

Effect of Pfizer/BioNTech and Oxford/AstraZeneca vaccines against COVID-19 morbidity and mortality in real-world settings at countrywide vaccination campaign in Saudi Arabia

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Abstract. – **OBJECTIVE:** Vaccinations are highly essential to control infectious diseases and epidemics. Presently, the entire world faces a challenging crisis of “Severe Acute Respiratory Diseases Coronavirus 2 (SARS-CoV-2), also known as the COVID-19 pandemic”. The impact of vaccines at national levels to reduce the SARS-CoV-2 cases and deaths are unclear, and people have concerns about the effectiveness of vaccines in real-world settings. This study’s objective was to examine the effect of the “Pfizer/BioNTech and Oxford/AstraZeneca” vaccines to prevent SARS-CoV-2 cases and deaths in Saudi Arabia.

MATERIALS AND METHODS: In this retrospective cohort study, we collected data on SARS-CoV-2 cases and deaths from the date of the first case of SARS-CoV-2 in Saudi Arabia March 2, 2020, to the date of launching the vaccination campaign on December 14, 2020; and from December 15, 2020, to September 8, 2021. We recorded the World Health Organization data and Ministry of Health of Saudi Arabia to evaluate the impact of the “Pfizer/BioNTech, (BNT162b2 mRNA) and Oxford/AstraZeneca (AZD1222)” vaccine against SARS-CoV-2 cases and deaths before and after the vaccination campaign in Saudi Arabia.

RESULTS: Saudi Arabia launched the “Pfizer/BioNTech and Oxford/AstraZeneca” vaccination campaign against SARS-CoV-2 on December 14, 2020. In Saudi Arabia, before the vaccination campaign from March 2, 2020, to December 14, 2020, the mean daily SARS-CoV-2 cases were 1235.60, daily deaths were 22.70, that significantly reduced ($p=0.0001$) compared to the period after the vaccination campaign from De-

ember 15, 2020, to September 8, 2021, in which the daily cases fell to 692.08, and daily deaths fell to 9.48 ($p=0.0001$).

CONCLUSIONS: In Saudi Arabia, Pfizer/BioNTech and Oxford/AstraZeneca vaccinations significantly reduced the number of SARS-CoV-2 cases and deaths after the vaccination compared to the period before the vaccination campaign at country levels. The study findings demonstrate that vaccination and adherence to nonpharmaceutical intervention can better control the COVID-19 pandemic.

Key Words:

Vaccination, SARS-CoV-2, COVID-19, Epidemiology, Saudi Arabia.

Introduction

The “Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2)”, also known as the COVID-19 pandemic, has developed a provocative and highly threatening situation worldwide¹. It has involved every corner of the globe, including urban and rural regions in developing and developed nations. The global prevalence of the COVID-19 infection is variable from country to country¹. This pandemic has affected the human population and significantly damaged international industrial sectors, economies, and educational systems. Moreover, the COVID-19 disease has caused many neurological and psychological morbidity impacts on

human beings². On October 15, 2021, the global number of confirmed SARS-CoV-2 cases was 239,437,517, and deaths were 4,879,235 (2.03%). In Saudi Arabia, on that date, the total number of SARS-CoV-2 cases was 547807 (0.23%), and deaths were 8755 (0.17%)³.

Saudi Arabia hosts about 33.7 million people⁴. The state took early preventive procedures against the COVID-19 pandemic, executed the nonpharmaceutical intervention (NPI) policies of staying-at-home, social distancing, free testing, quality treatment facilities, and understood the extent of the COVID-19 pandemic and its related complications. Health officials provided door-to-door treatments *via* speedy courier services for patients who suffered from debilitating conditions⁴. Although social distancing and quarantine limited the number of people infected during the pandemic, a lack of immunity still makes people susceptible to SARS-CoV-2 infections. Health-care workers, older people, and those with underlying health conditions are at the highest risk⁵.

Controlling the COVID-19 pandemic is highly challenging and complicated because the task involves many stakeholders, beginning with public members and ending with health care officials and other organizational establishments. Preventive measures and vaccination are essential in preventing the spread, mutations, and viral replication and controlling the COVID-19 pandemic⁶. The vaccination campaign aims to control the COVID-19 pandemic. The other practical procedures for preventing the pandemic are NPIs, such as social distancing, hygienic conditions, and face masking. The constant adherence to these NPIs is challenging to achieve at various levels in different countries and socioeconomic settings. Vaccination is the best tool to fight against the COVID-19 pandemic. However, the vaccine's impact on SARS-CoV-2 cases and deaths is unclear from country to country, and some people have expressed concerns about the effectiveness of vaccines in real-world settings. This study's objective was to investigate the effects of the "Pfizer/BioNTech and Oxford/Astra Zeneca" vaccination on SARS-CoV-2 cases and deaths in Saudi Arabia.

Materials and Methods

Study Design and Settings

The present retrospective cohort study was conducted in the Department of Physiology, Col-

lege of Medicine, King Saud University, Riyadh, Saudi Arabia.

Launching of Vaccines in Saudi Arabia

In Saudi Arabia, the "BNT162b2 mRNA (Pfizer-BioNTech)" vaccine was the first vaccine approved for use in mid-December 2020, and "Oxford-AstraZeneca (AZD1222)" was the second vaccine approved for use in early February 2021⁷. The Pfizer-BioNTech and AstraZeneca COVID-19 vaccines work in different ways. The Pfizer-BioNTech vaccine uses mRNA technology, while the AstraZeneca vaccine uses an adenovirus vector⁷.

Data Collection

In this retrospective cohort study, we collected the data on "SARS-CoV-2 cases and deaths" from the day of existence of the first case of SARS-CoV-2 in Saudi Arabia, March 2, 2020, to the date of launching the vaccination campaign, December 14, 2020; and from December 15, 2020, to September 8, 2021. We recorded the data from the World Health Organization website³ to assess the "Pfizer/BioNTech and Oxford/AstraZeneca" vaccine impact against COVID-19-related cases and deaths before and after the start of the national vaccination campaign. The day-to-day data on vaccination and the COVID19 cases and mortality were retrieved from the World Health Organization³ and Coronavirus (COVID-19) vaccinations updates websites^{8,9,10}.

For this study, we analyzed the data from the first case in Saudi Arabia dated March 2, 2020, to September 9, 2021. The data were further divided and analyzed based on the implementation of lockdown policies from March 24, 2020, to June 20, 2020. The lockdown phase started on March 24, 2020, and an initial partial lockdown phase extended until April 06, 2020, followed by a total lockdown phase from April 06, 2020, to June 20, 2020. The data were further analyzed based on the appearance of the first case from March 2, 2020, to the launch of a vaccination campaign on December 14, 2020, and then from December 15 to September 9, 2021.

Statistical Analysis and Ethical Approval

The data were obtained from the Ministry of Health of Saudi Arabia website and the World Health Organization (WHO). The data were entered into the computer, and based on the protocol mentioned in the methodology section, data were classified and analyzed. The significance level

Table I. Demographic characteristics^{3,7-11}.

| Country | Kingdom of Saudi Arabia |
|------------------------------|---|
| Population | 34.2 (Saudis: 31.2 million, non-Saudis: 10.2 million) |
| Level of Education | 100% at primary levels |
| Health care sector | Free services in all public health care sectors |
| Total number of COVID Cases | 547402 (0.23%) Oct 10, 2021, manuscript submission date |
| Total number of COVID deaths | 8732 (0.18%) Oct 10, 2021, manuscript submission date |
| Vaccination launching date | December 15, 2020 |
| The first vaccine launched | BNT162b2 mRNA (Pfizer-BioNTech) Dec 15, 2020 |
| The second vaccine launched | Oxford-AstraZeneca (AZD1222) February 15, 2021 |
| Total doses completed | 38,738,841 (63.96%) Sept 8, 2021 |
| Vaccination completed | 16,134694 (45.65%) Sept 8, 2021 |

was compared between the various periods of the study. We used a descriptive statistic, defined the period, and assessed the study cohort outcome by the Pfizer/BioNTech and Oxford/AstraZeneca vaccines against “SARS-CoV-2 cases and deaths” before and after the vaccination campaign in Saudi Arabia. The impact of the vaccine on SARS-CoV-2 cases and deaths was compared using independent *t*-tests. A *p*-value less than 0.05 was considered significant. The data were obtained from publicly available databases; hence ethical approval was not required.

Results

On March 2, 2020, the first case of COVID-19 was reported in Saudi Arabia; immediately after that, Saudi Arabia initially implemented partial and later complete lockdown policies from March 24, 2020, to June 20, 2020. On December 14, 2020, the government launched a vaccination campaign and provided free vaccinations to people (Table I, II).

As of September 8, 2021, Saudi Arabia’s healthcare system has administered 38,738,841

COVID-19 vaccines with a capacity of about 165,979 doses per day. In Saudi Arabia, 45.65% of the population was fully vaccinated following two doses of vaccine, and 63.96% population was vaccinated with total vaccinated following receipt of at least one dose of the vaccination (Table I, II). Meanwhile, the public’s adherence to nonpharmaceutical interventions has been almost 100%. Table III demonstrates that SARS-CoV-2 daily cases (pre- vs. post-onset of the vaccination campaign) were 1235.60 vs. 692.08 (*p*= 0.0001), and daily deaths 22.70 vs. 9.48 (*p*=0.0001) were both significantly reduced after the launch of the vaccination campaign (Table III, Figures 1-3).

We also identified that before the launch of the vaccination campaign on December 15, 2020, the number of cases was 1235 and deaths 22 (Figures 1-3). However, after launching the vaccination campaign, the number of daily cases was markedly reduced to 692, and the number of daily deaths was dramatically reduced to 9 (both compared to before the same total period of about nine months). Table II shows the significant impact of vaccination on decreasing COVID-19 cases and deaths in Saudi Arabia.

Table II. The nonpharmaceutical preventive measures adopted to stop the spread of the mCOVID-19 pandemic¹¹.

| Date | Policy implemented |
|----------------|---|
| March 2, 2020 | The first case of COVID reported |
| March 5, 2020 | Cancellation of gatherings, festivals, travel restrictions |
| March 7, 2020 | Limited the international flights |
| March 7, 2020 | Implemented SARS-CoV-2 negative travel certificate |
| March 8, 2020, | Closure of schools & universities, on-campus teaching suspended |
| March 13, 2020 | Prohibition of gatherings and wedding ceremonies |
| March 15, 2020 | International flights suspended; quarantine implemented |
| March 21, 2020 | Bans on local flights, train and bus transportation |
| March 23, 2020 | Stay home from 7 PM-6 AM |
| March 24, 2020 | Lockdown policies from March 24, 2020, to June 20, 2020. |

Table III. SARS-CoV-2 daily cases & deaths before and after launching the campaign of vaccination.

| Parameters | Before vaccination | After vaccination | % Change | p-value |
|-----------------------|--------------------------------|-------------------------------|-------------|---------|
| Study period | March 24, 2020, to Dec14, 2020 | Dec 15, 2020, to Sept 9, 2021 | N/A | N/A |
| Total study days | (288 days) | (260 days) | 89.93 | N/A |
| SARS-CoV-2 Max cases | 4919 | 1534 | 31.18 [-] | N/A |
| SARS-CoV-2 Max deaths | 58 | 19 | 32.75 [-] | N/A |
| SARS-CoV-2 cases | 1235.60 ± 3.33 | 692.08 ± 1.21 | 56.01% [-] | 0.0001 |
| SARS-CoV-2 deaths | 22.70 ± 0.03 | 9.48 ± 0.01 | 41.76 % [-] | 0.0001 |

Before vaccination period: March 2, 2020, to Dec 14, 2020; after vaccination period: Dec 15, 2020 to Sept 9, 2021; [-] decreased.

Discussion

Saudi Arabia is the largest Arab world country and hosts about 33.7 million people⁴. In immediate response to World Health Organization (WHO), Saudi Arabia implemented lockdown policies, staying at home, social distancing, free testing, and opening treatment facilities to COVID-19 patients⁴. Saudi Arabia then launched a timely vaccination campaign for the country’s people to control the COVID-19 pandemic. This study observed that SARS-CoV-2 daily cases and daily deaths were significantly reduced after launching the vaccination campaign compared to before the vaccination.

At global levels, about 46.0% of the population has received a single dose of a COVID-19 vaccine, 6.48 billion dosages have been administered, 23.28 million doses are distributed per day. Nevertheless, 2.5% of low-income countries have received one dose of the vaccine¹⁰. As of Sep-

tember 8, 2021, Saudi Arabia has administered 38,738,841 COVID-19 vaccines, 45.65% of the population was fully vaccinated following two doses of vaccine, and 63.96% population was vaccinated with total vaccinated following receipt of at least one dose of the vaccination^{10,11}.

Haas et al¹² reported that two doses of BNT162b2 effectively protect various age groups, including older-aged people, from SARS-CoV-2 infections, hospitalizations, severe cases, and death. Their findings further demonstrated a significant decline in SARS-CoV-2 incidence consistent with growing vaccine coverage. These results support the idea that vaccination can control the COVID-19 pandemic¹². The literature has reported that the mortality rate has swiftly declined in the UK who received vaccines compared to the non-vaccinated population¹³.

Despite the significant efforts and benefits of vaccination in Brazil in 2021, the associated mortality rate continues to increase, mainly among

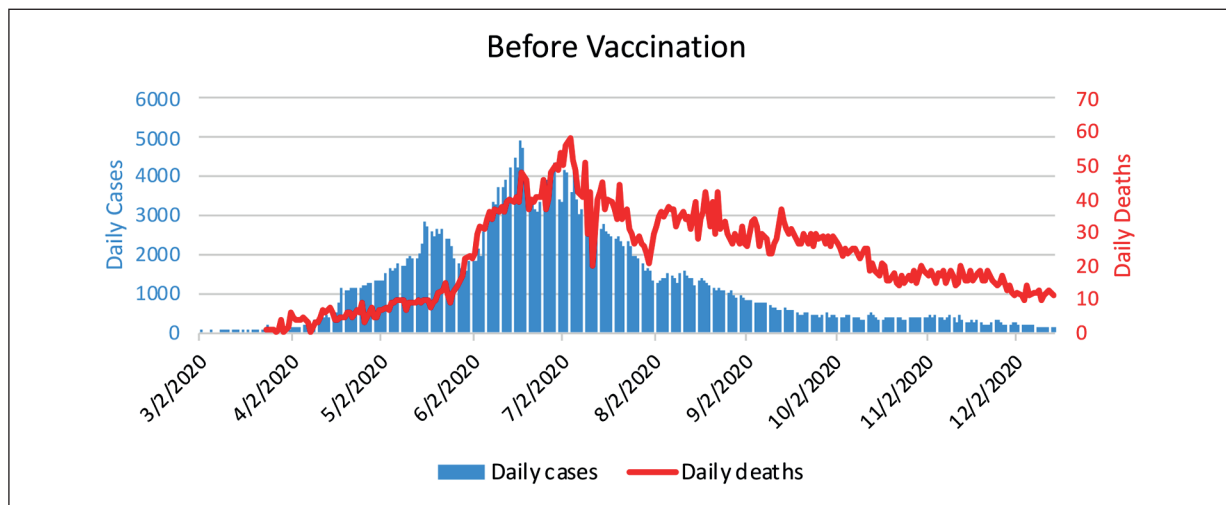


Figure 1. Epidemiological trends of SARS-CoV-2 daily cases and deaths before launching the campaign of vaccination in Saudi Arabia.

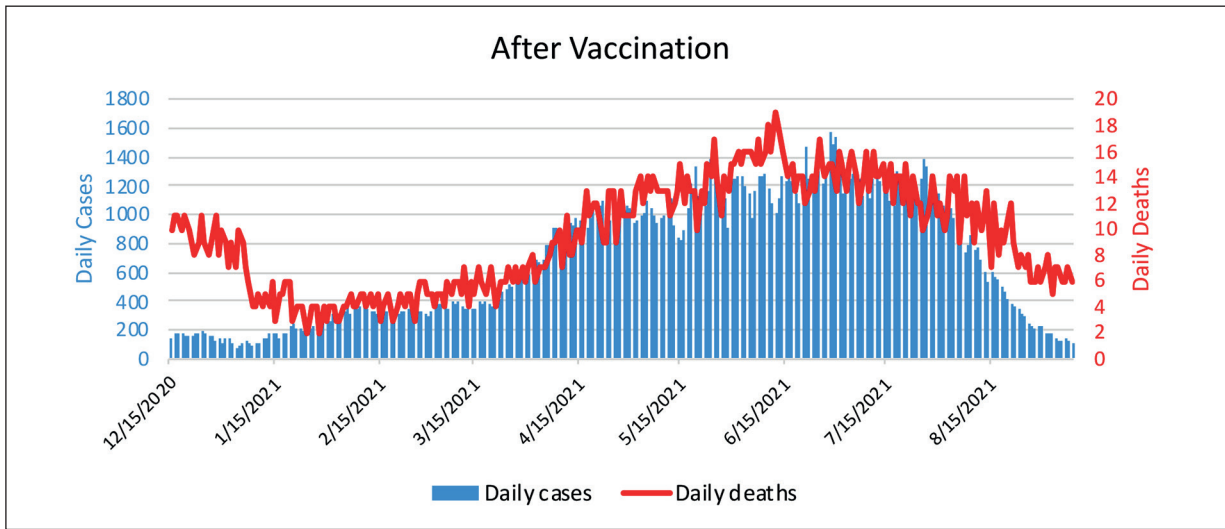


Figure 2. Epidemiological trends of SARS-CoV-2 daily cases and deaths after the launching campaign of vaccination in Saudi Arabia.

people who are 80 years or older. The most probable reason for this increased number of deaths is the slow pace of vaccination; the initial dose left about 20% of older-age people unvaccinated. Moreover, the low acceptance of the second dose reduced the protection against COVID-19¹⁴. The present study is consistent with the existing literature by demonstrating that vaccine coverage and the pace of vaccination impact the control of the diseases.

Moghadas et al¹⁵ demonstrated that vaccination minimized the risk rate to 4.6%. The highest relative reduction was 54-62% among people over 65 years old. The vaccination significantly reduced adverse outcomes, and the death rate was decreased by about 63.5%. These results demonstrate that vaccination has an impact on mitigating COVID-19 outbreaks. In another study, Domi et al 2021¹⁵ showed that the vaccine is linked with the low spread of SARS-CoV-2 and reduced

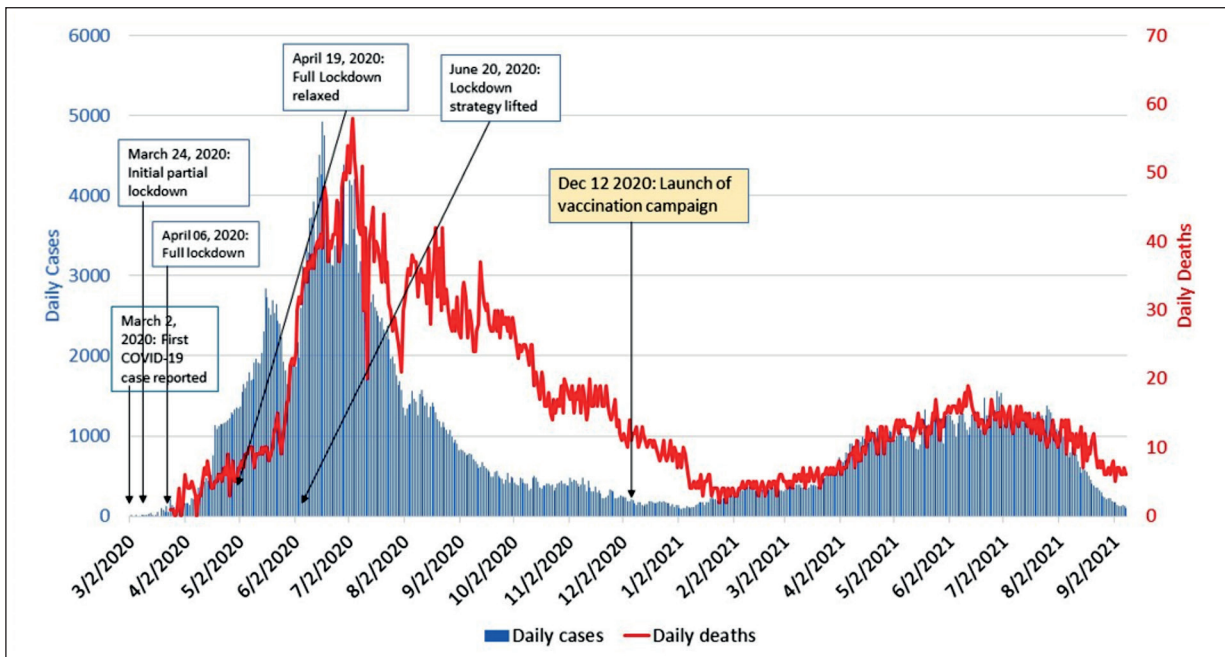


Figure 3. Epidemiological trends of SARS-CoV-2 daily cases and deaths before and after the launch of the vaccination campaign and preventive measures to stop the spread of the COVID-19 pandemic.

deaths among the residents. However, there is no denying that continued compliance with nonpharmaceutical interventions is also vital to achieving better outcomes.

In a randomized controlled trial, the Pfizer-BioNTech vaccine demonstrated over 95% effectiveness against severe COVID-19 disease¹⁶. It has been shown that this vaccine is effective in real-world settings, and it has had a significant public health impact on falling rates of infections, hospital admissions, and deaths^{17,10}, in the USA¹⁸, Canada¹⁹, the UK^{20,21}, and Qatar²².

A longitudinal analysis of multiple cohorts was performed in Israel by Glatman-Freedman et al²³ on the outcomes of a rapid vaccination campaign against COVID-19. It was identified that the Pfizer-BioNTech vaccine is highly effective in preventing SARS-CoV-2 cases. However, among 80-year-old people, efficacy was established gradually. The vaccines can protect people from a SARS-CoV-2 infection by forming antibodies and providing immunity against a SARS-CoV-2 infection²⁴.

The global appearance of SARS-CoV-2 variants has raised concerns that COVID-19 vaccines may reduce the effectiveness against new viral strains²⁵. However, the Pfizer-BioNTech and Oxford/AstraZeneca vaccine campaign in Saudi Arabia has shown robust positive results against all variants currently of concern. The present study results support the hypothesis that vaccines minimize the SARS-CoV-2 cases and deaths.

Even in the face of widespread dissemination of the various variants, the declining trend was significant after the vaccine campaign in Saudi Arabia was launched. The real-world literature shows that the efficacy of two doses of BNT162b2 against COVID-19 supports preventing disease caused by various variants, including alpha, beta, and delta, in various settings²⁵. The present study findings support the hypothesis that there is a significant decline in SARS-CoV-2 cases and deaths after vaccinations compared to before the vaccination.

Study Strengths and Limitations

This study has some merits. First, this is the first country-level novel study in real-world settings that assessed the vaccine impact on “SARS-CoV-2 cases and deaths”. Second, the data considered from the entire country level, the findings might be generalizable at the regional and international levels. Third, the study findings support the global hypothesis about the vaccine and its

efficacy in preventing COVID-19 illness and the transmission of SARS-CoV-2. Fourth, the results provide great hope that vaccines effectively prevent the spread of new and future virus variants. Fifth, both the Pfizer and Oxford vaccines are effective against the various variants found in Saudi Arabia.

This study has some limitations. First, in this retrospective cohort, we analyzed the overall impact of two COVID-19 vaccines on SARS-CoV-2 cases and deaths without further classifying unvaccinated, fully, and partially vaccinated populations. Second, the other variables might have linkage with cases, and mortality data that could influence the estimates.

Conclusions

SARS-CoV-2 daily cases and daily deaths were significantly reduced in Saudi Arabia after launching the vaccination campaign compared to before the vaccination. The present study findings demonstrate that the vaccination and adherence to NPIs can better control the COVID-19 pandemic. The study findings provide empirical evidence and suggest that vaccination plays a critical role in reducing the country’s cases and deaths of COVID-19. Vaccination has been a highly effective tool to eradicate the SARS-CoV-2 from regional and worldwide levels.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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