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Analyzing the Effectiveness of Different Vaccines against SARS-CoV-2 Infection: A Retrospective Study from Lahore, Pakistan

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ABSTRACT

Coronavirus disease (COVID-19), a viral disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has affected the entire world, killing approximately 5 million people. The COVID-19 pandemic has raised several questions for the researchers to answer in terms of therapeutics and proteins. Several vaccines against SARS-CoV-2 are now available all around the world. These vaccines showed significant efficacy in clinical trials. However, some individuals become affected by COVID-19 even after vaccination. This study aimed to determine the effectiveness of different vaccines being used in Lahore, Pakistan on the basis of symptoms and relapse. This cross-sectional study was conducted at the Institute of Public health, Mayo Hospital, Lahore, Pakistan. Samples collected from September 18, 2021 to October 18, 2021 were included in the study. The nasopharyngeal swab samples of patients were collected and put in the viral transport medium (VTM) to safely transfer them to the diagnostic lab. Real-time PCR was used for the identification of the virus. The study found that some vaccinated people were affected by SARS-CoV-2 infection; however, the prevalence of the infection in such people was low (9.21%, 93 out of 1010). It was observed that most of the vaccinated patients remained stable. The authors did not commemorate any deaths among them. It was concluded that the vaccines that are currently available and being used have significant efficacy. However, future studies are required to determine their side effects.

Keywords: clinical severity, COVID-19, infection, patients, SARS-CoV-2, vaccines

1. INTRODUCTION

In December 2019, several patients with symptoms similar to pneumonia appeared in Wuhan city, China. After genome sequencing, it was discovered that this pneumonia of unknown etiology was caused by a novel CoV, henceforth known as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)[1]. The coronavirus family belongs to the order *Nidovirales* and consists of two subfamilies, namely Letovirinae and Orthocoronavirinae[2].

Human immune system is a defense system that fights against foreign infectious agents by producing specific antibodies and lymphocytes. Lymphocytes and macrophages are the main components of the human immune system. They develop in thymus and bone marrow [3]. SARS-CoV-2 is an RNA virus with a diameter of approximately 60-140 nm. By binding to host receptors and fusing host and viral membranes, SARS-CoV-2 enters into the host cell. ACE2 is the primary receptor of SARS-CoV-2 [4]. After entering the cell the virus starts propagating itself, faces a minor immune response and can be

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detected by nasal swab. The virus continues to multiply and eventually reaches the respiratory tract, meeting a vigorous innate immune response [5]. According to one study, 80% of the infected people experience mild symptoms and infection is restrained to the upper and conducting airways [6]. On the other hand, 20% of people develop severe infection [7]. Different reports state that patients aged over 60 years, who have issues such as hypertension or are immunocompromised, are more prone to severe illness and at a high risk of death[8,9].

The COVID-19 pandemic forced researchers to give answers in terms of therapeutics and vaccines. Immunotherapy is considered as one of the best methods used for the treatment of cancer and (many) infectious diseases [10]. It involves artificially triggering the immune system to elicit an immune response [10]. Access to a safe and effective vaccine is necessary to deal with the COVID-19 pandemic. Through reports, it has been discovered that no obvious cross-neutralization exists between SARS-COV and SARS-CoV-2, so recovery from one infection does not guarantee a shield for the other. Being vaccinated does not mean that there is no risk in the future, as research is still going on regarding the effectiveness of vaccines and how they can help fight against SARS-CoV-2 and reduce its transmission [11].

This study aimed to assess the effectiveness of the available vaccines against the SARS-CoV-2 infection. It included different parameters such as age and gender for this purpose.

2. METHODOLOGY

2.1. Study Design

This cross-sectional study was conducted at the Institute of Public Health,

Mayo Hospital, Lahore, Pakistan. People tested for SARS-CoV-2 in Mayo Hospital, Lahore from September 18, 2021to October 18, 2021 were screened for inclusion. Out of the 1010 enrolled subjects, 668 were male and 342 were female. The enrolled subjects were recruited from Lahore, Pakistan. Convenient sampling method was adhered to for their enrollment. Written informed consent was obtained from the patients during data collection. Only completely vaccinated subjects were included, while partially vaccinated subjects were excluded. Data including the types of vaccines, number of dozes, and the date of vaccination were recorded. Fig. 1 presents the study design in the flow chart diagram. Table 3 presents the number of subjects included under each vaccine group.
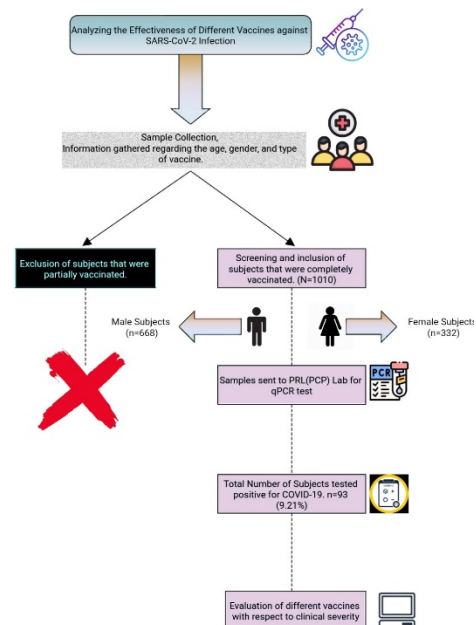
Figure 1. Schematic Diagram of Study Design

2.2. Sample Collection

The nasopharyngeal swab samples of patients registered at the Institute of Public Health, Mayo Hospital, Lahore, Pakistan were collected and put in the viral transport medium (VTM) to safely transfer the sample to the diagnostic lab for SARS-CoV-2 detection [12].

2.3. Real-time PCR

Nasopharyngeal swab samples of enrolled subjects were submitted to PRL (PCP) lab. COVID-19 was quantitatively analyzed using the fully automated cobas system (FDA, CE-IVD) of Roche [13].

2.4. Statistical Analysis

For statistical analysis, chi-square test was applied using IBM SPSS (version 25). *P-value*< 0.05 was considered statistically significant.

Most of the subjects (671 out 1010) had moderate symptoms. Subjects with moderate symptoms had the respiratory rate 24-30 /min, SpO2 90-94% at room temperature. Among the 671 symptomatic subjects, 17 tested positive for SARS-CoV-2 infection, followed by subjects with mild symptoms (266 out of 1010). Furthermore, 7 subjects with mild symptoms tested positive. People with mild symptoms had the respiratory rate <24/min, SpO2>94% at room temperature. Moreover, 68 subjects were stable. Of these, only 1 tested negative and 67 tested positive for SARS-CoV-2 infection. Furthermore, 3 subjects were asymptomatic, while 2 subjects (with severe symptoms) tested positive for SARS-CoV-2 infection. These subjects had the respiratory rate > 30 /min, SpO2 < 90% at room temperature.

3. RESULTS

Table 1. Symptoms of COVID-19 in Enrolled Subjects and Positivity Rate of PCR Test for SARS-CoV-2

Symptoms	National Guidelines	PCR Results for SARS-CoV-2					
		Negative	Percentage	Positive	Percentage	Total	Percentage
Stable	Minor fever and slight body pain	1	0.11%	67	72.04%	68	6.73%
Asymptomatic	asymptomatic	3	0.33%	0	0%	3	0.3%
Mild	Respiratory rate <24/min, SpO2>94% at room temperature	259	28.24%	7	7.53%	266	26.34%
Moderate	Respiratory rate 24-30 /min, SpO2 90-94% at room temperature	654	71.32%	17	18.28%	671	66.44%
Severe	Respiratory rate > 30 /min, SpO2 < 90% at room temperature	0	0%	2	2.15%	2	0.2%
Grand Total		917	90.79%	93	9.21%	1010	100%

The current study found that the prevalence of SARS-CoV-2 infection in vaccinated people was low (9.21%, 93 out of 1010). In this regard, 68 out of 668 males tested positive, while 25 out of 342 females tested positive. Moreover, subjects who were in the age group 25-34 years had a greater incidence of COVID-19 (15.33%), followed by subjects in the age group of 35-44 years (9.46%). However, the relationship of age and gender with SARS-CoV-2 infection was not found to be statistically significant.

Table 2. Age-wise and Gender-wise Distribution of SARS-CoV-2 Vaccinated Patients

Age Interval	Total Tested	Males Tested	Found Positive	Females Tested	Found Positive	Total Positive Tested	p-value
18-24	169	112	6 (5.36%)	57	2 (3.51%)	8 (4.73%)	0.593
25-34	300	196	38 (19.39%)	104	8 (7.69%)	46 (15.33%)	0.007
35-44	232	150	14 (9.33%)	82	7 (8.54%)	21 (9.46%)	0.84
45-54	149	99	4 (4.04%)	50	2 (4%)	6 (4.03%)	0.991
55-64	109	70	3 (4.29%)	39	4 (10.26%)	7 (6.42%)	0.223
65-74	41	33	2 (6.06%)	8	1 (12.5%)	3 (7.32%)	0.53
75-84	8	7	1 (14.29%)	1	1 (100.0%)	2 (12.5%)	0.064
≥85	2	1	0 (0%)	1	0 (0%)	0 (0%)	<0.05
Total	1010	668	68 (10.18%)	342	25 (7.31%)	93 (9.21%)	0.136

Most of the people received inactivated vaccines (Sinovac and Sinopharm) in Lahore, Pakistan. Pfizer, an mRNA vaccine, was found to be the most effective vaccine, as the infection rate and relapse ofCOVID-19 was low in Pfizer vaccinated subjects (n=2, 8%), followed by Sinopharm (n=29, 8.03%) and Sinovac (n=42, 8.42) vaccinated subjects. Moreover, two subjects were vaccinated by Sputnik and both tested negative for SARS-CoV-2 infection. VaxZrvria-AstraZeneca was not found to be efficient as the prevalence of SARS-CoV-2 infection was high in VaxZrvria-AstraZeneca vaccinated subjects (n=8, 29.63%). The result of VaxZrvria-AstraZeneca was also found to be statistically significant (p<0.05). The relationship of these results with gender was not found to be statistically significant.

Table 3. Status of Different Types of Vaccines in 1010 Vaccinated and Tested Patients

Vaccine Types	Trade Names	PCR Results for SARS-CoV-2		Gender (Infected)		p-value
		Negative	Positive	Male	Female	
Recombinant Vaccine	PakVac	5 (71.43%)	2 (28.57%)	1 (50%)	1 (50%)	0.284
	Sputnik	2 (100%)	0 (0%)	0 (0%)	0 (0%)	
	Cansino	58 (89.23%)	7 (10.77%)	6 (85.71%)	1 (14.29%)	
Adenovirus vaccine	VaxZrvria-AstraZeneca	19 (70.37%)	8 (29.63%)	6 (75%)	2 (25%)	<0.05
mRNA based vaccine	Moderna	21 (87.5%)	3 (12.5%)	2 (66.67%)	1 (33.33%)	0.361
Inactivated Vaccine	Pfizer	23 (92%)	2 (8%)	2 (100%)	0 (0%)	0.530
	Sinovac	457 (91.58%)	42 (8.42%)	29 (69.05%)	13 (30.95%)	
	Sinopharm	332 (91.97%)	29 (8.03%)	22 (75.86%)	7 (24.14%)	

The clinical severity of infected patients was analyzed. It was found that most vaccinated people remained stable after being infected by SARS-CoV-2 (67 out of 93, 72.04%). Only two patients developed a severe condition. Moreover, the relationship of clinical severity with vaccination was not found to be statistically significant ($p = 0.63$).
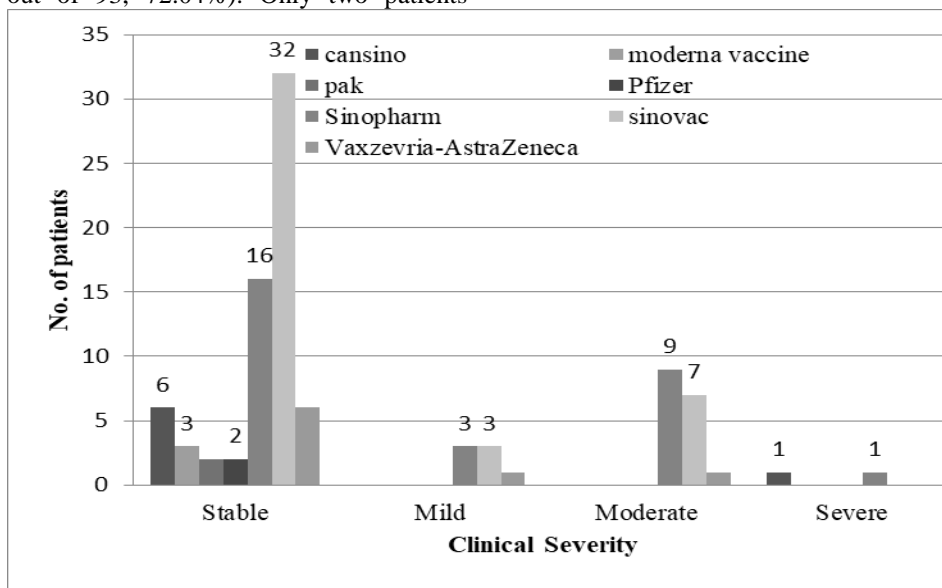
Figure 2. Relationship of Different Types of Vaccines with Clinical Severity of (Vaccinated) SARS-CoV-2 Infected Patients

4. DISCUSSION

Currently available COVID-19 vaccine-related studies are not sufficient to relate the current findings with the findings of other authors. Furthermore, the existing literature covers minimal data of different types of vaccines, their side effects, and SARS-CoV-2 infection in vaccinated persons. Therefore, in the discussion section, significant findings related to COVID-19 vaccines are summarized.

Vaccination against COVID-19 is the primary strategy to deal with the COVID-19 pandemic. At present, several vaccines are available. The UK was the first country to authorize the first COVID-19 vaccine. A good efficacy of the vaccine in clinical trials was found. It is necessary to determine the effectiveness of vaccines and their side effects, keeping in view the large number of vaccinated people.

According to one study, some people can catch SARS-CoV-2 infection even after vaccination [14]. The current study also observed that several vaccinated patients (9.21%, 93 out of 1010) were affected by SARS-CoV-2 infection. According to the findings, the infection was milder in vaccinated patients, although the mortality rate was still high in UK hospitals [15]. It was also found that vaccinated patients remained stable after SARS-CoV-2 infection; however, the current authors did not observe any mortality.

As the vaccination process is ongoing, and since most people have been vaccinated, it is essential to determine the vaccines' efficacy and side effects. Therefore, the current study aimed to assess the efficacy of different vaccines being used in Pakistan. However, several studies are required to determine the side effects associated with COVID-19 vaccines.

4.1. Conclusion

The findings indicated that the prevalence of SARS-CoV-2 infection in vaccinated people is low as compared to unvaccinated people. Furthermore, it was also observed that most of the vaccinated patients remained stable after contracting the infection. The current authors did not observe any mortality among vaccinated patients. It was also concluded that the vaccines used in Pakistan are effective against SARS-CoV-2 infection. However, further studies should be conducted to determine the side effects associated with these vaccines so that their impact can be fully understood.

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