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COVID-19

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Comparative Study about the Effectiveness of Certain Vaccines Against SARS-CoV-2 Reinfection among Iraqi Population

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Abstract

Background: With the continuation of the COVID-19 pandemic, some COVID-19 patients have a risk of SARS-CoV-2 reinfection. Viral gene sequencing has found that some of these patients were reinfected by a different and others by the same strains. This has raised concerns about the effectiveness of immunity after infection and the reliability of vaccination. We conducted a survey study to assess the characteristics of patients with reinfection and possible causes.

Methods and Results: An online survey study was conducted in October 2021 on Facebook social media. This study included 2413 respondents: 1315 subjects received the BNT162b2 mRNA-based Vaccine (Pfizer/BioNTech), 811 received the ChAdOx1 (AZD1222) adenoviral vector vaccine (Oxford–AstraZeneca), and 287 received the Sinopharm inactivated COVID-10 vaccine (BBIBP-CorV). The Pfizer/BioNTech vaccine appeared to be the most effective (84%) in preventing reinfection compared to the Oxford–AstraZeneca vaccine (79%) and the Sinopharm vaccine (70%) (P<0.0001). The reinfection after the first dose appeared to be proximate between the Pfizer/BioNTech vaccine and the Oxford–AstraZeneca vaccine: 10% and 11%, respectively, while the reinfection after the first dose of the Sinopharm vaccine was highest (18%) (P=0.0005). The reinfection after full dose vaccination appeared to be very low in the Pfizer vaccine (6%) but higher in the Astra Zeneca vaccine (10%), which was proximate to the reinfection after the Sinopharm vaccine (12%) (P=0.000). In addition, subjects with comorbidities had three times the risk of reinfection than those without.

Conclusion: Vaccinated patients can be reinfected by SARS-CoV-2, with reinfection rates depending on the vaccine type and comorbidities. **(International Journal of Biomedicine. 2024;14(3):423-427.)**

Keywords: SARS-CoV-2 • COVID-19 • pandemic • reinfection • vaccine

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Abbreviations

COVID-19, coronavirus disease 2019; **RCTs,** randomized controlled trials; **RWE**, real-world effectiveness; **SARS-CoV-2**, severe acute respiratory syndrome coronavirus-2; **VE**, vaccine effectiveness;

Introduction

A novel coronavirus, called severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), was first detected in December 2019 in Wuhan, China. It causes the highly contagious illness COVID-19. Some individuals are asymptomatic, and for others, it can cause symptoms ranging from flu-like to acute respiratory distress syndrome, pneumonia, and death.[(1)]

Social separation, masks, novel antiviral medications, and a potent vaccination were expected to effectively control the COVID-19 pandemic. Creating herd immunity by acquiring natural immunity through diseases is feasible, but the resulting death toll and effects would be catastrophic.[(2)] Therefore, creating a vaccine that works is essential and is seen as the only workable method of creating herd immunity.

Scientists worldwide are working nonstop to create a COVID-19 vaccine. As of June 14, 2022, around 6.3 million

COVID-19 deaths and over 535 million cases of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection have been documented globally. Approximately 66.3% of the global population has received nearly 11.94 billion doses of the SARS-CoV-2 vaccine.[3] Since the outbreak of COVID-19, several vaccines have been tested and granted emergency use authorization. COVID-19 vaccines can be classified into some types: 1. Inactivated Vaccine, 2. Live Attenuated Vaccine, 3. Protein Subunit Vaccine, 4. DNA Vaccine, 5. Vector-Based Vaccine, 6. Recombinant Vector Vaccine. High vaccine effectiveness (VE) against SARS-CoV-2 infection was reported in phase III trials using these vaccines. For example, the ChAdOx1 nCoV-19 vaccine (AZD1222; Oxford-AstraZeneca) and the BNT162b2 mRNA COVID-19 vaccine (Pfizer-BioNTech) demonstrated a VE of 70.4%[4] and 95%[5] effectiveness, respectively.

The Pfizer-BioNTech COVID-19 vaccine consists of an mRNA molecule, sometimes known as a "messenger" ribonucleic acid, that codes for the coronavirus's spike protein on its surface. The virus utilizes this protein to bind to human cells. The mRNA present in the vaccine signals the immune system to generate protein like the spike protein present over the surface of the coronavirus, which generates an immunity barrier in the body by generating antibodies antagonistic toward the SARS-CoV-2 virus.[6,7]

Attenuated adenovirus is included in the AstraZeneca vaccine. To prevent the virus from replicating in human cells, the scientists altered it. Next, the genes encoding the spike protein present on the Coronavirus surface were included. These spike protein genes are delivered to the cells by the vaccine once it has entered the body; these genes are then utilized to assemble the protein. An immunological response is triggered by the spike proteins. Sinopharm created an aluminum-hydroxide-adjuvanted, inactivated whole-virus vaccine (Sinopharm BBIBP-CorV).[8,9]

The effectiveness of COVID-19 vaccines is determined by the number of people who are protected from the virus after receiving the vaccine. The effectiveness of a vaccine is usually measured by its ability to reduce the risk of infection, hospitalization, and death from COVID-19. In general, most vaccines are highly effective in preventing severe illness and death from COVID-19.[10]

Randomized controlled trials (RCTs) are conducted in controlled settings and may not reflect the real-world effectiveness (RWE) of the vaccines. RWE may be contingent on clinical factors such as the unknown level of protection mediated by antibody responses and uncertainties regarding the real-world applicability of post-vaccination antibody responses. Nonclinical factors that can cause problems include dynamics in vaccine supply and demand, availability issues, storage and distribution logistics across large geographical areas, and the need to serve a diverse ethnic population.[10]

The challenge now is that confidence in vaccines has been undermined by waning immunity against infections, misunderstandings and misperceptions around vaccine safety and performance, and the emergence of highly transmissible and immune-evading variations. Several vaccine platforms have been licensed for emergency use worldwide, most providing a high degree of protection from disease and hospitalization. However, the degree of protection from infection is still controversial. To address some of these issues, we aimed to better understand whether VE varied between the most commonly used vaccines for the main clinical outcomes associated with vaccine protection.[11]

At this time, it is not known how effective COVID-19 vaccines are against reinfection. While the vaccines have been shown to be highly effective in preventing initial infection, more research is needed to determine their effectiveness against reinfection.[12] This study will focus on the three vaccines, including the BNT162b2 mRNA-based Vaccine (Pfizer/BioNTech), ChAdOx1 (AZD1222) adenoviral vector vaccine (Oxford–AstraZeneca), and Sinopharm inactivated COVID-10 vaccine (BBIBP-CorV).

This study aimed to compare the practical efficacy against recurrent SARS-CoV-2 infections among three vaccines administered in Iraqi society: BNT162b2 mRNA-based Vaccine (Pfizer/BioNTech), ChAdOx1 (AZD1222) adenoviral vector vaccine (Oxford–AstraZeneca), and an aluminum-hydroxide-adjuvanted, inactivated whole-virus vaccine (Sinopharm BBIBP-CorV).

Materials and Methods

The data for this study was collected via an online survey in Iraqi governorates in October 2021. The web-based questionnaire covered the health state history of SARS-CoV-2 infection and vaccination dosing and type. Respondents to the survey were recruited from Facebook users. A total of 2413 individuals responded. A screening procedure blocked or removed respondents if they were not residents of one of the Iraqi governorates.

Statistical analysis was performed using the statistical software package SPSS version 21.0 (SPSS Inc, Armonk, NY: IBM Corp). Baseline characteristics were summarized as frequencies and percentages for categorical variables. Group comparisons with respect to categorical variables were performed using chi-square tests. A probability value of $P<0.05$ was considered statistically significant.

Results

The proportion of females in the study was higher than that of males (59% vs. 41%) (Figure 1). The study population was administered three types of vaccines: BNT162b2 – 54%, AZD1222 – 34%, and BBIBP-CorV – 12% (Figure 2).

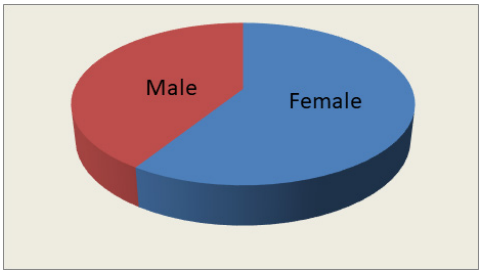

Fig. 1. *Gender distribution for the study population.*

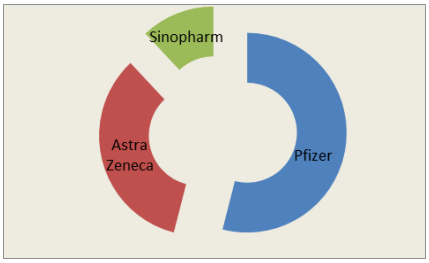

Fig. 2. *The distribution of vaccine types in the study population.*

The distribution of the study population in age groups is demonstrated in Figure 3. The infected individuals were 47%, while the non-infected were 53% (Figure 4). The non-infected division represented individuals who were not infected before or after vaccination.

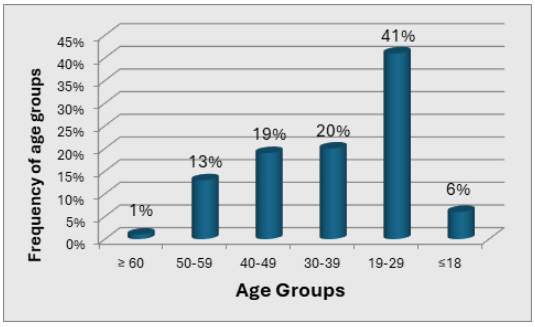

Fig. 3. *Age distribution for the study population.*

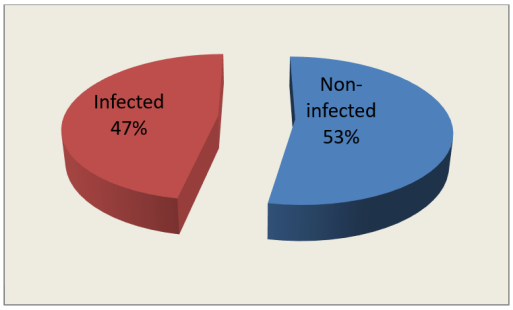

Fig. 4. *Infected and non-infected respondents in the study population.*

The infected individuals were divided into three groups according to the time of infection relative to vaccination. Group 1 included individuals infected before vaccination (37%), Group 2 included individuals infected after the first dose of vaccination (6%), and Group 3 included individuals infected after the second dose of vaccination (4%) (fully vaccinated) (Figure 5). The SARS-CoV-2 reinfection after each vaccine type was demonstrated in Figure 6. In each vaccinated group, Group A represents those who were not infected after vaccination, Group B represents those reinfected after the first dose, and Group C represents those reinfected after the full vaccination. The Pfizer/BioNTech vaccine appeared to be the most effective (84%) in preventing reinfection compared to the Oxford–AstraZeneca vaccine (79%) and the Sinopharm vaccine (70%) (P<0.0001). Patients with comorbid disease had a rate of reinfection three times higher than those who were without comorbid disease.

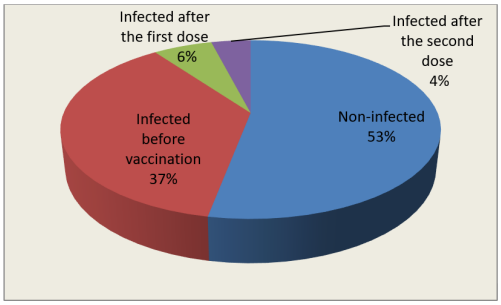

Fig. 5. *Distribution of infected patients according to time of infection*

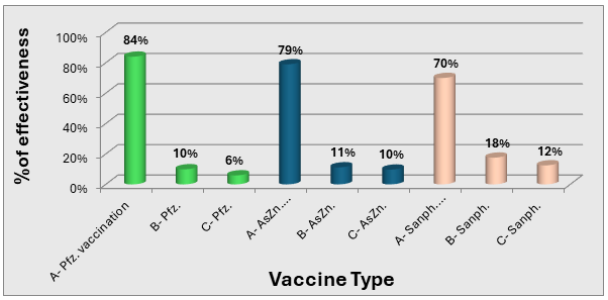

Fig. 6. *The SARS-CoV-2 reinfection after each vaccine type administered.*

Discussion

SARS-CoV-2 is a new coronavirus that, since its discovery, has been spreading all over the world, causing an impressive amount of deaths. Patients infected with SARS-CoV-2 or vaccinated with its FDA-licensed vaccines are believed to carry protective antibodies after recovery. In literature, nonetheless, a series of cases of recurrences is reported as the duration and dynamics of humoral Ab responses against SARS-CoV-2 remain poorly understood.[13]

In this study, 59% of respondents were female, while 41% were males. This may be because women respond more to surveys than men.[14] Another reason may be that women are more aware of disease than men, so they were vaccinated more. A study by Lee et al.[15] also found that women are more likely to answer survey questions, particularly when the survey concerns a relevant topic. Women are also more likely to provide detailed responses and are more likely to complete the entire survey. Additionally, women are more likely to provide honest and accurate answers than men, as presented by Lallukka et al.[16] This finding agrees with Griffith et al. [17] that women are generally more aware of their health than men. Women are more likely to seek medical advice and take preventative measures to protect their health. Women are also more likely to discuss their health concerns with friends and family, which can help them stay informed about potential health risks. Men, on the other hand, tend to be less proactive when it comes to their health,

often waiting until they experience symptoms before seeking medical attention.

Three types of COVID-19 vaccines (Pfizer/BioNTech, Oxford–AstraZeneca, and Sinopharm) are used in Iraq, and all types can reduce the morbidity of COVID-19.[7]

Our study demonstrated that the 19-29-year-old group had the highest percentage (41%) among the others. This may be because this age group represents the highest number of Facebook users to whom the survey was applied, not because they represent the most vaccinated age group in Iraqi society. This finding agreed with Adarsh et al.,[18] who stated that the age group that responds to surveys on Facebook can vary depending on the survey and the target audience. Surveys on Facebook tend to be most effective when targeting users aged 18-34.

According to our study, 53% of the population was noninfected before or after vaccination. The effectiveness of real-world vaccination against COVID-19 is still being studied. However, early studies suggest that the vaccines are highly effective in preventing severe illness and death from the virus. In the UK, for example, a study of more than one million people found that those who had received two doses of the Pfizer/BioNTech vaccine had a 99.9% reduction in hospitalization due to COVID-19 compared to those who had not been vaccinated.[19] In Israel, a study of more than two million people found that those who had received two doses of the Pfizer/BioNTech vaccine had an 86% reduction in symptomatic cases compared to those who had not been vaccinated.[19]

We analyzed the infected individuals, who represented 47% of the study population, according to the time of infection relative to vaccination. The decrease in the proportion of infected individuals from 37% without vaccination to 6% after the first dose, decreasing to 4% after the full vaccination, represents the vital role of vaccination in preventing infection, not only in reducing hospitalization or symptomatic cases. In our study, the effectiveness of vaccination after the first dose agreed with Hunter & Brainard,[20] who stated that a single dose of vaccine is highly protective, although it can take up to 21 days to achieve this. This supports the UK policy of extending the gap between doses by showing that a single dose can give high protection. A decrease in the SARS-CoV-2 reinfection ratio to 4% after full vaccination agreed with data by Seaquist et al.[21]

In our study, the Pfizer/BioNTech vaccine appeared to be the most effective (84%) in preventing reinfection compared to the Oxford–AstraZeneca vaccine (79%) and the Sinopharm vaccine (70%) (P<0.0001). The reinfection after the first dose appeared to be proximate between the Pfizer/BioNTech vaccine and the Oxford–AstraZeneca vaccine: 10% and 11%, respectively, while the reinfection after the first dose of the Sinopharm vaccine was highest (18%) (P=0.0005). The reinfection after full dose vaccination appeared to be very low in the Pfizer vaccine (6%) but higher in the Astra Zeneca vaccine (10%), which was proximate to the reinfection after the Sinopharm vaccine (12%) (P=0.000).

In summary, our data indicate that full vaccination reduced the incidence of reinfection, and the Pfizer/BioNTech vaccine had the greatest protective power against reinfection. A review by Yan et al.[22] reported that the Pfizer vaccine was 95% effective, while the Oxford–AstraZeneca and Sinopharm vaccines were about 70–80% effective.

The large sample of people tested can explain the high effectiveness of the Pfizer/BioNTech vaccine in preventing reinfection. On the other hand, the Oxford–AstraZeneca and Sinopharm vaccines were tested on smaller groups of people and thus could not demonstrate as high a level of protection against the virus. Additionally, the Pfizer/BioNTech vaccine uses mRNA technology that more effectively stimulates an immune response than traditional vaccines.[23] The leading causes of COVID-19 reinfection in Iraqi society are failure to adhere to safety protocols such as wearing masks, social distancing, frequent handwashing, exposure to an infected person, low-income living conditions, continuous traveling between governorates for visiting holy shrines and reinfection with different SARS-CoV-2 variant/lineage, which comes in accordance with Fakhroo et al.[24] who reported that primary exposure to SARS-CoV-2 does not necessarily confer protection from reinfection. Patients with comorbidities in the present study were three times as likely to be reinfected after vaccination. This may be because people with underlying health conditions such as diabetes, heart disease, and obesity are at a higher risk of contracting and suffering from more severe cases of COVID-19.[25]

In conclusion, vaccinated patients can be reinfected by SARS-CoV-2, with reinfection rates depending on the vaccine type and comorbidities.

Competing Interests

The authors declare that they have no competing interests.

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