Evaluating the Role of COVID-19 Vaccines in Patient Outcomes

Evidence From the Eighth Wave in Kerman, Iran

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Abstract: Background: The recent SARS-CoV-2 pandemic posed a significant threat to human life. Vaccines played an unprecedented role in managing adverse outcomes, but the virus's ability to mutate and produce new variants posed ongoing challenges. This research aimed to examine the association between different types and numbers of doses of COVID-19 vaccinations and the clinical and demographic characteristics of patients.

Methods: This retrospective cross-sectional study was carried out on 161 COVID-19 patients hospitalized at Afzalipour Hospital in Kerman, Iran, during the eighth wave of the pandemic. Data on demographic features, symptoms, patient status, disease outcome, and vaccination history of patients were collected.

Results: Most patients (over 75%) had received 2 or 3 doses of the vaccine. Vaccination type and the number of doses showed significant differences based on patient gender ($P = 0.048$) and age group ($P = 0.034$), respectively. Shortness of breath showed significant differences based on the type of vaccine received ($P = 0.0178$). Fatigue substantially differed based on the number of vaccine doses ($P = 0.03975$). There were no significant differences in gastrointestinal symptoms, patient or disease status based on the number or type of vaccines, but lower death rates were observed in vaccinated patients. Additionally, while trends indicated better outcomes with a higher number of vaccine doses, there were no significant variations in blood oxygen saturation (SpO_2) or respiratory rate based on the type or number of vaccine doses.

Conclusions: The findings highlight the role of vaccination in managing COVID-19 outcomes despite the reduction of vaccine efficacy against emerging variants.

Key Words: COVID-19, vaccines, patients, hospitalization

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The recent pandemic of the SARS-CoV-2 virus had a drastic impact on people's lives and economics around the world and challenged healthcare systems globally.[1,2] Since the beginning of this pandemic, researchers have struggled to create suitable treatment and prevention methods to stop the spread of the virus. This has led to numerous treatment strategies and diverse vaccination methods being introduced and used in different parts of the world.[3,4] On June 12th, 2023, the World Health Organization (WHO) officially declared that COVID-19 was no longer a public health emergency of international concern.[5] However, the risk of COVID-19 disease spreading and its outcomes are not over, and research continues to unravel different aspects of this disease and the long-term implications of its infection.[6,7] Understanding the impacts of strategies used to control COVID-19 will not only help in better disease management but will also provide insights for preparing for other emerging infectious diseases in the future.

While the great impact of vaccination in controlling the COVID-19 disease is undeniable, the ability of SARS-CoV-2 to undergo genetic changes and the emergence of new variants can help the virus develop resistance against immunity elicited by vaccines designed based on the earlier variants.[8–10] During the pandemic, multiple waves were distinguished based on different characteristics of COVID-19 and the predominant circulating variants of SARS-CoV-2.[11,12]

Earlier studies concluded that natural infection and vaccination are highly effective in eliciting protection.[13] However, the clinical characteristics of infected patients can vary based on the variant of the virus, the demographic characteristics, the type of vaccines administered, and the number of doses received by patients. Because the vaccine types used in different countries and populations are varied, it is important to investigate the effect of vaccine type and efficiency of immunization programs in different regions and populations to gain a thorough understanding of the vaccination efficacy during different waves of COVID-19. Therefore, further research in various contexts can help gain a more comprehensive understanding of the impact of vaccination in different settings.

In this retrospective cross-sectional study, we explored the relationship between different vaccine types that were administered in Iran and the number of administered doses with clinical and demographic characteristics of COVID-19 disease in patients during the eighth wave of the pandemic (January 21st to May 21st, 2023) in Afzalipour Hospital, Kerman, Iran. We aimed to investigate whether there is an association between vaccination and the severity of the disease, symptoms, and demographic characteristics of the disease in COVID-19 patients.

MATERIAL AND METHODS

Study Population

The study was performed retrospectively on 161 patients admitted to Afzalipour Hospital in Kerman, Iran, during the eighth

wave of COVID-19 (January 21st to May 21st, 2023). The criteria for hospitalization of patients in our study included severe shortness of breath, rapid breathing, low blood oxygen levels (≤90%), and clinical signs of pneumonia.

Informed consent was obtained from all patients prior to their participation, and the study was conducted in accordance with the Declaration of Helsinki. This research received ethical approval from the Ethics Committee of Kerman University of Medical Sciences (reference number: IR.KMU.AH.REC.1402.028, Date: 05/14/2023).

Participants were included based on the following criteria:

1. A confirmed diagnosis of COVID-19, determined by positive RT-PCR test results or chest CT scan findings, regardless of the presence of clinical signs and symptoms.
2. Availability of medical records, including disease identification, vaccination history, clinical and demographic characteristics, patient outcomes, and disease severity.
3. Consent from the patient or the patient's family (in cases of the patient's death) for inclusion in the study.
4. Residency in Kerman, Iran.

Data Collection

Demographic data (age and gender) and clinical information, including symptoms (respiratory, general, and gastrointestinal symptoms), patient status (hospitalization (patients hospitalized without admission to the intensive care unit (ICU) and discharged in a healthy condition), admission to the ICU (Patients admitted to the ICU and discharged in a healthy condition), and death), and vaccination history (number of doses and type of vaccines), were collected from medical records. Disease status was also collected from medical records and categorized into 3 groups (mild, moderate, and severe) based on the WHO's classification criteria.[14]

Statistical Analysis

Quantitative data were summarized using descriptive statistics, including mean ± standard deviation (SD) and frequency counts. The normality of data distribution and homogeneity of variance were assessed using Shapiro-Wilk and Levene tests, respectively. Depending on the distribution of data, parametric tests (*t* test or 1-way analysis of variance) or nonparametric tests (Mann-Whitney U or Kruskal-Wallis test) were carried out. A χ^2 test was used to analyze the association between qualitative variables. For significant associations, Phi and Camer's V tests were used to specify the strength of the association.

All statistical analyses were performed using R Studio software (version 4.3.2). The ggplot2 package in R Studio was employed for data visualization. A significance level of 0.05 (95% confidence interval) was established as the threshold for accepting or rejecting the null hypothesis.

RESULTS

Patient Characteristics

This study analyzed 161 patients admitted to the Afzalipour Hospital in Kerman, Iran, diagnosed with COVID-19 during the eighth wave of the pandemic (January 21st to May 21st, 2023). The study population included 89 males and 72 females, with ages ranging from 14 to 95 years (mean age 61.2 ± 18.6 years). The mean age was 61.4 ± 19.2 years for men and 60.8 ± 18.1 years for women. There was no significant age-group difference between genders.

Vaccination Status and Types

The patients involved in this study had received between 0 and 4 doses of vaccines, with over 75% receiving 2 or 3 doses. Only 14% of the population (22 patients) had received 0 vaccines. The administered vaccines included the Oxford/AstraZeneca (ChAdOx1 nCoV-19) recombinant vaccine, Sinopharm inactivated vaccine, Sputnik V adenovirus vector vaccine, COVIran Barekat inactivated virus-based vaccine, and PastoCovac recombinant vaccine. A relatively higher vaccination rate was observed in men. Sinopharm was the most frequently administered vaccine (105 patients), while PastoCovac was the least (2 patients). χ^2 analysis showed a significant difference in the number of vaccines received based on the age group of patients ($P = 0.034$, Camer's V = 0.254) (Fig. 1A). Moreover, a significant difference was found in vaccine type based on patient gender ($P = 0.048$, Camer's V = 0.263) (Fig. 1C). No significant differences were observed in vaccine number based on gender or in vaccine type based on age group (Figs. 1B, D).

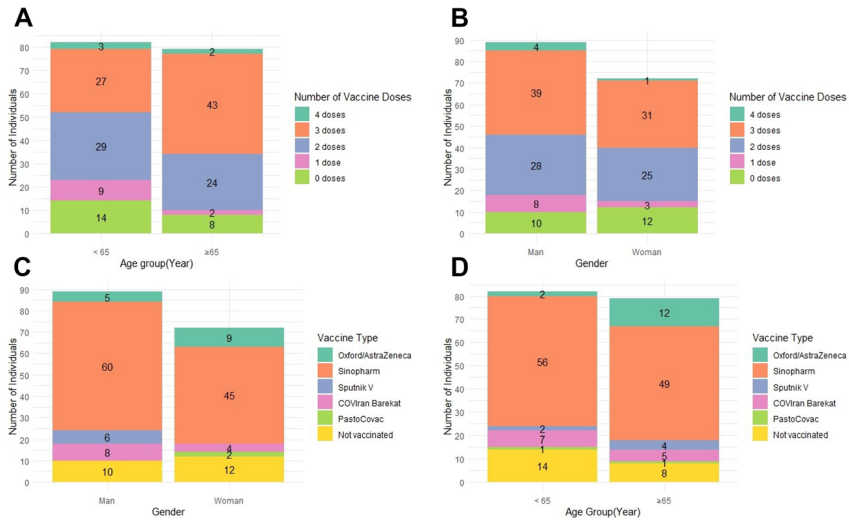

FIGURE 1. The number and type of vaccines received by COVID-19 patients based on gender and age groups.

TABLE 1. The Statistical Analysis Results of Symptoms and Clinical Characteristics Comparison Based on the Type and Number of Vaccines Received by COVID-19 Patients

	Pearson's χ^2 Test (P)	
Symptoms	**Types of Vaccines**	**No. Vaccines**
Shortness of breath	**0.01778***	0.219
Sore throat	0.1537	0.694
Runny nose	0.2576	0.8437
Cough	0.07884	0.6599
Smell loss	0.6206	0.7117
Diarrhea	0.2722	0.9326
Vomiting	0.2056	0.3235
Fever	0.5332	0.6435
Muscle pain	0.07003	0.2393
Headache	0.1324	0.5648
Fatigue	0.416	**0.03975***
Clinical characteristics	**Kruskal-Wallis test (P)**	
	Types of vaccines	**No. vaccines**
Blood oxygen saturation (SpO_2)	0.3911	0.7732
RR	0.9082	0.9429

*$P < 0.05$.

Symptoms, Clinical Characteristics, and Vaccination

Respiratory symptoms analyzed in this study included shortness of breath, sore throat, runny nose, coughing, and loss of smell. There were no significant differences in these symptoms based on the number of vaccine doses received. However, shortness of breath showed significant differences based on the type of vaccine administered ($P = 0.0178$, Cramer's V = 0.2915), with the lowest rate of shortness of breath observed in patients receiving the Sputnik V vaccine (33%).

The lowest average blood oxygen saturation (SpO_2) was observed in the patients who had received 1 dose of the vaccine (86.09 ± 11.55%) and those who had received the COVIran Barekat vaccine (86.17 ± 12.22%). Conversely, the highest average SpO_2 was observed in patients who had received 4 doses of vaccine (89.4 ± 6.35%) and those who had received PastoCovac (94 ± 4.24%). The lowest average respiratory rate (RR) was recorded in unvaccinated patients (17.82 ± 2.38 breaths per minute), while the highest RR was observed in patients who had received 4 doses of vaccine and those who had received the COVIran Barekat vaccine (18.6 ± 1.95 breaths per minute). Kruskal-Wallis test results revealed no significant differences in SpO_2 or RR based on the number or type of vaccines received (Table 1).

Gastrointestinal symptoms (diarrhea and vomiting) and general symptoms (fever, muscle pain, and headache) showed no differences based on the type or number of vaccine doses received. Fatigue was the only general symptom with significant differences based on the number of doses ($P = 0.03975$, Camer's V = 0.2497) (Table 1).

Patient and Disease Status

Patient status was categorized into the following 3 groups: hospitalization, ICU admission, and death. Disease status was classified as mild, moderate, and severe. No statistically significant differences were found in patient status or disease status based on the number or type of vaccines received. However, the mortality rate was higher in unvaccinated patients (23%, 5 patients) compared to all other groups of patients who had received at least one dose of a vaccine (Fig. 2).

DISCUSSION

The pandemic of SARS-CoV-2 put many lives at risk, prompting efforts to eliminate the virus's spread in human populations. Vaccination significantly contributed to mitigating the virus's spread and impact, helping control the pandemic. Understanding the effects of administered vaccines on different populations and demographics provides necessary information for public health strategies to combat COVID-19 and its future threats.

In this study, we comprehensively analyzed the demographic characteristics, symptoms, patient and disease status, and vaccine status of 161 COVID-19 patients admitted to Afzalipour Hospital, Kerman, Iran, during the eighth wave of the pandemic (January 21st to May 21st, 2023). The study included 89 males and 72 females, with a mean age of 61.2 years. No significant differences in the age distribution of the study population were found based

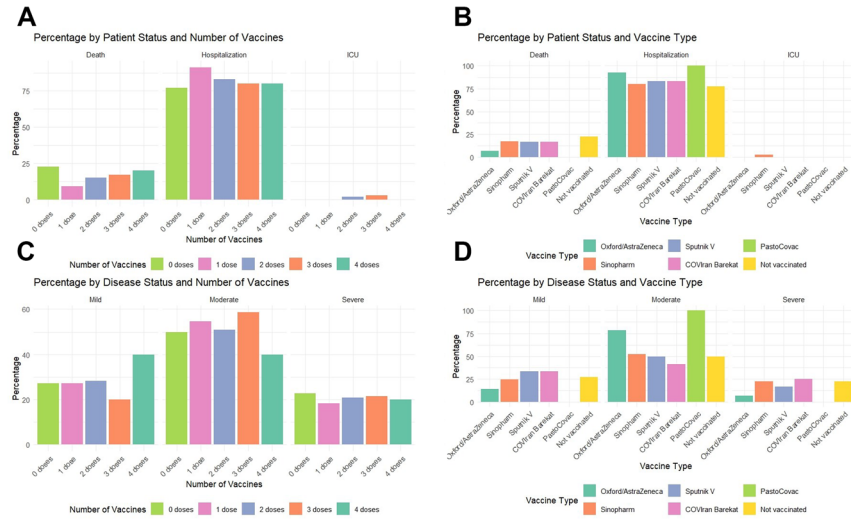

FIGURE 2. Patient and disease status percentages based on the number and type of vaccines received by COVID-19 patients.

on gender. The age and gender distribution aligns with other studies on hospitalized COVID-19 patients, underscoring the elevated vulnerability of older individuals to severe COVID-19 outcomes.[15,16]

A significant portion of the study population had received between 2 and 4 doses of a COVID-19 vaccine, with over 75% receiving 2 or 3 doses. Sinopharm was the most frequently administered vaccine, showing its widespread acceptance, while PastoCovac was the least administered. χ^2

analysis indicated significant differences in the number of vaccines received based on the age group of patients, as well as in the type of vaccine administered based on patient gender. The results regarding the high percentage of vaccination in the studied population suggest either a high rate of vaccination acceptance or a high rate of access to vaccination against COVID-19 and highlight the need to consider demographic characteristics in vaccination strategies for greater efficacy and coverage.

Among the respiratory symptoms investigated, shortness of breath showed significant differences based on the type of vaccine, with Sputnik V vaccination being more effective in reducing this symptom compared to other vaccines. These findings highlight that while vaccinations alleviate symptoms, their effects on certain symptoms may differ depending on their mechanism of action.

Although general and gastrointestinal symptoms did not show significant differences based on vaccine type or number, fatigue showed notable differences based on the number of doses received. It is vital to mention that while SpO_2 and RR did not show any difference based on type or number of vaccines, both showed a trend toward better respiratory outcomes with a higher number of vaccination doses, aligning with previous studies indicating enhanced vaccine efficacy with multiple doses.[17]

Patient and disease severity showed no significant differences based on the number or type of vaccines received. However, the death rate was lower in patients who had received at least 1 dose of the vaccine compared to unvaccinated patients. These findings suggest that, while the effects of vaccination have been reduced compared to other studies conducted in previous waves of the SARS-CoV-2 pandemic, the efficacy of vaccination in improving outcomes and saving lives remains undeniable. Multiple studies have investigated the positive effect of vaccination on different symptoms, disease severity, and patient outcomes.[15,18–20] Furthermore, the Oxford/AstraZeneca vaccination demonstrated the lowest rates of mortality and severe COVID-19 cases among patients, with the exception of the PastoCovac group, which included only 2 individuals. Although there is an indication of improved effectiveness for the Oxford/AstraZeneca vaccination, it is not possible to draw definite conclusions due to the absence of statistical significance in the comparison of vaccine types and outcomes, as well as the small sample size of patients who got the Oxford/AstraZeneca vaccine (14 individuals). While the death rate from other vaccines was similar at 17%, the Sinopharm and COVIran Barekat vaccines recorded the highest severity rates, at 23% and 25%, respectively. Comparing the efficacy of different vaccinations is difficult because of the significant disparity in the number of individuals vaccinated with each vaccine. Sinopharm had the highest number of recipients (105), followed by Oxford/AstraZeneca (14), and even fewer for the remaining vaccines.

The evolving nature of SARS-CoV-2 can cause the virus to escape immunity induced by vaccination. This study was conducted during the eighth wave of the pandemic when the highly prevalent circulating variant was Omicron (XBB.1.5).[21,22] Studies on the SARS-CoV-2 variants align with our findings, showing a trend toward the waning efficacy of vaccines against Omicron variants while maintaining high effectiveness against Alpha and Delta variants.[23,24] Therefore, it is of high importance to update vaccines based on circulating variants to prevent future prevalence, especially in vulnerable groups.

As we move forward to the postpandemic era of COVID-19, more studies are needed to investigate vaccination efficacy in diverse populations. This will help confirm the association between vaccine types and the number of doses with disease symptoms and outcomes in different regions and settings, considering the evolving nature of the virus. Moreover, while prior COVID-19 infection data was not collected in this study, future research should consider the combined effects of vaccination and natural immunity. This comprehensive approach will provide a clearer picture of immunity and protection against severe outcomes.

In conclusion, this investigation provided valuable insights regarding the vaccination status and its association with demographic characteristics and clinical outcomes during the eighth wave of COVID-19 in Kerman, Iran. The high vaccination rate shows the success of public health campaigns and distribution protocols. The overall better outcomes of vaccinated patients compared to unvaccinated patients highlight the ongoing efficacy of vaccines despite limitations in full protection against emerging variants. This information can inform public health strategies and prioritize updating vaccines to address emerging variants effectively.

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