

Coronavirus Pandemic

Containment of COVID-19: the unprecedented response of Saudi Arabia

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Abstract

The emergence of a novel coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), from Wuhan, China, in December 2019 has challenged many countries. The current pandemic caused by this coronavirus has already negatively affected millions of people and the economies of countries worldwide. However, the challenges faced by Saudi Arabia during the Middle East respiratory syndrome coronavirus (MERS-CoV) epidemic that began in 2012 led to marked improvements in the government's response to the current pandemic. Saudi Arabia is one of largest countries in the Middle East and is home to the holiest Muslim sites. Since the global risk of the virus was declared by the World Health Organization (WHO), Saudi Arabia has taken substantial public health measures to control the spread of the infection. This review reports on the transmission of SARS-CoV-2 in Saudi Arabia and the proactive responses taken by the government, comparing the Saudi government's actions and their effects with those of other countries. Although Saudi Arabia is currently experiencing the peak of the pandemic, their early precautionary responses have shortened the period of individual/family isolation, reduced the number of confirmed infections and infection-related fatality rates, and decreased the economic burden of the people and the country compared with other countries in the Middle East and elsewhere.

Key words: SARS-CoV-2; COVID-19; infectious diseases; Saudi Arabia.

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Introduction

In late December 2019, a respiratory illness was documented in the city of Wuhan, in the Province of Hubei, China [1]. The illness has since disseminated throughout the world via human-to-human contact, mostly through travel, to circulate in more than 150 countries, forcing the World Health Organization (WHO) to declare a pandemic [2]. Recently, WHO named this disease coronavirus disease 2019 (COVID-19) and called the causative agent severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [3].

Coronaviruses are ubiquitous. Prior to 2002, they accounted for up to 30% of common cold infections among humans. However, three exceptionally pathogenic beta coronaviruses have spread in the last three decades, namely, SARS-CoV-1 in 2002, the Middle East respiratory syndrome coronavirus (MERS-CoV) in 2012, and SARS-CoV-2 in 2020 [4]. Many coronaviruses exist in nature, and this recently emerged coronavirus does not differ much from the previously known ones. SARS-CoV-2 is a positive-sense, single-stranded RNA coronavirus. In January 2020, it was genomically sequenced after nucleic acid testing

detected a patient during the 2019 to 2020 Wuhan pneumonia outbreak who was positive for the virus [5]. The analysis showed that the novel virus was genetically related closely to SARS-CoV-1 and distantly to MERS-CoV. Genetic alignment tests indicated approximately 70% sequence similarity between SARS-CoV-2 and the 2002 SARS-CoV and 40% sequence similarity between SARS-CoV-2 and MERS-CoV [6]. Similar to other coronaviruses, the transmembrane spike (S) glycoprotein of SARS-CoV-2 is responsible for binding to the host cell angiotensin-converting enzyme 2 receptor [7].

As with SARS-CoV and MERS-CoV, SARS-CoV-2 is believed to have originated in bats and to have been transferred to another animal zoonotically (possibly from pangolins) before infecting humans [8]. Some researchers believe that SARS-CoV-2 moved directly from bats to humans because it was reported that the first cases of the disease came from humans who had consumed bat meat [9]. The virus is extremely contagious, and it is mainly transferred in droplets from infected people and contaminated surfaces, where it can remain infectious for up to 9 days. However, it has not

been definitively shown that the virus can be ordinarily airborne. In addition, transmission from household pets to humans has not been demonstrated.

All people are susceptible to infection by SARS-CoV-2 although they may or may not show symptoms of COVID-19. Elderly people, individuals who are immunocompromised, and those with chronic or debilitating diseases (e.g., cardiovascular, diabetics, or asthma) are extremely vulnerable to the effects of the virus [10]. However, dying of COVID-19 is a far less likely outcome than dying of SARS or MERS, with death from COVID-19 currently estimated at approximately 7% of confirmed cases, whereas recovery from COVID-19 is estimated at approximately 32% of confirmed cases. The incubation period for the vast majority of cases is 5-10 days (although it could be 1-28 days), during which time patients can be infectious [11]. Symptoms include fever, extreme fatigue, dry cough and breathing difficulties. The vast majority of patients (approximately 80%) will recover without medical intervention. However, the remaining patients may have serious or even a fatal outcome requiring hospitalization and the assistance of ventilators.

The epicenter of the disease started with China. It then moved to Iran followed by Italy, Spain, United States, and, currently, it is centered in Latin America. Other countries (France, Germany and nowadays Russia in Europe, and currently Brazil in South America) have also been heavily affected. Treatment at hospitals focuses on pulmonary supportive therapy. No specific therapy for the virus is in place yet, although hydroxychloroquine anecdotally produced worthy results when administered to patients in France, South Korea, and China. Very recently, the United States Food and Drug Administration approved the compassionate use of two drugs (hydroxychloroquine sulfate and chloroquine phosphate) for certain hospitalized COVID-19 patients [12]. Antivirals, such as a combination of lopinavir and ritonavir, have not provided satisfactory treatment results, although very recently remdesivir was reported to show promising results. In Saudi Arabia, clinical trials are being conducted, including a combination of the antimalarial hydroxychloroquine and the antibiotic azithromycin.

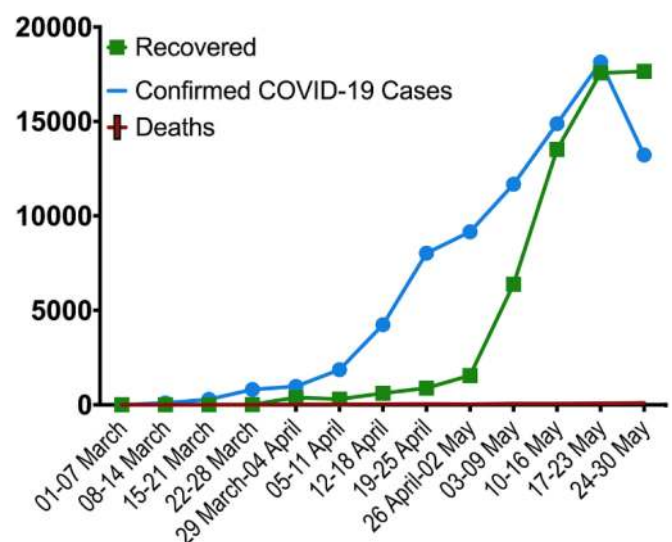
COVID-19 in Saudi Arabia

The first confirmed COVID-19 case in Saudi Arabia was announced on 02 March 2020. This patient had returned to Saudi Arabia from Iran, where it is believed he contracted the disease [13]. Until 31 May 2020, there have been 85,261 confirmed cases, with 62,442 total recoveries and 503 deaths (Figure 1). These

individuals became infected from contact with patients who were themselves infected through travel to Saudi Arabia from Iran, various European countries, and other Arab countries. The first several cases were reported in the City of Al-Qatif (in the Eastern Province of Saudi Arabia) and were attributed to people who had returned from Iran. The death rate per million of population is very low in Saudi Arabia, this could be the result of Ministry of Health (MOH) preparedness and efforts, for both increasing hospitals capacities, and provide treatment protocols.

The number of confirmed positive cases began escalating despite early actions taken by the Saudi Arabian Government. Most of these actions were initiated before the first case was even reported in the country (Figure 2). In anticipation of possible disease spread, the Government of Saudi Arabia carried out a series of proactive decisions. First, a high-level task force, headed by the Minister of Health, was established to make decisions regarding prevention of the pandemic. Second, Royal and Ministerial Orders were publicly announced to curb the spread of the disease. Many activities in which crowds could potentially gather were suspended until further notice. The suspensions started with no issuance of new tourist visas. Then allowance of Umrah (a religious ritual that can be undertaken any time of year in Makkah) was suspended for visitors followed by suspension for all citizens and residents. International flights were then cancelled, all schools and universities were closed, and public and private workers were asked to remain home

Figure 1. Number of deaths confirmed and recovered cases of COVID-19 infection in Saudi Arabia from 01 March to 30 May 2020. Data are presented by weeks since the report of the first positive case in the country.

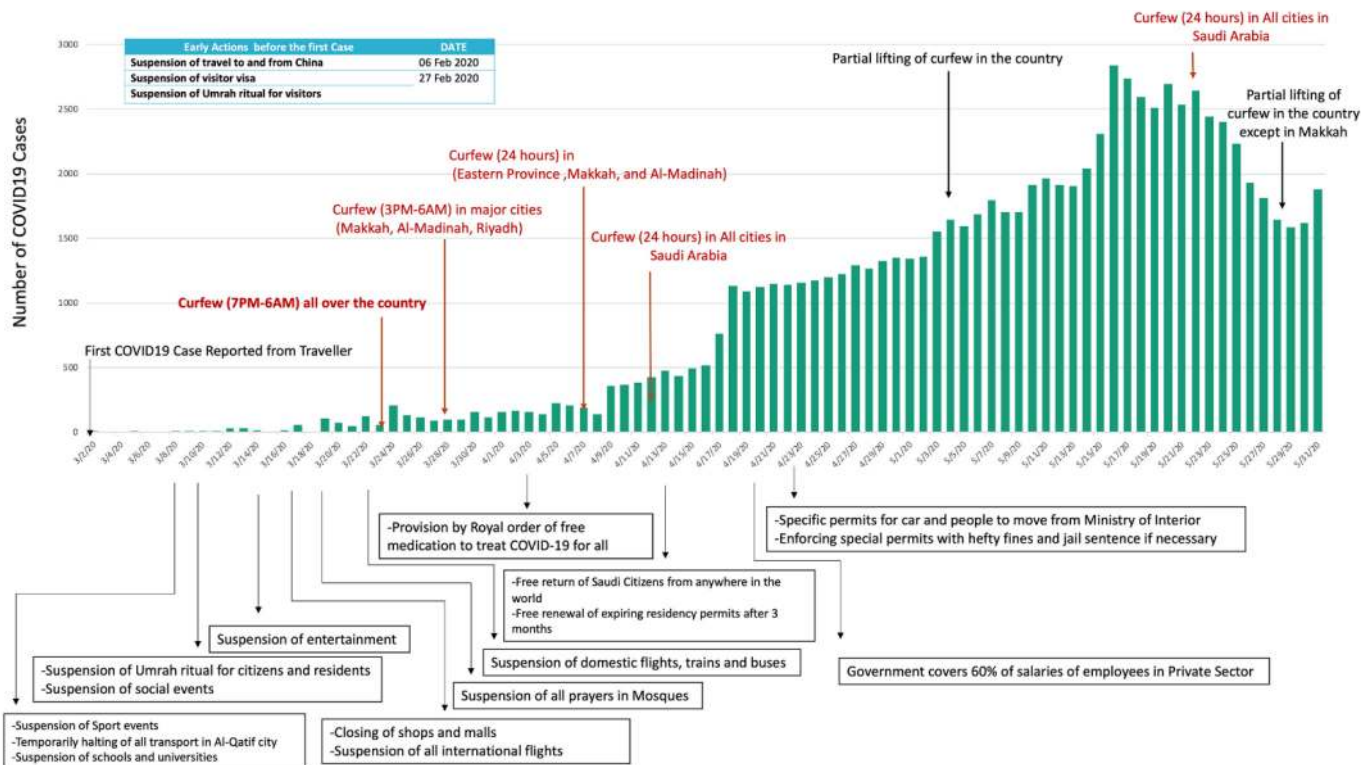


until further notice, except for those who keep safety and security or delivery staff. The orders culminated in an almost 24-hour curfew for everyone in the country. Moreover, figure 2 shows that once the country has partially lifted the curfew the cases peaked which shows the importance of public health measures and its influence during the early pandemic stages [14].

All precautionary preventive measures appeared to be adhered to by the population of Saudi Arabia, and it seems that expatriate workers accounted for the majority of COVID-19 cases [15]. Social distancing, proper hand washing or sanitizing with antiseptic gels, using a tissue or elbow when sneezing or coughing, sanitizing surfaces, and staying home when curfews were announced, including home isolation when necessary, were largely practiced by the inhabitants. All ports of entry to Saudi Arabia (air, sea, and land) were equipped with infrared and other devices to obtain body temperatures, and official staff were available for obtaining travel history of individuals. Health care professionals at entrances of hospitals, supermarkets, and all other communal places were available to measure temperatures and provide sanitizing gels as well as gloves. Although the use of masks was not enforced on the public early on, suitable masks were

available, and their use (especially N95 masks) was obligatory for health care staff. Electronic applications were offered for ordering food and groceries for home delivery and for consulting with physicians, especially during curfew times. Online and mobile apps functioned well for orders of groceries, medicine, food from restaurants, and other purchases. Remote, electronic, and virtual meetings and work implementation from homes took place for all applicable public and private employees to resume work once they were instructed not to report to their original place of work. Additional space for patient beds and medical support was prepared in schools and stadiums in anticipation for increased numbers of cases. Free health care, including prescription medications, was granted to all people, citizens, and residents (legal or illegal). Awareness SMS messages in various languages were regularly sent from the MOH to all registered mobile cell phones in the country. When the number of cases reached more than 5,000, to avoid overwhelming hospitals with unnecessary visits, the Saudi MOH made available more than 300 Rapid Response Teams, each composed of five health care workers. Persons who suspect that they are ill with SARS-CoV-2 were provided a specific number to call,

Figure 2. Actions taken by the Saudi Arabian government to mitigate the 2020 SARS-COV-2 pandemic. The 24-hour curfew allows people to leave home from 6:00 AM to 3:00 PM to obtain medicines or to purchase food or house supplies, but only in their neighborhood quarters, not in any other part of the city. Data were obtained from the Ministry of Health’s official portal.



and a team was dispatched to the caller's location for medical examination; thus, there was no need to go to a hospital. Before going out of the house to purchase sanitizers or masks, individuals could call to check the availability and geographic location of the nearest pharmacy [14-20]. People scanned prescriptions and sent them online to pharmacies, which fill their prescriptions and send to their homes through dispatchers. A daily press conference was held by the Saudi MOH, providing COVID-19-related updates and events information national and internationally, as well as answering questions from reporters. On 9 March 2020, the Saudi Arabian Government issued a directive ordering the donation of 10 million USD to support the efforts of WHO to combat the disease [21].

Because Saudi Arabia holds the presidency of the Group of Twenty (G-20) countries for the year 2020, a video conference of the G-20 leaders (a virtual summit) was called by Saudi Arabia and took place on the 26th and 27th of March 2020. The leaders agreed on providing trillions of dollars to support global economy and to promote cooperation in financing research and development to obtain therapeutic drugs and vaccines for COVID-19 [22].

The Saudi Government also allowed residents with existing reentry permits to cancel their permits without penalty, and residents whose residency permits expired during the pandemic were allowed to renew online without any charge. Other instructions will follow, such as for those residents who are out and would like to return. The Government dispatched airplanes to various countries to bring back all those who desired to return to Saudi Arabia. When they arrived at designated airports, these people were examined and taken to hotel-style isolation for 14 days before they were discharged. Apps that operated in several languages (e.g., Asefeni) were developed for inhabitants to check their status if they suspected a coronavirus infection before they call the emergency hotlines (i.e., 911 or 937).

Starting on 31 May 2020 and until 20 June 2020, the Government eased all curfews to become from 8PM until 6AM the next morning, except in the Holy City of Makkah. It included the resumption of (1) domestic flights and inter- and intra-cities travel, (2) malls and small shops activities, (3) office work for all government and private employees, and (4) all mosques for prayers.

Patient characteristics, mode of transmission and screening

As of 31 May 2020, the MOH official portal declared 85,261 confirmed positive cases in Saudi Arabia, with 73% of patients recovered and only 0.6% mortality [15]. The nationalities of the infected individuals were publicly reported from 23 April. Approximately 82% of the infected individuals were non-Saudis, and 18% were Saudis. Most of the people infected with SARS-CoV-2 were males. Among the confirmed cases and on average, 85% were males, 90% were adults, 6% were children and 4% were elderly. These demographic characteristics were comparable to those reported in China, in which 95% of the infections were in adults, 3% were in the elderly, and 2% were in children [23]. Although the sex distribution in Saudi Arabia was similar to that in Italy (82% male), the age distribution differed, with more elderly (60%) infected in Italy [24]. This difference may be due to the younger population in Saudi Arabia as compared to Italy; the median age in Italy is 46.5 years and in Saudi Arabia it is approximately 30.8 years [25].

Another patient characteristic shared with the public through the MOH official portal was the mode of infection transmission. From 02 March until 25 March 2020, most patients with confirmed COVID-19 had traveled outside of Saudi Arabia and returned. The pattern of transmission changed after 25 March, with most patients infected by local contact transmission. This change in the pattern of transmission was mainly due to the strict implementation of the international travel ban instituted on 15th March by the Saudi Government.

The testing capacity in Saudi Arabia as of the end of May 2020 was approximately 23,508 tests per 1 million people, a total of 822,769 individuals were screened [15]. The Saudi Government is striving to increase its testing capacity. The latest effort by the Government is an agreement with BGI, a Chinese company that will build six testing laboratories across the Saudi Arabia and promises to provide 50,000 tests per day per location [26]. This improvement will move screening from targeted testing to national screening. The ability to test the entire population will enable detection of asymptomatic cases. Such a screening capacity has shown substantial results in containing the SAR-COV-2 pandemic in Iceland and in South Korea, with both countries flattening the curve generated by plotting the number of people infected with the virus against time [27,28]. The main limitation of population screening is that the risk of increased proportion of false positive results. The investment by Saudi Arabia in

improving national testing for the current situation will also lead to greater preparedness for future epidemics or pandemics.

MERS Lessons Applied to the COVID-19 Pandemic

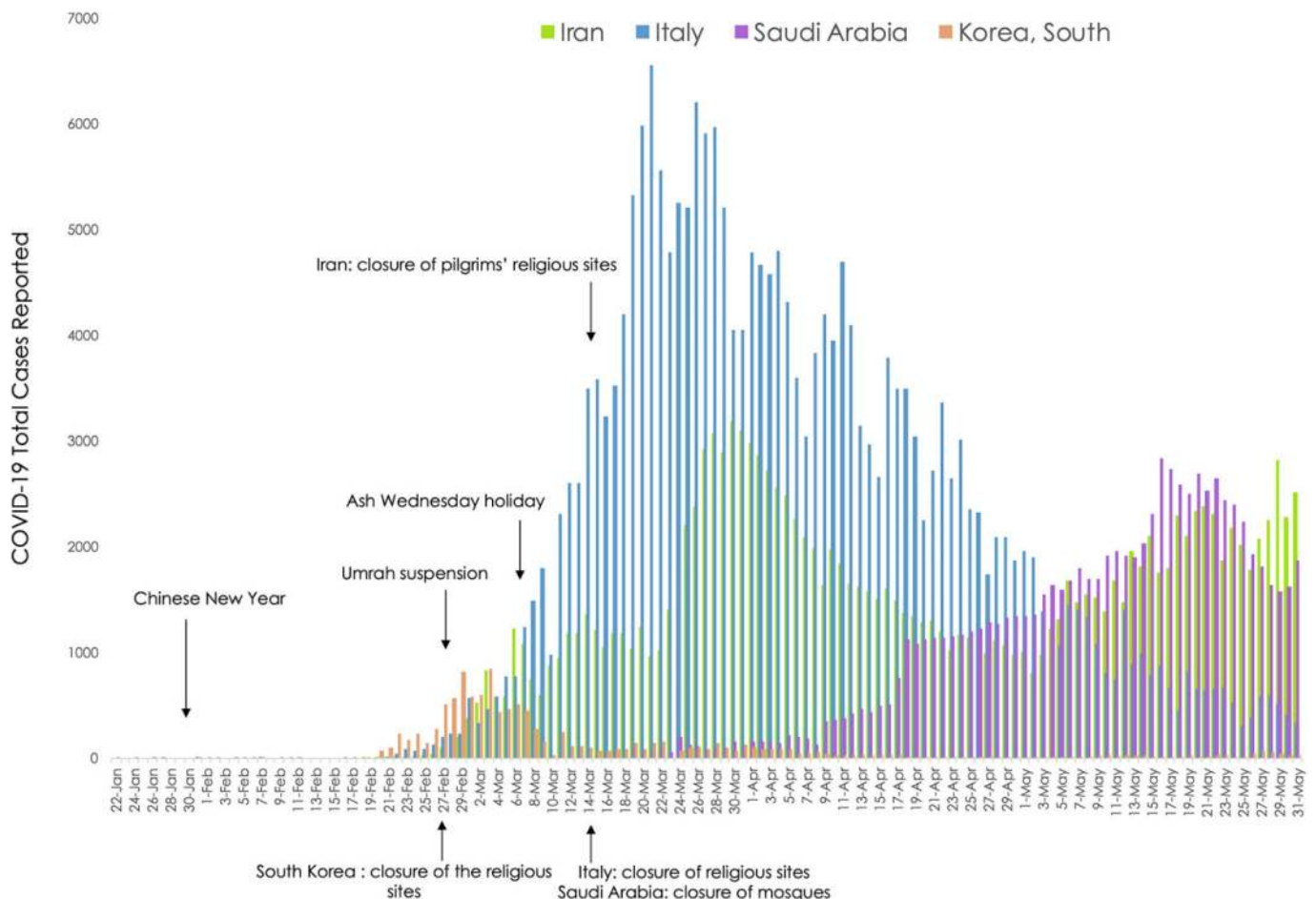
In 2012, another member of the coronavirus family, MERS-CoV, became widespread throughout Saudi Arabia. Both SARS-CoV-2 and MERS-CoV cause severe pneumonia, whereas MERS-CoV may cause greater disease severity among infected patients, SAR-CoV-2 has a higher rate of transmission. From 2012 to 2015 in Saudi Arabia, the MERS-CoV-caused infection that strained the health care system and caused high casualty, with the fatality rate of about 34% in the general population and about 22% among health care workers [29].

One of the crucial lesson learned from that outbreak was the vital role that infection control units play. Most hospitals had underestimated the role of these units. However, after the MERS outbreaks, many national

programs were established for teaching infection control measures. Those programs were developed and monitored by the MOH and the Saudi Commission for Health Care Specialties. Because those programs were in place, their implementation and the number of already trained staff were vital in controlling the current pandemic. Indeed, the number of hospital-acquired COVID-19 cases was markedly lower than that during the MERS outbreaks. The previous epidemic also highlighted the importance of health care system preparedness, with many hospitals increasing the numbers of their isolation units, beds in their intensive care units, and ventilators.

Public health surveillance studies during the MERS epidemic were scarce, with few professional Saudi epidemiologists available and insufficient case tracing at the time. To increase the number of professionals in the field of public health, the MOH supported the establishment of an Epidemiology major in Saudi Universities. Thus, case transmission tracking for the current pandemic was conducted using local expertise.

Figure 3. Number of confirmed COVID-19 cases in religious countries by events since the announcement of first positive case in these countries until 31 May 2020.



In addition, based on the MERS outbreak experience, several organizations were developed under the MOH, including the Saudi Centers for Disease Control and Prevention and Reference Laboratories, with the aims of monitoring infectious diseases over time in Saudi Arabia and supporting primary health care clinics.

Perhaps the most critical lesson learned from the MERS outbreaks was the importance of research and development. The MOH, King Abdulaziz City for Science and Technology, and various Saudi Universities are currently sponsoring many national and regional projects promoting the development of vaccines and promising therapeutic targets, as well as innovative technologies, to help contain the current pandemic and supporting research aimed at understanding the pathogenesis of the disease. Such effort will be useful for future possibilities.

Saudi Arabia's response compared with other countries where religious rituals are widely recognized

Makkah and Al-Madinah in Saudi Arabia, the two holiest sites in Islam, attract millions of Muslims from around the globe to perform a short journey of Umrah ritual in Makkah, to take part in Al-Hajj, the pilgrimage to Makkah recommended once in a lifetime, and/or to visit the holy mosque of Prophet Muhammad in Al-Madinah. Last year, according to the Saudi Ministry of Hajj and Umrah, approximately 18 million people visited Makkah throughout the year to perform Umrah and more than 7 million individuals came to perform Al-Hajj [30]. These religious events in Saudi Arabia lead to mass gatherings, which under the current pandemic would lead to not only increased risk of importing COVID-19 cases but also increase risk of exporting the infection and spreading it to many other countries. Owing to the high international risk imposed, the Saudi Government proactively suspended Umrah on 27 February for both external visitors, before the first case of SAR-COV-2 infection was detected in Saudi Arabia. Later, on 9 March, it was also suspended for citizens and residents. Other religious mass gatherings in Saudi Arabia, including Mosques, where Muslims pray five times a day, as well as Friday Service, were suspended approximately 1 week after the first COVID-19 case was detected. These actions taken in the early stages of the pandemic have been key to controlling the rate of infection in Saudi Arabia.

A comparison of the effects of the actions taken by Saudi Arabia with those of other religious countries on the number of positive COVID-19 cases is shown in Figure 3. In Iran, the closure of the religious sites

occurred later in the course of the spread of the virus in the country, with the government action taken just prior to the number of cases reaching into the thousands; the number of cases peaked 3 weeks later. In the predominately Christian countries of Italy and other countries where there are Christian congregations such as South Korea, when celebrations of Easter, Ash Wednesday, and Saint Patrick's day were near, Italy churches were not closed until their health care system was already overwhelmed with COVID-19 cases on 12 February. South Korea reported their peak number of cases of SARS-CoV-2 infections before closing churches late in February. The action in Saudi Arabia was sufficiently rapid to decrease the number of COVID-19 cases acquired from mass gatherings. Together, the data gathered from these countries indicates that in regions with a high population of religious people, a rapid response is needed to halt mass gatherings to reduce the number of sporadic cases and to avoid initiating new outbreaks.

Conclusions

The unprecedented precautions taken by Saudi Arabia to combat the spread and number of SARS-CoV-2 infections have been praised by WHO officials and are considered a role model for other countries. Stopping mass gatherings, identifying positive cases, instituting isolation policies, and conducting contact tracing early in the game kept the rate of infections relatively low in Saudi Arabia. In addition, compared with other countries, the rapid response taken by the Saudi government shortened the period of isolation, reduced the number of confirmed COVID-19 cases, and decreased the economic burden of disease on the people and the nation at large.

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Authors' contributions

All authors contributed to the design and preparation of this scientific review and take responsibility for all information contained herein.

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