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Research Article

Sex-Based Differences in Outcomes of Coronavirus Disease 2019 (COVID-19) in Korea

Jiyoung Kim,1,* Narae Heo,2 Hyuncheol Kang3

1 Department of Nursing, Sangmyung University, Republic of Korea
2 Department of Nursing, Haneui University, Republic of Korea
3 Department of Big Data AI, Hoseo University, Republic of Korea

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Purpose: This study examined the factors affecting mortality and clinical severity score (CSS) of male and female patients with Coronavirus Disease 2019 (COVID-19) using clinical epidemiological information provided by the Korea Disease Control and Prevention Agency.

Methods: This is a retrospective, observational cohort study. From January 21 to April 30, 2020, a total of 5624 patients who were released from quarantine or died were analyzed.

Results: The factors influencing release or death that differed by sex were high heart rate and malignancy in males and chronic kidney disease in females. In addition, the factors influencing progression to severe CSS were high BMI (severe obesity) and rheumatic disease in males and high temperature, sputum production, absence of sore throat and headache, chronic kidney disease, malignancy, and chronic liver disease in females. Older age, low lymphocyte count and platelets, dyspnea, diabetes mellitus, dementia, and intensive care unit (ICU) admission affected mortality in all the patients, and older age, low lymphocyte count and platelets, fever, dyspnea, diabetes mellitus, dementia, and ICU admission affected progression to severe stage of CSS.

Conclusions: This study is expected to contribute to the general results by analyzing nationally representative data. The results of this study present an important basis for development of differentiated nursing and medical management strategies in consideration of factors that influence treatment effects and outcomes according to sex of patients with COVID-19.

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Introduction

The World Health Organization (WHO) declared the Coronavirus Disease 2019 (COVID-19) was a pandemic on March 11, 2020 [1]. As of July 4, 2022, a total of 546,357,444 patients were reported to have COVID-19, and 6,336,415 were reported to have died from the disease [2]. In comparison, severe acute respiratory syndrome (SARS) was identified first on November 16, 2002 and confirmed in 8096 patients, causing 774 deaths in 29 countries through July 2003, but was not judged to be a global pandemic.

COVID-19 is believed to be one of the most serious health crises ever.

Detecting the causative agent of COVID-19 and providing appropriate isolation and treatment by sharing information is a top priority. Therefore, several studies have analyzed clinical epidemiological data. Studies based on early epidemiological data found that males were more likely to be infected than females [3,4]. A study of severely ill patients with COVID-19 identified a larger proportion of males than females, indicating that COVID-19 varies by sex, and that male patients are more susceptible to severe COVID-19 [5,6]. In particular, severity and complications were more severe in male patients, and this was premised on pathophysiological evidence that the potential functional regulation of angiotensin-converting enzyme 2 (ACE2) by estrogen results in sex differences between morbidity and mortality [7–11]. Conversely, androgens can be a predisposing factor to greater severity of COVID-19 in males [12]. Additionally, although the mechanism of these sex differences is not fully understood, factors such as
socioeconomic status, lifestyle habits (e.g., smoking and drinking rates), personal hygiene patterns (e.g., hand washing), healthcare-seeking behavior, and access to healthcare might partially explain the sex-based differences [5,13,14]. The mortality and severity of patients with COVID-19 differ according to sex, indicating it is an important variable in prevention and treatment of COVID-19. However, most studies have generally reported differences in incidence, mortality, and severity according to epidemiological characteristics [5,6,15,16]. A meta-analysis of 4420 patients with SARS-CoV-2/COVID-19 by Brady et al. [17] found that sex/gender was included as an analytical variable in only 178 (4%). In other words, there have been no reports on systematic analysis of specific and various factors for effective medical management, such as clinical findings, comorbid diseases, and blood tests, according to sex. A study of patients with COVID-19 in Korea identified risk factors for progression to severe stage [18] using models that predicted clinical severity and duration of hospitalization [19] but failed to account for sex differences. A study using data from the Korea Disease Control and Prevention Agency (KDCA) daily reports also analyzed dynamic patterns among age and sex groups and found that epidemics among young adults resulted in the epidemic spreading across the entire population, whereas overall sex differences in the COVID-19 epidemic were moderate; however, other related factors could not be analyzed [20]. In light of the current results, researchers of SARS-CoV2 and COVID-19 are urged to systematically apply sex-specific methodologies [17]. This should include performance of sex-specific analyses and reporting of sex-disaggregated results for identification of differences in treatment effects [21].

Therefore, this study uses clinical epidemiological information recorded by the KDCA from patients confirmed to have COVID-19 to identify and compare factors that affect mortality and clinical severity score (CSS) of male and female patients. The predictive variables selected in this study (age, body mass index [BMI], clinical findings at hospitalization, comorbidities, etc.) were found to be related to COVID-19 outcomes in previous studies [18–20]. In addition, as much information as can be obtained from the early clinical process, it could be very useful in identifying the risk of mortality and CSS in male and female patients before or at the early stage of diagnosis of COVID-19. Therefore, the results of this study will provide data for planning evidence-based nursing and medical management strategies by sex for the prevention and treatment of COVID-19.

**Methods**

**Study design and samples**

This is a retrospective observational cohort study using patient clinical epidemiological information provided by the KDCA (http://www.kdca.go.kr/). The clinical epidemiological information was collected for COVID-19 patients with confirmed COVID-19 who were confirmed to be released from quarantine or died as of April 30, 2020. Confirmed cases include those who have been confirmed as infected with the infectious disease pathogen according to the diagnostic testing standard, regardless of clinical manifestations [22]. The raw data included 5628 patients; each variable did not have many missing values and patients with missing values were excluded from the analysis. A total of 5624 patients (2317 males, 3307 females) were included in the final analysis.

**Measurements**

Epidemiological and clinical characteristic data were obtained by healthcare providers at admission. Patients were followed until the end of hospitalization. During hospitalization, patients were monitored by the KDCA of the National Medical Center.

**Epidemiological and clinical characteristics**

The age, BMI, initial examination findings (heart rate, temperature), clinical findings at hospitalization (fever, cough, sputum production, sore throat, rhinorrhea, dyspnea, headache, confusion), comorbid diseases (diabetes mellitus, hypertension, chronic kidney disease, malignancy, chronic liver disease, rheumatic disease, dementia), intensive care unit (ICU) admission, and complete blood count (lymphocytes and platelets) of the patients were analyzed.

**Definition of outcome**

The first treatment effect was mortality according to the following criteria. Confirmed cases who display symptoms are discharged if they meet the clinical and testing criteria. (1) According to the clinical criteria, a person should not exhibit a fever without taking fever reducers and show improvements in clinical symptoms for at least 72 hours after 10 days on onset. (2) For the testing criteria, a person should not exhibit a fever without taking fever reducers and show improvements in clinical symptoms after 7 days on onset. Thereafter, the person should test negative on PCR tests twice in a row with at least a 24-hour interval. Confirmed cases who do not display symptoms are discharged if they do not exhibit any clinical symptoms for 10 days on confirmation. According to the testing criteria, they should test negative on PCR tests twice in a row with at least a 24-hour interval after 7 days on confirmation [22]. Death was defined as in-hospital mortality.

The second treatment effect was CSS. The CSS represents clinical severity of patients with COVID-19. The original CSS provided by the KDCA is scored from 1 to 8, with the lowest stage 1 indicating no disruption of daily life and the highest stage 8 indicating death. In this study, appropriate treatment was determined by reclassifying severity into four stages from the original 8 stages according to patient condition. These CSS stages (Stage 1: No disruption to daily life; Stage 2: Hindrance to daily life but no oxygen required; Stage 3: Oxygen treatment, multi-organ damage, extracorporeal membrane oxygenation (ECMO); Stage 4: Death) were classified and analyzed.

**Data analysis**

Data were analyzed using SAS 9.4 program [23]. Epidemiological and clinical characteristics of the patients were analyzed as the frequency, percentage, mean, and standard deviation, and Chi-square test was used to examine the differences in epidemiological and clinical characteristics between male and female patients. Pearson’s correlation coefficient analysis was used to identify the associations between CSS and age, heart rate, temperature, lymphocytes, platelets variables in male and female patients. Multiple binary/ordinal stepwise logistic regression was performed to investigate the major factors affecting treatment effect and outcomes (mortality, CSS) in male and female patients, considering the useable major factors such as age, BMI, rhinorrhea, dyspnea, confusion, diabetes mellitus, chronic kidney disease, malignancy, dementia, ICU admission, lymphocytes, platelets, and so on. The stepwise logistic regression was used to remove variables that were not required to explain the dependent variable. The variance inflation factors (VIF) of all selected independent variables are below 3, which means multicollinearity does not exist in these regression models. The threshold for statistical significance for this study was $p < .05$. 


Ethical considerations

This study was approved for information disclosure by the KDCA. The research was approved by the Institutional Review Board of the associated institute (IRB No. SMUIRB, ex-2020-005). To ensure the anonymity and confidentiality of participants, personal information was provided and used through a secured closed system.

Results

Participants’ characteristics

A total of 5624 participants was in the final analysis, including 2317 males (41.2%) and 3307 females (58.8%). Of the 5624 confirmed patients with COVID-19, 5383 (95.7%) were released from quarantine and 241 (4.3%) died. The mortality rate for males was 5.5%, higher than that for females (3.5%). There were significant differences between male and female patients according to release or death, CSS, age, BMI, temperature, cough, sputum production, sore throat, headache, diabetes mellitus, chronic liver disease, dementia, ICU admission, lymphocyte, and platelets (Table 1).

Correlation coefficients for variables

To identify bivariate correlations, Pearson’s correlation coefficient analyses were performed and confirmed that predictor variables had an association with CSS (Table 2).

Multiple binary logistic regression for mortality

To identify factors affecting mortality, multiple binary logistic regression was conducted by dividing all patients into quarantine

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Table 1 Epidemiological and Clinical Characteristics.

| Variables | Categories | Men (n = 2317) | Women (n = 3307) | Total | X² | p |
|-----------|------------|---------------|-----------------|-------|----|---|
| Release or death | Release | 2190 (97.5) | 3193 (96.6) | 5383 (95.7) | 13.74 | <.001 |
| | Death | 127 (5.5) | 114 (3.5) | 241 (4.3) | |
| Clinical severity score (CSS) | No disruption to daily life | 1804 (78.2) | 2647 (80.5) | 4451 (79.5) | 18.53 | <.001 |
| | Hindrance to daily life but no oxygen required | 118 (5.1) | 212 (6.4) | 330 (5.9) | |
| | Oxygen treatment, multi-organ damage, and extracorporeal membrane oxygenation (ECMO) | 201 (11.2) | 317 (9.6) | 575 (10.3) | |
| Age (years) | 60< | 127 (5.5) | 114 (3.5) | 241 (4.3) | |
| | 60–69 | 1604 (69.2) | 2235 (68.7) | 3839 (68.3) | 12.04 | 0.007 |
| | 70–79 | 377 (16.3) | 539 (16.3) | 916 (16.3) | |
| | ≥80 | 232 (10.0) | 313 (9.5) | 545 (9.7) | |
| | No disruption to daily life | 104 (4.5) | 220 (6.7) | 324 (5.8) | |
| | Hindrance to daily life but no oxygen required | 87 (4.7) | 173 (6.8) | 260 (5.9) | |
| | Oxygen treatment, multi-organ damage, and extracorporeal membrane oxygenation (ECMO) | 487 (26.1) | 551 (21.5) | 1038 (23.5) | |
| | Death | 576 (30.1) | 476 (18.6) | 1052 (23.8) | |
| | Temperature | 99 (5.3) | 109 (4.3) | 208 (4.7) | |
| | <36.1 | 48 (2.3) | 59 (1.9) | 107 (2.0) | |
| | 36.1–37.2 | 1762 (82.9) | 2615 (84.0) | 4377 (83.6) | |
| | 37.3–38.2 | 3690 ± 0.57 | 3698 ± 0.54 | 3694 ± 0.56 | 41.48 | <.001 |
| | 38.3–40.4 | 63 ± 3.1 | 70 (2.2) | 136 (2.6) | |
| | Fever | 521 (22.5) | 784 (23.7) | 1305 (23.2) | 1.14 | 0.286 |
| | Cough | 918 (39.6) | 1423 (43.0) | 2341 (41.6) | 6.52 | 0.011 |
| | Sputum production | 592 (25.6) | 1027 (31.1) | 1619 (28.8) | 20.14 | <.001 |
| | Sore throat | 239 (10.3) | 382 (11.6) | 621 (11.0) | 2.12 | 0.145 |
| | Rhinorrhea | 290 (12.5) | 591 (17.9) | 881 (15.7) | 29.57 | <.001 |
| | Dyspnea | 263 (11.4) | 403 (12.2) | 666 (11.8) | 0.91 | 0.340 |
| | Headache | 299 (12.9) | 668 (20.2) | 967 (17.2) | 50.92 | <.001 |
| | Confusion | 16 (0.7) | 19 (0.6) | 35 (0.6) | 0.30 | 0.586 |
| | DM | 325 (14.0) | 366 (11.1) | 691 (12.3) | 11.07 | 0.001 |
| | Hypertension | 506 (21.8) | 695 (21.0) | 1201 (21.4) | 0.55 | 0.459 |
| | CKD | 261 (11.1) | 29 (0.9) | 55 (1.0) | 0.85 | 0.358 |
| | Malignancy | 49 (2.1) | 96 (2.9) | 145 (2.6) | 3.37 | 0.066 |
| | CLD | 48 ± 4.2 | 35 (1.1) | 83 (1.6) | 9.62 | 0.002 |
| | Rheumatoid disease | 12 (0.6) | 26 (0.8) | 38 (0.7) | 1.46 | 0.227 |
| | Dementia | 71 (3.2) | 153 (4.9) | 224 (4.2) | 8.70 | 0.003 |
| | ICU admission | 115 (5.0) | 74 (2.3) | 189 (3.4) | 31.10 | <.001 |
| Lymphocytes (%) | <20 | 27.60 ± 12.28 | 30.12 ± 11.14 | 29.15 ± 11.66 | 46.27 | <.001 |
| | 20–39 | 428 (27.2) | 455 (18.3) | 883 (21.8) | |
| | 40 | 913 (58.0) | 1579 (63.3) | 2492 (64.1) | |
| | ≥40 | 232 (14.8) | 450 (18.0) | 682 (16.8) | |
| | PLT (10^3/µL) | <150 | 263 (16.6) | 237 (25.5) | 500 (12.2) | 44.99 | <.001 |
| | 150–399 | 1298 (81.7) | 2212 (88.7) | 3510 (86.0) | |
| | ≥400 | 27 (1.7) | 45 (1.8) | 72 (1.8) | |

Note: BMI = body mass index; CKD = chronic kidney disease; CLD = chronic liver disease; DM = diabetes mellitus; HR = heart rate; ICU = intensive care unit; PLT = platelets. * Indicates that the proportions of male and female are significantly different at significance level 0.05 by Chi-square test.
release or death (Table 3). Older age, high heart rate, low lymphocyte count and platelets, dyspnea, diabetes mellitus, malignancy, dementia, and ICU admission were factors influencing mortality among all patients.

Older age, high heart rate, low lymphocyte count and platelets, dyspnea, diabetes mellitus, malignancy, dementia, and ICU admission affected mortality among male patients. When other variables were controlled, the odds ratio of release was 25.22 times lower in the younger than 60-year-old group, 7.73 times lower in the 60-69-year-old group, and 5.23 times lower in the 70-79-year-old group compared with patients 80 years or older. When heart rate increased by 1 beat per min, the odds ratio of release was 0.97 times higher than that of death; when the number of lymphocytes increased by 1%, the odds ratio of release was 1.10 times higher than that of death. In clinical findings, the odds ratio of release in the absence of dyspnea symptoms was 5.88 times (1/0.17) greater than that in patients with symptoms. For comorbid diseases, the odds ratio of release was 2.96 times (1/0.34), 9.43 times (1/0.11), and 2.80 times (1/0.36) higher in the absence of diabetes mellitus, chronic kidney disease, and dementia, respectively. In addition, the odds ratio of release was 17.24 times (1/0.06) higher in cases not admitted to the ICU.

Table 2. Correlation Coefficients for Variables in Males and Females.

| Variables                  | Men                        | Women                     |
|----------------------------|----------------------------|---------------------------|
|                            | Clinical severity score (CSS) |                            |
|                            | r 95% CI Low High           | r 95% CI Low High         |
| Age                        | 0.43*** 0.40 0.47           | 0.38*** 0.35 0.40         |
| HR                         | 0.11*** 0.07 0.15           | -0.00 -0.04 0.03          |
| Temperature                | 0.16*** 0.12 0.20           | 0.11*** 0.07 0.14         |
| Lymphocytes                | -0.41*** -0.44 -0.38       | -0.34*** -0.37 -0.31      |
| PLT                        | -0.20*** -0.23 -0.16        | -0.17*** -0.20 -0.14      |

*p < .05, **p < .01, ***p < .001.

Note. HR = heart rate; PLT = platelets.

Multiple ordinal logistic regression for clinical severity score

For testing the proportional odds assumption, p values of score Chi-squares are .607 (for male), .512 (for female), and .538 (for total), which indicate that the proportional odds assumption is reasonable.

Multiple ordinal logistic regression was performed to identify the factors affecting CSS (Table 4). Older age, high BMI (severe obesity), low lymphocyte count and platelets, fever, sputum production, absence of sore throat and headache, rhinorrhea, dyspnea, confusion, diabetes mellitus, malignancy, dementia, and ICU admission affected progression to severe CSS in all patients.

Older age, high BMI (severe obesity), low lymphocyte count and platelets, fever, dyspnea, diabetes mellitus, rheumatic disease, dementia, and ICU admission were found to affect progression to severe CSS in male patients. When the coefficients were increased and other variables were controlled, the odds ratio of stage 1 CSS (No disruption to daily life) in the under 60-, 60-69-, and 70-79-

Table 3. Multiple Binary Logistic Regression for Mortality.

| Variables       | Men OR 95% CI | Women OR 95% CI | Total OR 95% CI |
|-----------------|--------------|-----------------|---------------|
| Age 60<         | 25.22*** 7.45 85.44 | 67.15*** 12.52 360.27 | 33.43*** 12.76 87.56 |
| 60–69           | 7.73*** 2.87 20.85 | 35.73*** 4.88 261.57 | 10.72*** 4.66 24.67 |
| ≥ 80            | Ref. 1.96 13.95 | 4.63** 1.66 12.96 | 4.88*** 2.39 9.94 |
| BMI <18.5       | 0.15 0.02 1.18 | Ref. 0.20 <0.01 0.70 | 0.79 0.18 3.43 |
| 18.5–22.9       | 0.81 0.12 5.40 | 1.80 0.48 6.66 | 1.39 0.38 5.08 |
| 23.0–24.9       | 1.66 0.18 15.00 | 3.98 1.00 15.80 | Ref. 0.38 5.08 |
| 25.0–29.9       | 0.63 0.09 4.25 | Ref. 0.18 <0.01 0.70 | 0.95 0.10 1.00 |
| ≥ 30            | Ref. 0.22 0.96 | Ref. 0.14 <0.01 0.90 | 0.97 0.97 1.00 |
| HR              | 0.97 0.95 1.00 | Ref. 0.97 1.00 | 0.97 1.00 |
| Rhinorrhea      | 0.38* 0.18 0.83 | 0.17*** 0.07 0.43 | 0.34*** 0.19 0.61 |
| Confusion       | 0.46* 0.22 0.96 | 0.34* 0.14 0.85 | 0.38** 0.21 0.67 |
| DM              | 0.11* 0.02 0.61 | Ref. 0.10 0.55 | 0.20** 0.07 0.55 |
| CKD             | 0.17** 0.05 0.61 | 0.21*** 0.10 0.44 | 0.21** 0.10 0.44 |
| Malignancy      | 0.10*** 0.03 0.33 | 0.36* 0.13 0.98 | 0.08*** 0.04 0.15 |
| ICU admission   | 0.09*** 0.04 0.21 | 0.06* 0.02 0.17 | 1.11*** 1.08 1.15 |
| Lymphocytes (%) | 1.10*** 1.05 1.15 | 1.11*** 1.06 1.16 | 1.11*** 1.08 1.15 |
| PLT (10^9/L)    | 1.00** 1.00 1.00 | 1.00 1.00 | 1.00*** 1.00 1.00 |

*p < .05, **p < .01, ***p < .001.

Note. BMI = body mass index; 95% CI = 95% confidence interval; CKD = chronic kidney disease; DM = diabetes mellitus; HR = heart rate; ICU = intensive care unit; OR = odds ratio; PLT = platelets; Ref = reference group.

Excluded predictors are temperature, fever, cough, sputum production, sore throat, headache, hypertension, chronic liver disease, and rheumatoid disease.
years age groups increased compared with that of the 80-year-old group. In BMI, the odds ratio of stage 1 CSS was increased in the normal and overweight groups compared with the group of severe obesity.

Older age, high temperature, low lymphocyte count and platelets, fever, sputum production, absence of sore throat and headache, dyspnea, diabetes mellitus, chronic kidney disease, malignancy, chronic liver disease, dementia, and ICU admission were found to affect progression to severe CSS in female patients. When the coefficients were increased and other variables were controlled, the odds ratio of having stage 1 CSS in the under 60-, 60-, 69-, and 70-79-years age groups increased compared with those of the 80-year-old group.

**Discussion**

This study used clinical epidemiological information of COVID-19 patients to determine the factors affecting mortality and CSS of male and female patients in 5624 confirmed cases of COVID-19. The results showed differences according to sex.

In this study, male and female patients showed a significant difference according to mortality and CSS. In this retrospective observational cohort study among COVID-19 patients in Korea, the mortality rate was 5.4% for males and 3.45% for females. In CSS, there were 11.2% male and 9.6% female patients with stage 3 (oxygen treatment, multi-organ damage, and ECMO). In addition, 5.0% of males and 2.3% of females used the ICU during the hospitalization period. In a study of patients hospitalized for COVID-19 at Wuhan Hospital in China [16], among 168 severely ill patients (86 males and 82 females), the mortality rate was 12.8% for males and 7.3% for females. As a result of examining the odds ratio of intensive treatment unit (ITU) admission through a meta-analysis of 3,111,714 cases reported worldwide, it was found that male patients were more than three times more likely to die than females [6]. The results of this study were similar to the difference in prognosis according to sex in other COVID-19-related studies.

Factors that influenced mortality in all patients included older age, low lymphocyte count and platelets, dyspnea, diabetes mellitus, dementia, and ICU admission. In a study of patients with confirmed COVID-19 in China [24], the risk factors for severe pneumonia or death were age over 60, hypertension, diabetes mellitus, cardiovascular disease, chronic lung disease, and cancer. In a meta-analysis study, it was shown that comorbid diseases such as hypertension, diabetes mellitus, cardiovascular disease, and respiratory diseases can have a significant effect on the prognosis of COVID-19 [15]. Moon et al. [25] reported that elderly age can influence the clinical course of COVID-19 and COVID-19-related mortality through immune aging or high prevalence of comorbid diseases. A study of adult patients with COVID-19 in England and Wales [26] showed that hypertension, dementia, chronic lung disease, and diabetes mellitus were associated with death. The results of this study were similar to the results of domestic and foreign studies that showed a high mortality rate among the elderly with comorbid diseases. Among complete blood counts, lymphocytes are important for immunological responses such as cytokines and chemokines [27,28]. When abnormal lymphocytes and abnormal platelets enter the immune system, patients were believed to be vulnerable and COVID-19 symptoms could be exacerbated [18,27,28]. In terms of the biological mechanisms and in viral-associated inflammatory syndromes, mediators (which primarily kill viral infected cells by stimulating CD8 cells) are secreted during eradication of the virus, which inadvertently inhibits bone marrow function and activates platelets, resulting in thrombocytopenia [29]. In addition, COVID-19 starts with systemic symptoms such as fever, cough, and malaise. These symptoms are followed by respiratory symptoms, and in severe cases, patients may develop acute respiratory distress syndrome, shock, and multi-organ failure. Therefore, early identification and appropriate treatment are crucial to prevent severe outcomes.

**Table 4 Multiple Ordinal Logistic Regression for Clinical Severity Score (CSS).**

| Variables       | Men  |         | Women |         | Total |
|-----------------|------|---------|-------|---------|-------|
|                 | B    | 95% CI  | B     | 95% CI  | B     | 95% CI |
|                 | Low  | High   | Low   | High   | Low   | High   |
| Age             |      |        | 2.03***| 4.64    | 2.16***| 5.90    |
| 60<             | 2.73***| 8.31    | 28.53  |        | 3.49    | 3.78    |
| 60–69           | 1.96***| 3.81    | 13.14  |        | 1.66***| 3.52    |
| 70–79           | 1.55***| 2.49    | 8.95   |        | 0.90** | 4.11    |
| ≥80             | Ref. |        | Ref.   |        | Ref.   |        |
| BMI             | <18.5| 0.57    | 0.66   | 4.76   | 0.33   | 0.75    |
| 18.5–22.9       | 1.24**| 1.61    | 7.35   |        | 0.55*  | 1.07    |
| 23.0–24.9       | 1.07**| 1.37    | 6.19   |        | 0.58*  | 1.09    |
| ≥25.0–29.9      | 0.64 | 0.91    | 3.91   |        | 0.16   | 0.73    |
| Temperature     |      |        |        |        |        |        |
| Fever           | -0.97***| 0.27    | 0.53   |        | -0.32*| 0.55    |
| Sputum production|      |        |        |        |        |        |
| Sore throat     |      |        |        |        |        |        |
| Rhinorrhea      |      |        |        |        |        |        |
| Dyspnea         | -1.29***| 0.19    | 0.41   |        | -1.48***| 0.17   |
| Headache        |      |        |        |        |        |        |
| Confusion       |      |        |        |        |        |        |
| DM              | -0.50**| 0.42    | 0.88   |        | -0.67***| 0.36   |
| CKD             |      |        |        |        |        |        |
| Malignancy      |      |        |        |        |        |        |
| CLD             |      |        |        |        |        |        |
| Rheumatoid disease | -2.12**| 0.03    | 0.53   |        |        |        |
| Dementia        | -1.78**| 0.08    | 0.37   |        | -1.20***| 0.17   |
| ICU admission   | -2.24***| 0.06    | 0.18   |        | -2.08***| 0.07   |
| Lymphocytes (%) | 0.06***| 1.05    | 1.09   |        | 0.85***| 1.04   |
| PLT (10^11/μL)  | 625.09/15***| 1.00    | 1.00   |        | 661.02/17***| 1.00    |

*p < .05, **p < .01, ***p < .001.

Note: BMI – body mass index; CSS – clinical severity score; DM – diabetes mellitus; ICU – intensive care unit; PLT – platelets; Ref – reference group.

Excluded predictors are heart rate, cough, and hypertension.
This study is a comprehensive comparative analysis of factors influencing mortality and CSS of male and female patients using the clinical epidemiological information of COVID-19 patients provided by the KDCA. The results of this study will be used as important information to develop nurses’ infection expertise. Nursing management strategies for new infectious diseases such as COVID-19 should be based on evidence, and it is important to develop strategies for preemptive and tailored nursing care to vulnerable populations. Therefore, nurses should provide differentiated nursing management for each patient by identifying various factors that affect treatment effects and outcomes according to sex, thereby reducing the risk of developing into severe COVID-19 or mortality. However, the present study has some limitations. It is not clear whether the results of this study can be generalized to other regions of the world, so a study that specifically analyzes various factors related to sex differences in COVID-19 patients in various countries is necessary. In this study, we did not report gender differences in the statistical significance of each predictor, and evaluated based on the results of previous studies. In the future, specific studies are needed to investigate the difference in the predictors presented in this study. Currently, since the validity verification was not performed while modifying the CSS scale in the study, the validity verification should be performed by accumulating related data for the precision of the study. In addition, it was not possible to collect and analyze data on various diagnostic tests, medications, and lifestyle factors by male and female patients as a retrospective study. Research should take into account not only biological differences, but also social and behavioral differences (lifestyle habits, health care seeking behavior, etc.). Lastly, the strain of coronavirus, the type of vaccine, the number of inoculations, and treatment information are not reflected in these data. In the future, repeated studies including various factors are needed, and prospective studies are needed to confirm mechanisms between symptoms, comorbidities, mortality, and CSS.

Conclusions

This study is expected to contribute to the general results by analyzing nationally representative data using the clinical epidemiological information of COVID-19 patients provided by the KDCA. It is significant in that it identifies factors affecting mortality and the CSS of COVID-19 male and female patients and identified differences according to sex. In this study, factors influencing mortality that differed according to sex were high heart rate and malignancy in men and chronic kidney disease in women. In addition, factors influencing CSS that differed by sex were high BMI and rheumatic disease in men and high temperature, sputum production, absence of sore throat and/or headache, chronic kidney disease, malignancy, and chronic liver disease in women. Therefore, classifying patients as at high risk of mortality and severe CSS according to sex and managing patients considering risk factors as such clinical findings at hospitalization and comorbid diseases can lead to effective management of COVID-19 patients. Understanding the specific factors that affect COVID-19 treatment effects and outcomes by sex is important for nursing and medical management, including prevention and treatment. As COVID-19 continues to spread, it is important to be aware of vulnerable populations, and there is a need to tailor ongoing and planned prevention and treatment according to sex. Ultimately, the results of this study can be used to efficiently allocate nursing and medical resources by identifying the factors affecting mortality and CSS according to sex. Understanding sex differences in COVID-19 outcomes is expected to contribute to the development of individualized nursing and
medical management strategies for COVID-19 and new infectious diseases.

Data statement

The data in this study were obtained from the Korea Disease Control and Prevention Agency (KDCA). All data generated or analyzed during this study are included in this published article.

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Conflict of interest

The authors declare no conflict of interest.

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