Diagnostic Pathology: Open Access
ISSN: 2476-2024
Jamiyan T, et al., Diagn Pathol Open 2023, 1:210
Research Article
Open Access

# Risk Factors for Mortality among COVID-19 Patients: Nationwide Cohort Study of Mongolia

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## Abstract

**Background:** Through this first large retrospective cohort study in Mongolia, we tried to provide some useful information for predicting the character of Coronavirus disease 2019 (COVID-19) patients.

**Materials and methods:** Adult inpatients with COVID-19 were retrospectively analyzed from national, provincial, and municipal health reports from April 1, 2020 to October 1, 2021.

**Results:** 554 non-survivor and 161 survivors, for a total of 715 patients were included in the final analysis. Female patients accounted for 51.5% of all patients. The mean age was 65.5 (18-100) years, and patients in the non-survivor group were much older than those in the survivor group (57 years vs. 69 years, p<0.001). Most of the cases in the non-survivor group had unvaccinated (139; 25%). The top five symptoms in all patients were cough (78.3%), dyspnea (74.5%), fever (39.9%), chest pain (46.3%), and fatigue (26.9%). Factors of comorbidity such as cardiovascular disease (p<0.001), hypertension (p<0.001), and cancer (p=0.003), were statistically significant. Patients with hypertension (OR: 5.065, 95% CI, 3.065-8.368, p<0.001) were significantly different between survivor and non-survivor groups.

**Conclusion:** Elderly, dyspnea, cough, chest pain, cardiovascular disease, and hypertension were the major predictors of COVID-19 patient mortality in the multivariate analysis. From these findings, improving the infection situation in Mongolian patients may require greater attention and improvement in the management of the character of patients in COVID-19 patients. However, in an environment with limited economic resources like our country, high costs could be restrictive in Mongolia.

**Keywords:** SARS-CoV-2; COVID-19; Risk factor; Mortality

## Introduction

Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), the virus responsible for Coronavirus Disease 2019 (COVID-19), was transmitted to humans in Wuhan, China reported on November 17, 2019 [1-5]. Due to the lack of data in one of the most influenced areas by the COVID-19 pandemic, the result of Mongolia profits the management. Mongolia is the region with a high prevalence of non-communicable diseases, which are risk factors for SARS-CoV-2 infection [6,7]. COVID-19 is an emerging infectious disease with poor evidence associated with disease characteristics and seemed to be affected by multiple factors such as patient characteristics, geography, and difference in social systems [8-14]. The direction of the research is as follows. First, we focused specifically on Mongolian data, as most published reports on COVID-19 were from China, and patients' characters associated with COVID-19 vary widely among geographic regions. Mongolia has a vast land area, and a diverse population, and is located in neighboring China where the SARS-CoV-2 infection occurred. COVID-19 has affected unequally in Mongolia compared to other countries. Therefore, it is necessary to adjust the risk of COVID-19 based on the situation in Mongolia. We have created data aimed at characterizing the SARS-CoV-2 infected patients who died in Mongolia. Through this first large retrospective cohort study in Mongolia, we tried to provide some useful information for predicting the character of COVID-19 patients.

## Materials and Methods

Adult inpatients with COVID-19 were retrospectively analyzed from national, provincial, and municipal health reports from April 1, 2020 to October 1, 2021. All patients were laboratory-confirmed positive cases of SARS-CoV-2 by Real-Time Transcriptase-Polymerase Chain Reaction (RT-PCR) of nasopharyngeal swab samples. We excluded those under 18 years old, with incomplete medical records, and survivors. The study was approved by the Institutional Ethics Committee of the Mongolian National University of Medical Sciences (No2021/3-08).

### Data collection

Demographic data about the age and sex of cases, as well as chronic

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**Received:** 06-Feb-2023, Manuscript No. DPO-23-88804; **Editor assigned:** 09-Feb-2023, PreQC No. DPO-23-88804(PQ); **Reviewed:** 23-Feb-2023, QC No. DPO-23-88804; **Revised:** 02-Mar-2023, Manuscript No. DPO-23-88804(R); **Published:** 09-Mar-2023, DOI: 10.4172/2476-2024.8.1.210

**Citation:** Jamiyan T, Kuroda H, Mendsaikhan N, Gotov U, Enkhbat B (2023) Risk Factors for Mortality among COVID-19 Patients: Nationwide Cohort Study of Mongolia. Diagnos Pathol Open 8:210.

comorbidities and date of symptoms onset, hospital admission, SARS-CoV-2 infection diagnosis confirmation, and death, were compiled. Risk factors of mortality, including sex, age, vaccination, symptoms, and comorbidities, were evaluated among COVID-19 patients.

### Statistical analysis

Multivariable logistic regression was used to evaluate risk factors among patients using SPSS version 22.0 (SPSS Inc., Chicago, III, USA). Univariate analysis of categorical variables was performed using the Chi-square test, while an independent sample t-test/Mann-Whitney U test was used for continuous data. Multivariable analysis using logistic regression was performed for the factors found to be significant in the univariate analysis. Covariates with a P value ≤ 0.05 in the univariate analysis were included in the multivariate analysis. All statistical tests were two-sided and P ≤ 0.05 was considered significant.

## Results

Clinical characteristics of cases can be shown in Table 1 and 2. 554 non-survivor and 161 survivors, for a total of 715 patients were included in the final analysis. Female patients accounted for 51.5% of all patients. The mean age was 65.5 (18-100) years, and patients in the non-survivor group were much older than those in the survivor group (57 years vs. 69 years, p<0.001). Most of the cases in the non-survivor group had unvaccinated (139; 25%). The top five symptoms in all patients were cough (78.3%), dyspnea (74.5%), fever (39.9%), chest pain (46.3%), and fatigue (26.9%). Factors of comorbidity such as cardiovascular disease (p<0.001), hypertension (p<0.001), and cancer (p=0.003), were statistically significant. In regression analysis are shown in Table 2. Older age (OR: 1.034, 95% CI: 1.018-1.051, p<0.001), patients with dyspnea (OR: 5.209; 95% CI, 3.218-8.433, p<0.001), patients with fever (OR: 0.489, 95% CI, 0.305–0.784, p<0.001), patients with headache (OR: 0.334; 95% CI, 0.205-0.543, p<0.001), patients with loss of taste and smell (OR: 0.142; 95% CI, 0.073–0.275, p<0.001), patients with sputum production (OR: 0.509; 95% CI, 0.283–0.917, p=0.025), and patients with sore throat (OR: 0.466; 95% CI, 0.251–0.865, p=0.016) were identified as significant between survivor and non-non-survivor groups. Patients with hypertension (OR: 5.065, 95% CI, 3.065-8.368, p<0.001) were significantly different between survivor and non-survivor groups. However, cardiovascular disease (OR: 1.184, 95% CI, 0.654-2.144 p=0.576) and cancer (OR: 0.772, 95% CI, 0.274–2.177, p<0.001) were not significant.

| Variable | Survivor (n=161) | non-Survivor (n=554) | p-value |
|---|---|---|---|
| Age | 57 (26-96) | 69 (18-100) | <0.001 |
| Gender | | | 0.293 |
| Female | 77 (47.8%) | 291 (52.5%) | - |
| Male | 84 (52.2%) | 263 (47.5%) | - |
| Vaccination | | | <0.001 |
| Unvaccinated | 28 (17.3%) | 139 (25.0%) | - |
| Sinopharm | 42 (26.0%) | 361 (65.1%) | - |
| Pfizer | 10 (6.2%) | 20 (3.6%) | - |
| Sputnik V | 2 (1.2%) | 11(1.9%) | - |
| AstraZeneca | 2 (1.2%) | 8 (1.4%) | - |
| Unknown | 77 (48.1%) | 15 (3.0%) | - |
| Symptoms | Dyspnea | | <0.001 |
| | yes | 49 (47.3%) | 413 (74.5%) | - |
| | no | 112 (52.7%) | 141 (25.5%) | - |
| | Cough | | 0.002 |
| | yes | 107 (66.4%) | 434 (78.3%) | - |
| | no | 54 (33.6%) | 120 (21.7%) | - |
| | Fever | | <0.001 |
| | yes | 104 (64.6%) | 221 (39.9%) | - |
| | no | 57 (35.4%) | 333 (60.1%) | - |
| | Headache | | <0.001 |
| | yes | 74 (45.9%) | 126 (22.7%) | - |
| | no | 87 (54.1%) | 428 (77.3%) | - |
| | Chest pain | | 0.04 |
| | yes | 60 (37.2%) | 257 (46.3%) | - |
| | no | 101 (62.8%) | 297 (53.7%) | - |
| | Fatigue | | 0.377 |
| | yes | 49 (30.4%) | 149 (26.9%) | - |
| | no | 112 (69.6%) | 405 (73.1%) | - |
| | Loss of taste and smell | | <0.001 |
| | yes | 57 (35.4%) | 28 (5.0%) | - |
| | no | 104 (64.6%) | 526 (95.0%) | - |
| | Sputum production | | <0.001 |
| | yes | 45 (27.9%) | 76 (13.7%) | - |
| | no | 116 (72.1%) | 478 (86.3%) | - |
| | Sore throat | | <0.001 |
| | yes | 38 (23.6%) | 62 (11.2%) | - |
| | no | 123 (76.4%) | 492 (88.8%) | - |
| Comorbidity | Diabetes mellitus | | 0.713 |
| | yes | 43 (26.7%) | 140 (25.2%) | - |
| | no | 118 (73.3%) | 414 (74.8%) | - |
| | Cardiovascular disease | | 0.001 |
| | yes | 26 (16.1%) | 162 (29.2%) | - |
| | no | 135 (83.9%) | 392 (70.8%) | - |
| | Hypertension | | <0.001 |
| | yes | 26 (16.1%) | 313 (56.5%) | - |
| | no | 135 | 241 (43.6%) | - |
| | Cancer | | 0.003 |
| | yes | 20 (12.4%) | 31 (5.6%) | - |
| | no | 141 (87.6%) | 523 (94.4%) | - |

**Table 1:** Comparisons of clinical characteristics between the survivor and non-survivor 19 (n=715)

| Risk factors | Univariate analysis | | | Multivariate analysis | | |
|---|---|---|---|---|---|---|
| | OR | 95% CI | P value | OR | 95% CI | p value |
| Age | 3.081 | 2.120-4.479 | <0.001 | 1.034 | 1.018-1.051 | <0.001 |
| Gender | 0.828 | 0.583-1.177 | 0.294 | | - | - |
| Symptoms | | | | | | |
| Dyspnea | 6.695 | 4.550-9.852 | <0.001 | 5.209 | 3.218-8.433 | <0.001 |
| Cough | 1.825 | 1.243-2.681 | 0.002 | 1.399 | 0.814-2.402 | 0.224 |
| Fever | 0.364 | 0.252-0.524 | <0.001 | 0.489 | 0.305-0.784 | <0.001 |
| Headache | 0.346 | 0.240-0.500 | <0.001 | 0.334 | 0.205-0.543 | 0.001 |
| Chest pain | 1.457 | 1.-16-2.089 | 0.041 | 1.073 | 0.665-1.731 | 0.772 |
| Fatigue | 0.841 | 0.572-1.235 | 0.377 | - | - | - |
| Loss of taste and smell | 0.097 | 0.059-0.160 | <0.001 | 0.142 | 0.073-0.275 | <0.001 |
| Sputum production | 0.41 | 0.269-0.624 | <0.001 | 0.509 | 0.283-0.917 | 0.025 |
| Sore throat | 0.408 | 0.260-0.639 | <0.001 | 0.466 | 0.251-0.865 | 0.016 |
| Comorbidity | | | | | | |
| Diabetes mellitus | 0.928 | 0.623-1.382 | 0.713 | - | - | - |
| Cardiovascular disease | 2.146 | 1.357-3.392 | 0.001 | 1.184 | 0.654-2.144 | 0.576 |
| Hypertension | 6.744 | 4.291-10.598 | <0.001 | 5.065 | 3.065-8.368 | <0.001 |
| Cancer | 0.418 | 0.231-0.755 | 0.004 | 0.772 | 0.274-2.177 | 0.624 |
| OR: Odds Ratio | | | | | | |

**Table 2:** Impact of risk factors for survivors and non-survivors.

Of the 667 trackable cases shown that 667 cases were x-rayed, and 127 were Computed Tomography (CT) (Table 3). In contrast, there was no Magnetic Resonance Imaging (MRI). 554 patients had performed x-ray of these, 553 (99.82%) patients with abnormalities in the non-survivor group. Of the 77 chest CT scans, 76 (98.7%) showed abnormalities such as ground-glass opacities or consolidation and 1(1.3%) patient had entirely normal chest CT examinations in the non-survivor group (Figure 1).

| | Survivor (n=161) | | non-Survivor (n=554) | p value* |
|---|---|---|---|---|
| X-ray | | 113 (70.1%) | 554 (100%) | <0.001 |
| Normal | | 13 (8.0%) | 1 (0.18%) | - |
| Abnormal | Consolidation | 3 (1.8%) | 42 (7.58%) | - |
| | GGO | 101 (62.3%) | 508 (91.7%) | - |
| | GGO/ consolidation | 0 (0%) | 3 (0.54%) | - |
| CT | | 50 (31.0%) | 77 (13.9%) | <0.001 |
| Normal | | 1 (0.6%) | 1 (0.2%) | - |
| Abnormal | Consolidation | 11 (6.8%) | 49 (8.8%) | - |
| | GGO | 36 (22.4%) | 16 (2.9%) | - |
| | GGO/ consolidation | 2 (1.2%) | 11 (2.0%) | - |
| Chi square*, CT: Computed Tomography, GGO: Ground Glass Opacity | | | | |

**Table 3:** Frequency of imaging in the COVID-19 patients.

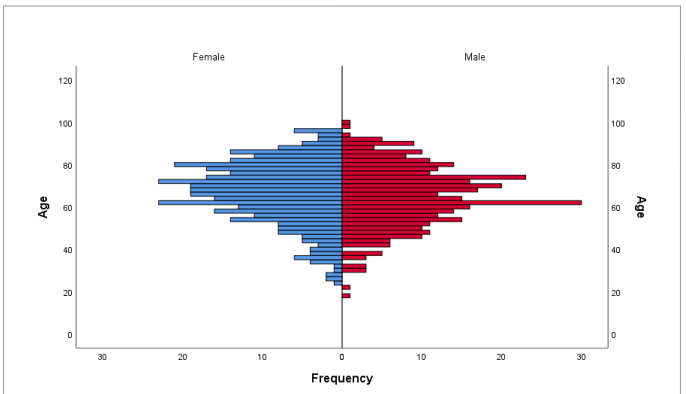


**Figure 1:** The age-sex pyramid. Age distribution of reported deaths by gender. The COVID-19-related mortality in Mongolia.

Vaccination reduced the SARS-CoV-2 infection ratio to (OR: 0.999, 95% CI: 0.999-1.000, p>0.001) compare with unvaccinated group. Sinopharm and AstraZeneca has reduced SARS-CoV-2 infection ratio to (OR: 0.403, 95% CI: 0.170-0.953, p=0.038; OR: 0.039, CI: 0.020-0.078, p<0.001, respectively) compare with unvaccinated. However, other types of vaccination were not statistically significant (Table 4).

| Vaccinations | OR | 95% CI | p value |
|---|---|---|---|
| Unvaccinated | | Reference | - |
| Vaccinated | 0.999 | 0.999-1.000 | 0.002 |
| Types of vaccination | | | |
| Unvaccinated | | Reference | - |
| Sinopharm | 0.403 | 0.170-0.0.953 | 0.038 |
| Pfizer | 1.108 | 0.232-5.274 | 0.898 |
| Sputnik V | 0.806 | 0.162-3.998 | 0.792 |
| AstraZeneca | 0.039 | 0.020-0.078 | <0.001 |
| OR: Odds Ratio | | | |

**Table 4:** Impact of vaccinations for COVID-19 patients.

## Discussion

### Patients characters, symptoms, and comorbidities of COVID-19

In our report, we found elderly and dyspnea may influence the motility of COVID19 patients. However, fever, headache, loss of taste and smell, and sputum production, etc. are common clinical symptoms of COVID19 patients. Our results were also similar to those previously reported and elderly, dyspnea, cough, and chest pain was significantly more frequent in patients infected with SARS-CoV-2 [15-17].

COVID-19 patients have a wide range of diseases, from asymptomatic to extremely severe cases. World Health Organization (WHO) reported that the majority of COVID-19 patients (about 80%) are asymptomatic or mild, 15% are severe, require oxygen, and 5% are critical cases that require mechanical ventilation [18-20]. Therefore, COVID-19 and other common colds can be difficult to distinguish due to their similar initial symptoms [21-23].

Further, several previous studies have shown that the appearance of comorbidities such as elderly, cardiac disease, diabetes, chronic lung disease, and obesity contribute to severe outcomes [12,14,24-28]. The initial stages of COVID-19 patients were managed in China and further management procedures were performed globally [29]. On the other hand, our report is the first to examine the correlations of patient-related factors to the COVID-19 patient rate in Mongolia, and in this respect, this report provides new knowledge. Our study showed that risk factors for cardiovascular disease and hypertension are also important risk factors for severe COVID-19. In particular, hypertension has been reported as a common comorbidity of COVID-19, especially among patients with more serious diseases. In a cohort of 138 inpatients with COVID-19, the reported hypertension rate was 31% [30]. Further, Kong, et al. reported that 22.6% had hypertension [31]. In a large series of COVID-19 patients, of 3335 Italian patients died in the hospital where the clinic charts could be analyzed. Only 136 deaths (4.1%) did not have a pathological report, while 493 (14.8%), 716 (21.5%) and 1990 (59.7%) had one and two, respectively. Reported to have one or at least three chronic diseases. Of these, hypertension is the most frequently reported comorbidity, followed by diabetes and ischemic heart disease [30].

Consistent with these data, an analysis of 44,672 confirmed COVID-19 cases from Wuhan, China, showed increased case fatality in the presence of cardiovascular disease (10.5%) and hypertension (6.0%) [32]. In the Italian retrospective case series, hypertension, regardless of age, is the most common comorbidity of COVID-19 patients referred to the Intensive Care Unit (ICU), with a global prevalence of 49%, followed by cardiovascular disease (21%) and hypercholesterolemia (18%) [33]. The prevalence of hypertension was also higher in critically ill patients who died in the intensive care unit (ICU) compared to individuals discharged from the ICU [33]. Therefore, the findings of our data also support previous data that individuals with cardiovascular disease and hypertension may have a tendency to mortality of COVID-19 patients and that treatment of these diseases may improve prognosis.

In our report, cancers were significantly found in survivors of COVID-19 patients (Table 1). Recent reports have shown that the tumor microenvironment such as Tumor Infiltrating Lymphocytes (TILs) and macrophages is an important factor in tumor growth and development [34-38]. The immunosuppressive status of some cancer patients, whether caused by the disease itself or the treatment, increases their risk of mortality. Immunosuppression may also induce cancer patients from developing serious complications due to infection, causing delays in treatment and unnecessary hospitalizations, which could negatively affect patients. After the initial innate response, a specific adaptive immune response is required to eliminate COVID-19 [39,40]. However, lymphopenia, an independent poor prognostic indicator in COVID-19 patients is common and therefore likely to happen in cancer patients receiving aggressive treatment, the required immune response is weakened [41,42]. In the COVID-19 pandemic, cancer patients are considered a highly hazardous group due to immune systems disorders caused by both tumor growth and anti-cancer treatment [43-47]. A cohort study of 28 COVID-19 cancer patients reported that Stage IV patients showed a higher proportion of infected patients. They assume that patients with later-stage cancer may be more susceptible to SARS-CoV-2 [29,44,48,49]. Therefore, our results are inconsistent with these previous results. This may be due to the Mongolian social system. Compared to the vast territory of Mongolia, there are small numbers of hospitals, which have radiographic diagnostic equipment, which mostly exist in Ulaanbaatar (half of Mongolia's population lives in this city). Even if symptoms of infectious diseases are observed, patients are not possible to be hospitalized for appropriate diagnosis and treatment due to the symptoms of COVID-19 patients may resemble a usual infection as we mention above. On the other hand, cancer patients can be preferentially admitted and receive sufficient treatment not only for COVID-19 but also for general infectious diseases. These may have caused our results to conflict with other reports.

### COVID-19 and radiographic equipment

In our data, we found a significantly high ratio of abnormal findings in both x-rays and CT in non-survival patients (Table 2). Nevertheless, many sources now acknowledge that radiographic findings are more sensitive than RT-PCR in detecting SARS-CoV-2 and the previously reported cases could have a SARS-CoV-2 infection because of a false negative PCR test [50,51]. Ai, et al. reported that compared to RT-PCR, chest CT imaging may be a more reliable, practical, and rapid method to diagnose and assess COVID-19 patients, especially in the epidemic area. With RT-PCR results as a reference in 1,014 patients, the sensitivity, specificity, and accuracy of chest CT in indicating SARS-CoV-2 infection were 97%, 25%, and 68%, respectively [50]. In contrast, the positive rate of RT-PCR assay for throat swab samples was 59%. Further, Kohli, et al. reported that commonality of CT findings regardless of RT-PCR status in a large cohort of 2,581 patients and due to its high sensitivity with quick turnaround time is a very useful support method for RT-PCR [51]. These previous reports and our data suggest that the mortality risk of COVID-19 patients can be reduced by advanced diagnostic equipment.

However, in Mongolia, there are few medical facilities equipped with CT, and MRI, and most of them only evaluate respiratory diseases by x-ray. Our available 715 cases showed that, 667 cases were x-rayed, 127 were CT and there was no MRI (Table 3). Further, as chest x-ray was regarded as an insensitive tool, the American College of Radiologists and the Fisher Society have suggested that imaging is not advised for patients who tested positive by RT-PCR who were asymptomatic or have mild symptoms and a CT scan should be performed for patients with a progressive disease course [52,53]. Rousen, et al. reported that a total of 190 chest x-rays were obtained for the 88 patients with a total of 59 (31%) abnormal chest x-rays and 85% of the COVID-19 patients had negative chest x-rays [54,55]. Therefore, our country's radiographic diagnosis must be improved in the future, but it may depend on the social and financial situation in Mongolia.

## Conclusion

From our data, elderly, dyspnea, cough, chest pain, cardiovascular disease, and hypertension were the major predictors of COVID-19 patient mortality in the multivariate analysis. From these findings, improving prognosis in Mongolian patients may require greater attention and improvement in the management of characters of patients with COVID-19. However, in an environment with limited economic resources like our country, high costs could be restrictive in Mongolia.

Our study has several limitations. First, Mongolia is in a special position to monitor the effects of SARS-CoV-2 vaccines as four approved

ones including the BNT-162b2 (BioNTech/Pfizer) mRNA vaccine, the BBIBP-CorV (Sinopharm), inactivated whole virus vaccine, and the vector vaccines Gam-COVID Vac (Gamaleya Research Institute) and ChAdOx1-S (AstraZeneca), have been available. Therefore, there is heterogeneity in performed vaccines. However, most of the vaccines used were BBIBP-CorV (Sinopharm), so we could not find out the difference between the vaccines. Although the vaccination rate has not been performed in a total of 56.9% of citizens in our data (Dec 2021) which is similar to some of the countries. Second, several variables such as the detail of CT and MRI data, optimal use and efficacy of antivirals and antibiotics, adherence to high levels of supportive therapies, or others could not be exhaustively analyzed in this study as data were collected by only electronic medical records. However, a large sample size from our country supports the internal validity of our results.

Further research is necessary to elucidate the mechanism and characteristics of COVID-19 patients. Our data will contribute to a better understanding of COVID-19 patients in a similar developing country and probably help in the guidance of research and treatment strategies.

## Authors contributions

T Jamiyan and H Kuroda contributed equally to this work; T Jamiyan, H Kuroda and B Enkhbat collected clinical and pathological information; H Kuroda and T Jamiyan analyzed the data and wrote the manuscript; B Enkhbat, N Mendsaikhan and U Gotov made critical revisions to the manuscript; H Kuroda and T Jamiyan designed the study; T Jamiyan gave the final approval of the manuscript for publication. All authors read and approved the final manuscript.

## Conflict of interests

No conflict of interests is declared

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