Characteristics and outcome of COVID-19 cases in Saudi Arabia: Review of six-months of data (March–August 2020)

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Abstract

Background: This study presents the demographic, epidemiological, and clinical characteristics of Coronavirus Disease 2019 (COVID-19) in Saudi Arabia (KSA). It identifies the important predictors of the disease prognosis.

Methods: The study reviewed and analysed a sample of 307,010 confirmed symptomatic COVID-19 cases, between March and August 2020, available in the health electronic surveillance system (HESN) of the Ministry of Health of KSA. Descriptive and univariate analyses were conducted.

Results: The overall estimated prevalence of symptomatic COVID-19 cases in KSA between March and August 2020 was 6.1%. The estimated incidence proportion was 879.7 per 100,000 population. The overall case fatality ratio was 2.0%. Males represented 63.9%, with a mean age of 35.1 ± 16.6 years. Young adults (16–39 years) were the most affected ages (53.3%). Fever (90.5%) with a mean body temperature of 37.4 ± 2.0 Celsius, cough (90%), and sore throat (77.4%) were the most prevalent symptoms. A history of contact with a confirmed COVID-19 case was reported in 98.8% of patients.

Males (2.1%) and elderly cases aged 65–99 years (25.6%) had the highest association with mortality (p < .001). Among the clinical characteristics investigated, low oxygen saturation (SpO2 < 93%) had the highest association with hospital admission (50.8%) and mortality (19.1%) (p < .001). Cases with cardiovascular diseases (28.6%) and malignancy (28%) demonstrated the highest associations with mortality compared to other underlying diseases (p < .001).

Conclusions: In KSA, the prevalent symptoms of COVID-19 are fever, cough, and sore throat. Makkah and Almadinah regions are significantly associated with highest burden of mortality. The low level of oxygen saturation, high fever, old age, and underlying cardiovascular disease are the most important predictors for prognosis.

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1. Introduction

Since December 2019, the emerging coronavirus disease, COVID-19, has spread worldwide, causing over 80 million cases and over one million deaths in >190 countries (Johns Hopkins University, 2020). As of November 2020, there have been over 300,000 cases of COVID-19 in Saudi Arabia (KSA), with over 5000 deaths. While the exact mechanisms of COVID-19 transmission are under continuing investigation, it is thought to primarily spread from person to person through airborne respiratory droplets produced when an infected person coughs, sneezes, or talks (Hossain et al., 2020; Harmooshi et al., 2020). Infection is transmitted by symptomatic patients, but transmission can also occur from asymptomatic individuals and before symptom onset (Singhal, 2020). The transmission of COVID-19 is propagative and its trend is affected by the implemented preventive measures like majority of viruses. At the early stages of the epidemic in KSA, Youssef HM et al., (Oct 2020, and Dec 2020) could apply the modified Susceptible-Exposed-Infectious-Recovered (SEIR) statistical model and successfully predicted that the number of COVID-19 cases would decrease to >500 per day by the beginning of October 2020. Moreover, this model could statistically prove that
prevention is better than cure and isolation of infected people is essential to control the epidemic.

The novelty of the virus, the rapid national and international spread, the lack of therapeutic and preventative strategies, and its ability to paralyse health systems worldwide led the World Health Organization (WHO) to declare the disease a Public Health Emergency of International Concern on January 30, 2020 (Al-Tawfiq and Memish, 2020). To limit spread, many countries, including KSA, implemented preventive measurements of varying degrees. The first confirmed case of COVID-19 was reported by the Saudi MoH on March 2, 2020 from AlQatif region, where lockdown was enforced, all community gathering was prohibited, and recommendations of social precautions such as social distancing, hand hygiene, and wearing a mask were made. With the gradual spread of the disease, several congregational events were cancelled, and travel was limited. For the first time in the history of the annual Muslim pilgrimage, KSA restricted visitors from abroad from performing Hajj (Al-Tawfiq and Memish, 2020; Alkhawlied et al., 2020). While research of COVID-19 in KSA has been conducted, these studies were based on limited sample sizes and lacked important information on the outcome of COVID-19 (Alsafayan et al., 2020; Jdaitawi et al., 2020; Almaghlouth et al., 2020). The clinical characteristics of 1519 COVID-19 cases in KSA reported that cough, fever, and sore throat were the most common symptoms. Around 71% of the cases were admitted to hospital while 4.7% admitted to ICU (Alsafayan et al., 2020). Understanding the clinical behaviour of the disease and its epidemiology is crucial to establishing the appropriate policies and guidelines to control the epidemic. Therefore, this study used the largest available sample of confirmed COVID-19 cases in KSA from March 2 to August 31, 2020 to investigate their clinical and epidemiological characteristics and to estimate the dynamics of COVID-19 during this period. This study aimed to evaluate the magnitude and distribution of COVID-19 cases in KSA, determine the demographic, clinical, and epidemiological characteristics of the COVID-19 cases, and examine the relationship between these characteristics with hospital admission and death.

2. Materials and methods

2.1. Study design and data collection

This was a descriptive quantitative study of all available data of COVID-19 cases obtained from the HESN database between March and August 2020. Data originally belong to main laboratories and blood banks, regional health directorates, and all hospitals (governmental and private sector). The total number of COVID-19 tests administered was based on the KSA health reports for March to August 2020 (COVID-19 dashboard, Saudi Arabia, 2020).

Abbreviations

| Abbreviation       | Description                                      |
|--------------------|--------------------------------------------------|
| CDC                | Centres for Disease Control and Prevention       |
| CFR                | Case fatality ratio                              |
| COVID-19           | Coronavirus Disease 2019                         |
| HESN               | Health electronic surveillance network            |
| ICU                | Intensive care unit                              |
| IRB                | Institutional Review Board                       |
| KSA                | Saudi Arabia                                     |
| MERS-CoV           | Middle East respiratory syndrome coronavirus     |
| PCR                | Polymerase chain reaction                        |
| p-value            | Probability value                                |
| SARS-COV1          | Severe acute respiratory syndrome coronavirus 1  |
| SpO2               | Peripheral blood oxygen saturation               |
| SPSS               | Statistical Package for Social Sciences          |
| UK                 | United Kingdom                                   |
| WHO                | World Health Organization                        |

2.2. Ethics approval

Identities of all cases remained anonymous throughout all stages of the study. Central IRB approval (No: 20–199 M) was granted on 02/11/2020.

2.3. Data analysis

Data extracted from the HESN was cleaned by removing duplicates, cases from outside the specified date range, and entry errors. A COVID-19 case was defined as any individual in the dataset who tested positive for COVID-19 infection using a polymerase chain reaction (PCR) test and only these positive cases were included in analysis. Any cases with missing values were excluded. SPSS & Microsoft Excel software were used for data analysis.

Frequency and percentage were calculated for all variables in addition to mean and standard deviation for continuous variables. Incidence proportion, case fatality ratio (CFR) and mortality rate were calculated using the following formulae (CDC, 2008):

Incidence proportion: Number of new cases of COVID-19 during the given time period/the average population ($\times 10^6$).

Mortality rate: Number of deaths attributed to COVID-19 during the given time period/the average population ($\times 10^6$).

CFR: Total number of new deaths due to COVID-19/the total number of patients with COVID-19 ($\times 10^6$).

Categorical data of independent variables were compared and tested against the identified dependent variables (outcomes) using univariate analysis with Chi square as measure of association and significance level at $p < 0.05$.

3. Results

3.1. Magnitude and distribution of COVID-19 cases

As of August 31, 2020, 5,063,693 COVID-19 PCR tests had been administered in KSA, (COVID-19 dashboard, Saudi Arabia, 2020) with an overall estimated prevalence of COVID-19 of 15.8%, with a prevalence of symptomatic COVID-19 cases of 6.1%. The total number of confirmed symptomatic COVID-19 cases was 307,010 (47.3% of all positive cases), with an incidence proportion of 879.7 per 100,000 national population. The overall death rate was 2.1% each, followed by the Northern Borders region (0.8%; Table 1).

The epidemic curve demonstrates a propagative distribution of symptomatic cases (Fig. 1). On May 25, 2020, the number of cases tripled from the previous day and continued to increase until a peak on July 7, 2020. From that overall peak to the end of August, there was continuous decrease in the number of new cases, with weekly peaks.
3.2. Demographic characteristics

Most COVID-19 cases (mean age 35.1 ± 16.6 years) were youth and young adults (16–39 years, 53.3% of all cases) followed by middle age (40–64 years, 30.8%). Cases in older adults (> 100 years) registered the lowest proportion (0.1%; Table 2). Males represented 63.9% of all cases.

The nationalities among COVID-19 cases represented >170 countries/territories, with the majority from KSA (63.1%), followed by India (7.4%), Bangladesh (5.1%), and Egypt (4.7%). The nationalities among cases of death attributed to COVID-19, included Saudis (26.6%), Bangladeshis (15.4%) and Yemenis (9.4%).

3.3. Clinical and epidemiological characteristics of symptomatic cases

Among COVID-19 cases, 47.3% were symptomatic, however only 13.0% required hospitalization, with an overall death rate of 2.0% (Table 3). Fever was the most prominent symptom (90.5%) followed by cough (90.0%) and sore throat (77.4%). Only 13.9% of patients with fever presented with temperature >38 °C (mean 37.4 ± 0.7°C). Tachyphoeic patients with a mean respiratory rate of 21.4 ± 11.0 breaths/minute represented only 1.8% of cases. Oxygen saturation (SpO2) ≤ 93% was reported in 8.7% of the symptomatic patients (mean 93.5 ± 6.3%). Among symptomatic cases, 11.6% were diagnosed with pneumonia, among which 19.7% had a severity score of ≥ 3. The average disease course between symptom onset and recovery was 19.4 ± 13.9 days, and 9.1 ± 8.6 days from diagnosis to death. Most positive cases (98.8%) reported a history of contact with a confirmed COVID-19 case (Table 3).

Hospital admissions for COVID-19 were the highest in the regions of Riyadh (46.0%) followed by Makkah (21.4%), and Najran region has the lowest rate of hospitalization (0.5%). The highest proportion of hospital admissions occurred in May (28.9%) and the lowest was in March (2.6%).

3.4. Relationship between demographic factors and symptoms of COVID-19

Among COVID-19 cases, symptoms were more likely to appear in males (48.2%) than females (45.7%). The eldest group...
Table 2
Demographic characteristics of the COVID-19 confirmed cases in Saudi Arabia, March-August 2020 (N = 799,184).

| Variable                        | Number | %     |
|---------------------------------|--------|-------|
| **Age**                         |        |       |
| 0-1                             | 12,413 | 1.6   |
| 2-5                             | 20,182 | 2.5   |
| 6-15                            | 55,088 | 6.9   |
| 16-39                           | 425,786 | 53.3 |
| 40-64                           | 246,424 | 30.8 |
| 65-99                           | 38,520  | 4.8   |
| ≥100                            | 334     | 0.1   |
| **Total**                       | 798,747 | 100  |
| **Mean**                        |        | 35.12 |
| **SD**                          |        | 16.61 |
| **Gender**                      |        |       |
| Male                            | 510,741 | 63.9 |
| Female                          | 288,291 | 36.1 |
| **Total**                       | 799,032 | 100  |
| **Nationality**                 |        |       |
| Saudi                           | 500,361 | 63.1 |
| Arab                            | 103,482 | 13.1 |
| Non-Arab                        | 188,846 | 23.8 |
| **Total**                       | 792,689 | 100  |
| **Occupation**                  |        |       |
| Healthcare workers              | 27,806  | 3.5   |
| Governmental                    | 77,933  | 9.8   |
| Private sector                  | 121,634 | 15.2 |
| Freelancers                     | 54,007  | 6.8   |
| Unemployed                      | 367,437 | 46.0 |
| Unknown                         | 150,367 | 18.8 |
| **Total**                       | 799,184 | 100  |
| **Healthcare Workers department:** |          |       |
| ER                              | 466     | 25.4 |
| ICU                             | 78      | 4.2  |
| OR                              | 15      | 0.8  |
| OPD                             | 122     | 6.6  |
| Other                           | 1155    | 62.9 |
| **Total**                       | 1836    | 100  |
| **Region:**                     |        |       |
| Riyadh                          | 187,234 | 23.4 |
| Makkah                          | 193,673 | 24.2 |
| AlMadina                        | 44,247  | 5.5  |
| AlQassim                        | 33,979  | 4.3  |
| Eastern                         | 168,619 | 21.1 |
| Tabouk                          | 15,210  | 1.9  |
| Hail                            | 13,530  | 1.9  |
| Northern Borders                | 6340    | 0.8  |
| Jazan                           | 33,877  | 4.2  |
| Najran                          | 13,027  | 1.6  |
| AlBahah                         | 9421    | 1.2  |
| AlJouf                          | 5755    | 0.7  |
| Asir                            | 72,192  | 9.0  |
| **Total**                       | 799,104 | 100  |
| **Top 10 nationalities infected:** |      |       |
| Saudi Arabia                    | 500,361 | 63.1 |
| India                           | 59,489  | 7.4  |
| Bangladesh                      | 40,676  | 5.1  |
| Egypt                           | 37,585  | 4.7  |
| Yemen                           | 31,824  | 4.0  |
| Pakistan                        | 25,228  | 3.2  |
| Philippines                     | 23,851  | 3.0  |
| Sudan                           | 15,105  | 1.9  |
| Syrian Arab Republic            | 9141    | 1.1  |
| Nepal                           | 7612    | 1.0  |

Deaths by nationality (N = 2,356):

| Nationality                | Number | %     |
|---------------------------|--------|-------|
| Saudi Arabia              | 626    | 26.6 |
| Bangladesh                | 364    | 15.4 |
| Yemen                     | 222    | 9.4  |
| Pakistan                  | 186    | 7.9  |
| India                     | 183    | 7.8  |
| Myanmar                   | 165    | 7.0  |
| Philippines               | 75     | 3.2  |
| Egypt                     | 69     | 2.9  |
| Sudan                     | 69     | 2.9  |
| Afghanistan               | 45     | 1.9  |

(>100 years) had the highest rate of symptomatic cases (60.9%) compared to all other age groups. Individuals from KSA had the highest rate of symptomatic cases (55.5%) compared to any other nationality. Individuals from Alqassim region reported the highest rate of symptomatic cases (63.7%) than other regions. Finally, those who are privately employed had the highest rate of cases with symptoms (54.0%) followed by healthcare workers (53.8%; P > .001) (Table 4).

3.5. Relationship between demographic factors and the outcome of COVID-19

Among COVID-19 cases, males had a greater incidence of death (2.1%) than females (1.8%). The eldest cases (>100 years) had the highest rate of death (25.6%). Generally, Arab nationalities reported the highest rate of death (2.5%) compared to other nationalities. However, among all non-Arab nationalities, Nigerians had the highest rate of death (9.3%) and Egyptians had the least rate of death from COVID-19 (P > .001) (Table 4).

3.6. Relationship between demographic factors and hospital admission

A greater proportion of male COVID-19 patients (14.0%) were admitted to hospital than female (10.9%). Older adult patients (65–99 years) has the highest rate of hospitalization (29.4%) while the adolescents group (6–15 years) had the lowest hospital admission rate (5.6%). Among COVID-19 cases from the Northern Borders region, 56.0% required hospital admission, while only 2.6% of cases in Asir region required hospital admission. Freelancers with COVID-19 were more likely to be admitted to the hospital compared to any other occupations. Generally, cases of COVID-19 of non-Arab nationalities had the highest rate of hospital admission (18.1%) compared to other nationalities. Among non-Saudi nationalities, individuals from Myanmar were associated with the highest rate of hospital admission (33.1%), and the lowest rate was reported among the Sudanese (15.3%; P > .001) (Table 5).

3.7. Relationship between signs and symptoms and hospital admission

Cases with fever were associated with higher rate of hospital admission (17.9%) compared to those without fever, with those who had a temperature of >39 Celsius having the highest rate of hospital admission (30.1%). Cases with low oxygen saturation (SpO2 < 93%) had a higher rate of hospital admission (50.8%) compared to cases with SpO2 > 93%. Patients who had a respiratory rate >26 < were associated with a higher rate of hospital admission (34.8%) than patients with lower respiratory rates. Patients with pneumonia were associated with greater hospital admission rates (17.5%) than those without pneumonia. Among them, patients with a pneumonia severity score ≥ 3 had the highest rate of hospital admission (28.6%) than patients with the lower pneumonia severity score (P > .001) (Table 6).
3.8. Relationship between signs and symptoms and final outcome

Compared to asymptomatic cases, those who presented with fever or cough were associated with a higher than average rate of death (4.3% for each), with a fever of 39 °C having an even higher rate of death (6.1%). A low level of oxygen saturation (\(\text{SpO}_2\) ≤ 93%) was associated with a higher rate of death (19.1%) in comparison with \(\text{SpO}_2\) > 93%. Cases of COVID-19 with cardiovascular diseases or malignancy had the highest associations with death, 28.6% and 28% respectively, compared to other underlying diseases. Patients who were diagnosed with higher severity score of pneumonia (≥3) were associated with higher death rate (6.7%) compared to those with a lower pneumonia severity score (>3; 1.8%; \(P > .001\)) (Table 6).

4. Discussion

4.1. Distribution of COVID-19 cases in KSA

The Eastern, AlQassim, and Assir regions were the most affected regions, with a greater association of symptomatic cases. As large industrial and agricultural centres, and tourist attraction areas, there was likely higher traffic and movement of people in these regions, contributing to higher rates of COVID-19 infection compared to other regions. Furthermore, Makkah and Almadina, the two holy cities, had the highest CFRs. These regions have the highest proportion of Non-Saudis (Saudi General Authority for Statistics, 2018) primarily made up of illegal and low socioeconomic residents seeking to be close to the two holy mosques. Fear of deportation contributes to illegal residents who become ill avoiding medical care in the health facilities unless their condition becomes severe.

The effect of nationality on acquiring COVID-19 was statistically minimal, however Arabs appeared to be more likely to be affected by COVID-19 than other nationalities. Since distribution based on ethnicity groups is ethically prohibited in KSA, this report cannot assess the effect of ethnicity on COVID-19. Foreign workers make up a significant portion (26%) of the population in KSA. There are significant numbers of Asian expatriates, mostly from India and Bangladesh, who were worst hit by COVID-19. Commonly, unlike Western expatriates, they live in shared and crowded dormitories where transmission of infection likely occurs much faster (Jackson and Manderscheid, 2015). Those who work in the private sector were more likely to contract COVID-19 than other occupations. Longer work periods and day & night shifts system in the private sector could play a role in this effect. By the end of July 2020, the number of new cases started to decrease remarkably, likely due to the earlier lockdown and ban on local and international travel.

4.2. Demographic characteristics of COVID-19 cases

Infection was most commonly observed in young adults. Previous studies have reported the age profile of infection was highest among those aged 20–29 years in the USA, China and Europe (Boechmer et al., 2020; Zhao et al., 2020; European CDC, 2020). This age group consists of working-age adults, contributing to community transmission since COVID-19 can be easily transmitted among socially active people and in crowded settings. Given the role of asymptomatic and pre-symptomatic transmission, strict adherence to community mitigation strategies and personal preventive behaviours by young adults is needed to help reduce their risk for infection and subsequent transmission of COVID-19. This pandemic has shown a markedly low proportion of COVID-19 cases among children (Jiu et al., 2020; Sun et al., 2020; Shim et al., 2020; CDC COVID-19 Response Team, 2020). This epidemiological feature contrasts with that of other respiratory infections, such as the 2009 influenza pandemic and H1N1pdm infection, where the cumulative incidence was highest among children and young adults, and much smaller among older adults (Van et al., 2011; Badawi and Ryoo, 2016).

Similar to reports of MERS-COV and SARS-COV1, the male predominant culture of KSA and other Middle Eastern countries was likely reflected in the 2-fold higher number of males than females observed in the total COVID-19 positive cases (Channappanavar et al., 2017; Klein and Huber, 2009; Conti and Younes, 2020). Males are typically more involved in daily activities outside the home than females. Moreover, most females in KSA wear a veil, which could serve as a pseudo facemask. Finally, previous studies of MERS-CoV and SARS-CoV1 have suggested possible protective effect of female sex hormones and the X-chromosome (Channappanavar et al., 2017; Assiri et al., 2013).

4.3. Clinical and epidemiological characteristics

The clinical presentation of COVID-19 is similar to other flu-like illnesses, with fever appearing as predominant symptom worldwide. Fever is the cardinal symptom and the first indicator of COVID-19 infection, but a mild temperature (>38 Celsius) was present in the majority of symptomatic cases in this study. In the USA, it was reported that 44% of hospitalized COVID-19 patients did not have fever at the time of admission, but eventually 89% of them developed a high fever (CDC, 2020), therefore COVID-19 patients may present with normal or even low temperature upon hospital admission.

Cough, a symptom most commonly associated with respiratory infections, was the second most prevalent symptom among COVID-19 patients in KSA and worldwide (British Broadcasting Company, 2020). While sore throat and runny nose appear to be of less importance, all respiratory symptoms must be considered when screening for COVID-19 cases, among other epidemiological and clinical parameters. For instance, in the United Kingdom (UK), runny nose is a determinant for COVID-19 testing only if associated with a loss of smell (British Broadcasting Company, 2020).

In this study, most COVID-19 cases had a normal respiratory rate, typically measured when patients are dyspnoeic, or at the time of hospital admission. Therefore, it is assumed that all respiratory rate data were for hospitalized patients, explaining the relatively high mean respiratory rate (21.4 breaths/min) in this dataset. Shortness of breath typically appears 5–14 days after fever onset, and the degree of increase in respiration rate is proportionate to the severity of lung injury (Wu et al., 2020). The Saudi MoH defines a COVID-19 case as severe if respiration is ≥30 breaths/min (adult) or ≥40 breaths/min (child < 5) among other signs and symptoms (Saudi Weqaya & Ministry of Health, 2020).

\(\text{SpO}_2\) alone is not a reliable sign for COVID-19 screening, unless other respiratory symptoms and signs are also present (Saudi Weqaya & Ministry of Health, 2020). Severe lung injury or pneumonia leads to a decrease in \(\text{SpO}_2\), however, in some cases, patients with low or even very low \(\text{SpO}_2\) have normal physical status. The available data about \(\text{SpO}_2\) in this study demonstrated that around 9% of symptomatic cases had \(\text{SpO}_2\) ≤ 93%. This result is relatively high but congruent with previous findings in KSA as well as in China, USA and UK (Alsofayan et al., 2020; European CDC, 2020; Wu et al., 2020; Burrow et al., 2020).

Pneumonia with a confirmed positive PCR result for COVID-19 is not always an indication for hospital admission in KSA, especially during the outbreak peak (Saudi Weqaya & Ministry of Health, 2020). Therefore, clinicians use a pneumonia severity score (vital signs, history of chronic diseases, demographics, comorbidities, physical exam, laboratory and radiological findings) to determine those who require hospitalization. This comprehensive score...
Table 3
Clinical and epidemiological characteristics of the COVID-19 confirmed cases in Saudi Arabia, March-August 2020.

| Variable                  | No   | %    |
|---------------------------|------|------|
| **Signs & symptoms:**    |      |      |
| Yes                       | 307,010 | 47.3 |
| No                        | 342,508 | 52.7 |
| Total                     | 649,518 | 100  |
| **Fever:**                |      |      |
| Yes                       | 137,915 | 90.5 |
| No                        | 14,557  | 9.5  |
| Total                     | 152,472 | 100  |
| **Temperature (°C):**     |      |      |
| 37–38                     | 176,761 | 86.1 |
| 38.1–39>                  | 25,310  | 12.3 |
| 39                        | 3238    | 1.6  |
| Total                     | 205,309 | 100  |
| Mean 37.4                 |       | 1.2  |
| SD 2.0                    |       |      |
| **Cough:**                |      |      |
| Yes                       | 117,005 | 90.0 |
| No                        | 13,022  | 10.0 |
| Total                     | 130,027 | 100  |
| **Sore throat:**          |      |      |
| Yes                       | 44,009  | 77.4 |
| No                        | 12,830  | 22.6 |
| Total                     | 56,839  | 100  |
| **Runny nose:**           |      |      |
| Yes                       | 18,830  | 60.4 |
| No                        | 12,358  | 39.6 |
| Total                     | 31,188  | 100  |
| **Respiratory rate (breath/minute):** |      |      |
| ≤ 20>                     | 37,632  | 98.2 |
| 26                        | 695     | 1.8  |
| Total                     | 38,327  | 100  |
| Mean 21.4                 |       | 1.0  |
| SD 11.0                   |       |      |
| **Oxygen saturation: \(\text{SpO}_2\) (%):** |      |      |
| < 93>                     | 4762    | 8.7  |
| 93                        | 50,221  | 91.3 |
| Total                     | 54,983  | 100  |
| Mean 93.5                 |       | 6.3  |
| **Pneumonia:**            |      |      |
| Yes                       | 35,497  | 11.6 |
| No                        | 271,513 | 88.4 |
| Total                     | 307,010 | 100  |
| **Severity score of pneumonia:** |      |      |
| > 3                       | 28,497  | 80.3 |
| ≤ 3                       | 6,970   | 19.7 |
| Total                     | 35,467  | 100  |
| **Hospital admission:**   |      |      |
| Yes                       | 34,554  | 13.0 |
| No                        | 230,823 | 87.0 |
| Total                     | 265,377 | 100  |
| **Length of disease course until Recovery (Days):** |      |      |
| 1–7                       |       |      |
| 8–15                      | 1935    | 1.8  |
| 16–30                     | 57,902  | 53.9 |
| 31–90                     | 35,182  | 32.7 |
| < 91                      | 11,065  | 10.3 |
| Total                     | 1401    | 1.3  |
| Mean 19.42                | 107,485 | 100  |
| SD 13.93                  |       |      |
| **Length of disease course until Death (Days):** |      |      |
| 1–7                       |       |      |
| 8–15                      | 154     | 42.8 |
| 16–30                     | 138     | 38.3 |
| 31–90                     | 55      | 15.3 |
| Total                     | 13      | 3.6  |
| Mean 9.11                 | 360     | 100  |
| SD 8.61                   |       |      |
| **Contacted confirmed case:** |      |      |
| Yes                       | 117,185 | 98.8 |
| No                        | 1390    | 1.2  |
| Total                     | 118,575 | 100  |

### Table 3 (continued)

| Variable                  | No   | %    |
|---------------------------|------|------|
| **Travel outside KSA:**   |      |      |
| Yes                       | 869  | 1.1  |
| No                        | 74,724 | 98.9 |
| Total                     | 75,593 | 100  |
| **Travel inside KSA:**    |      |      |
| Yes                       | 12,500 | 4.7  |
| No                        | 252,857 | 95.3 |
| Total                     | 265,357 | 100  |
| **Final outcome:**        |      |      |
| Recovered                 | 114,946 | 98.0 |
| Dead                      | 2356  | 2.0  |
| Total                     | 117,302 | 100  |

1 From the date of symptom onset to 3 days after fever subsided or PCR result was negative.
2 From the date of symptom onset to death declaration.

ranges from 1 to 5 with patients who score ≥ 3 qualifying for hospital admission (Burrow et al., 2020). While time consuming, it was conducted in some hospitals in KSA where 19.7% of pneumonia patients were deemed severe cases.

Hospital admission of COVID-19 cases in KSA was 13%, which is below the world average (15–20%) (Boechmer et al., 2020; European CDC, 2020) and much lower than the rate was reported in KSA at the beginning of the pandemic (Alsafayan et al., 2020). Early active surveillance, case detection, case management, and most importantly a change in the case definition could have played a role in decreasing the rate of hospital admission.

Close contact to a confirmed COVID-19 case is the single-most important risk factor for contracting COVID-19 in KSA, confirming either direct or indirect transmission is possible through contaminated shared belongings. This finding confirms the importance of stipulating limited close contact with others during the pandemic, especially for those who would be at risk for severe illness.

### 4.4. Relationship between demographics and outcome of COVID-19 infection

Age demonstrated the highest and strongest association with the outcome of the COVID-19: as age increases, the chance of death increases. This finding has been reported worldwide during the COVID-19 pandemic, as well as in the previous MERS-CoV and SARS-CoV1 outbreaks (Boechmer et al., 2020; Badawi and Ryoo, 2016; Channappanavar et al., 2017; Onder et al., 2020). Generally, non-Saudis in KSA had an almost 2-fold higher association with mortality from COVID-19 than Saudis. Possible reasons behind this finding is the genetic differences, the lower socio-economic status, or the limited access to the health services. Further investigation is needed. Similar to reports from United States of America (USA) and UK which found those of African ethnicity had the highest mortality rate (Patel et al., 2020), Nigerians were more likely to die from COVID-19 than other nationalities in KSA.

In comparison to other regions of KSA, Makkah and Almadina had the highest association with death due to COVID-19. This result supports the earlier suggestion that the presence of a greater number of Non-Saudis of illegal residency and low socio-economic status, who fearing deportation, makes early access to the health services difficult. Patients who are labelled as freelancers and unemployed are more likely to die from COVID-19 than other occupations. This statistically significant result suggests that working in a formal and secured job could have a protective effect against...
serious complications of COVID-19, however this finding requires further exploration.

4.5. Relationship between signs & symptoms and final outcome of COVID-19 infection

Low oxygen saturation (SpO₂ < 93%) was the most important and critical indicator in predicting death associated with COVID-19 infection in KSA. Clinical studies at the beginning of the pandemic in China demonstrated that improving SpO₂ with oxygen supplementation was associated with reduced mortality, independent of other factors (Xie et al., 2020). This study demonstrated that COVID-19 patients with higher body temperature (>38 Celsius) were 2-times likely to die than those with temperature 38°C. A previous report among COVID-19 patients found a significant increase in mortality for every 0.5 Celsius increase in temperature, and the mortality was as high as 42% in those with temperature 40°C. Nevertheless, a lower temperature at initial presentation is a marker of poor prognosis: mortality is 26.5% of those with a temperature ≤ 36 Celsius, and

| Symptomatic Outcome | Male | Female | Total I | X² | df | p-value | Total II | X² | df | p-value |
|---------------------|------|--------|---------|----|----|---------|---------|----|----|---------|
|                     | 195,217 | 111,758 | 306,975 | 378 | 1 | 0.001 | 1858 | 2 | 87,411 | 0.99 | 98,269 | 0.99 |
|                     | 209,763 | 132,698 | 342,461 | 433 | 1 | 0.001 | 1966 | 2 | 93,758 | 0.99 | 94,716 | 0.99 |
| Total               |        |        | 649,436 | 2355 | 1 | 0.001 |        |        | 184,169 |        | 192,685 |        |

Table 4

Association of demographic factors with symptoms and outcome of COVID-19 cases in Saudi Arabia, March-August 2020.
further increases (44.0%) with temperature ≤ 35.5 Celsius (Tharakan et al., 2020).

Patients who presented with severe pneumonia (severity score ≥ 3) are 3-fold more likely to die of COVID-19 infection than those with lower severity score. Acute respiratory distress syndrome of severe pneumonia is a common predictor of poor prognosis and is associated with a high rate of death in COVID-19 patients (Wu et al., 2020). Finally, chronic diseases have significant negative impact on the prognosis of COVID-19 patients. It is well documented that cardiovascular and respiratory diseases are related to the worst prognoses among COVID-19 patients (Boechmer et al., 2020; European CDC, 2020; liu et al., 2020; Wu and McGoogan, 2020). Likewise, this study demonstrated that cardiovascular diseases have the highest association with death among COVID-19 patients.

4.6. Relationship of demographics and symptoms with hospital admission of COVID-19 cases

The Northern Borders region had the highest association with hospital admission of COVID-19 patients in KSA. Northern Borders has a high hospital bed capacity relative to its small population. Likely, this availability of hospital beds made it possible for the doctors to admit mild to moderate COVID-19 cases, in addition to severe cases. A change in the case definition, different case management protocol, and the unique genetic factors of the virus or patients are among the other possible reasons for this high hospital admission rate. Oxygen saturation (SpO₂ ≤ 93%) appears to be the most important determinant in hospital admission.

Table 5
The effect of demographic factors on hospital admission of COVID-19 cases in Saudi Arabia, March-August 2020.

| Gender | Hospital Admission Yes | % | No | % | Total | X² | df | p-value |
|--------|------------------------|---|----|---|-------|----|----|---------|
| Male   | 25,080                 | 14.0 | 153,686 | 86.0 | 178,766 | 500.0 | 2  | 0.001   |
| Female | 9,462                  | 10.9 | 77,100 | 89.1 | 86,562 |       |    |         |
| Total  | 34,553                 | 13.0 | 230,819 | 87.0 | 265,372 |       |    |         |
| Age group | 0–1                  | 448 | 10.2 | 3936 | 89.8 | 4384 | 8315.2 | 6  | 0.001   |
|        | 2–5                   | 347 | 5.9  | 5528 | 94.1 | 5875 |       |    |         |
|        | 6–15                  | 784 | 5.6  | 13,439 | 94.4 | 14,233 |       |    |         |
|        | 16–39                 | 12,160 | 9.1 | 121,753 | 90.9 | 133,913 |       |    |         |
|        | 40–64                 | 16,202 | 17.8 | 75,070 | 82.2 | 91,272 |       |    |         |
|        | 65–99                 | 4557 | 29.4 | 10,947 | 70.6 | 15,504 |       |    |         |
|        | ≥ 100                 | 33   | 25.0 | 99   | 75.0 | 132  |       |    |         |
| Total  | 34,541                 | 13.0 | 230,772 | 87.0 | 265,313 |       |    |         |
| Nationality | Saudi                  | 12,845 | 9.0 | 129,278 | 91.0 | 142,123 | 4337.0 | 2  | 0.001   |
|        | Arab                   | 7,197 | 16.7 | 35,951 | 83.3 | 43,148 |       |    |         |
|        | Non-Arab               | 14,512 | 18.1 | 65,594 | 81.9 | 80,106 |       |    |         |
| Total  | 34,554                 | 13.0 | 230,823 | 87.0 | 265,377 |       |    |         |
| Region | Riyadh                | 7,408 | 10.6 | 62,687 | 89.4 | 70,095 | 11992.7 | 12 | 0.001   |
|        | Al-Baha               | 222  | 37.7 | 367  | 62.3 | 589  |       |    |         |
|        | Al-Jouf               | 276  | 33.7 | 543  | 66.3 | 819  |       |    |         |
|        | Al-Madinah            | 2285 | 24.8 | 6919 | 75.2 | 9204 |       |    |         |
|        | Al-Qassim             | 1,514 | 12.9 | 10,199 | 87.1 | 11,713 |       |    |         |
|        | Makkah                | 15,888 | 19.2 | 67,004 | 80.8 | 82,892 |       |    |         |
|        | Asir                  | 857  | 2.6  | 32,026 | 97.4 | 32,883 |       |    |         |
|        | Eastern               | 3734 | 7.8  | 44,329 | 92.2 | 48,063 |       |    |         |
|        | Hail                  | 448  | 19.0 | 1998 | 81.0 | 2356 |       |    |         |
|        | Jazan                 | 470  | 27.6 | 1233 | 72.4 | 1703 |       |    |         |
|        | Najran                | 167  | 14.8 | 964  | 85.2 | 1131 |       |    |         |
|        | Northern Borders      | 778  | 56.0 | 612  | 44.0 | 1390 |       |    |         |
|        | Tabouk                | 507  | 20.3 | 1987 | 79.7 | 2494 |       |    |         |
| Total  | 34,554                 | 13.0 | 230,778 | 87.0 | 265,332 |       |    |         |
| Occupation | Governmental        | 776  | 4.4  | 16,758 | 95.6 | 17,534 | 714.8 | 4  | 0.001   |
|        | Private sector        | 4519 | 10.0 | 40,531 | 90.0 | 45,050 |       |    |         |
|        | Freelancers           | 1855 | 11.8 | 13,808 | 88.2 | 15,663 |       |    |         |
|        | Healthcare workers    | 771  | 7.7  | 9201 | 92.3 | 9972 |       |    |         |
|        | Unemployed            | 9,655 | 10.1 | 85,543 | 89.9 | 95,198 |       |    |         |
| Total  | 17,576                 | 9.6  | 165,841 | 90.4 | 183,417 |       |    |         |
| Non-Saudi nationalities | Bangladesh    | 3,564 | 21.6 | 12,965 | 78.4 | 16,529 | 5157.4 | 11 | 0.001   |
|        | Yemen                 | 2,096 | 17.7 | 9768 | 82.3 | 11,864 |       |    |         |
|        | Pakistan              | 2,398 | 22.0 | 8518 | 78.0 | 10,916 |       |    |         |
|        | India                 | 4,057 | 15.7 | 21,788 | 84.3 | 25,845 |       |    |         |
|        | Myanmar               | 516  | 33.1 | 1045 | 66.9 | 1561 |       |    |         |
|        | Philippines           | 1,550 | 14.7 | 9009 | 85.3 | 10,559 |       |    |         |
|        | Egypt                 | 2,901 | 15.9 | 13,733 | 84.1 | 16,334 |       |    |         |
|        | Sudan                 | 930  | 15.3 | 5154 | 84.7 | 6084 |       |    |         |
|        | Afghanistan           | 416  | 32.9 | 848  | 67.1 | 1264 |       |    |         |
|        | Syria                 | 746  | 20.8 | 2846 | 79.2 | 3592 |       |    |         |
|        | Nigeria               | 74   | 23.3 | 243  | 76.7 | 317  |       |    |         |
|        | Others                | 15,606 | 9.7 | 144,906 | 90.3 | 160,512 |       |    |         |
| Total  | 34,554                 | 13.0 | 230,823 | 87.0 | 265,377 |       |    |         |
5. Limitations

First, there were limited details for the asymptomatic cases in HESN database to compare with the symptomatic cases. The registration process in HESN is lengthy and public health personnel focus on and enter the details of symptomatic cases more than that of asymptomatic cases. Second, the data set lacks sufficient information on the complications of the disease.

6. Conclusion

In KSA, COVID-19 was easily transmitted among young people who are socially active. Fever, cough, and sore throat were the prevalent symptoms consecutively. All regions are affected by the disease and inexplicably, the highest morbidity was distributed among the Eastern region, AlQassim and Assir respectively. However, Makkah and Almadina regions are significantly associated with highest burden of mortality. Low level of oxygen saturation, high fever, old age, and underlying cardiovascular disease are the most important predictors for the worst prognosis among COVID-19 cases.

CRediT authorship contribution statement

Fahad M. Alswaidi: Conceptualization, Methodology, Writing - original draft. Abdullah M. Assiri: Writing - review & editing. Haya H. Alhaqbani: Data curation, Formal analysis, Project administration. Mohrah M. Alalawi: Formal analysis, Writing - original draft.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Table 6

| Fever           | Hospital Admission | Outcome                  |
|-----------------|--------------------|--------------------------|
| Yes             | 20518 17.9         | 94131 82.1               |
| No              | 722 8.6            | 7633 91.4               |
| Total           | 21240 17.3         | 101764 82.7             |
| Temperature °C  | 37–38              | 12384 2.2                |
| >39             | 28180 13.8         | 176915 86.2             |
| Cough           | 18873 19.0         | 80436 81.0               |
| No              | 663 8.8            | 6838 91.2               |
| Total           | 19536 18.3         | 87274 81.7              |
| Sore throat     | 4689 12.5          | 32844 87.5              |
| No              | 849 12.0           | 6207 88.0               |
| Total           | 5538 12.4          | 39051 87.6              |
| Runny nose      | 1591 9.9           | 14478 90.1              |
| No              | 922 13.2           | 6062 86.8               |
| Total           | 2513 10.9          | 20540 89.1              |
| Underlying diseases |        |                          |
| Respiratory     | 22394 92.6         | 1780 7.4                |
| Cardiovascular  | 346 100.0          | 0 0.0               |
| Renal           | 144 100.0          | 0 0.0               |
| Malignancy      | 86 100.0           | 0 0.0               |
| Hepatic         | 21 100.0           | 0 0.0               |
| Other           | 1809 19.4          | 7898 80.6              |
| Total           | 10383 18.9         | 44586 81.1             |
| Oxygen saturation (SpO₂) |        |                          |
| ≤ 93           | 2417 50.8          | 2345 49.2               |
| > 93           | 7966 15.9          | 42241 84.1             |
| Total          | 10003 18.9         | 44586 81.1             |
| Respiratory rate (breath/minute) |        |                          |
| ≤ 26           | 6522 17.7          | 30250 82.3             |
| > 26           | 586 34.8           | 1100 65.2              |
| Total          | 7108 18.5          | 31390 81.5             |
| Pneumonia diagnosis |        |                          |
| Yes            | 6212 17.5          | 29247 82.5             |
| No             | 28342 13.2         | 201575 87.7            |
| Total          | 34554 13.0         | 230822 87.0            |
| Severity score of pneumonia |        |                          |
| >3             | 4218 14.8          | 24275 85.2             |
| ≤ 3            | 1994 28.6          | 4972 71.4              |
| Total          | 6212 17.5          | 29247 82.5             |

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