mRNA vaccines (Pfizer and Moderna) experienced the most side effects, with many reporting pain at the injection site in both nations. Following that, fever, body pain, and headache were common in Bangladesh, whereas body pain, fatigue, and arm numbness were common in Turkey. The study found no significant adverse events reported in Turkey and Bangladesh following the first and second doses of COVID-19 vaccination. These COVID-19 vaccines showed similar patterns of efficacy and safety during the short period of analysis. Vaccines from different manufacturers showed a non-significant level of adverse events during this binational AEFI approach to COVID-19 vaccines. More studies are recommended on the efficacy and safety of several vaccines to discover unexpected effects.

Keywords COVID-19 vaccine; Vaccine side effect · After Events following Immunization (AEFI) · Turkey · Bangladesh

Introduction

The novel coronavirus disease 2019 (COVID-19) is primarily caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and causes public health issues as well as substantial economic implications across the world (Hossain et al. 2020). In December 2019, the first case of COVID-19 was detected, and in the latter week of January 2020, it was proclaimed a public health emergency, and in the middle of March 2020, it was designated a pandemic (Wiersinga et al. 2020; Zhu et al. 2020). This pandemic has continued till now due to the virus's fast mutation and spread around the world (Hatmal et al. 2021). In order to slow down the global spread of COVID-19, several preventative and control measures at varying levels have been developed in country territories. Individually, they include things like keeping at least three feet of distance from each other, washing hands often, using hand sanitizers, covering mouth while coughing or sneezing, not shaking hands

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or kissing strangers, staying away from those who are showing the symptoms of different respiratory diseases, and wearing a face mask in public places (Al-Tammemi 2020; Lai et al. 2020). At least 186 nations have instituted varied degrees of population movement restrictions in order to curb the spread of the coronavirus and keep health services from being overburdened; these restrictions have resulted in lockdowns in 82 countries (Lai et al. 2020).

The rapid development of vaccines and anti-viral medicine against the SARS-CoV-2 virus prevents the acceleration of the explosive nature of the pandemic (Harmukh 2020; Felsenstein et al. 2020; Wu et al. 2021). Prevention of diseases from life-threatening infections is made simpler with the use of vaccinations which assist the body's adaptive immunity (Lee 2021; Fritsche et al. 2010). Moreover, this novel discovery also faces challenges in regard to keeping promises of ensuring optimal immune response against the extremely infectious and lethal strains of SARS-CoV-2 (Harrison and Wu 2020). Multiple advanced technological approaches in structural biology and genomics present a new era of COVID-19 vaccines with very non-significant adverse effects (Sharma et al. 2020).

By the beginning of 2021, many international health authorities had declared the licensing of several vaccine candidates for emergency use (Alhazmi et al. 2021). The COVID-19 worldwide pandemic problem has generated socioeconomic and public health challenges that are part of the ongoing debate (Ardito et al. 2021). Yet, the success rate of disease prevention and management across countries is correlated not only with the quick distribution of COVID-19 vaccines to the mass population but also with strong governance, relatively high health expenditures, and universal healthcare systems (Coccia 2021). Since November 11, 2020, 259 vaccine development projects have been initiated worldwide with the objective to provide safe and effective vaccines for COVID-19 (Saeed et al. 2021), there are several vaccines that get authorized approval for worldwide use. Expansion of vaccine production got the priority to meet the urge in the time of the explosion of various strains of SARS-CoV-2 (Shahcheraghi et al. 2021). Increased availability of vaccine supply provides mass immunization efforts and offers a promise in expanding vaccination capacity and increasing vaccination rates — a critical step toward ending the COVID-19 global pandemic (Goralnick et al. 2021). Consequently, both Turkey and Bangladesh initiated a mass vaccination program on January 14, 2021 (COVID, 19 C.E.) and February 7, 2021 (Abedin et al. 2021), respectively. Already, Turkey has deployed four vaccines (Tokuç and Varol 2020), and Bangladesh has deployed five vaccines (Khatun 2021). However, certain common and uncommon adverse events have been observed after the deployment of a widespread vaccination program (El-Shitany et al. 2021; Riad et al. 2021; Solomon et al. 2021; Tissot et al. 2021). Though according to "The Centers for Disease Control and Prevention (CDC)," the majority of these symptoms should subside after a few days, some unusual effects were reported to stay longer than expected (Gee et al. 2021; Hartert and Sockrider 2021). For instance, suspected severe allergic reactions and anaphylaxis following vaccination were reported in the Vaccine Adverse Event Reporting System (VAERS), the national passive surveillance (spontaneous reporting) system for adverse events after immunization after the administration of Pfizer-BioNTech vaccine (Shimabukuro and Nair 2021).

Therefore, collecting pharmacovigilance data is critical for recognizing adverse events and comprehending their nature, frequency, and potential risk factors to the degree feasible (Hossain and Amran 2019). Besides, it is important to monitor side effects and perceptions following immunization in order to better understand vaccine efficacy and to combat vaccine pessimism and rumors (Sallam et al. 2021). However, it is pretty much possible that the prevalence and severity of side effects may vary with age, gender, or even geographic location. Thus, the primary aim of this study is to picture a comparative assessment of the adverse effects that patients reported after receiving different COVID-19 vaccines in Bangladesh and Turkey. In particular, this study can provide potential answers to various questions and logical inferences, such as (a) Is vaccination safe?; (b) What is the perception of people of two countries towards the mass vaccination process?; (c) Which vaccine is relatively more effective?; (d) Which variables influence the function of vaccines?; (e) Do the environments of two nations have an influence on the effects of vaccines?; and (f) Has any vaccination demonstrated negative impacts or interactions with body components? Besides, this study has also provided a glimpse of the management patterns of people from two countries before mass vaccination started. This study could therefore provide a clear idea of the differences in disease prevalence according to demographic characteristics, perception of people towards vaccines, distribution of vaccines, patterns, and management of side effects after taking different COVID-19 vaccines between Turkey and Bangladesh, which may help to decide effective management systems to terminate COVID-19 pandemic.

Materials and methods

Sample and data

This retrospective and cross-sectional survey on AEFIs of the COVID-19 vaccination was conducted online. Following a thorough assessment of COVID-19 data and surveillance from the CDC, the survey questionnaire was developed (Sultana et al. 2021). The questionnaire was finalized after an

extensive review of relevant literature on the related adverse effects of different COVID-19 vaccines (Hatmal et al. 2021) (Alhazmi et al. 2021; Saeed et al. 2021) (Khan et al. 2020) and group discussion. The Ethical Review Committee of the Faculty of Biological Sciences, University of Dhaka gave its clearance for this survey (Reference No. 159/Biol. Scs.), and all users provided consent for the non-commercial use of their data. The online questionnaire was then circulated via social and electronic media (Email, Facebook, Messenger, Twitter, and WhatsApp) using a snowball sampling method. We pre-tested the questionnaire by sending it to 50 primary recipients at the start of the COVID-19 immunization program. The pre-testing was conducted to ensure that the questionnaire was clear and unambiguous. These individuals were thereafter urged to share the survey questionnaire on their social networking sites.

Sample selection

The intended participants were Bangladeshi and Turkish persons who can read and comprehend Bangla, Turkish, or English, and received either a single dose or a double dose of any of the COVID-19 vaccines. Because of the limitations of employing face-to-face procedures during an active outbreak, all data were collected only through the use of the Google Forms platform. We have removed any participants who declined to take part in the study or who were not immunized against COVID-19 from consideration. Throughout Bangladesh and Turkey, this online form was widely circulated on social media and electronic websites and included people from various socioeconomic levels as well as across all age groups.

Measures of variables

The survey questionnaire was created using Google Forms in English and evaluated by an expert panel who offered input on the survey's various components, which were subsequently revised based on their ideas. Prior to testing and distribution, the survey was translated into Bangla and Turkish for greater comprehension.

The survey form was divided into eight sections, each of which contained information about the vaccination, the participant's health prior to and following the vaccination, the associated side effects of the first and second doses of the vaccine, and any symptom management steps taken by the participant. The first section provided background information about the study and requested approval. All respondents were required to respond to this section in order to proceed with the survey. The second section of the questionnaire requested information about the respondent's age, gender, nationality, area of residence, educational qualifications, and occupation. Additionally, this part included a 5-point Likert scale remark stating that "Taking COVID-19 vaccination can successfully prevent COVID-19 infection." The third section of the questionnaire was designated for women exclusively. It included four questions on the female's pregnancy and lactation status, as well as information about tetanus vaccination. The next part Section 4 addressed numerous issues about the individuals' health status before immunization. This portion included questions about the participant's current COVID-19 status, allergic problems, chronic diseases with current treatment routines, and past immunization history. The majority of the questions in this section have a binary "yes" or "no" structure. Section 5 of the questionnaire was prepared specifically for responders who had been infected with COVID-19 prior to immunization. It included some questions containing the complications related to COVID-19 infection, pharmacological and non-pharmacological management of the infection and recovery time. Section 6 was specially designed for the chronic disease condition (comorbidity) before vaccination. The respondents who were suffering from different types of chronic diseases were asked two questions containing the name of the disease(s) and medicines taken for their disease(s). Sections seven and eight were addressed as "After Events Following Vaccination" for the 1st and the 2nd doses, respectively. These sections contained some questions concerning the vaccination information of the current individual, including vaccine name, vaccination date, vaccination center, and any specific information given after vaccination. In our segment on side effects, we included the most frequently reported adverse effects from prior studies (Alhazmi et al. 2021; Gee et al. 2021; Hatmal et al. 2021; Menni et al. 2021; Saeed et al. 2021; Zhu et al. 2020), including pain and irritation at the site of injection, body and joint pain, headache, fever, nausea, vomiting, diarrhea, sore throat, decreased appetite, fatigue, anaphylaxis, and drowsiness. Additionally, we included a space for reporting any additional unlisted adverse events that our trial participants may have encountered. These sections discussed the duration and severity of side effects, as well as the management and treatment plan for physical discomfort experienced following vaccination. There were also two questions where the respondents were asked if they were affected by COVID-19 or had COVID-like symptoms after taking the 1st or the 2nd doses of the vaccine.

Duration of the study

The research was carried out between July 10, 2021, and December 10, 2021. To gather responses from COVID-19 vaccine recipients, a total of 5 months was allotted for response collection.

Data analysis procedure

The data collected from Turkey and Bangladesh were first analyzed for consistency. Inconsistent data in the data set and the participants who filled out the questionnaire even though they were not vaccinated were excluded from the study. Frequency and percentage distributions of the demographic data of the participants were examined on the data set. In addition, the questions about the vaccination status of the participants, the symptoms that are seen after the vaccination, the hospitalization status, side effects, the intensity and duration of the side effects, and the treatments applied were compared using the chi-square test of independence in the samples of Turkey and Bangladesh. The Monte Carlo *p*-value was used for the variables for which there were not enough observations in the distributions. Analyses were conducted on SPSS 22 software package. Internal consistency between multiple survey items of the questionnaire was evaluated through Cronbach's alpha analysis (Sultana et al. 2021). In this analysis, Cronbach's alpha describes the coherence between the descriptors of the survey study. Internal consistency among the demographical data, COVID-19 vaccine-related side effects, and severity of it has been explained with the reliability indicator Cronbach's alpha value of 0.89. This value indicates a higher interrelatedness in the assessment of the questionnaire (Taber 2018).

Results

The study consisted of 602 people from Turkey and 1508 people from Bangladesh who had at least one dose of the COVID-19 vaccines. Among them, 561 individuals from Turkey and 806 individuals from Bangladesh took the second dose of the COVID-19 vaccines. Table 1 showed the demographic data of individuals from Turkey and Bangladesh who participated in the research.

Figure 1 shows the distributions of perceptions regarding the prevention of infection by COVID-19 vaccines. The participants both from Turkey and Bangladesh agreed that vaccines would prevent infection.

The rate of women who were vaccinated during pregnancy was 0.42% in Turkey and 0.87% in Bangladesh. Two out of seven women (28.57%) who were vaccinated during pregnancy stated that there was an abnormality in their pregnancy.

Table 2 included the COVID-19 status and treatments applied before vaccination. Before they were vaccinated, 23.26% of respondents in Turkey and 13.53% of respondents in Bangladesh had COVID-19. While 66.86% of these people who had COVID-19 before they were vaccinated received drug treatment, 55.23% used herbal supplements and alternative treatment.

Due to COVID-19 infection, 2.49% of individuals in Turkey and 5.31% of individuals in Bangladesh were hospitalized before vaccination. Numerous complexities were shown when they were suffering from the infection. While upper respiratory tract infection was observed with a maximum of 60% in these hospitalized people in Turkey, low oxygen saturation, and other symptoms were observed with a maximum of 37.50% in Bangladesh.

Table 3 showed the distributions of vaccines for the first and second doses. For the first dose, the most applied vaccine in Turkey was Pfizer-BioNTech (78.41%) and Sinovac (20.93%). In Bangladesh, the most applied vaccines were Sinopharm (49%), Oxford-AstraZeneca (22.68%), and Moderna (17.51%). For the second dose, the most applied vaccines in Turkey were Pfizer-BioNTech with 78.43%

Table 1 Demographic data of participants from Turkey and Bangladesh who have taken at least one dose of COVID-19 vaccine

Sociodemographic parameters		Turkey		Bangladesh		Total	
		F	%	*F*	%	*F*	%
Gender	Male	125	20.8	931	61.7	1056	50.0
	Female	474	78.7	574	38.1	1048	49.7
	Not specified	3	0.5	3	0.2	6	0.3
Age	< 18	29	4.8	9	0.6	38	1.8
	18–30	457	75.9	953	63.2	1410	66.8
	31–40	38	6.3	210	13.9	248	11.8
	41–50	53	8.8	153	10.1	206	9.8
	51–60	20	3.3	115	7.6	135	6.4
	61–70	3	0.5	53	3.5	56	2.7
	> 70	2	0.3	15	1.0	17	0.8
Place of residence	Village	38	6.3	352	23.3	390	18.5
	City	557	92.5	1079	71.6	1636	77.5
	Abroad	7	1.2	77	5.1	84	4.0
Total		602	100	1508	100	2110	100

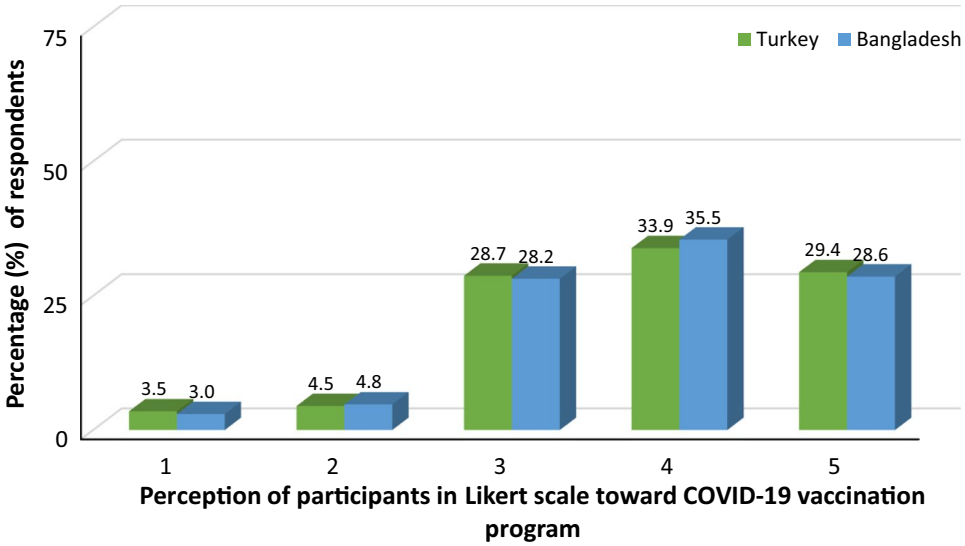

Fig. 1 Perceptions regarding the prevention of infection by COVID-19 vaccines (1: Totally disagree, 2: Disagree, 3: Neutral, 4: Agree 5: Totally agree)

Table 2 Contracting COVID-19 and treatments before getting vaccinated

		Turkey		Bangladesh		Total		χ^2	*p*
		F	%	*F*	%	*F*	%		
Contracting COVID-19 before getting vaccinated	No	462	76.74	1304	86.47	1766	83.70	28.838	< 0.001
	Yes	140	23.26	204	13.53	344	16.30		
Plasma treatment	No	137	97.86	202	99.02	339	98.55	0.783	0.652[a]
	Yes	3	2.14	2	0.98	5	1.45		
Herbal support/alternative treatment	No	70	50.00	84	41.18	154	44.77	2.614	0.106
	Yes	70	50.00	120	58.82	190	55.23		
Hospital	No	116	82.86	175	85.78	291	84.59	0.546	0.460
	Yes	24	17.14	29	14.22	53	15.41		
Medicine	No	36	25.71	78	38.24	114	33.14	5.874	0.015
	Yes	104	74.29	126	61.76	230	66.86		

[a]Monte Carlo *p*-value

Table 3 Distributions of the vaccines for first and second doses in Turkey and Bangladesh

Name of the vaccine	First dose				Second dose			
	Turkey ($n=602$)		Bangladesh ($n=1508$)		Turkey ($n=561$)		Bangladesh ($n=806$)	
	F	%	F	%	F	%	F	%
Moderna	2	0.33	264	17.51	2	0.36	113	14.02
Pfizer-BioNTech	472	78.41	148	9.81	440	78.43	91	11.29
Sinovac	126	20.93	8	0.53	117	20.86	7	0.87
Sputnik V	1	0.17	6	0.40	1	0.18	2	0.25
Turkovac	1	0.17	0	0.00	1	0.18	0	0.00
Oxford-AstraZeneca	0	0.00	342	22.68	0	0.00	278	34.49
Sinopharm	0	0.00	739	49	0	0.00	314	38.96
Johnsons	0	0.00	1	0.07	0	0.00	1	0.12

and Sinovac with 20.86%. In Bangladesh, the most applied vaccines were Sinopharm (38.96%), Oxford-AstraZeneca (34.49%), Moderna (14.02%), and Pfizer-BioNTech (11.29%) for the second dose.

Table 4 shows the results of the comparison of physical discomfort experienced after the first and second doses of vaccination according to the vaccine types. As a result of the analysis, for the first dose, there was a significant difference

Table 4 Prevalence of physical discomfort after taking the first and second doses

Name of the vaccine	Physical discomforts							
	First dose ($n=2110$)				Second dose ($n=1367$)			
	Yes		No		Yes		No	
	F	%	*F*	%	*F*	%	*F*	%
Johnsons	1	100	0	0	0	0	1	100
Moderna	173	65.04	93	34.96	99	86.09	16	13.91
Oxford-AstraZeneca	228	66.47	115	33.53	110	39.15	171	60.85
Pfizer-BioNTech	465	75.00	155	25.00	378	71.19	153	28.81
Sinopharm	463	62.65	276	37.35	141	45.34	170	54.66
Sinovac	55	41.04	79	58.96	36	29.03	88	70.97
Sputnik V	1	14.29	6	85.71	2	66.67	1	33.33
Turkovac	0	0	1	100	0	0	1	100

in the state of experiencing physical discomfort according to the vaccine types ($\chi^2=83{,}909$, $p<0.0001$). Johnsons and Turkovac were taken by a limited number of participants, but Pfizer-BioNTech, Sinopharm, and Oxford-AstraZeneca were taken by large populations. When more vaccines were examined, the rate of physical discomfort was at most 75% in the Pfizer-BioNTech vaccine. Then, there was Oxford-AstraZeneca with 66.47%, Moderna with 65.04%, and Sinopharm with 62.65%. The vaccines with the lowest rate of physical discomfort were Sputnik V with 14.29%. For the second dose, there was a significant difference in physical discomfort according to vaccine types ($\chi^2=180{,}754$, $p<0.0001$). The Johnsons and Turkovac vaccine types were administered to very few people, and none of them experienced physical discomfort. When more vaccines were examined, the rate of physical discomfort was the Moderna vaccine with the highest rate of 86.09%. Then, Pfizer-BioNTech with 71.19% and Sputnik V vaccine with 66.67%. The vaccines with the lowest rate of physical discomfort were Sinovac at 29.03%, Oxford-AstraZeneca at 39.15%, and Sinopharm at 45.34%.

Figure 2 illustrated that among the major classes, mRNA vaccines exerted maximum side-effects after the 1st dose (Pfizer 75% and Moderna 65.04%) and after the 2nd dose (Pfizer 71.19% and Moderna 86.09%).

Table 5 shows the distribution of physical discomfort experienced after the first and second doses. In the case of the first dose, post-vaccination physical discomfort occurred in 67.28% of those who got vaccinated in Turkey and 64.99% of those who got vaccinated in Bangladesh. In Turkey, 75.06% of the participants with physical

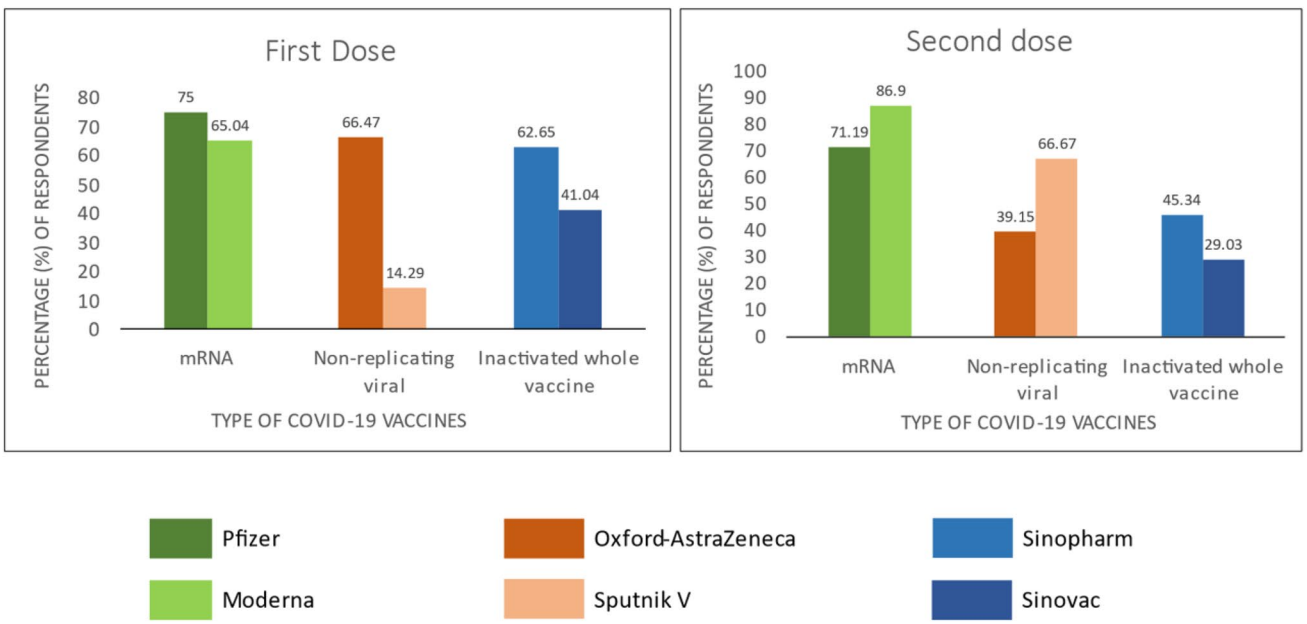

Fig. 2 Side-effects according to vaccine type after getting the first and second doses

Table 5 Physical discomforts experienced after the first and second doses

		First dose				Second dose			
		Turkey ($n=602$)		Bangladesh ($n=1508$)		Turkey ($n=561$)		Bangladesh ($n=806$)	
		F	%	*F*	%	*F*	%	*F*	%
Experiencing physical discomfort after the first dose	No	197	32.72	528	35.01	219	39.04	382	47.39
	Yes	405	67.28	980	64.99	342	60.96	424	52.61
Pain at the injection site		304	75.06	740	75.51	263	76.90	299	70.52
Irritation/ rash at the injection site		24	5.93	129	13.16	23	6.73	59	13.92
Fever		79	19.5	403	41.12	25	7.31	159	37.50
Body pain		131	32.35	379	38.67	145	42.40	143	33.73
Joint pain		94	23.21	137	13.98	106	30.99	49	11.56
Arm numbness		117	28.89	150	15.31	87	25.44	49	11.56
Headache		96	23.7	237	24.18	113	33.04	93	21.93
Nausea		38	9.38	62	6.33	43	12.57	27	6.37
Diarrhea		10	2.47	13	1.33	15	4.39	7	1.65
Sore throat		10	2.47	21	2.14	14	4.09	7	1.65
Shortness of breath		11	2.72	21	2.14	15	4.39	4	0.94
Appetite reduction		22	5.43	28	2.86	16	4.68	10	2.36
Fatigue		127	31.36	116	11.84	116	33.92	40	9.43
Complaints about ear		3	0.74	3	0.31	6	1.75	2	0.47
Heartburn		2	0.49	16	1.63	5	1.46	10	2.36
Itching		7	1.73	29	2.96	6	1.75	10	2.36
Stroke		0	0	5	0.51	0	0.00	1	0.24
Intestinal blockage problem		0	0	2	0.2	1	0.29	2	0.47
Hypersensitivity		4	0.99	3	0.31	8	2.34	1	0.24
Muscle pain		48	11.85	9	0.92	48	14.04	6	1.42
Swelling		16	3.95	17	1.73	15	4.39	10	2.36
Dizziness		52	12.84	89	9.08	55	16.08	43	10.14
Vertigo		20	4.94	88	8.98	17	4.97	46	10.85

discomfort had pain at the injection site; 32.35% had body pain; and 31.36% had symptoms of fatigue. On the other hand, 75.51% of participants with physical discomfort in Bangladesh had pain at the injection site; 41.12% had a fever; and 38.67% had body pain. For the second dose, post-vaccination physical discomfort occurred in 60.96% of those vaccinated in Turkey and 52.61% in Bangladesh. In Turkey, 76.90% of the participants with physical discomfort had pain at the injection site; 42.40% had body pain; 33.04% had a headache; and 30.99% had joint pain symptoms. In Bangladesh, 70.52% of the participants with physical discomfort had pain at the injection site; 37.50% had a fever; and 33.73% had body pain.

Figure 3 shows the opinions of the participants about the severity of the side effects experienced after the first dose and second dose of COVID-19 vaccines. The majority of participants both from Turkey and Bangladesh experienced the side effects at a mild level after taking the first dose. In the case of the second dose, while the majority of the participants from Turkey experienced the side effects at a moderate level, the majority of the participants from Bangladesh experienced them at a mild level.

Figure 4 shows the distribution of the duration of side effects after the first dose and second dose of vaccines. For both doses, the side effects lasted between 1 and 3 days for the majority of participants from Turkey and Bangladesh.

After the first and second doses, it was observed that the percentages of the medication use to treat the side effects of the participants from Bangladesh were significantly higher ($p<0.05$).

There was no significant difference ($p>0.05$) after the first and second vaccine doses of the participants from Turkey according to the presence of chronic disease. On the other hand, while there was no significant difference ($p>0.05$) after the first dose of the participants from Bangladesh according to the presence of chronic disease, a significant difference ($p<0.05$) was found after the second dose of the vaccine. While 60.73% of the participants with chronic diseases from Bangladesh experienced side effects after the first dose, the rate of those who experienced side effects after the second dose was 42.31%. For Turkey, it

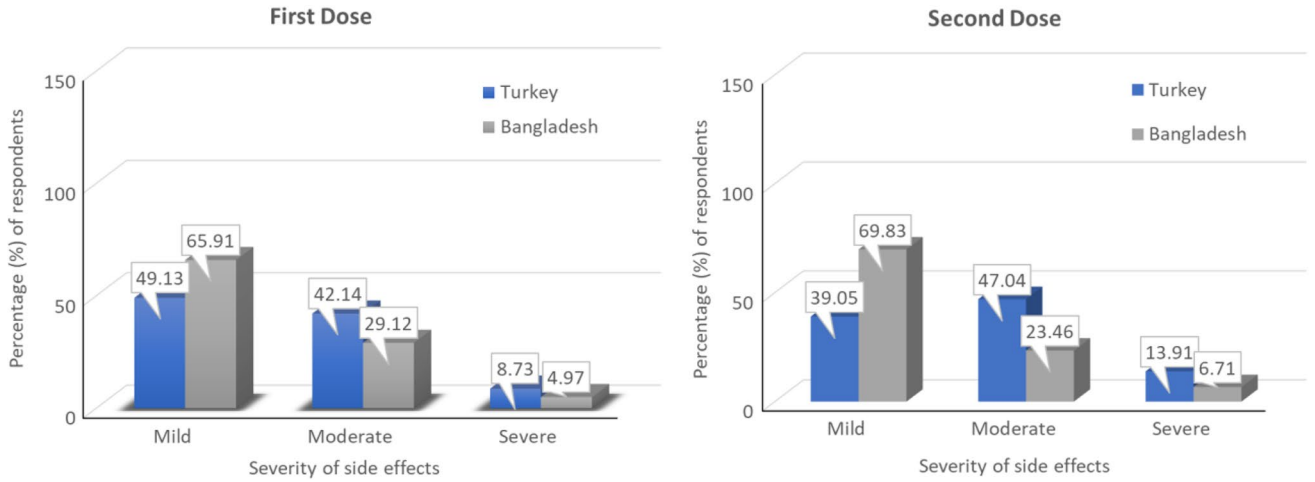

Fig. 3 The severity of side effects experienced after getting the vaccines (both for the first dose and second dose)

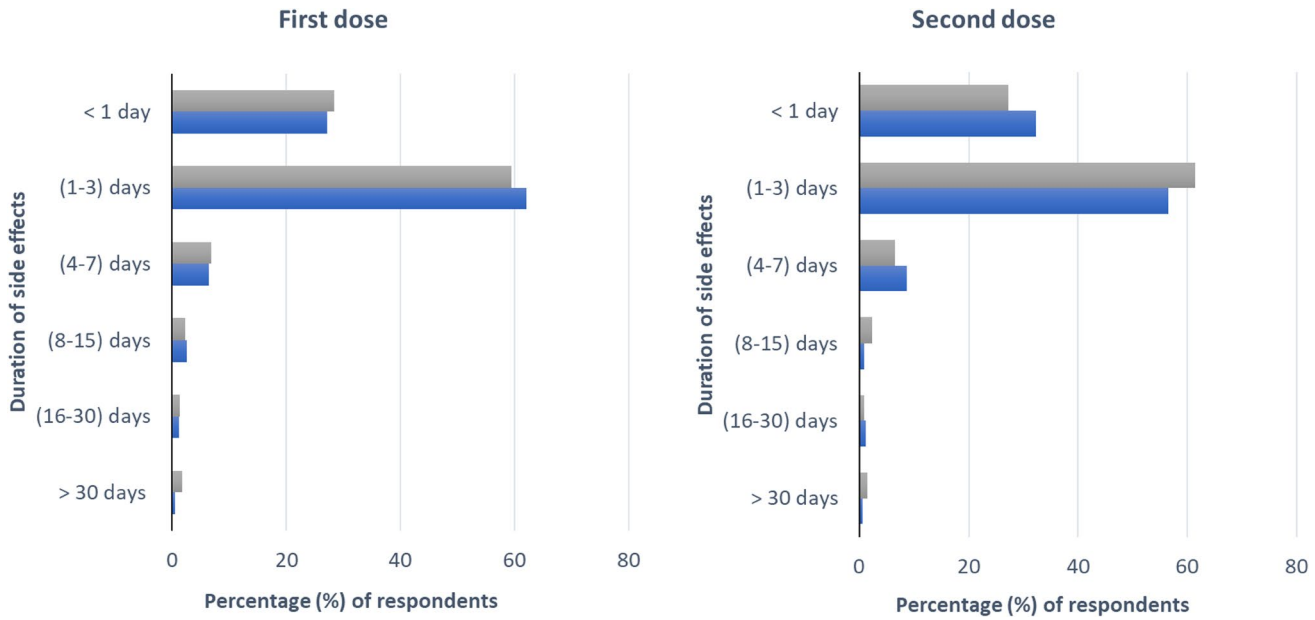

Fig. 4 Duration of side effects after taking the first and second doses of COVID-19 vaccines

was 73.85% for the first dose and 63.93% for the second dose, which is slightly greater than the data obtained from Bangladesh.

Table 6 shows the distribution of COVID-19-like symptoms experienced after vaccines. The majority of the participants both from Bangladesh and Turkey did not experience any COVID-like symptoms after either dose. However, while there was no significant difference between Turkey and Bangladesh in terms of the symptoms experienced after the first dose, there was a significant difference after the second dose. While the rate of experiencing symptoms similar to COVID-19 after the second dose was 10.34% in Turkey, it was 4.34% in Bangladesh.

Discussion

Our study aimed at pooling the local and systemic adverse effect differences among COVID-19 vaccines in a binational approach. The reasons behind choosing Turkey and Bangladesh for the comparison are the geographic and socioeconomical differences between the two countries along with their disease management system and different distribution patterns of different COVID-19 vaccines. To lessen the severity of this pandemic, different vaccines were manufactured and administered worldwide (Callaway 2021; Mallapaty and Ledford 2020). This study's

Table 6 The distribution of COVID-19-like symptoms experienced after vaccines

		Turkey		Bangladesh		Total		χ^2	*p*
		F	%	*F*	%	*F*	%		
First dose	No	532	88.37	1320	87.53	1852	87.77	1.988	0.216[a]
	Yes	70	11.63	84	5.57	154	7.30		
	Unknown	0	0.00	104	6.90	104	4.93		
Second dose	No	461	82.17	744	92.31	1205	88.15	13.796	0.001
	Yes	58	10.34	35	4.34	93	6.80		
	Unknown	42	7.49	27	3.35	69	5.05		

[a]Monte Carlo *p*-value

demographic information indicated that the majority of respondents were female. In our survey, 77.5% of vaccination recipients reside in urban regions whereas 29.37% reside in rural areas. Consequently, there was a discernible disparity in awareness among rural residents. The biggest number of responders (66.8%) belonged to the 18–30 age group.

Our previous research showed the AEFI of Oxford-AstraZeneca vaccines with a non-replicating viral vector against COVID-19 and its severity (Sultana et al. 2021). The present study revealed that the mRNA vaccines Pfizer and Moderna have shown a higher percentage of adverse events, compared to inactivated whole virus vaccines Sinopharm and Sinovac, in both countries. Some previous studies also support this data (Kadali et al. 2021; Navar et al. 2021; Braun-Moscovici et al. 2021; Cohen 2021; Krammer et al. 2021).

The mRNA vaccines showed a higher percentage of occurrence of local and systemic side effects such as fever, pain, irritation at the site of injection, headache, and body pain in both countries. It is also noticeable that Sinopharm, Sinovac, and Oxford-AstraZeneca vaccines showed a significant reduction in adverse events after the second dose of overall immunization.

In some previous studies, the Moderna vaccine showed injection-site urticarial and injection-site maculopapular dermatitis. Immediate injection site reaction and delayed inflammatory reaction after the first dose were reported during the phase III clinical trial (Paterlini 2021). After receiving the Pfizer-BioNTech vaccine, a 55-year-old woman visited the Oral Medicine Department at the Policlinic of Bari, where she reported experiencing severe sores on her lips, oral mucosa, hands, knees, and feet (Petruzzi et al. 2022). Oxford-AstraZeneca and Sputnik-V showed allergic skin reactions, dermatitis, alopecia, eczema, and most concerning, four deaths in the phase III clinical trial (Kounis et al. 2021; Munavalli et al. 2021; Rice et al. 2021; Wise 2021). When listing the potential side effects of the Oxford-AstraZeneca vaccine, it is important to include superficial vein thrombosis (SVT). The potential for thromboses is outweighed by the benefits of the vaccination in preventing the further spread of COVID-19 (Chavda et al 2022).

Administering Johnson and Johnson vaccine has been paused due to blood clotting problems in vaccinated people. Six cases of blood clots were reported with low platelet counts in the US till April 13, 2021 (Fansher et al. 2022; Mahase 2021).

It has been determined that COVID-19 infection can lead to a variety of cardiovascular complications, including thrombosis (particularly in the coronary arteries), acute coronary syndrome, cardiac arrest, and myocarditis. Similar cardiovascular side effects are linked to a number of COVID-19 vaccines, according to data from regulatory surveillance and self-reporting systems like the Vaccine Adverse Events Reporting System (VAERS) in the United States (US), the Yellow Card System in the UK, and the EudraVigilance system in Europe (Sun et al. 2022).

In this study, we determined the severity of AEFI based on its duration. Different COVID-19 vaccine side effects generally stayed for 0–3 days, and most adverse events were mild to moderate in both countries. However, the Bangladeshi population faced 15% more mild side effects and 10% fewer side effects, compared to the Turkish population. The trend for the severity was surprisingly similar for both the 1st and 2nd doses in both countries. For both doses, the most taken vaccine was Pfizer-BioNTech in Turkish participants and Sinopharm in Bangladeshi participants. Turkish population showed almost two times higher severe side effects, compared to the Bangladeshi population, but the fatality ratio is 0.89% and 1.77% for Turkey and Bangladesh, respectively (Tazerji et al. 2022). According to CDC recommendations, the majority of participants were directed to remain at the vaccination center for longer than 15 min following injection (CDC, 2021). During this period, participants also received guidance on how to manage mild to moderate side effects.

In our study, 60.73% of the participants from Bangladesh experienced side effects after the first dose and 42.31% after the second dose who had chronic disease conditions. Results obtained from Turkey showed an almost similar pattern. A previous study showed that individuals with no prior comorbid disorders had a case fatality rate of 0.9%; it was much higher for those with diabetes, cardiovascular diseases,

chronic respiratory diseases, systemic hypertension, and cancer, making these demographic groups high-risk and more susceptible to severe COVID-19 (Varghese et al. 2020).

In both countries, the population experiences a lower percentage of COVID-like symptoms after the second vaccination, and the possible reason could be the boost of the immune system (Mancuso et al. 2021). Various literature studies suggest that the COVID-19 vaccines can hold up to half of the antibodies every 3.5 months (CDC 2022; Dolgin 2021). During the surge of delta variants of SARS-CoV-2, the second jab was deployed to the adolescent to elderly mass population in Turkey and Bangladesh. The young population aged from 18 to 30 years is the majority of the recipient of COVID-19 vaccines with the percentages of 75.9% and 63.2%, respectively, for Turkey and Bangladesh. This indicates that the awareness of this pandemic in both countries is prominent to the young generation compared to the elder. Tendency to explore different mass media and the use of logical thought to imagine the worst consequences of COVID-19 drives them to be alert to this pandemic. Senior citizens in both countries aged above 60 years are the minority who were included in this survey (Turkey 4.1%, Bangladesh 9.9%). The possible reason behind this could be less internet use by elderly people in both countries. However, strict regulation of mass vaccination programs has an impact on this worldwide vaccination rate variation among the elderly population (Callaway 2021). In the beginning, people had hesitancy to take the vaccines due to their uncertain severity, but it overcame over time (Sallam 2021; Troiano and Nardi 2021). In our study, we found that the majority of people (Turkey 63.5% and Bangladesh 64%) agreed that vaccines would help to prevent the pandemic. Although there has been a neutral thought about the vaccine efficacy in a similar percentage of 28.7% and 28.2% for Turkey and Bangladesh, respectively, these perception statistics regarding vaccination efficacy help us understand people's interaction with the medicinal treatment approach to eradicate a pandemic. Additionally, we discovered in our study that the COVID-19 vaccination was related to a decreased percentage of any type of allergic reaction. Thus, our review of the COVID-19 vaccine-associated adverse effects will be useful in dispelling misconceptions surrounding these vaccinations and providing a clear scenario of the outcomes of the COVID-19 vaccination rollout in Turkey and Bangladesh.

Conclusion

After the systematic analysis of the associated side effects and severity of COVID-19 vaccines, we can summarize that the COVID-19 vaccines are safe. People gave preferences and values to the effectiveness of COVID-19 vaccines more than the minor side effects. These vaccines have shown proof of immune response through non-serious adverse events. Binational assessment between Turkey and Bangladesh also showed a similar pattern of non-serious adverse events in healthy adults along with the elderly population with different comorbid diseases. The study possesses multiple strengths and a few limitations. Considering different possible variables including age, perception about vaccination, comorbid conditions, the inclusion of a wide range of possible side effects due to COVID-19 vaccination, the binational approach of the survey, and the role of social networking are the remarkable strengths of our COVID-19 vaccine AEFI study. Regarding limitations, our online-based survey study could not approach the mass population with face-to-face interactions. Another limitation was that the participation of the elder population was not as high as the participation of the young adult population due to technological retrogression. The effectiveness of existing vaccines in controlling and preventing SARS-CoV-2 infection in Turkey and Bangladesh should be evaluated by defining the appropriate vaccination strategy in the context of a large-scale follow-up study. Longitudinal surveys and pharmacovigilance analyses should also be conducted to investigate vaccination adverse effects over time. As the COVID-19 pandemic crisis continues to unfold, it is becoming increasingly urgent to assess the level of precautions taken by nations to face this pandemic and to explain the crucial qualities that might facilitate more effective policy responses to limit and/or avoid the detrimental consequences of future pandemic crises on people's health and the economy.

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Author contribution MSA, SMB, and MSR have conceived the original idea. AS (Arifa Sultana), SRM, SMB, and MSA constructed the questionnaire in Google form. AS (Arifa Sultana), SRM, AS (Ananya Saha), FY, RT, NBB, KRF, SS, KMRP, FR, FN, MS, QAS, MIU, JF, MAHM, TA, MMR, MRK, FA, and SMB extensively collected the survey data by using electronic and social media. AS (Arifa Sultana), SRM, AS (Ananya Saha), and NBB prepared the initial manuscript with references. SMB, SRM, SS, and KMRP did the statistical analysis. MMRS, SMB, JAC, AAC, and SK critically reviewed the overall activities. SMB, MSR, and MSA supervised the whole activity. All the authors have read and agreed to the published version of the manuscript.

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Data and material/code availability The data used for this study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval Ethics approval was obtained from the Ethical Review Committee of the Faculty of Biological Sciences, University of Dhaka (Ref. No. 159/Biol. Scs.).

Consent to participate Participants gave their implied consent to participate in the study by voluntarily completing the survey.

Consent for publication Not applicable.

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