Natural History and Clinical Course of Symptomatic and Asymptomatic COVID-19 Patients in the Kingdom of Saudi Arabia

Rasha A. Almubark1, Ziad A. Memish2,3,4, Hani Tamim5, Thamer H. Alenazi6,7, Mohammed Alabdulla8, Faisal M. Sanai9, Nasser F. BinDhim1,3,10, Sarah Alfaraj11, Saleh A. Alqahtani12,13

1Scientific Affairs Department, Sharik Association for Health Research, 2Research and Innovation Center, King Saud Medical City, Ministry of Health, 3College of Medicine, Al-Faisal University, 4Department of Medicine, King Abdulaziz Medical City, 5College of Medicine, King Saud Bin Abdulaziz University for Health Sciences, 6Department of Transplant Infectious Disease, Prince Mohammed Bin Abdulaziz Hospital, 7Infection Control and Corona Center, Prince Mohammed Bin Abdulaziz Hospital, 8Liver Transplantation Unit, King Faisal Specialist Hospital and Research Center, Riyadh, 9Department of Medicine, Gastroenterology Unit, King Abdulaziz Medical City, Jeddah, Saudi Arabia, 10CEO Office, Saudi Food and Drug Authority, 11Hubert Department of Global Health, Rollins School of Public Health, Emory University, Atlanta, GA, 12Division of Gastroenterology and Hepatology, John Hopkins University, Baltimore, USA, 13Department of Internal Medicine, American University of Beirut Medical Center, Beirut, Lebanon

Abstract

Objectives: To analyze symptomatic and asymptomatic COVID-19 patients in Saudi Arabia in terms of initial presentation, risk factors, laboratory findings, clinical outcomes and healthcare utilization.

Methods: All laboratory-confirmed reverse transcription–polymerase chain reaction positive COVID-19 patients who had been tested at three governmental hospitals in Saudi Arabia (two in Riyadh and one in Makkah) between March 8 and May 18, 2020 were included. Demographics, COVID-19 variables, clinical characteristics and healthcare utilization variables were extracted and combined, and a descriptive analysis was conducted. Symptomatic and asymptomatic (on presentation) patients’ data were compared.

Results: Eighty percent of the patients were males (81.4% of symptomatic and 73.2% of asymptomatic patients, P = 0.02). Moreover, 47.6% and 38.4% of symptomatic and asymptomatic patients were aged 40–64 years, respectively. Fever, cough and breathing difficulties were frequent presenting symptoms. Overall, diabetes (16.4%), hypertension (11.7%), chronic respiratory disease (7.1%) were the most frequent comorbidities, with no differences between the two groups. Symptomatic patients had higher C-reactive protein levels (3.55 vs. 0.30 mg/L; P < 0.0001) and lower total lymphocytes (1.41 vs. 1.70; P = 0.02). ICU admission and mortality were 12.1% and 4.1% in symptomatic, compared to 6.0% and 2.9% in asymptomatic patients, respectively.

Conclusion: In the studied COVID-19 cohort, symptomatic patients tended to be older, had higher C-reactive protein and more lymphopenia with worse outcome than asymptomatic patients. This granular analysis of COVID-19 cohorts enables identification of at-risk cohorts in future waves, optimizing development of patient pathways and public health interventions.

Keywords: Coronavirus, epidemiology, public health surveillance, SARS-CoV-2, Saudi Arabia, symptoms
INTRODUCTION

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), remains one of the most challenging zoonotic infectious disease faced worldwide. As of February 10, 2021, over 106 million cases of COVID-19 had been reported worldwide that have resulted in > 2 million deaths.[1] In the Kingdom of Saudi Arabia (KSA), which is the largest country in the Arabian Peninsula with a population of 34 million, 370,987 COVID-19 cases had been reported with 6410 deaths as of March 2nd, 2021.[2]

A large proportion of those testing positive for COVID-19 are pauci-symptomatic or asymptomatic.[3] In symptomatic patients, the clinical presentation of COVID-19 varies markedly and is impacted by risk factor groups, including older age and patients with comorbidities.[4] The clinical features of COVID-19 appears to differ in prevalence in different clinical populations.[5]

In the Middle East, few studies have reported the course and clinical presentation of COVID-19 and compared these between symptomatic and asymptomatic patients. Therefore, this study aims to compare the initial presentation, risk factors, laboratory findings and healthcare utilization of symptomatic and asymptomatic COVID-19 patients from KSA.

METHODS

This retrospective study analyzed the clinical data of all laboratory-confirmed reverse transcription–polymerase chain reaction-positive COVID-19 patients who had been tested at three governmental hospitals in KSA (two in Riyadh and one in Makkah) between March 8 and May 18, 2020. This study was approved by the Ethics Committee of Ministry of Health (MoH) (Ref no.: 20-63E) and permissions were obtained from the concerned departments of all three hospitals.

Participants and setting

In KSA, healthcare is available for free at governmental hospitals for nationals, and expatriates typically access the private healthcare system through insurance supplied by their employer. Nonetheless, the Saudi government had passed an order for free COVID-19 treatment across the country to ensure larger accessibility.[6] In addition, the testing facility was freely made available by the MoH at healthcare facilities, all individuals with suspected COVID-19 – either based on symptoms or exposure to those with confirmed COVID-19 – can be tested at these sites. If positive, they are immediately enrolled in the MoH testing and contact tracing program. In the early phase of the pandemic, all patients who tested positive were admitted to hospitals, which was later changed to only include symptomatic patients. To provide data for comparison between symptomatic and asymptomatic patients, this study retrospectively analyzed the data of the initial phase.

All cases presented in this study are from three governmental hospitals, that are part of the Saudi MoH: Al Noor Specialist Hospital, a 500-bed specialized teaching hospital located centrally in Makkah;[7] Prince Mohammed bin Abdulaziz Hospital, a 500-bed hospital in Riyadh that is one of the major hospitals for COVID-19 case referrals;[8] and Al-Imam Abdulrahman Al Faisal Hospital, Riyadh.

Grouping of patients was based on their initial presentation, with those presenting with at least one of the following symptoms were considered symptomatic: fever, cough, shortness of breath (SOB), sore throat, digestive symptoms, rhinorrhea, headache, or other symptoms. In the absence of any of the mentioned symptoms, patients were considered asymptomatic.

Data collection

The following data were collected: demographics (gender, weight, and height), symptoms at presentation, reasons for testing (suspected as per case definition, contact of a positive case or travel history), baseline vitals and laboratory results, complete blood count, liver function, C-reactive protein, lactate dehydrogenase (LDH), D-dimer, alkaline phosphatase, albumin and total bilirubin. Moreover, information regarding treatment received, intensive care unit (ICU) admission, discharge date and survival (i.e., death date) were also extracted. Data extraction was done by a single author and was quality checked by another author to ensure accuracy and quality of data.

Statistical analysis

The data were manually entered into a Microsoft Excel (Microsoft Corp, Redmond, WA), and then transferred to SPSS version 25 (SPSS Inc., Chicago, IL, USA) for data cleaning, management and analysis. The collected information is presented as total numbers and valid percentage for categorical variables, and as median and interquartile range (IQR) for continuous variables. Differences between variables for symptomatic and asymptomatic patients were assessed with a Chi-square test or independent t-test, as appropriate. $P < 0.05$ was considered statistically significant.
RESULTS

Demographic characteristics
A total of 1051 patients tested positive for COVID-19 in the three hospitals during the included period. Table 1 details the demographic characteristics of these patients. The sample consisted of 80.3% males, with 2.0% being aged ≤18 years and 8.9% aged ≥65 years. Further, 24.7% of the patients were Saudi, 3.1% were healthcare workers, 5.9% were tested due to travel and 16.4% were linked epidemiologically to a confirmed case. In total, 913 (86.9%) patients were symptomatic. Significantly more males were symptomatic than asymptomatic (81.4% vs. 73.2%, respectively; \( P = 0.02 \)). Moreover, symptomatic patients were more likely to be non-Saudi (\( P < 0.0001 \)) and were less likely to be linked epidemiologically to a confirmed case (13.9%) compared to asymptomatic patients (32.6%, \( P < 0.0001 \)).

Comorbidities and symptomatology of the studied patients
The most common comorbidities were diabetes (16.4%), hypertension (11.7%) and chronic respiratory disease (7.1%). Diabetics were more likely to be symptomatic (17.5% vs. 12.0% among non-symptomatic), although the association was not statistically significant (\( P = 0.15 \)). No significant differences were found in other comorbidities between the two groups. For BMI, data on weight was only available for 551 patients (52.4%), and symptomatic patients were found to more likely be obese than asymptomatic patients (26.6% and 18.8%, respectively, \( P = 0.09 \)) was observed [Table 2].

In the symptomatic group, the most common symptoms were fever and cough (66.0% and 64.5%, respectively). SOB, sore throat, and digestive symptoms were also frequently reported, although at a lower frequency (26.2%, 20.3% and 6.4%, respectively) [Figure 1]. Headache, fatigue, rhinorrhea or any other symptom were rarely reported.

Laboratory findings
Overall, no medians were found to be outside the reference ranges. When comparing the two groups, symptomatic patients were found to have significantly higher C-reactive protein levels (3.55 vs. 0.30 mg/L; \( P = <0.0001 \)) and lower total lymphocyte levels (1.41 vs. 1.70; \( P = 0.02 \)). Significant difference was not noted in any other studied parameters. Regarding vital signs, symptomatic patients had higher heart rate (95.0 beats/min) than asymptomatic patients (86.0 beats/min) (\( P < 0.0001 \)) [Table 3].

Healthcare utilization and outcome
Antibiotics and hydroxychloroquine were frequently administered (73.9% and 32.0%, respectively), while steroids and antiviral drugs were less common (14.8% and 20.5%, respectively) [Table 4]. Antibiotics were more frequently administered to symptomatic patients (78.6% vs. 34.5%, \( P <0.0001 \)). Similarly, hydroxychloroquine and corticosteroids were more frequently administered to symptomatic patients (34.7% and 14.8%, respectively) than asymptomatic patients (9.2% and 2.5%, respectively) (\( P < 0.0001 \)) and (0.001, respectively). Oseltamivir use was not significantly different between the two groups.

A total of 11.3% of the patients were admitted to the ICU, with symptomatic patients more likely to be admitted (12.1% vs. 6.0%, \( P = 0.04 \)). Hospital stay of less than 2 days was rare (10.2%); most were admitted for 2–7 days (52.5%), followed by 8–14 days (26.8%) and >2 weeks (10.4%). No differences were found between the two groups in terms of lengths of hospital stay. The vast majority (73.3%) of the patients had been discharged at the time of data collection, but about one-fifth (22.8%) remained admitted, while 3.9% had died.

DISCUSSION

The clinical features of patients hospitalized for COVID-19 in the KSA were similar to patients in studies from other parts of the world: a significant number of our patients had underlying medical conditions, and a considerable proportion of patients were asymptomatic.

About 80% of COVID-19 patients in this study were male; similar proportions have been observed in China, Italy and the United States.[9‑11] It is currently unclear why COVID-19 infects males at a higher rate, and further research will be needed to understand this epidemiologic trend. The median age in this study (41 years) was noticeably lower than that in other countries. For example, the median age of patients with COVID-19 reported from other countries was between 62 – and 66 – years old in the
United States,\textsuperscript{[9,12,13]} 63 – years old in Italy,\textsuperscript{[10]} and ranged from 49 – to 56 – years old in Wuhan, China.\textsuperscript{[11,14,15]} This could be attributed to the fact that that KSA has a younger population compared to European and Asian countries.\textsuperscript{[16,17]}

Diabetes, hypertension, and chronic lung disease were common comorbidities, similar to previous reports of patients hospitalized for COVID-19.\textsuperscript{[18–21]} It is well established that patients with diabetes are at increased risk of viral infections and related complications,\textsuperscript{[22]} due to impaired immune responses against viral pathogens. Although not yet fully established, it has been postulated that the weakened immune system expedites the progression of COVID-19 in patients with diabetes.\textsuperscript{[23]} Accordingly, those with diabetes are at higher risk of severe disease, need for mechanical ventilation and admission to ICU; these factors likely contribute to the overall poor survival in this subset of patients.\textsuperscript{[24]}

Although the pathogenesis of COVID-19 in patients with hypertension or COPD remains poorly understood, both comorbidities are independently associated with a 2.5- and a 5.7-fold risk of COVID-19 disease severity and death, respectively.\textsuperscript{[25,26]}

In our cohort, the majority of the patients were symptomatic. Among asymptomatic patients, some developed symptoms during the hospital stay. We believe the percentage of positive asymptomatic is underestimated, as one of the criteria for undertaking a COVID-19 test in KSA is the presence of symptoms or known exposure to a confirmed case. A random community wide testing would provide a more robust understanding of the percentage of asymptomatic patients. Further studies focused on random, unbiased testing of individuals would be necessary to accurately determine the exact percentage of patients who remain asymptomatic. Understanding this proportion is of great importance, as asymptomatic patients are at risk of transmitting the virus.\textsuperscript{[27,28]} In fact, it is believed that the spread of the infection by asymptomatic individuals, combined with the relatively high basic reproduction number ($R_0$) of 5.7\textsuperscript{[29]} hastened the global pandemic and hindered public health efforts to effectively prevent and control the pandemic. Several studies have attempted to estimate the rate of asymptomatic COVID-19 infection, but the estimates vary widely (from 2% to 52%) and depend on the geographic location and setting.\textsuperscript{[29–32]}

Irrespective of the actual value, our results support a low

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|c|}
\hline
Category & Level & All ($n=1051$), n (%) & Symptomatic ($n=913$), n (%) & Asymptomatic ($n=138$), n (%) & $P$ \\
\hline
Hospital & Riyadh 1 & 136 (12.9) & 104 (11.4) & 32 (23.2) & <0.0001 \\
 & Riyadh 2 & 597 (56.8) & 504 (55.2) & 93 (67.4) & 0.02 \\
 & Makka 1 & 318 (30.3) & 305 (33.4) & 13 (9.4) & <0.0001 \\
Gender & Male & 844 (80.3) & 743 (81.4) & 101 (73.2) & 0.00 \\
 & Female & 207 (19.7) & 170 (18.6) & 37 (26.8) & 0.00 \\
Age (years) & $\leq$ 18 & 21 (2.0) & 13 (1.4) & 8 (5.8) & 0.01 \\
 & 19-39 & 446 (42.7) & 383 (42.2) & 63 (45.7) & 0.00 \\
 & 40-64 & 485 (46.4) & 432 (47.6) & 53 (38.4) & 0.00 \\
 & $\geq$ 65 & 93 (8.9) & 79 (8.7) & 14 (10.1) & 0.00 \\
Nationality & Saudi & 260 (24.7) & 201 (22.0) & 59 (42.8) & <0.0001 \\
 & Non-Saudi & 791 (75.3) & 712 (78.0) & 79 (57.2) & 0.00 \\
Healthcare worker & & 28 (3.1) & 22 (2.7) & 6 (5.7) & 0.12 \\
Reason for testing & Linked to travel & 62 (5.9) & 49 (5.4) & 13 (9.4) & <0.0001 \\
 & Linked to confirmed case & 172 (16.4) & 127 (13.9) & 45 (32.6) & 0.00 \\
\hline
\end{tabular}
\caption{Demographic, occupation, and reason for testing for patients infected with severe acute respiratory syndrome coronavirus-2 as well as distribution according to symptoms}
\end{table}
Findings | Normal value | Median (IQR) | All (n=1051) | Symptomatic (n=913) | Asymptomatic (n=138) | P
--- | --- | --- | --- | --- | --- | ---
WBCs (×10^9/L) | 3.5-9.5 | 6.6 (3.6) | 6.5 (3.6) | 6.9 (3.8) | | 0.91
Hb (g/L) | 130-175 | 143.0 (25.0) | 143.0 (25.0) | 144.0 (27.0) | | 0.26
Platelets (×10^9/L) | 150-350 | 231.0 (106.0) | 231.0 (109.0) | 230.0 (95.0) | | 0.89
Neutrophils (×10^9/L) | 1.8-6.3 | 3.89 (3.16) | 3.92 (3.21) | 3.66 (3.06) | | 0.31
Lymphocytes (×10^9/L) | 1-3.3 | 1.45 (0.85) | 1.41 (0.86) | 1.70 (0.71) | | 0.01
CK (U/L) | 25-200 | 123.0 (195.8) | 130.5 (211.8) | 96.0 (86.0) | | <0.0001
ALT (U/L) | 10-45 | 36.0 (34.0) | 36.0 (35.0) | 31.0 (30.0) | | 0.20
AST (U/L) | 10-40 | 36.0 (31.0) | 37.0 (33.0) | 29.0 (17.0) | | 0.050
Creatinine (μmol/L) | 57-111 | 79.0 (26.1) | 79.5 (26.9) | 74.5 (24.8) | | 0.31
Albumin (g/L) | 40-55 | 40.0 (10.0) | 39.3 (11.0) | 42.0 (8.0) | | 0.047
Bilirubin (μmol/L) | 0-21 | 9.4 (6.6) | 9.6 (6.5) | 8.7 (6.2) | | 0.30
PT (s) | 9.5-13.5 | 13.6 (1.3) | 13.6 (1.3) | 13.7 (1.1) | | 0.23
PTT (s) | 25-37 | 35.8 (7.3) | 35.8 (7.3) | 35.4 (5.1) | | 0.65
INR | 0.8-1.2 | 1.02 (0.11) | 1.02 (0.11) | 1.03 (0.11) | | 0.86
CRP (mg/dL) | 0.0-0.40 | 2.78 (9.08) | 3.55 (9.52) | 0.30 (1.23) | | <0.0001
Erythrocytes sedimentation rate (mm/h) | 0-15 | 26.5 (59.9) | 35.0 (66.7) | 5.34 (10.9) | | <0.0001
LDH (U/L) | 50-242 | 265.0 (196.5) | 273.5 (203.0) | 209.0 (101.0) | | <0.0001
D-Dimer (ng/mL) | 0-229 | 0.91 (1.70) | 0.91 (1.50) | 0.79 (3.3) | | 0.65
Ferritin (ng/mL) | 15-400 | 629.1 (1006.1) | 629.1 (1005.2) | 597.3 (695.0) | | 0.88
Lactate (mmol/L) | 0.5-1 | 1.66 (0.66) | 1.68 (0.70) | - | - | -
Temperature (°C) | 35.5-37.5 | 37.3 (1.0) | 37.4 (1.0) | 37.0 (0.5) | | <0.0001
HR (beats/min) | 60-100 | 93.0 (23.0) | 95.0 (23.0) | 86.0 (17.0) | | <0.0001
RR (breaths/min) | 12-20 | 20.0 (1.0) | 20.0 (1.0) | 20.0 (1.0) | | <0.0001
SBP (mmHg) | 90-120 | 125.0 (20.0) | 125.0 (20.0) | 129.0 (20.0) | | 0.10
DBP (mmHg) | 60-90 | 78.0 (14.0) | 78.0 (13.0) | 75.0 (15.0) | | 0.20

AST – Aspartate aminotransferase; ALT – Alanine aminotransferase; CK – Creatine kinase; CRP – C-reactive protein; DBP – Diastolic blood pressure; Hb – Hemoglobin; HR – Heart rate; INR – International normalized ratio; LDH – Lactate dehydrogenase; NLR – Neutrophil-lymphocyte ratio; PT – Prothrombin time; PTT – Partial thromboplastin time; RR – Respiratory rate; SBP – Systolic blood pressure; WBCs – White blood cells; Hb – Hemoglobin; HR – Heart rate; INR – International normalized ratio; LDH – Lactate dehydrogenase; NLR – Neutrophil-lymphocyte ratio; PT – Prothrombin time; PTT – Partial thromboplastin time; RR – Respiratory rate; SBP – Systolic blood pressure; WBCs – White blood cells; Hb – Hemoglobin; HR – Heart rate; INR – International normalized ratio; LDH – Lactate dehydrogenase; NLR – Neutrophil-lymphocyte ratio; PT – Prothrombin time; PTT – Partial thromboplastin time; RR – Respiratory rate; SBP – Systolic blood pressure; WBCs – White blood cells.

Table 4: Intensive care unit admission, management, and outcome of patients infected with severe acute respiratory syndrome coronavirus-2 as well as distribution according to symptoms

| Category | Level | All, n (%) | Symptomatic (n=913), n (%) | Asymptomatic (n=138), n (%) | P
--- | --- | --- | --- | --- | ---
Medication | Antibiotic | 596 (73.9) | 566 (78.6) | 30 (34.5) | <0.0001
Hydroxychloroquine | 258 (32.0) | 250 (34.7) | 8 (9.2) | | <0.0001
Steroid | 94 (14.8) | 92 (14.8) | 2 (2.5) | 0.001
Oseltamivir | 130 (20.5) | 117 (17.5) | 13 (16.5) | | 0.34
ICU admission | 0-1 | 115 (11.3) | 107 (12.1) | 8 (6.0) | 0.04
2-7 | 82 (10.2) | 73 (10.4) | 9 (8.7) | | 0.19
8-14 | 423 (52.5) | 362 (51.6) | 61 (57.8) | | 0.78
>14 | 216 (26.8) | 187 (26.7) | 29 (27.9) | | 0.78
Outcome | Remained admitted at the time of data collection | 2102 (22.8) | 2077 (22.7) | 33 (32.9) | 0.78
Discharged | 770 (73.3) | 669 (73.3) | 101 (73.2) | | 0.78
Died | 41 (3.9) | 37 (4.1) | 4 (2.9) | | 0.78

* Among discharged patients. ICU – Intensive care unit.

threshold for testing of COVID-19 and stress the need for testing availability to diagnose COVID-19, particularly in asymptomatic patients.

Interestingly, most of the laboratory values were within normal ranges. The degree of abnormalities in the laboratory findings of patients with COVID-19 varies across different studies[11-13] but the levels of LDH and total lymphocytes are consistently reported as elevated in these patients. In our study, both the LDH and lymphocytes level were within the normal range. It must be noted that the patients in this study were younger and had fewer comorbidities; presumably, they were healthier and more able to mount an adequate immune response against the virus, which would minimize the degree of laboratory abnormalities. To fully understand the link between age and degree of laboratory abnormalities, future large-scale studies are needed to compare patients with and without laboratory abnormalities, particularly LDH, lymphocyte, ferritin, D-dimer, procalcitonin and interleukin 6 levels. Similarly, the lack of laboratory abnormalities combined with fewer comorbidities and younger age may have
contributed to the study’s favorable composite endpoints. Overall, 10% of our cohort was admitted to the ICU, nearly 73% of patients were discharged and <4% died. These rates compared favorably to previously reported values for ICU admission (14%–39%), discharge (26%–66%) and mortality (7%–26%).[9-15,33]

The study had some noteworthy limitations and strengths. The study was a retrospective, cross-sectional analysis, and no patient data were collected after hospital discharge. Further, we were unable to collect the data for several different parameters for a significant proportion of patients. Notwithstanding, the study included COVID-19 patients from hospitals in two large metropolitan cities in KSA. To our knowledge, this is only the third study that describes the characteristics of patients with confirmed COVID-19 hospitalized in the KSA.[34,35] Therefore, this study adds to the growing body of literature characterizing the clinical features of COVID-19. The majority of currently available studies are retrospective in design, limited to single centers and carried out during short time periods. In the future, larger prospective, multi-center studies are required to be conducted over longer observation periods and with a larger sample size. Likewise, more studies are necessary to adequately examine and compare the clinical features and outcomes of patients with COVID-19 and MERS, to facilitate the implementation of optimal prevention and control strategies not only for COVID-19 but also in the event of any future coronavirus outbreaks.

CONCLUSION

In this studied COVID-19 cohort in KSA, about 80% of the patients were male. Symptomatic patients tended to be older, had higher C-reactive protein and more lymphopenia with worse outcome than asymptomatic patients. This granular analysis of COVID-19 cohorts enables identification of at-risk cohorts in future waves, optimizing development of patient pathways and public health interventions.

Ethical considerations

Ethical approval for this study was obtained from the Ethics Committee of Saudi Ministry of Health (Ref no: 20-63E) on April 22, 2020.

Peer review

This article was peer-reviewed by three independent and anonymous reviewers.

Financial support and sponsorship

Nil.

Conflict of interest

There are no conflicts of interest.

REFERENCES

1. WHO. WHO Coronavirus Disease (COVID-19) Dashboard. WHO Health Emergency Dashboard 2021. Available from: https://covid19.who.int. [Last accessed on 2021 Feb 10].
2. WorldOMeter. Saudi Arabia Coronavirus: 98,869 Cases and 676 Deaths – Worldometer, 2021. Available from: https://www.worldometers.info/coronavirus/country/saudi-arabia/. [Last accessed on 2021 Feb 10].
3. Day M. Covid-19: Four fifth of cases are asymptomatic, China figures indicate. BMJ 2020;369:m1375.
4. CDC. Coronavirus Disease 2019 (COVID-19). Centers for Disease Control and Prevention; 2020. Available from: https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/diy-cloth-face-coverings.html. [Last accessed on 2020 Apr 06].
5. Jiang F, Deng L, Zhang L, Cai Y, Cheung CW, Xia Z. Review of the clinical characteristics of coronavirus disease 2019 (COVID-19). J Gen Intern Med 2020;35:1-5.
6. Alshammari TM, Altebnawi AF, Alenzzi KA. Importance of early precautionary actions in avoiding the spread of COVID-19: Saudi Arabia as an Example. Saudi Pharm J 2020;28:898-902.
7. Al Noor Specialist Hospital n.d. Available from: http://nsh.med.sa/Pages/Home.aspx. [Last accessed on 2021 Mar 21].
8. Prince Mohammed Bin Abdulaziz Hospital. EyeofriyadhCom n.d. Available from: https://www.eyeofriyadh.com/directory/details/2754_prince-mohammed-bin-abdulaziz-hospital. [Last accessed on 2021 Mar 21].
9. Goyal P, Choi JJ, Pinheiro LC, Schenck EJ, Chen R, Jabri A, et al. Clinical characteristics of COVID-19 in New York City. N Engl J Med 2020;382:2372-4.
10. Grasselli G, Zangrillo A, Zanella A, Antonelli M, Cabrini L, Castelli A, et al. Baseline Characteristics and Outcomes of 1591 Patients Infected With SARS-CoV-2 Admitted to ICUs of the Lombardy Region, Italy. JAMA 2020;323:1574-81.
11. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhuan, China. JAMA 2020;323:1061-9.
12. Aggarwal S, Garcia-Telles N, Aggarwal G, Lavee C, Lippi G, Henry BM. Clinical features, laboratory characteristics, and outcomes of patients hospitalized with coronavirus disease 2019 (COVID-19): Early report from the United States. Diagnosis (Bed) 2020;7:91-6.
13. Richardson S, Hirsch JS, Narasimhan M, Crawford JM, McGinn T, Davidson KW, et al. Presenting characteristics, comorbidities, and outcomes among 5700 patients hospitalized With COVID-19 in the New York City Area. JAMA 2020;323:2052-9.
14. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhuan, China: A descriptive study. Lancet 2020;395:507-13.
15. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhuan, China. Lancet 2020;395:497-506.
16. Saudi Arabia General Authority for Statistics. General Authority for Statistics. General Authority for Statistics n.d. Available from: https://www.stats.gov.sa/en. [Last accessed on 2021 Feb 10].
17. Alyami MH, Naser AY, Orabi MA, Alwahi H, Alyami HS. Epidemiology of COVID-19 in the Kingdom of Saudi Arabia: An ecological study. Front Public Health 2020:8:506.
18. Centers for Disease Control and Prevention. Morbidity and Mortality Weekly Report (MMWR) | MMWR n.d. Available from: https://www.cdc.gov/mmwr/index.html. [Last accessed on 2020 Jun 18].
19. Emami A, Javanmardi F, Pirbonyeh N, Akbani A. Prevalence of underlying
diseases in hospitalized patients with COVID-19: A systematic review and meta-analysis. Arch Acad Emerg Med 2020;8:e35.
20. Pranata R, Lim MA, Huang J, Raharto SB, Lukito AA. Hypertension is associated with increased mortality and severity of disease in COVID-19 pneumonia: A systematic review, meta-analysis and meta-regression. J Renin Angiotensin Aldosterone Syst 2020;21:1470320320926899.
21. Yang J, Zheng Y, Gou X, Pu K, Chen Z, Guo Q, et al. Prevalence of comorbidities and its effects in patients infected with SARS-CoV-2: A systematic review and meta-analysis. Int J Infect Dis 2020;94:91-5.
22. Kronsteiner B, Chaichana P, Sumonwiriya M, Jenjaroen K, Chowdhury FR, Chumseng S, et al. Diabetes alters immune response patterns to acute melioidosis in humans. Eur J Immunol 2019;49:1092-106.
23. Hussain A, Bhowmik B, do Vale Moreira NC. COVID-19 and diabetes: Knowledge in progress. Diabetes Res Clin Pract 2020;162:108142.
24. Yan Y, Yang Y, Wang F, Ren H, Zhang S, Shi X, et al. Clinical characteristics and outcomes of patients with severe COVID-19 with diabetes. BMJ Open Diabetes Res Care 2020;8:e001343.
25. Lippi G, Henry BM. Chronic obstructive pulmonary disease is associated with severe coronavirus disease 2019 (COVID-19). Respir Med 2020;167:105941.
26. Lippi G, Wong J, Henry BM. Hypertension in patients with severe coronavirus disease 2019 (COVID-19): A pooled analysis. Pol Arch Intern Med 2020;130:304-9.
27. Almadi MA, Aljahbi AM, Alzamam N, Alammam N, Aljahdi ES, Alsahlabil FI, et al. COVID-19 and endoscopy services in intermediately affected countries: A position statement from the Saudi Gastroenterology Association. Saudi J Gastroenterol 2020;26:240-8.
28. Gao Z, Xu Y, Sun C, Wang X, Guo Y, Qiu S, et al. A systematic review of asymptomatic infections with COVID-19. J Microbiol Immunol Infect 2021;54:12-16.
29. Nishiura H, Kobayashi T, Miyama T, Suzuki A, Jung SM, Hayashi K, et al. Estimation of the asymptomatic ratio of novel coronavirus infections (COVID-19). Int J Infect Dis 2020;94:154-5.
30. Ki M; Task Force for 2019-nCoV. Epidemiologic characteristics of early cases with 2019 novel coronavirus (2019-nCoV) disease in Korea. Epidemiol Health 2020;42:e2020007.
31. Kimball A. Asymptomatic and presymptomatic SARS-CoV-2 infections in residents of a long-term care skilled nursing facility – King County, Washington, March 2020. MMWR Morb Mortal Wkly Rep 2020;69:377-81.
32. Mizumoto K, Kagaya K, Zarebski A, Chowell G. Estimating the asymptomatic proportion of coronavirus disease 2019 (COVID-19) cases on board the Diamond Princess cruise ship, Yokohama, Japan, 2020. Euro Surveill 2020;25:2000180.
33. Gold JA, Wong KK, Szablewski CM, Patel PP, Rossow J, da Silva J, et al. Characteristics and Clinical Outcomes of Adult Patients Hospitalized with COVID-19 — Georgia, March 2020. MMWR Morb Mortal Wkly Rep 2020;69:545–550.
34. Alsofayan YM, Althunayyan SM, Khan AA, Hakawi AM, Assiri AM. Clinical characteristics of COVID-19 in Saudi Arabia: A national retrospective study. J Infect Public Health 2020;13:920-5.
35. Alahmari AA, Khan AA, Elganzainy A, Almohammadi EL, AM Hakawi, Assiri AM, et al. Epidemiological and clinical features of COVID-19 patients in Saudi Arabia. J Infect Public Health. 2021:14:437-43.