



The battle against the COVID-19 pandemic- a perspective from Saudi Arabia

Shahid Bashir^{a,*}, Nouf Alabdulkarim^b, Nouf Altwajiri^b, Nojood Alhaidri^b, Refan Hashim^b, Eman Nasim^a, Ali Mir^a, Raidah Albaradie^a, Syed Shahid Habib^b, Turki Abualait^c

^a Neuroscience Center, King Fahad Specialist Hospital, Dammam, Saudi Arabia

^b College of Medicine, King Saud University, Riyadh, Saudi Arabia

^c College of Applied Medical Sciences, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia

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ABSTRACT

COVID-19 has emerged as the world's biggest challenge that has not only threatened human lives but also had an immense impact on the economy, safety and religious practices. The situation has worsened due to the lack of proper guidelines for fighting the sudden unexpected outbreaks. The world was not prepared for this situation. Muslims make up the largest religious group in the world, and Saudi Arabia is the center of religious life for Muslims. The eye of the Muslim world is turned toward the measures and reforms that the Saudi state is implementing during this pandemic, including strict curfews and quarantines with heavy fines and punishments for violations. This review highlights some important steps the Saudi government is taking and their impact on controlling the COVID-19 outbreak.

1. Introduction

In late December 2019, several cases of pneumonia began appearing in Wuhan, China. It was later discovered that the aforementioned cases were caused by a β -coronavirus that was named SARS-CoV-2 based on its genomic similarity with SARS-CoV [1,2]. Upon investigating the virus's origin, it was found that it emerged from the depths of Wuhan, specifically from a seafood market. It was proven that the pathogen is of a zoonotic source and, given that it has a highly identical genome to bat coronavirus, it was concluded that the natural host is the bat [2]. Human-to-human transmission was confirmed by the cases that turned up in families and among people who had not visited the seafood market [3]. Transmission was reported to be mainly by respiratory droplets and fomites. Furthermore, the incubation period ranges from 2 to 14 days. The typical signs and symptoms include fever, dry cough, fatigue, sputum production, shortness of breath, sore throat, headache, myalgia or arthralgia, chills, nausea or vomiting, nasal congestion, diarrhea, hemoptysis, and conjunctival congestion [4]. As of this writing, no definitive treatment or vaccination has been established. On March 11, 2020, the novel coronavirus disease (COVID-19) was declared by the World Health Organization (WHO) to be a global pandemic [5].

2. The extent of COVID-19

As of April 2020, the outbreak has shifted from China to other epicenters Italy and now in the United States of America (USA), as their number of confirmed cases has exceeded China's. As of January 28, there are around 100 million cases of COVID-19 around the world with over 2.1 million deaths [6]. The incidence increased rapidly around the world (Table 1). COVID-19 struck the Middle East at the end of January 2020, beginning with the United Arab Emirates, when a Chinese family arriving for vacation tested positive for the disease. From that day forward, cases started appearing all over the region. The Kingdom of Saudi Arabia (KSA) was the last Gulf country to identify cases of COVID-19. KSA is the largest country in the Arabian Peninsula and it is the fifth largest country in Asia [7,8]. However, the incidence rate is relatively low in KSA, which could be attributed to the effective precautionary measures taken by the government with the assistance of the Ministry of Health (MOH) and to the people abiding by these guidelines (Figs. 1 and 2).

2.1. Religious measures

Since its emergence, COVID-19 has posed a near impossible

* Corresponding author.

E-mail address: shahid.bashir@kfsh.med.sa (S. Bashir).

Table 1
Confirmed cases and incidence rate of COVID-19.

Country	Confirmed cases (as of 28 January)	Incidence
United States	26,166,423	7.87%
India	10,702,031	0.77%
Brazil	9000,485	4.2%
Russia	3,774,672	2.58%
United Kingdom	3,715,054	5.45%
France	3,106,859	4.75%
Kingdom of Saudi Arabia	367,023	1.04%

challenge for containment. In KSA, the outbreak was first recognized in early March 2020, when a citizen arriving from Iran via Bahrain tested positive for COVID-19 [9]. Prior to this, the authorities had already released a number of unprecedented precautionary measures.

Makkah is the holiest city of Islam, where over 1.3 million visitors, from outside of the country, come to the Holy Mosque in early 2019 to perform Umrah, a religious duty performed by Muslims from all over the world. Umrah is an optional Islamic pilgrimage to Makkah that can be done at any time during the year. Hajj, on the other hand, is a mandatory pilgrimage for adults who are able to accomplish it once in their lives. It is performed during specific days in the last month of the Islamic lunar calendar every year. Both Hajj and Umrah bring in over 20 million participants in Makkah yearly.

The Ministry of Hajj and Umrah issued more than 1.6 million visas during 2019 for Umrah alone [10]. Taking that into consideration, toward the end of February, the Ministry of Foreign Affairs announced suspending entry to KSA for the purpose of performing Umrah and visiting the Prophet’s Mosque in Medina [11]. A few days later, an official source of the Ministry of Interior announced the temporary suspension of Umrah for citizens and residents of KSA [12]. At that time, only two cases were confirmed. The remaining Umrah performers were placed in hotels around Jeddah and Makkah for medical isolation. After they tested negative, the visitors were put on flights back to their home countries [13]. In that manner, their safety was ensured and the possibility of them transmitting the disease to their home country was avoided.

In early March, the Islamic Affairs Minister encouraged certain measures, such as decreasing visitation time inside mosques [14]. Around the middle of March, daily congregational prayers in mosques were suspended [15].

The rituals of this year’s Hajj season began amid strict health measures due to fears of the spread of the COVID-19 among pilgrims. About 10 thousand residents participated in the rituals that continued over a period of five days, compared to about 2.5 million Muslims who attended last year, after a critical selection process carried out by the authorities based on the health status [16]. Given the fact that Hajj is one of the largest annual human gatherings in the world and a major potential focus for the spread of diseases, including the emerging Corona virus, and its organization usually represents a major logistical challenge, as millions of pilgrims from many countries flock to the crowded religious sites. As the last year was exceptional, all pilgrims had to be tested for the new Corona virus before their arrival in Makkah, and they had to quarantine after the Hajj. The Ministry of Hajj and Umrah prepared many health facilities and mobile clinics and equipped ambulances to meet the needs of pilgrims who would be required to adhere to social distancing [16]. The Minister of Health affirms that the health and safety of the pilgrims will remain the top priority [16].

2.2. Detection of cases

In an effort to detect all possible cases of COVID-19, early in the process of prevention, when there were still zero confirmed cases, the entry of tourist visa-holders from countries where the coronavirus had spread was suspended [11]. Furthermore, with only five confirmed cases, all passengers arriving from countries stricken by COVID-19 were required to be screened [17]. Three days later, it was declared that everyone traveling to KSA must submit a report that proves they are COVID-19 free [18]. In the middle of March, the Saudi government suspended all international flights [19], and toward the end of March, domestic flights were suspended, as well [20]. MOH urged the people to call the national number, 937, if they have questions or concerns. It was reported that more than 1.4 million calls were received about COVID-19 [21]. As of January 28, 12,128,395 tests have been performed [22].

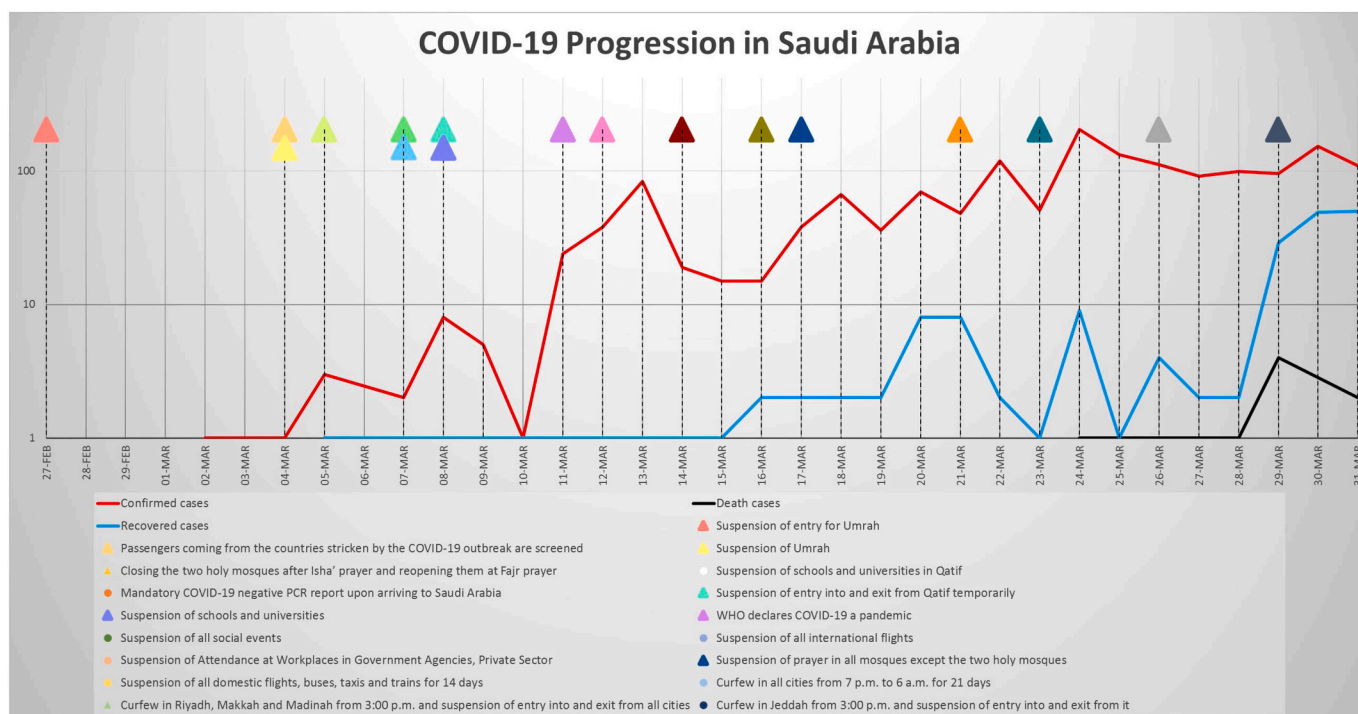


Fig. 1. COVID-19 progression in Kingdom of Saud Arabia.

2.3. Social distancing

In order to achieve social distancing, KSA introduced a number of measures, starting with the suspension of schools and universities in Qatif, where the first cases of COVID-19 appeared [23]. A few days later, temporary lockdowns were instituted in Qatif [24]. One day after that, the Minister of Education declared the suspension of all schools and universities in KSA [25]. About 6 million students were served through distance learning via online platforms without interruptions to the school year [26]. In addition, all sport and social events were adjourned and attendance at government and private workplaces was suspended [27–30]. Consequently, as the number of confirmed cases increased drastically, curfews were mandated in all cities from 7 p.m. to 6 a.m. [31]. On March 29, a total of 1299 cases and 8 deaths were confirmed, which warranted changing the curfew start time to 3 p.m. in Riyadh, Makkah, and Medina and the initiation of lockdowns of the same cities [32]. Later, they were changed to 24-h lockdowns in Riyadh, Tabuk, Dammam, Dhahran, Hafouf, Jeddah, Taif, Qatif, Khobar, Makkah, and Madinah [33,34]. Moreover, fines and imprisonment await curfew violators (see Fig. 2) [35]. These measures have contributed to 90% of social distancing efforts [36].

2.4. Government response

The Minister of Health encouraged the public to abide by these measures, stating that whether or not the number of cases increases will depend on the public's cooperation and commitment to these efforts [36].

As mentioned by King Salman, “the next phase will be more difficult at the global level.” The Minister of Health warned that the number of cases might multiply to a maximum of 200,000 [37]. On March 30, King Salman ordered health care workers to provide treatment to citizens, residents, and residence violators free of charge. In response to that, an increase in confirmed cases was noticed in the days following the statement (see Fig. 2) [38]. In conclusion, the Saudi Arabian

government's response to the COVID-19 pandemic consisted of multiple statements, ranging from preventative measures to efforts in providing treatment. Strict measures of curfews and quarantines have been implemented with heavy fines and punishments as the result of violating any of these measures.

3. The comorbidities in patients with COVID-19 and their impact on the severity of the disease

The global impact seen from this pandemic emphasizes the importance of studies that may identify the risk factors associated with COVID-19 and recognize the comorbidities that implicate a worse outcome for the patient. The identification of these comorbidities will lead to the early recognition of COVID-19 patients with a poor prognosis, which can therefore allow hospital personnel to apply the appropriate interventions that may mitigate complications and allow for a better outcome overall.

3.1. COVID-19 symptoms and possible outcomes

Based on recent reports, the clinical manifestations of COVID-19 include a multitude of symptoms that vary in severity. The most common symptoms are fever, cough, sputum, myalgia, fatigue, and shortness of breath. The majority of patients have shown an uncomplicated course of the disease. However, the literature shows that a significant portion of COVID-19 patients experience severe (35%) to critical (28%) courses [38]. Critically ill patients may suffer from adverse outcomes necessitating ICU admission, such as: sepsis, Acute Respiratory Distress Syndrome (ARDS), shock, heart failure, respiratory failure, coagulopathy, acute kidney injury, and death [39]. Everyone is susceptible to this virus, but the elderly and those with underlying diseases are most at risk of adverse outcomes [40]. A great limitation in handling the disease is lack of proper guidelines for every stage and state of illness. The strains of the virus also differ from region to region. As only limited epidemiological data on COVID-19 is currently available, health care workers

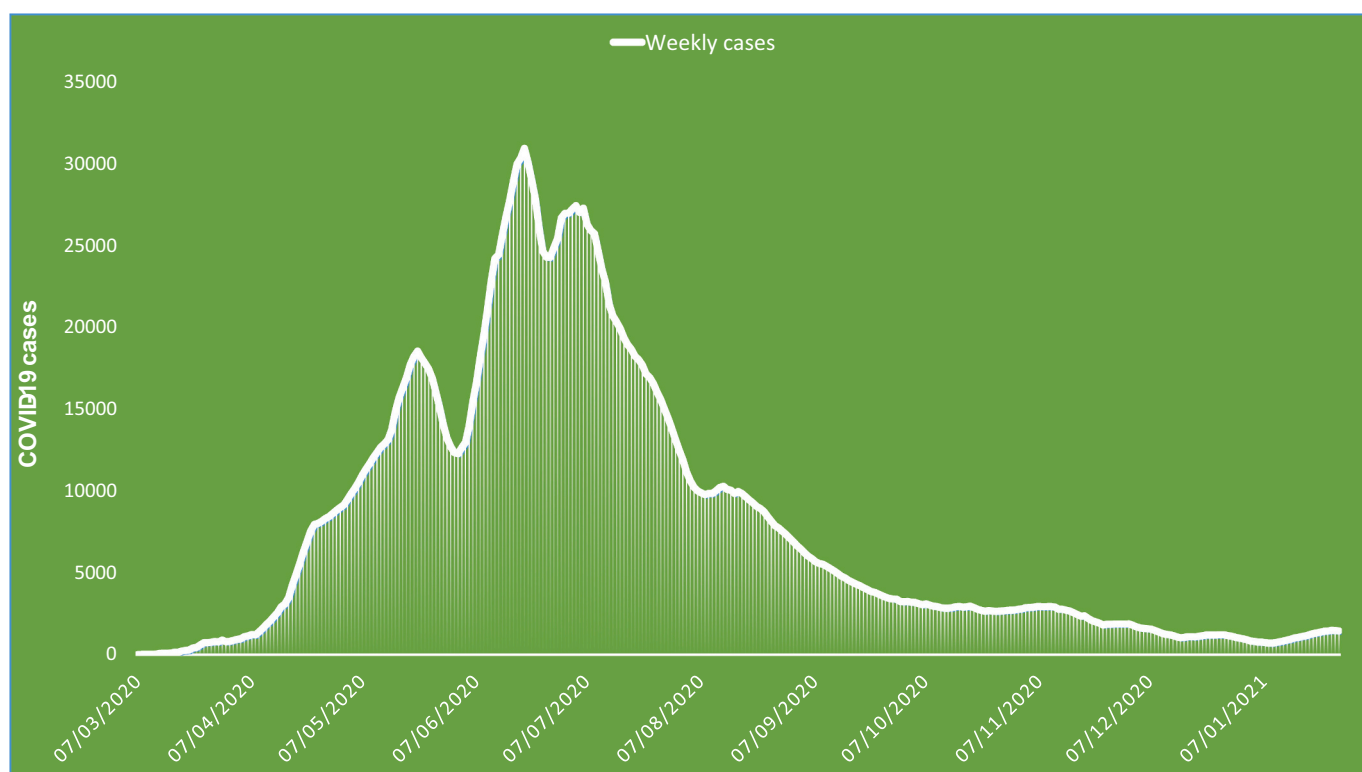


Fig 2. Weekly COVID-19 cases in Kingdom of Saud Arabia.

(HCWs) are advised to follow guidelines and tools designed for MERS-CoV case investigations.

3.2. The prevalence of comorbidities in COVID-19 patients

A nationwide analysis conducted in China regarding the prevalence of comorbidities in patients with COVID-19 reports that almost 50% of the patients hospitalized have at least one of the following comorbidities: diabetes, hypertension, or cardiovascular or cerebrovascular disease. The study concluded that patients with any comorbidity have poorer clinical outcomes than those who were previously healthy [41]. This is supported by a study that shows that severely afflicted patients had a higher proportion of hypertension, diabetes, and coronary heart disease. Moreover, COVID-19 patients with concomitant cardiovascular disease were associated with a higher risk of mortality [42]. Another comparative study in Wuhan revealed that patients who were suffering from severe illness had a higher prevalence of comorbid conditions than those with a non-severe course. This suggests that comorbidities may be a risk factor for yielding a severe course of the disease [39].

A meta-analysis studying the prevalence of comorbidities in hospitalized COVID-19 patients found that hypertension was the most common, found in 16% of all cases. Cardiovascular diseases followed and occurred in about 12% of cases. Diabetes mellitus had a prevalence of 7.8%. COPD and chronic kidney disease had a meager prevalence of 0.95% and 0.83%, respectively [43]. The number of comorbidities in patients may play a role in determining the prognosis of the disease. In other words, a greater number of comorbidities was correlated with poorer clinical outcomes [41].

3.2.1. Diabetes

Patients afflicted with SARS-CoV-2 pneumonia and concurrent diabetes have been reported to have a more severe course of illness than those without diabetes. The severity is evaluated in terms of organ damage, inflammatory factors, or hypercoagulability. Moreover, these patients are more likely to progress to a worse prognosis. Therefore, diabetes might be considered as a risk factor for a poor outcome of SARS-CoV-2 pneumonia [44].

3.2.2. Hypertension

The current literature suggests that hypertension may be associated with an up to 2.5-fold higher risk of severe COVID-19, especially among older individuals. It has also been associated with higher mortality compared to non-hypertensive patients [45].

3.2.3. Chronic obstructive pulmonary disease

According to the literature, COPD is associated with over a five-fold increased risk of severe COVID-19 infection [46].

3.2.4. Cardiovascular disease

Patients with previous cardiovascular diseases are more likely to have a severe course of the disease. Simultaneously, SARS-CoV-2 may also expedite cardiac damage through multiple mechanisms, further worsening the patient's prognosis [47].

4. The mechanisms through which comorbidities affect the course and severity of COVID-19

It has been suggested that these comorbidities have multiple mechanisms through which they may facilitate the occurrence of disease complications, which lead to poorer outcomes. For example, diabetes mellitus is known to lead to a compromised immune state by impairing macrophages and lymphocyte function [48]. This, in turn, makes the patient more likely to experience severe illness and develop any of its aforementioned complications. Another mechanism that has been suggested implicates angiotensin-converting enzyme 2 (ACE2) imbalance as the cause of severe disease in patients with both COVID-19 and

cardiovascular disease.

This can be explained by the fact that ACE2 is the main active peptide in the Renin-Angiotensin-Aldosterone-System (RAAS). By targeting angiotensin II, it acts as a protective compound to the cardiovascular system and even shows protective effects against respiratory failure in some infections. Similar to SARS, SARS-CoV-2 is believed to invade the host through the cell entry receptor ACE2 [49,50].

SARS-CoV-2 has been shown to bind ACE2 with high affinity. This, in turn, leads to a reduction in active ACE2, thus limiting its protective effect and aggravating the cardiovascular disease and COVID-19. This may elucidate why these patients have a worse disease course than those who are not afflicted with a simultaneous cardiovascular disease [51].

Moreover, patients with diabetes and hypertension who are treated with ACE inhibitors may be at an increased risk for developing COVID-19. This can be explained by the fact that human pathogenic coronaviruses, like SARS-CoV-2, bind to their target cells through ACE2. The expression of ACE2 is substantially increased in patients with diabetes and hypertension who are treated with ACE inhibitors. Thus, the increased expression of ACE2 may facilitate infection with SARS-CoV-2 by increasing its cellular binding and expediting its entry [52].

Studies have also suggested that glucolipid metabolic disorders—such as hyperlipidemia, diabetes, and atherosclerotic cardiovascular disease—may play a role in increasing the disease severity in COVID-19 patients. These disorders are associated with chronic inflammation and elevated levels of cytokines, which have been associated with an increase in severity of COVID-19 [51].

In conclusion, the literature shows that the most common comorbidities with COVID-19 are hypertension, cardiovascular disease, and diabetes. Patients with these comorbidities are more likely to yield poor clinical outcomes than those without. A thorough assessment of comorbidities may help prevent complications and improve the overall prognosis. Finally, patients with comorbidities should adopt more restrictive measures to prevent exposure to SARS-CoV-2, given their higher risk of severe disease.

5. Will seasonal variation affect corona virus spread in KSA?

Coronaviruses are a family of single-stranded RNA viruses that cause disease in animals and humans [53]. These viruses have been known to cause mild to moderate upper respiratory tract infections, but the three newly emerged strains can cause fatal disease [54]. Currently, there are only six types of coronaviruses that affect humans. Two of those have been the source of epidemics: SARS-CoV and MERS-CoV.

The characteristics of SARS-CoV, MERS-CoV, and SARS-CoV-2 are briefly detailed in the Table 2 [53–66]. To answer the question of whether or not seasonal temperature change plays a role in the spread of COVID-19, we must keep in mind that there are multiple factors that can change with the increase in temperature and do, indeed, matter. The most important of these are the viability of the virus under different conditions and humans' innate immunity.

5.1. The viability of the virus in different conditions

Interestingly, both SARS-CoV and SARS-CoV-2 have broken out primarily in China, which raises the question, why were they the first to experience these epidemics [67]? Both SARS 1 and SARS 2 broke out during the coldest months of the year in China, November and December [67–69]. This likely happened during these time periods is most probably related to the fact that because, in general, cold and dry conditions aid in virus survival [67,70–72].

To further elaborate, during the winter, the air is dry and cold, which is considered favorable for the transmission of the influenza virus, given that humidity strongly affects the transmission of the virus. However, when it comes to a coronavirus, transmission in different climates is possible. SARS-CoV-2 might be transmitted during the winter more efficiently, but that does not mean that transmission will be hindered

Table 2
Comparison of SARS-CoV, MERS-CoV and SARS-CoV-2.

	SARS-CoV	MERS-CoV	SARS-CoV-2
Year Identified	2002 (2)	2012 (3)	2019 [4]
Transmission Clinical Features	Droplet and direct contact [2] Most commonly fever and systemic manifestations like myalgia, chills, or fatigue [2,5]	Severe course in patients with comorbidities such as renal failure and it starts with cough and dyspnea [2,5]	Most commonly fever, dry cough, and fatigue but other symptoms were relatively rare [2,6].
Animal reservoir	Chinese horseshoe bats have been proven to be reservoirs for SARS-CoV [7]	Camels [8] and bats [9]	It is likely that bats are the reservoir, but it is still not proven [9]
Confirmed cases worldwide	8098 [2]	2502 [2]	100 millions [6]
Confirmed cases in Saudi Arabia	None [11]	2121 [12]	367,023 [13]
Fatality Rate worldwide	9.6% (2)	34.5% (3)	2.3% [4,14]
Fatality rate in Saudi Arabia	–	37.1% [12]	1.7% [13]

during the summer; even if that is the case, the change in transmission rate is expected to be modest [73]. Similarly, the MERS-CoV is influenced by climate conditions by which high temperature, low humidity, low wind speed and high ultraviolet are contributors to increased MERS-CoV cases [77].

One study has concluded that low temperatures and low humidity correlate with the increase of respiratory tract infections [74]. Evidently, the dried virus can live up to five days or more on surfaces where the temperatures are 22–25 °C and relative humidity is around 40–50%. However, the viability of the SARS coronavirus was lost at higher temperatures and relative humidity [72]. Nevertheless, in normal air temperatures and relative humidity of indoor environments, coronaviruses, influenza, and other pathogenic enveloped viruses may survive for several days [71]. Relatively different results were found when examining the influenza virus under low temperatures and relative humidity [75]. It is known that the influenza virus is more stable in colder conditions [76]. A decrease in temperature and relative humidity increases the risk of acquiring the influenza virus, but very low temperatures do not [75]. One study concludes that at lower temperatures, the half-life of the virus increases [77].

5.2. Innate immunity of humans

Cold and dry conditions affect the innate immunity of humans [76]. Mucociliary clearance is inhibited by the inhalation of cold air, and the phagocytic activity of the upper airway innate immune cells could be limited [77,78]. The inhalation of dry air for thirty minutes significantly slows the mucociliary clearance [77,79]. Therefore, in summary, cold, dry conditions can prolong virus survival, making it easy for the virus to break through the weakened human defenses during the winter [67].

5.3. Will the change in weather make a difference?

In theory, higher temperatures and higher humidity can hinder the survival of the virus. One study concluded that the transmission of COVID-19 is significantly reduced in high temperatures and high humidity, which is consistent with the fact that the transmission of SARS and influenza is reduced in high temperatures and high relative humidity. Therefore, summer and the rainy season could, indeed, hinder

the transmission of COVID-19 effectively [80]. However, when we view the history of SARS, we find that the change in weather did not stop the spread of the virus. The main factor that led to the control of the spread was the extremely intense public health interventions, for example, isolating cases, quarantine, social distancing, and other efforts [73]. The SARS viruses have been proven to be killed at 56 °C [81]. However, when it comes to SARS-CoV-2, the answer remains unclear. One study has concluded that the increase in temperature and humidity alone will not lead to a decline in cases if it is not accompanied by extensive public health interventions [82]. An important consideration that still remains is that, although the environmental temperature is very high in the summer in Saudi Arabia, almost all buildings and houses are air conditioned, and the indoor temperature remains around 22–24 °C. Many people also use desert coolers that keep the environment humid. Both of these factors are favorable for virus survival.

Therefore, even with the high temperatures expected in summer in Saudi Arabia, and the high humidity in different regions, transmission of the virus is likely to occur. Previous studies have speculated about the possibility of both outcomes (i.e., whether or not heat and humidity will stall the virus), but there is still significant uncertainty. What we know for sure is that the efforts made by the Ministry of Health in implementing extensive public health interventions are a sure way to stop the virus.

6. Precaution measures taken by the KSA government

The government of the Kingdom of Saudi Arabia has taken rapid precautionary and preventive measures to combat the outbreak of the COVID-19 global pandemic. The government has moved decisively to tackle the unexpected effects and consequences of the coronavirus and has taken immediate measures to ensure the safety of its citizens and residents. Furthermore, they have taken steps to address the significant fiscal, financial, and economic impacts of this pandemic.

The Saudi government has announced the allocation of an “emergency budget” to cover the costs of any new developments from the effects of COVID-19. It has revealed a financial package worth more than 120 billion Saudi riyals (US\$32 billion) to reduce the impact of the virus outbreak on the national economy, while exposing the urgent economic treatments represented in multiple initiatives for the private sector. Several ministerial committees have also been organized to study the effects of the crisis and its challenges in a number of sectors and regions, as well as the opportunities to address them with either support or stimulus.

The initiatives package includes important policies in the realm of economic activities, whereby business owners will be exempt from compensating expatriates; this policy will expire at the end of next June. In addition, business owners will be allowed, for a period of three months, to postpone payment of the value-added tax, selective goods tax, and income tax; they also may delay the submission of “Zakat” declarations and postpone the payment of the obligations under it. Thus, such postponements of government dues will provide liquidity to the private sector so that it can manage its economic activities.

The package includes the pre-allocated value of 50 billion riyals (US \$13.3 billion) in support of banks and financial institutions and small and medium-sized companies, along with initiatives to support the economy, amounting to more than 70 billion riyals (US\$18.7 billion). Moreover, the government, through unemployment insurance, will bear 60% of the salaries of Saudi private sector workers for three months, starting in April 2020, up to 9000 riyals per month for a total value of 9 billion riyals (US\$2.4 billion). These decisions were made to help the government deal with the effects and consequences of the global pandemic and to guarantee the safety of citizens and residents facing financial and economic impacts. Within each city, driving is restricted between towns/areas. The government has announced a heavy fine of 10,000 riyals (US\$2600) if someone violates this rule or is driving without a permission letter.

In line with what the government is doing, a principle committee has been formed, headed by the Minister of Finance and including the Minister of Economy and Planning, the Minister of Commerce, the Minister of Industry and Mineral Resources, the Vice Chairman of the National Development Fund Board, and the Governor of the National Development Fund. With members from such high levels of government, this committee has reviewed and determined the incentives, facilities, and other initiatives that will be used to alleviate the extraordinary economic situation, in light of the implications of COVID-19 and the impact of the precautionary measures taken by the government with the current low oil prices. Among the tasks of the committee is to design criteria and controls for implementing and detailing the financial and economic initiatives, determining the amounts that will be used to support these initiatives from the available funds [83].

6.1. COVID-19 vaccination campaign in KSA

On December 17, 2020, a vaccination campaign was launched against COVID-19 by the Minister of Health. The campaign started with the Minister of Health taking the vaccine, alongside members of the scientific committees of vaccinations with a group of citizens. The ministry of health announced on January 7th, that over 1 million people were registered to take the COVID-19 vaccine. Registering to take the vaccine is readily available through the 'Sehhaty' application. It is reported that as of January 2021, more than 137,000 people have already received the vaccine, with numbers increasing day by day. The MOH has stressed that this vaccine is one of most important stages in dealing with this pandemic.

6.2. Anticipated economic losses due to COVID-19 in KSA

In response to the expected economic losses due to the COVID-19 pandemic, the United Nations Economic and Social Commission for Western Asia (ESCWA) warned that this crisis could cause the loss of more than 1.7 million jobs in the Arab world. ESCWA expected that the Gross Domestic Product (GDP) of Arab countries will decrease by no less than US\$42 billion in 2020 due to the drop in oil prices and the repercussions of the outbreak of the novel coronavirus. The region is likely to lose more than 1.7 million jobs this year, with the unemployment rate rising by 1.2%. It is also expected that employment opportunities will be affected in all sectors.

In Saudi Arabia, most of the companies affected are those that are exposed to the Asian markets, whether for export or to import raw materials from China, travel and tourism companies, high-debt companies, and companies that have high repetitions, in addition to companies that pay government taxes. Moreover, most of the retail companies that will be affected are electronics companies, as a result of the lack of supplies that will occur due to the continued spread of COVID-19.

In the petrochemical sector, most companies sell their products to Asian markets, and those that do will experience a larger impact in the form of lower sales volume due to lower demand. The prices of petrochemical products are expected to decrease further, considering the previous forecasts for price decline during the second half of 2020 to the second half of 2021 [84].

On the extent of the impact of the economic situation—in particular, the decrease in oil prices on the level of the budget deficit—the government of Saudi Arabia has stressed that it has the economic and financial ability, as well as the flexibility through reducing expenses or borrowing, to face such a crisis. It also expects to rely on its large reserves and investments. The Saudi government predicted that the budget deficit in place by the end of 2020 will not exceed 7–9%, which is what the government has aimed to reach.

The financial impact of the Coronavirus pandemic on 2020 budget expenditures in the second quarter was not taken into account when the estimates were drawn up for the 2020 budget, as the actual expenditures

increased from expected from US\$172 billion to US\$285 billion. As a result of the steps taken by the government to confront the Corona pandemic, by supporting the private sector, the health sector, and supporting salaries. Moreover, revenues for 2020 also decreased to US\$205 billion, about 17% from last year, and this was expected.

7. Conclusions

COVID-19 has emerged as the world's biggest challenge and has threatened human lives with deleterious effects on the economy, safety, and religious practices. The situation has worsened with lack of proper guidelines for fighting the sudden and unexpected outbreak. In the midst of the current COVID-19 pandemic, where building immune functions are vital to survive the infection, a balance in the factors supporting our self-mechanism may play an important role. Promoting activities that could provide the balance could also help to enhance our survival and mitigate irrational behaviors in this climate of high uncertainty. The Saudi government's efforts to control the COVID-19 pandemic have been significant. Strict measures by the government, along with cooperation by the general public, will hopefully make this battle a success.

Ethical approval

Not required.

Declaration of Competing Interest

Authors declare no conflict of interest.

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References

- [1] World Health Organization, Naming the coronavirus disease (COVID-19) and the virus that causes it. [https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/naming-the-coronavirus-disease-\(covid-2019\)-and-the-virus-that-causes-it](https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/naming-the-coronavirus-disease-(covid-2019)-and-the-virus-that-causes-it), 2020 [accessed 9 April 2020].
- [2] Y.R. Guo, Q.D. Cao, Z.S. Hong, Y.Y. Tan, S.D. Chen, H.J. Jin, et al., The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak - an update on the status, *Mil Med Res* 7 (2020) 11, <https://doi.org/10.1186/s40779-020-00240-0>.
- [3] C.W. Graham, C.S. Dela Cruz, B. Cao, S. Pasnick, J.S. Novel, Wuhan (2019-NCoV) coronavirus, *Am. J. Respir. Crit. Care Med.* 201 (2020) 7–8, <https://doi.org/10.1164/rccm.2014P7>.
- [4] World Health Organization, Joint Mission W-C. Report of the WHO-China joint mission on coronavirus disease 2019 (COVID-19). <https://www.who.int/docs/default-source/coronaviruse/who-china-joint-mission-on-covid-19-final-report.pdf>, 2020 [accessed 9 April 2020].
- [5] World Health Organization, Coronavirus disease (COVID-19) outbreak. <https://www.who.int/westernpacific/emergencies/covid-19> [accessed 9 April 2020].
- [6] World Health Organization, COVID-19 dashboard. <https://who.sprinklr.com/> [accessed 28 January 2021].
- [7] The Embassy of the Kingdom of Saudi Arabia, About Saudi Arabia. <https://www.saudiembassy.net/about-saudi-arabia>, 2020 [accessed 10 April 2020].
- [8] WorldAtlas.com, The largest countries in Asia by area. <https://www.worldatlas.com/articles/which-are-the-10-largest-asian-countries-by-area.html>, 2020 [accessed 10 April 2020].
- [9] Saudi Press Agency, Ministry of Health announces first case of new coronavirus for citizen coming from Iran. <https://www.spa.gov.sa/2041853>, 2020 [accessed 10 April 2020].
- [10] Ministry of Hajj and Umrah, Umrah Weekly Indicator: KSA receives over 1.3 million pilgrims and issues 1.6 million visas. <https://www.haj.gov.sa/en/News/Details/12415>, 2020 [accessed 10 April 2020].
- [11] Saudi Press Agency, Saudi Arabia takes precautionary measures to prevent transmission of novel coronavirus into its territory. <https://www.spa.gov.sa/viewstory.php?lang=en&newsid=2040533>, 2020 [accessed 10 April 2020].
- [12] Saudi Press Agency, Interior Ministry official source: Suspension of Umrah temporarily for citizens, residents in the Kingdom. <https://www.spa.gov.sa/2042815>, 2020 [accessed 10 April 2020].
- [13] Worldometer, Current COVID-19 cases, Retrieved January 28, 2021, from, <https://www.worldometers.info/coronavirus/>, 2021 [accessed 28 January 2021].

- [14] Saudi Press Agency, Islamic Affairs Minister instructs taking further measures in mosques to curb the spread of coronavirus in the Kingdom. <https://www.spa.gov.sa/viewstory.php?lang=en&newsid=2044828>; 2020 [accessed 11 April 2020].
- [15] Saudi Press Agency, Senior Ulema Commission temporarily bans Friday prayers and group prayers in mosques, with the exception of the two holy mosques, throughout the day. <https://www.spa.gov.sa/viewstory.php?lang=en&newsid=2048697>; 2020 [accessed 11 April 2020].
- [16] Saudi Press Agency, OIC holds emergency virtual meeting on combating novel coronavirus 2. <https://www.spa.gov.sa/viewstory.php?lang=en&newsid=2071981>; 2020 [accessed 10 April 2020].
- [17] MOH News, Preventive surveillance measures tightened at land ports. <http://www.moh.gov.sa/en/Ministry/MediaCenter/News/Pages/News-2020-03-04-001.aspx>; 2020 [accessed 10 April 2020].
- [18] Saudi Press Agency, Kingdom's government sets preventive, precautionary measures to prevent COVID-19 infection transmission, Interior Ministry says. <https://www.spa.gov.sa/viewfullstory.php?lang=en&newsid=2043855>; 2020.
- [19] Saudi Press Agency, Official source at Ministry of Interior: Kingdom's government decides to suspend international flights for two weeks starting tomorrow, Sunday. <https://www.spa.gov.sa/viewstory.php?lang=en&newsid=2047488>; 2020.
- [20] Saudi Press Agency, Official source at Ministry of Interior: Suspending all domestic flights, buses, taxis and trains for a period of 14 days starting at 6 a.m. Saturday morning. <https://www.spa.gov.sa/2049606>; 2020 [accessed 11 April 2020].
- [21] Saudi Press Agency, 937-call service receives more than 1.4 million calls in a month. <https://www.spa.gov.sa/2052260>; 2020 [accessed 11 April 2020].
- [22] Saudi Arabia, Ministry of Health. By April 8th, 115,585 tests for COVID-19 have been performed in Saudi Arabia, in 10 molecular labs using PCR technology. This translates to 12,128,395 tests per million population. <https://twitter.com/SaudiMOH/status/1248353596409864196?s=20>; 2020 [accessed 28 January 2021].
- [23] Asharq AL-Awsat, Saudi Arabia suspends classes in al-Qatif for 2 weeks over coronavirus. <https://aawsat.com/english/home/article/2168131/saudi-arabia-suspends-classes-al-qatif-2-weeks-over-coronavirus>; 2020 [accessed 11 April 2020].
- [24] Saudi Press Agency, Ministry of Interior: Suspending entry into and exit from Qatif Governorate temporarily. <https://www.spa.gov.sa/viewstory.php?lang=en&newsid=2044304>; 2020 [accessed 11 April 2020].
- [25] Gulf News, Saudi Arabia suspends schools, universities. <https://gulfnews.com/uae/government/saudi-arabia-suspends-schools-universities-1.1583692544604>; 2020 [accessed 11 April 2020].
- [26] Saudi Press Agency, Minister of Education: We were able to serve 6 million students in distance education without interrupting their education for one day. <https://www.spa.gov.sa/viewstory.php?lang=en&newsid=2050320>; 2020 [accessed 11 April 2020].
- [27] Saudi Press Agency, Ministry of Sports takes more precautionary measures in sports halls and centers to prevent spread of coronavirus. <https://www.spa.gov.sa/viewstory.php?lang=en&newsid=2046635>; 2020 [accessed 11 April 2020].
- [28] Saudi Press Agency, Ministry of Human Resources and Social Development: Suspending employees' coming to main offices of private sector establishments for a period of "15" days. <https://www.spa.gov.sa/2048802>; 2020.
- [29] Saudi Press Agency, Kingdom's government decides to suspend attendance at workplaces in all government agencies for period of 16 days except for health, security, military and electronic security center. <https://www.spa.gov.sa/2047989>; 2020.
- [30] Saudi Press Agency, Suspension of all social events in wedding halls and party halls. <https://www.spa.gov.sa/2047167>; 2020 [accessed 11 April 2020].
- [31] Saudi Press Agency, Custodian of the two holy mosques issues curfew order to limit spread of novel coronavirus from seven in the evening until six in the morning for 21 days starting in the evening of Monday 23 March. <https://www.spa.gov.sa/2050402>; 2020 [accessed 11 April 2020].
- [32] MOH News, COVID-19 monitoring committee holds its 35th meeting. <http://www.moh.gov.sa/en/Ministry/MediaCenter/News/Pages/News-2020-03-25-004.aspx>; 2020 [accessed 11 April 2020].
- [33] Saudi Press Agency, Saudi Arabia imposes 24-hour curfew on Riyadh, Tabuk, Dammam, Dhahran, Hafuf, Jeddah, Taif, Qatif and Khobar, Interior Ministry announces. <https://www.spa.gov.sa/viewstory.php?lang=en&newsid=2071013>; 2020 [accessed 11 April 2020].
- [34] Saudi Press Agency, Ministry of Interior: Curfew in all Makkah and Madinah for 24 hours effective from today until further notice. <https://www.spa.gov.sa/viewstory.php?lang=en&newsid=2054196>; 2020 [accessed 11 April 2020].
- [35] Saudi Press Agency, Official source of Ministry of Interior: Fine and imprisonment for violating curfew provisions. <https://www.spa.gov.sa/viewstory.php?lang=en&newsid=2050590>; 2020 [accessed 11 April 2020].
- [36] Saudi Press Agency, Health Minister: Increasing numbers of COVID-19 infections in the coming period primarily depends on everyone's cooperation and commitment to instructions. <https://www.spa.gov.sa/viewstory.php?lang=en&newsid=2071285>; 2020.
- [37] MOH News, Al-Rabiah: COVID-19 cases in the Kingdom could reach 200,000 within few weeks. <https://www.moh.gov.sa/en/Ministry/MediaCenter/News/Pages/News-2020-04-07-003.aspx>; 2020 [accessed 11 April 2020].
- [38] Saudi Press Agency, Custodian of the two holy mosques orders free treatment from Coronavirus for all citizens, residents, and violators of residency regulation in all health facilities. <https://www.spa.gov.sa/viewstory.php?lang=en&newsid=2052979>; 2020 [accessed 11 April 2020].
- [39] D.S. Hui, E.I. Azhar, T.A. Madani, F. Ntoumi, R. Kock, O. Dar, et al., The continuing 2019-nCoV epidemic threat of novel coronaviruses to global health — the latest 2019 novel coronavirus outbreak in Wuhan, China, *Int. J. Infect. Dis.* 91 (2020) 264–266, <https://doi.org/10.1016/j.ijid.2020.01.009>.
- [40] Y. Wu, W. Ho, Y. Huang, D.Y. Jin, S. Li, S.L. Liu, et al., SARS-CoV-2 is an appropriate name for the new coronavirus, *Lancet* 395 (2020) 949–950, [https://doi.org/10.1016/S0140-6736\(20\)30557-2](https://doi.org/10.1016/S0140-6736(20)30557-2).
- [41] F. Zhou, T. Yu, R. Du, G. Fan, Y. Liu, Z. Liu, et al., Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study, *Lancet* 395 (2020) 1054–1062, [https://doi.org/10.1016/S0140-6736\(20\)30566-3](https://doi.org/10.1016/S0140-6736(20)30566-3).
- [42] J. Yang, Y. Zheng, X. Gou, K. Pu, Z. Chen, Q. Guo, et al., Prevalence of comorbidities in the novel Wuhan coronavirus (COVID-19) infection: a systematic review and meta-analysis, *Int. J. Infect. Dis.* 94 (2020) 91–95, <https://doi.org/10.1016/j.ijid.2020.03.017>.
- [43] W.J. Guan, W.H. Liang, Y. Zhao, H.R. Liang, Z.S. Chen, Y.M. Li, et al., Comorbidity and its impact on 1590 patients with Covid-19 in China: a nationwide analysis, *Eur. Respir. J.* 55 (2020) 2000547, <https://doi.org/10.1183/13993003.00547-2020>.
- [44] Y.D. Peng, K. Meng, H.Q. Guan, L. Leng, R.R. Zhu, By Wang, et al., Clinical characteristics and outcomes of 112 cardiovascular disease patients infected by 2019-nCoV, *Zhonghua Xin Xue Guan Bing Za Zhi* 48 (2020), E004, <https://doi.org/10.1183/13993003.00547-2020>.
- [45] A. Emami, F. Javanmardi, N. Pirbonyeh, A. Akbari, Prevalence of underlying diseases in hospitalized patients with COVID-19: A systematic review and meta-analysis, *Arch Acad Emerg Med* 8 (2020) e35.PMID: 32232218; PMID: PMC7096724.
- [46] W. Guo, M. Li, Y. Dong, H. Zhou, Z. Zhang, C. Tian, et al., Diabetes is a risk factor for the progression and prognosis of COVID-19, *Diabetes Metab. Res. Rev.* (2020), e3319, <https://doi.org/10.1002/dmrr.3319>.
- [47] G. Lippi, J. Wong, B.M. Henry, Hypertension and its severity or mortality in coronavirus disease 2019 (COVID-19): a pooled analysis, *Pol Arch Intern Med* 130 (2020) 304–309, <https://doi.org/10.20452/pamw.15272>.
- [48] G. Lippi, B.M. Henry, Chronic obstructive pulmonary disease is associated with severe coronavirus disease 2019 (COVID-19), *Respir. Med.* 167 (2020) 105941, <https://doi.org/10.1016/j.rmed.2020.105941>.
- [49] B. Li, J. Yang, F. Zhao, L. Zhi, X. Wang, L. Liu, et al., Prevalence and impact of cardiovascular metabolic diseases on COVID-19 in China, *Clin. Res. Cardiol.* 109 (2020) 531–538, <https://doi.org/10.1007/s00392-020-01626-9>.
- [50] K.E. Dooley, R.E. Chaisson, Tuberculosis and diabetes mellitus: convergence of two epidemics, *Lancet Infect. Dis.* 9 (2009) 737–746, [https://doi.org/10.1016/S1473-3099\(09\)70282-8](https://doi.org/10.1016/S1473-3099(09)70282-8).
- [51] P. Zhou, X.L. Yang, X.G. Wang, B. Hu, L. Zhang, W. Zhang, et al., A pneumonia outbreak associated with a new coronavirus of probable bat origin, *Nature* 579 (7798) (2020) 270–273, <https://doi.org/10.1038/s41586-020-2012-7>.
- [52] R. Muniyappa, S. Gubbi, COVID-19 pandemic, corona viruses, and diabetes mellitus 318, 2020, <https://doi.org/10.1152/ajpnd.00124.2020>. E736–41.
- [53] Y. Chen, X. Gong, L. Wang, J. Guo, Effects of hypertension, diabetes and coronary heart disease on COVID-19 diseases severity: A systematic review and meta-analysis, *medRxiv*, 2020, <https://doi.org/10.1101/2020.03.25.20043133>.
- [54] L. Fang, G. Karakiulakis, M. Roth, Are patients with hypertension and diabetes mellitus at increased risk for COVID-19 infection? *Lancet Resp Med* 8 (2020), e21 [https://doi.org/10.1016/s2213-2600\(20\)30116-8](https://doi.org/10.1016/s2213-2600(20)30116-8).
- [55] S.E. Park, Epidemiology, virology, and clinical features of severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2; coronavirus disease-19), *Clin Exp Pediatr* 63 (2020) 119–124, <https://doi.org/10.3345/cep.2020.00493>.
- [56] NIH, Coronaviruses. <https://www.niaid.nih.gov/diseases-conditions/coronaviruses>; 2020 [accessed 10 April 2020].
- [57] World Health Organization, Summary of probable SARS cases with onset of illness from 1 November 2002 to 31 July 2003. https://www.who.int/csr/sars/country/table2004_04_21/en/; 2004 [accessed 16 April 2020].
- [58] World Health Organization, MERS-CoV global summary and assessment of risk. <https://www.who.int/publications-detail/who-mers-cov-global-summary-and-assessment-of-risk>; 2020 [accessed 8 April 2020].
- [59] Y. Chen, L. Li, SARS-CoV-2: virus dynamics and host response, *Lancet* 20 (2020) 515–516.
- [60] American Academy of Pediatrics, Coronaviruses, including SARS and MERS, editors, in: D.W. Kimberlin, M.T. Brady, M.A. Jackson, S.S. Long (Eds.), *Red Book: 2018 Report of the Committee on Infectious Diseases*. 31st ed. Itasca, American Academy of Pediatrics, 2018, pp. 297–301.
- [61] Y. Wang, Y. Wang, Y. Chen, Q. Qin, Unique epidemiological and clinical features of the emerging 2019 novel coronavirus pneumonia (COVID-19) implicate special control measures, *J. Med. Virol.* 92 (2020) 568–576, <https://doi.org/10.1002/jmv.25748>.
- [62] X.Y. Ge, J.L. Li, X.L. Yang, A.A. Chmura, G. Zhu, J.H. Epstein, et al., Isolation and characterization of a bat SARS-like coronavirus that uses the ACE2 receptor, *Nature* 503 (7477) (2013) 535–538. <http://www.nature.com/articles/nature12711>.
- [63] NIH, COVID-19, MERS & SARS. <https://www.niaid.nih.gov/diseases-conditions/covid-19>; 2020 [accessed 10 April 2020].
- [64] World Health Organization, Coronavirus disease 2019 (COVID-19) situation report-76. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200405-sitrep-76-covid-19.pdf?sfvrsn=6ecf0977_2; 2020 [accessed 16 April 2020].
- [65] World Health Organization, Summary of probable SARS cases with onset of illness from 1 November 2002 to 31 July 2003. https://www.who.int/csr/sars/country/table2004_04_21/en/; 2020 [accessed 10 April 2020].
- [66] World Health Organization, MERS situation update, January 2020 | MERS-CoV | Epidemic and pandemic diseases. <http://www.emro.who.int/pandemic-epidemic-diseases/mers-cov/mers-situation-update-january-2020.html>; 2020 [accessed 10 April 2020].

- [67] World Health Organization, COVID-19 dashboard. <https://who.sprinklr.com/region/emro/country/sa;>, 2020 [accessed 10 April 2020].
- [68] Z. Wu, J.M. McGoogan, Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72,314 cases from the Chinese Center for Disease Control and Prevention, *J. Am. Med. Assoc.* 323 (13) (2020) 1239–1242, <https://doi.org/10.1001/jama.2020.2648>.
- [69] Z. Sun, K. Thilakavathy, S.S. Kumar, G. He, S.V. Liu, Potential factors influencing repeated SARS outbreaks in China, *Int. J. Environ. Res. Public Health* 17 (2020), e1633, <https://doi.org/10.3390/ijerph17051633>.
- [70] NBSC, PRC: China Statistical Yearbook 2018 (Chinese-English Edition), China Statistics Press, Beijing, 2018.
- [71] NBSC, PRC: China Statistical Yearbook 2019 (Chinese-English Edition), China Statistics Press, Beijing, 2019.
- [72] L.M. Casanova, S. Jeon, W.A. Rutala, D.J. Weber, M.D. Sobsey, Effects of air temperature and relative humidity on coronavirus survival on surfaces, *Appl. Environ. Microbiol.* 76 (9) (2010) 2712–2717, <https://doi.org/10.1128/AEM.02291-09>.
- [73] K.H. Chan, J.S.M. Peiris, S.Y. Lam, L.L.M. Poon, K.Y. Yuen, W.H. Seto, The effects of temperature and relative humidity on the viability of the SARS coronavirus, *Adv Virol* 2011 (2011) 734690, <https://doi.org/10.1155/2011/734690>.
- [74] Center for Communicable Disease Dynamics, Seasonality of SARS-CoV-2: Will COVID-19 go away on its own in warmer weather. <https://ccdd.hsph.harvard.edu/will-covid-19-go-away-on-its-own-in-warmer-weather/> [accessed 16 April 2020].
- [75] T.M. Mäkinen, R. Juvonen, J. Jokelainen, T.H. Harju, A. Peitso, A. Bloigu, et al., Cold temperature and low humidity are associated with increased occurrence of respiratory tract infections, *Respir. Med.* 103 (3) (2009) 456–462, <https://doi.org/10.1016/j.rmed.2008.09.011>.
- [76] K. Jaakkola, A. Saukkoripi, J. Jokelainen, R. Juvonen, J. Kauppila, O. Vainio, et al., Decline in temperature and humidity increases the occurrence of influenza in cold climate, *Environ. Health* 13 (2014) 22, <https://doi.org/10.1186/1476-069X-13-22>.
- [77] A.C. Lowen, J. Steel, Roles of humidity and temperature in shaping influenza seasonality, *J. Virol.* 88 (14) (2014) 7692–7695, <https://doi.org/10.1128/JVI.03544-13>.
- [78] A.C. Lowen, J. Steel, Roles of humidity and temperature in shaping influenza seasonality, *J. Virol.* 88 (2014) 7692–7695, <https://doi.org/10.1128/JVI.03544-13>.
- [79] R. Eccles, An explanation for the seasonality of acute upper respiratory tract viral infections, *Acta Otolaryngol.* 122 (2002) 183–191, <https://doi.org/10.1080/00016480252814207>.
- [80] B. Salah, A.T. Dinh Xuan, J.L. Fouilladieu, A. Lockhart, J. Regnard, Nasal mucociliary transport in healthy subjects is slower when breathing dry air, *Eur. Respir. J.* 1 (9) (1988) 852–855.
- [81] J. Wang, K. Tang, K. Feng, W. Lv, High temperature and high humidity reduce the transmission of COVID-19, *SSRN Electron. J.* (2020), <https://doi.org/10.2139/ssrn.3551767>.
- [82] World Health Organization, First data on stability and resistance of SARS coronavirus compiled by members of WHO laboratory network. [https://www.who.int/csr/sars/survival_2003_05_04/en/;](https://www.who.int/csr/sars/survival_2003_05_04/en/), 2020 [accessed 16 April 2020].
- [83] W. Luo, M.S. Majumder, D. Liu, C. Poirier, K.D. Mandl, M. Lipsitch, et al., The role of absolute humidity on transmission rates of the COVID-19 outbreak. medRxiv, 2020, <https://doi.org/10.1101/2020.02.12.20022467>.
- [84] Saudi Arabia Ministry of Finance, Home page. <https://www.mof.gov.sa/en/Pages/default.aspx;>, 2020 [accessed 16 April 2020].