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## Review Article

## Preparedness and response to COVID-19 in Saudi Arabia: Building on MERS experience

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## ABSTRACT

Nearly four months have passed since the emergence of the severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2), which caused the rapidly spreading Coronavirus Disease 2019 (COVID-19) pandemic. To date, there have been more than 2.3 million confirmed cases and more than 160,000 deaths globally caused by COVID-19. Chinese health authorities, where the virus emerged, have taken prompt strict public health measures to control and prevent the spread of the outbreak. In Saudi Arabia, unprecedented precautionary strict measures were applied to prevent virus entry to the country or to mitigate its impact when it arrives. Here, we review the response of Saudi Arabia to COVID-19 pandemic and how did the experience learned from the Middle East respiratory syndrome coronavirus (MERS-CoV) epidemic since 2012 has helped the country to be better prepared for the current COVID-19 pandemic. We also discuss the country readiness, improvement in research and development, and the unprecedented rapid precautionary measures that have been taken by the Saudi government thus far.

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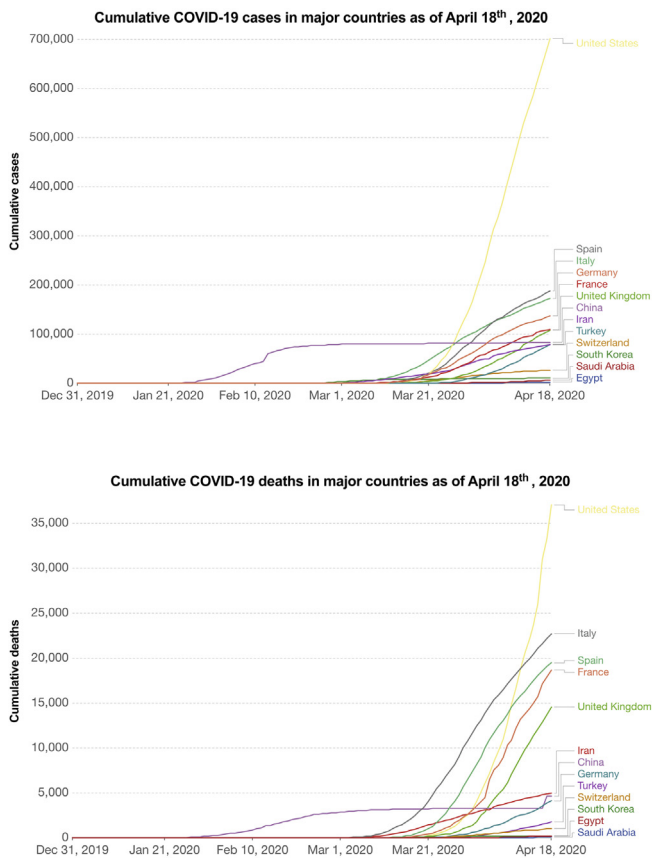
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## Emergence and global spread of coronaviruses

Coronaviruses (CoVs) tend to emerge as an important human and animal pathogens, representing serious public health and economic concerns. Generally, CoVs cause respiratory and gas-

trointestinal infections with some involving the central nervous system [1]. In humans, coronaviruses mainly affect the respiratory tract causing diseases ranging from the mild common cold to fatal pneumonia [2,3]. Four known human coronaviruses (hCoVs); hCoV-OC43, hCoV-229E, hCoV-NL63, and hCoV-HKU1 are associated with common cold [4–7]. In 2002–2003, a novel hCoV associated with severe respiratory diseases known as the severe acute respiratory syndrome-CoV (SARS-CoV) emerged in China [8,9], most likely from bats via civet cats into humans [10], and

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**Fig. 1.** Total COVID-19 confirmed cases and deaths in Saudi Arabia and other major countries as of March 30th, 2020.

Source: European CDC [14].

spread globally causing the SARS epidemic with >8000 cases and ~800 deaths. Since then, there has been focused research on CoVs and in 2012 a second novel zoonotic CoV known as the Middle East respiratory syndrome-CoV (MERS-CoV) emerged in Saudi Arabia [11] and spread to 27 countries causing ~2500 confirmed infections and ~860 deaths with large outbreaks, mainly in healthcare facilities and mostly in Saudi Arabia [12].

More recently, on January 7th, 2020, a previously unknown hCoV, named severe acute respiratory syndrome-CoV-2 (SARS-CoV-2), was identified as a causative agent of an acute respiratory syndrome, known as Coronavirus Disease 2019 (COVID-19), in the Chinese city of Wuhan, further confirming the imminent risk of zoonotic CoVs on humans [13]. Within few weeks, the virus spread to different Chinese provinces and subsequently outside China reaching 215 countries to date. The global rapid and continuous spread of SARS-CoV-2 has led the World Health Organization (WHO) to declare COVID-19 outbreak as a public health emergency of international concern (PHEIC) by the end of January 2020, and as a global pandemic on March 11th, 2020. As of April 21st, 2020, SARS-CoV-2 has caused more than 2.3 million confirmed cases and ~160,000 associated deaths. Several countries have reported extremely high number of COVID-19 cases including the USA, Spain, Italy, France, Germany, the UK, China, Turkey and Iran; strongly highlighting the quick spread and high transmissibility of the virus to new territories. Nonetheless, the situation in Iran, Turkey and Egypt raises fears of further virus spread in the Middle East mostly due to the possible insufficient testing. Indeed, the first case of COVID-19 in Saudi Arabia was detected in a traveler returning from Iran on March 2nd, 2020. As of April 18th, Saudi Arabia has reported more than 8200 cases with 92 deaths (Fig. 1). At the beginning of

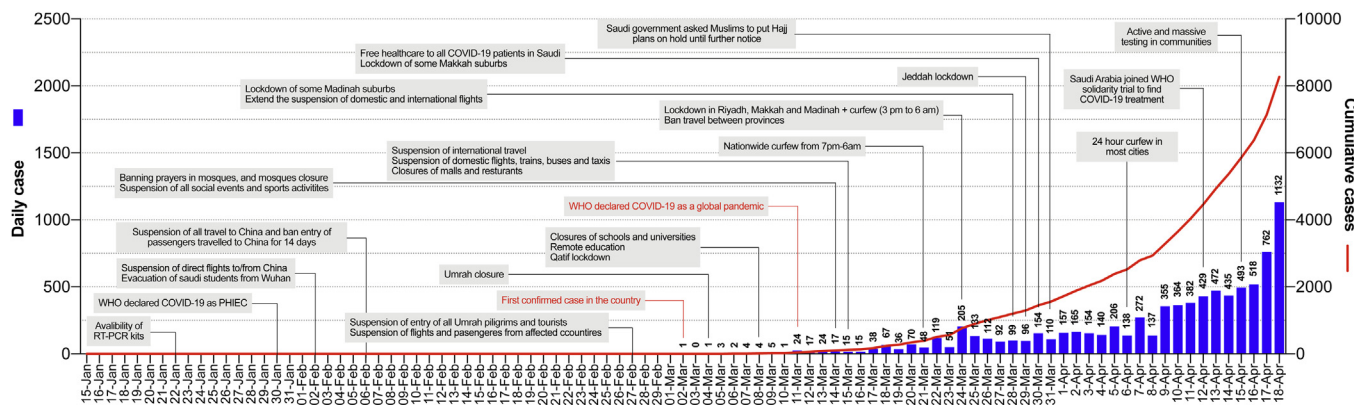
COVID-19 outbreak in Saudi Arabia, the majority of cases appears to be in returning travelers and their immediate contacts [15].

### Saudi Arabia response to COVID-19

The ongoing explosive spread of SARS-CoV-2 throughout the world represents a critical challenge for all countries. Like the H1N1 pandemic in 2009, SARS-CoV-2 reached most countries around the world. While stopping the spread of the virus is becoming extremely difficult according to the WHO, countries have to implement strict measures to mitigate its impact. In China, for example, since the SARS-CoV-2 outbreak broke out in Wuhan in late December 2019, historical strict control and preventive measures were undertaken including mass lockdown of cities and people, shutdown of schools and businesses, travel and transportation restrictions, building hospitals in days, rapid deployments of testing protocols, and using novel technologies to trace all cases [16]. All these extreme measures and massive responses applied with rigorous and innovative approaches have resulted in a dramatic slow spread of the virus across China. Currently, China is reporting few, if any, new local cases of SARS-CoV-2. On the other hand, the pandemic is spreading rapidly elsewhere around the world.

Saudi Arabia is the second largest country in the Arab world with a >34 millions in which non Saudis represent ~37% [17]. Most of the population in the country is in the middle age group of 15–64 while those in the age groups of 0–14 and >65 make up 32.4% and 2.8%, respectively [17]. The healthcare services in Saudi Arabia are provided for free to the general public through the Ministry of Health, military hospitals, and other government-sponsored hospitals. The private sector also has a wide network of for-profit hospitals throughout the country. Collectively, the number of beds per 1000 population in Saudi Arabia is at 2.2. Nonetheless, the Saudi vision 2030 is considering fundamental structural changes in the healthcare sector to meet the growing demand for health care services in the kingdom. Saudi Arabia is one of the countries that could have a serious impact during such global pandemic; because millions of Muslim from all over the world visit Saudi Arabia for Umrah and Hajj, which are considered among the largest global mass gatherings. Umrah is an Islamic rituals performed by thousands of Muslims daily in the city of Makkah while Hajj is an annual pilgrimage to the holy sites in Makkah that lasts for 5 days. Hajj is performed on average by more than 2 million Muslims annually. The pilgrims are visiting Saudi Arabia from across the globe, making the country a serious hotspot for spreading pandemics. In addition, businesses, international investments, growing tourism, and major projects for the country Vision 2030 make Saudi Arabia an active travel destination. Although the government of Saudi Arabia undertakes enormous efforts each year to ensure the healthiness, safety and security of pilgrims, Umrah and Hajj still represent a high risk for spreading infectious diseases globally [18,19]. Saudi Arabia is also one of the signatory on the WHO International Health Regulation (IHR; 2005) and has been reporting on pandemic preparedness ever since and following the WHO policies on infection prevention and control (IPC).

Saudi Arabia was among the first countries to implement early and unprecedented precautionary measures to prevent SARS-CoV-2 introduction into the country or to mitigate its impact when it arrives; such measures were implemented early before reporting the first case in the country on March 2nd, 2020. Also, a national committee was formed to follow global updates and to prepare for the possible introduction and spread of the virus from early January 2020. The committee consists of the government ministers for Health, Education, FDA, Interior and many others. Thus, on February 6th, a month before the first COVID-19 case in the country, the first early proactive decision issued by the Saudi government

Daily confirmed cases and major preventive and control measures in Saudi Arabia as of April 18<sup>th</sup>, 2020

**Fig. 2.** Confirmed COVID-19 cases in Saudi Arabia and the major preventive and control measures taken by the Saudi government and health authorities as of March 31<sup>st</sup>, 2020. Data are from the Ministry of Health, Saudi Center of Disease Control and Prevention, and Saudi Press Agency.

in response to the spread of COVID-19 pandemic was by stopping all direct flights between Saudi Arabia and China [20]. On February 27<sup>th</sup>, the government suspended entry of all international Umrah pilgrims and tourists and monitored all entry points to Makkah and Madinah. By February 28<sup>th</sup>, Saudi Arabia banned inbound travel of individuals from SARS-CoV-2 affected countries, including GCC citizens who have traveled to affected countries. Such decisions would not only minimize the chance of SARS-CoV-2 introduction into the country but would also prevent the exportation of cases to other countries.

Despite these restrictions, on March 2<sup>nd</sup>, Saudi Arabia reported its first COVID-19 confirmed case in a traveler returning from Iran through Bahrain without declaring travel history to Iran. In its continuous effort to minimize the devastating effects of COVID-19 and to curb the spread of the pandemic, Umrah was completely suspended by March 4<sup>th</sup> and the two holy mosques in Makkah and Madinah were put to daily closure for cleaning and disinfection by March 5<sup>th</sup>. On March 8<sup>th</sup>, the Saudi government shifted schools and universities to remote learning and virtual classrooms. This was accompanied by a travel ban to all affected countries and putting in place mandatory quarantine for passengers who already arrived from these countries. On March 9<sup>th</sup>, Saudi Arabia pledged 10 million US dollars to the WHO to help in their efforts to fight the pandemic. By March 12<sup>th</sup>, all social and governmental gatherings and events were suspended or postponed including the Saudi-African and Arab-African summits. Subsequently, all international and domestic air travels, sports events, workplaces (except security and health sectors) were suspended. In addition, the five daily prayers in all hundreds of thousands of mosques across the country were banned and all Muslims in Saudi Arabia were requested by religious authorities to pray at homes for the very first time in the history of the Kingdom. This is a remarkable step considering that Saudi Arabia law is based on the Islamic law and most Saudis do perform their prayers in masses in mosques five times a day. Digital health was quickly activated and utilized for several services such as a “my health” app that allows people to seek medical help and receive medical prescriptions without the need to visit the medical centers. It is important to note that all of these measures were taken while the number of confirmed cases in Saudi Arabia was still less than 300, in a country with over 34 million population [17].

The role of social media is not to be neglected as the percentage of Twitter users in Saudi Arabia is among the highest in the world [21]. Twitter was flooded with awareness campaigns; and ministers, celebrities, academics, medics, and others have been tweeting “Stay Home” and “flatten the curve”. Other governmental local awareness messages were also being sent every day using text

messages and media outlets. When the number of cases reached 500 in the last week of March, Saudi Arabia issued a curfew and imposed a strong financial penalty on lawbreakers. Eventually, the Saudi government issued a lockdown on major cities such Riyadh, Makkah, Madinah and Jeddah and banned travels between all of its 13 provinces. By the end of March, Saudi government offered free healthcare to all citizens and residents. In its latest strict actions in April, Saudi Arabia implemented a 24-h curfew in most of the country, enforced lockdown and isolation of several suburbs and districts in major cities, and started mass and extensive testing in communities.

So far, the spread of the virus across the country is considered limited as compared to other countries that reported their first case on or after Saudi reported its first case. Fig. 2 summarizes the control and preventive measures taken by Saudi Arabia in response to the COVID-19 pandemic. More measures are also expected as the situation evolves. While Saudi Arabia has not yet announced its decision concerning the 2020 Hajj; it call upon all countries to put all Hajj plans on hold until further notice. Saudi King has called for an online conference for the G20 countries leaders to join in supporting the global efforts against the impact of COVID-19 worldwide. In this extraordinary meeting, the G20 leaders committed to take all necessary measures and ensure adequate financing to contain the COVID-19 pandemic in which Saudi Arabia pledged half a billion US dollar to global organizations such as CEPI, GAVI, and others.

### MERS emergence and lesson learned

It is apparent that the experience learned by China from dealing with several emerging infectious diseases including the emergence and spread of SARS-CoV in 2002/2003 has enabled China to better respond to the current SARS-CoV-2 pandemic [16]. Similarly, Saudi Arabia has experienced the outbreak of MERS-CoV which was first identified in Jeddah in 2012 and is still endemic in the country [11]. Although MERS-CoV has spread to 27 countries, nearly 90% of the cases have occurred in Saudi Arabia. Since 2012, Saudi Arabia has gained tremendous experience from the MERS-CoV endemic. For example, after the discovery of the MERS-CoV, the Saudi Ministry of Health (MoH) has promptly established a command and control center and accelerated the establishment of the Saudi Center for Disease Control and Prevention (SCDC), which are now operational and are in the frontline of the country response to SARS-CoV-2. In addition, the Saudi MoH launched the National Health Laboratory (NHL) as a reference laboratory with an emphasis on providing advanced diagnostics to infectious diseases with high biocontain-

ment laboratories [22]. The biosafety in diagnostic laboratories and the application of strict IPC systems in all hospitals across the country has improved substantially. Additionally, the Saudi MoH has designated more than 25 regional hospitals for the isolation and treatment of MERS patients. These hospitals are now well prepared and started to receive COVID-19 patients.

Furthermore, the medical and scientific research community demonstrated marvelous efforts in the understanding and control of MERS-CoV in the past few years, as evident by more than 480 publications to date [23], covering both translational and clinical research. Saudi Arabia has also started its first ever phase I clinical trial on a vaccine candidate for MERS-CoV (Clinical trial NCT04170829) as well as the MIRACLE trial which has been ongoing to evaluate antiviral therapeutics in severely infected MERS patients (Clinical trial NCT02845843) and now could be expanded to include COVID-19 patients. In addition to several epidemiologic and observational studies, two MERS-CoV vaccines have been developed and tested in animal studies [24,25] with another vaccine tested in camels as a one-health veterinary vaccine [26].

This advancement in research was coupled and supported by improved regulations at the Saudi FDA, MoH, and other regulators. Saudi FDA has supported the approval of the first vaccine Phase I clinical trial in the history of Saudi Arabia; despite being a very young organization itself. MoH has advocated for national IRB approval for MERS research trials. King Abdulaziz City for Science and Technology (KACST) has enabled the advancement of R&D by building a national center for vaccine development and manufacturing and further supported the newly established BADIR Program in supporting the acceleration and incubation of life science discoveries [27]. Many areas of improvement are still ahead and needed to enable the country to be more prepared in the case of epidemics and pandemics. Except for one biosafety level 3 (BSL-3) laboratory in an academic institution, high containment laboratories such as BSL-3/4 and animal BSL-3 (ABSL-3) are still lacking in the country. More advanced industrial-scale development grants are needed with networking between academia and industry.

## Conclusion and remarks

Saudi Arabia and China are the two countries that have witnessed the emergence of novel highly pathogenic hCoVs. These countries must have accumulated a frontline experience in dealing with and preparing for CoVs epidemics. MERS-CoV emergence in 2012 with continuing but controlled epidemic has put Saudi Arabia on a high sense of alert and readiness to take whatever measures to curb COVID-19 spread. Saudi Arabia has imposed a number of extreme measures on social movement, social and religious gatherings, travel, and businesses way before the first COVID-19 case reported in the country and before reaching 100 cases. It is expected that Saudi Arabia would have a flatter curve and may be able to control the pandemic quicker than other countries. MERS epidemics helped Saudi Arabia to have better alerted public health system and infection control policies and measures. Saudi Arabia has improved in terms of clinical and scientific research on epidemics, but it has yet a long way to go in building its appropriate biocontainment laboratories and moving into better governance of research and development.

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## Competing interests

None declared.

## Ethical approval

Not required.

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