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Original article

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

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A B S T R A C T

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 ($SpO_2 \leq 93\%$) 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.

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

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Abbreviations

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

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; Alkhowailed 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 (Alsofayan 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 (Alsofayan 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)).

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 ($\times 10^n$).

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

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

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 among symptomatic COVID-19 cases was 2.0%, while the overall CFR was estimated as 0.8%. Makkah and Almadina regions registered the highest CFR (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.

Table 1
Distribution of COVID-19 confirmed cases and their outcome by Saudi administrative regions, March-August 2020.

Region	[1]Population	Confirmed cases (N = 649,511)				[2]Incidence proportion		Outcome (N = 117,299)				[3]CFR
		Symptomatic				Symptomatic						
		Yes	%	No	%	Yes	No	Recovered	%	Dead	%	
Riyadh	8,771,918	69,174	22.5	69,967	20.4	788.5	797.6	24,706	21.5	351	14.9	0.5
Eastern	5,271,050	73,018	23.8	65,387	19.1	1385.2	1240.4	26,002	22.6	122	5.2	0.2
Makkah	8,990,579	72,387	23.6	78,806	23.0	805.1	876.5	42,186	36.7	1514	64.3	2.1
AlMadina	2,280,945	12,846	4.2	17,697	5.2	563.2	775.8	12,342	10.7	275	11.7	2.1
AlQassim	1,550,080	18,706	6.1	10,672	3.1	1206.7	688.4	1833	1.6	18	0.8	0.1
Tabouk	1,000,609	3,869	1.3	9,739	2.8	386.6	973.30	2531	2.2	17	0.7	0.4
Hail	756,611	5,878	1.9	6,719	2.0	766.8	888.03	1073	0.9	14	0.6	0.2
Northern Borders	405,119	1,444	0.5	4,122	1.2	356.4	1017.4	528	0.5	11	0.5	0.8
Jazan	1,730,961	14,644	4.8	17,785	5.2	846.0	1027.4	1166	1.0	16	0.7	0.1
Najran	642,205	6,018	2.0	6,672	1.9	937.0	1038.9	675	0.6	3	0.1	0.0
AlBahah	519,994	3,244	1.1	5,798	1.7	623.9	1115.0	605	0.5	5	0.2	0.2
AlJouf	558,995	712	0.2	3,843	1.1	127.4	687.4	160	0.1	1	0.0	0.1
Assir	2,419,896	25,070	8.2	45,294	13.2	1036.0	1871.7	1136	1.0	9	0.4	0.0
Total	34,898,962	307,010 (47.3%)	100.0	342,501 (52.7%)	100.0	879.7	981.4	114,943 (98.0%)	100.0	2,356 (2.0%)	100.0	0.8

[1] Saudi General Authority for Statistics. The sixteenth guide 2017. [cited 2020 Oct 15]. Available from: https://www.stats.gov.sa/en/825.
[2] Incidence proportion = Symptomatic no/Population no * 100,000
[3] Case fatality ratio (CFR) = Dead no/Symptomatic no * 100

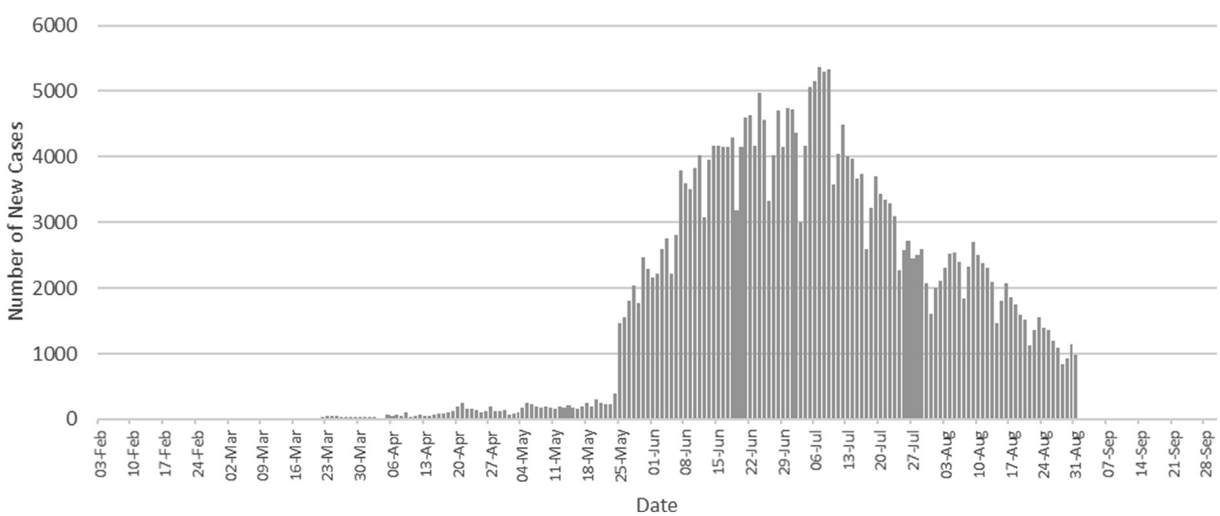

Fig. 1. Epidemic curve of new symptomatic COVID-19 cases in Saudi Arabia between March 1 and August 31, 2020.

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 ± 2.0 °C). Tachypnoeic patients with a mean respiratory rate of 21.4 ± 11.0 breaths/minute represented only 1.8% of cases. Oxygen saturation (SpO_2) ≤ 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	15,530	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):		
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
Syrian Arab Republic	33	1.4
Nigeria	26	1.1
Others	293	12.4

(>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-Saudi 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 ($SpO_2 \leq 93\%$) had a higher rate of hospital admission (50.8%) compared to cases with $SpO_2 > 93\%$. 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 ($SpO_2 \leq$ 93%) was associated with a higher rate of death (19.1%) in comparison with 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 ($\geq$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 (liu 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 $\geq$30 breaths/min (adult) or $\geq$40 breaths/min (child < 5) among other signs and symptoms (Saudi Weqaya & Ministry of Health, 2020).

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 SpO_2, however, in some cases, patients with low or even very low SpO_2 have normal physical status. The available data about SpO_2 in this study demonstrated that around 9% of symptomatic cases had $SpO_2 \leq$ 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		
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):		
$\leq$ 26>	37,632	98.2
26	695	1.8
Total	38,327	100.0
Mean 21.4		
SD 11.0		
Oxygen saturation; SpO_2 (%):		
$\leq$ 93>	4762	8.7
93	50,221	91.3
Total	54,983	100
Mean 93.5		
SD 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
$\leq$ 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]**:**		
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)[2]**:**		
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
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
Outcome		
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 $\geq$ 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 (Alsofayan 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

Table 4
Association of demographic factors with symptoms and outcome of COVID-19 cases in Saudi Arabia, March-August 2020.

	Symptomatic								Outcome							
Gender	Yes	%	No	%	Total	X^2	df	p-value	Dead	%	Recovered	%	Total	X^2	df	p-value
Male	195,217	48.2	209,763	51.8	404,980	378.3	1	0.001	1858	2.1	87,411	97.9	89,269	9.9	1	0.002
Female	111,758	45.7	132,698	54.3	244,456				498	1.8	27,504	98.2	28,002			
Total	306,975	47.3	342,461	52.7	649,436				2356	2.0	114,915	98.0	117,271			
Age group																
0–1	4967	49.8	5000	50.2	9967	5577.3	6	0.001	5	0.3	1478	99.7	1483	6605.4	6	0.001
2–5	6437	38.5	10,273	61.5	16,710				6	0.2	2494	99.8	2500			
6–15	16,857	35.6	30,432	64.4	47,289				2	0.0	6393	100	6395			
16–39	160,125	46.1	187,211	53.9	347,336				236	0.4	63,650	99.6	63,886			
40–64	101,054	51.3	95,766	48.7	196,820				1379	3.6	37,461	96.4	38,840			
65–99	17,237	56.1	13,506	43.9	30,743				718	17.4	3408	82.6	4126			
$\geq$100	159	60.9	102	39.1	261				10	25.6	29	74.4	39			
Total	306,836	47.3	342,290	52.7	649,126				2356	2.0	114,913	98.0	117,269			
Nationality																
Saudi	190,550	44.4	238,892	55.6	429,438	4630.6	2	0.001	626	1.4	42,621	98.6	43,247	111.5	2	0.001
Arabs	47,834	55.5	38,422	44.5	82,987				450	2.5	17,821	97.5	18,271			
Non-Arabs	68,626	51.3	65,194	48.7	133,665				1280	2.3	54,504	97.7	55,784			
Total	307,010	47.3	342,508	52.7	646,090				2356	2.0	114,946	98.0	117,302			
Region																
Riyadh	69,040	50.0	69,135	50.0	138,175	15171.2	12	0.001	351	1.4	24,706	98.6	25,057	906.8	12	0.001
AlBahah	3244	35.9	5798	64.1	9042				5	0.8	605	99.2	610			
AlJouf	846	15.3	4675	84.7	5521				1	0.6	160	99.4	161			
AlMadina	12,846	42.1	17,697	57.9	30,543				275	2.2	12,342	97.8	12,617			
AlQassim	18,706	63.7	10,672	36.3	29,378				18	1.0	1833	99.0	1851			
Makkah	72,387	47.9	78,806	52.1	151,193				1517	3.5	42,183	96.5	43,700			
Asir	25,070	35.6	45,294	64.4	70,364				9	0.8	1136	99.2	1145			
Eastern	73,018	52.8	65,387	47.2	138,405				122	0.5	26,002	99.5	26,124			
Hail	5878	46.7	6719	53.3	12,597				14	1.3	1073	98.7	1087			
Jazan	14,644	45.2	17,785	54.8	32,429				16	1.4	1166	98.6	1182			
Najran	6018	47.4	6672	52.6	12,690				0	0.0	678	100	678			
Northern Borders	1444	25.9	4122	74.1	5566				11	2.0	528	98.0	539			
Tabouk	3869	28.4	9739	71.6	13,608				17	0.7	2531	99.3	2548			
Total	307,010	47.3	342,501	52.7	649,511				2356	2.0	114,943	98.0	117,299			
Occupation																
Governmental	35,261	45.3	42,648	54.7	77,909	4404.7	4	0.001	15	0.5	2817	99.5	2832	91.7	4	0.001
Private sector	65,617	54.0	55,899	46.0	121,516				129	1.3	9554	98.7	9683			
Freelancers	27,689	51.3	26,278	48.7	53,967				76	2.3	3241	97.7	3317			
Healthcare workers	14,946	53.8	12,832	46.2	27,778				10	0.5	2048	99.5	2058			
Unemployed	162,975	44.4	204,361	55.6	367,336				361	2.4	14,822	97.6	15,183			
Total	306,488	47.3	342,018	52.7	648,506				591	1.8	32,482	98.2	33,073			
Healthcare Workers department																
ER	133	28.5	333	71.5	466	14.3	4	0.006	11	4.1	269	95.9	280	2.785	4	0.594
ICU	27	34.6	51	65.4	78				3	9.7	28	90.3	31			
OR	4	26.6	11	73.3	15				0	0	3	100.0	3			
OPD	55	85.1	67	54.9	122				2	4.1	47	95.9	49			
Other	411	35.6	744	64.4	1155				18	3.7	462	96.3	480			
Total	630	34.3	1206	65.7	1836				34	4.0	809	96.0	843			
Non-Saudi Nationalities																
Bangladesh	13,082	49.5	13,370	50.5	26,452	853.2	11	0.001	364	2.5	14,256	97.5	14,620	612.9	11	0.001
Yemen	14,572	54.5	12,180	45.5	26,752				222	4.1	5237	95.9	5459			
Pakistan	9025	51.7	8418	48.3	17,443				186	2.4	7468	97.6	7654			
India	22,973	54.8	18,979	45.2	41,952				183	1.1	17,056	98.9	17,239			
Myanmar	827	54.4	694	45.6	1521				165	7.1	2143	92.9	2308			
Philippines	9101	52.6	8215	47.4	17,316				75	1.6	4525	98.4	4600			
Egypt	16,789	57.2	12,586	42.8	29,375				69	0.9	7446	99.1	7515			
Sudan	6579	53.5	5727	46.5	12,306				69	3.1	2184	96.9	2253			
Afghanistan	1592	52.9	1419	47.1	3011				45	4.7	907	95.3	952			
Syria	4341	57.7	3184	42.3	7525				33	2.7	1189	97.3	1222			
Nigeria	290	38.1	472	61.9	762				26	9.3	254	90.7	280			
Others	17,291	48.5	18,374	51.5	35,665				293	2.9	9660	97.1	9953			
Total	116,462	52.9	103,618	47.1	220,080				1730	2.3	72,325	97.7	74,055			

serious complications of COVID-19, however this finding requires further exploration.

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

Low oxygen saturation ($SpO_2 \leq 93\%$) 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 SpO_2 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 (<39 Celsius) were 2-times likely to die than those with temperature 38 > Celsius. 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 < Celsius. Nevertheless, a lower temperature at initial presentation is a marker of poor prognosis: mortality is 26.5% of those with a temperature $\leq$ 36 Celsius, and

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

	Hospital Admission							
Gender	Yes	%	No	%	Total	X^2	df	p-value
Male	25,080	14.0	153,686	86.0	178,766	500.0	2	0.001
Female	9462	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	794	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	7197	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	7408	10.6	62,687	89.4	70,095	11992.7	12	0.001
AlBahah	222	37.7	367	62.3	589			
AlJouf	276	33.7	543	66.3	819			
AlMadina	2285	24.8	6919	75.2	9204			
AlQassim	1514	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	1908	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	9655	10.1	85,543	89.9	95,198			
Total	17,576	9.6	165,841	90.4	183,417			
Non-Saudi nationalities								
Bangladesh	3564	21.6	12,965	78.4	16,529	5157.4	11	0.001
Yemen	2096	17.7	9768	82.3	11,864			
Pakistan	2398	22.0	8518	78.0	10,916			
India	4057	15.7	21,788	84.3	25,845			
Myanmar	516	33.1	1045	66.9	1561			
Philippines	1550	14.7	9009	85.3	10,559			
Egypt	2601	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			

further increases (44.0%) with temperature $\leq$ 35.5 Celsius (Tharakan et al., 2020).

Patients who presented with severe pneumonia (severity score $\geq$ 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 (SpO_2-$\leq$ 93%) appears to be the most important determinant in hospital admission.

Table 6
Association of symptoms with the hospital admission and outcome of COVID-19 cases, March-August 2020.

	Hospital Admission								Outcome							
Fever	Yes	%	No	%	Total	X^2	df	p-value	Dead	%	Recovered	%	Total	X^2	df	p-value
Yes	20518	17.9	94131	82.1	114649	466.9	1	.001	1325	4.3	29456	95.7	30781	221.4	1	.001
No	722	8.6	7633	91.4	8355				25	0.4	6132	99.6	6157			
Total	21240	17.3	101764	82.7	123004				1350	3.7	35588	96.3	36938			
Temperature °C																
37–38	22818	12.9	153931	87.1	176749	1238.4	2	.001	1387	3.2	41423	96.8	42810	81.6	2	.001
38.1–39	4587	18.1	20722	81.9	25309				322	5.2	5856	94.8	6178			
>39	975	30.1	2262	69.9	3237				61	6.1	931	93.9	992			
Total	28380	13.8	176915	86.2	205295				1770	3.5	48210	96.5	49980			
Cough																
Yes	18873	19.0	80436	81.0	99309	482.2	1	.001	1294	4.3	28623	95.7	29917	234.8	1	0.001
No	663	8.8	6838	91.2	7501				16	0.3	5997	99.7	6013			
Total	19536	18.3	87274	81.7	106810				1310	3.6	34620	96.4	35930			
Sore throat																
Yes	4689	12.5	32844	87.5	37533	1.1	1	.283	279	3.0	9101	97.0	9380	104.2	1	0.001
No	849	12.0	6207	88.0	7056				24	0.5	5194	99.5	5218			
Total	5538	12.4	39051	87.6	44589				303	2.1	14295	97.9	14598			
Runny nose																
Yes	1591	9.9	14478	90.1	16069	54.6	1	.001	109	2.9	3660	97.1	3769	78.7	1	0.001
No	922	13.2	6062	86.8	6984				29	0.6	5176	99.4	5205			
Total	2513	10.9	20540	89.1	23053				138	1.5	8836	98.5	8974			
Underlying diseases																
Respiratory	22394	92.6	1780	7.4	24674	18793.9	5	0	806	7.5	9936	92.5	10742	171.1	5	.001
Cardiovascular	346	100.0	0	0.0	346				28	28.6	70	71.4	98			
Renal	144	100.0	0	0.0	144				7	18.9	30	81.1	37			
Malignancy	86	100.0	0	0.0	86				7	28.0	18	72.0	25			
Hepatic	21	100.0	0	0.0	21				0	0.0	6	100	6			
Other	1899	19.4	7898	80.6	9797				213	4.1	4966	95.9	5179			
Total	24863	71.9	9678	28.1	34541				1061	6.6	15026	93.4	16087			
Oxygen saturation (SpO_2)																
≤ 93	2417	50.8	2345	49.2	4762	3455.7	1	.001	283	19.1	1201	80.9	1484	0.373	1	.350
> 93	7966	15.9	42241	84.1	50207				352	2.2	16009	97.8	16361			
Total	10383	18.9	44586	81.1	54969				635	3.6	17210	96.4	17845			
Respiratory rate (breath/minute)																
≤ 26	6522	17.7	30250	82.3	36772	309.9	1	.001	312	2.9	10187	97.1	10499	0.373	1	.350
> 26	586	34.8	1100	65.2	1686				7	4.4	159	95.6	166			
Total	7108	18.5	31350	81.5	38458				319	3.0	10346	97.0	10665			
Pneumonia diagnosis																
Yes	6212	17.5	29247	82.5	35459	731.1	1	.001	233	2.8	8093	97.2	8326	27.3	1	1.67
No	28342	12.3	201575	87.7	229917				4479	1.9	221802	98.1	226281			
Total	34554	13..0	230822	87.0	265376				4712	2.0	229895	98.0	234607			
Severity score of pneumonia																
>3	4218	14.8	24275	85.2	28493	739.9	1	.001	121	1.8	6538	98.2	6659	104.7	1	0.001
≤ 3	1994	28.6	4972	71.4	6966				112	6.7	1555	93.3	1667			
Total	6212	17.5	29247	82.5	35459				233	7.5	8090	92.5	8326			

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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The data underlying this article cannot be shared publicly due to the non-disclosure agreement between the Saudi MOH and the authors. The data will be shared on reasonable request to the corresponding author.

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