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Factors affecting the survival of early COVID-19 patients in South Korea: An observational study based on the Korean National Health Insurance big data

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ABSTRACT

Objectives: This study aimed to identify the survival rate and explore factors affecting survival among early COVID-19 patients in South Korea.
Methods: Data reported by the Korea Disease Control and Prevention Agency (KDCA), up to 15 July, when COVID-19 was confirmed were used as research data in connection with the National Health Insurance Service's (NHIS) national health information database. The final analysis targets were 12,646 confirmed patients and 303 deaths. The survival rate of patients with COVID-19 was estimated through Kaplan-Meier survival analysis. Cox proportional hazard regression analysis was performed to search for factors affecting survival.
Results: When looking at the survival rate by age group for men and women, the 28-day survival rate for men aged >80 years was 77% and 73% at 42 days, while 83% and 81% for women. Men had a worse survival rate than women. For chronic diseases, the highest risk of mortality was observed in malignant neoplasms of the respiratory and urogenital systems, followed by diseases of the urinary system and diabetes.
Conclusions: The number of COVID-19 deaths was highest the next day after initial diagnosis. The case fatality rate was high in males, older age, and chronic diseases.

Introduction

After the first confirmed patient with COVID-19 in Korea occurred on 20 January, a sporadic outbreak occurred mostly from overseas. However, in mid-February, a religious gathering in Daegu caused a group infection by exposure to the COVID-19 virus, and the infection spread nationwide. After that, the incidence of infected patients decreased due to the effect of a social distancing policy, but the spread occurred again due to the Itaewon group infection. A policy of distancing in daily life has been implemented in Korea, but sporadic group infections continue to occur in local communities (Korea Disease Control and Prevention Agency, 2020). According to the data of confirmed COVID-19 in patients from 07 to 20 July 2020, the proportion was high at 41.6% among middle-aged patients aged ≥50 years, and 50% of deaths were in patients aged ≥80 years, which showed high fatality rates. In addition, 97.7% of the deaths were in people who had underlying disease (Korea Disease Control and Prevention Agency, 2020). Prior studies have suggested that this is related to the morbidity of severe COVID-19 in patients with chronic diseases (Rodriguez-Morales et al., 2020; Lee et al., 2020) and that the underlying disease may be a risk factor for severely ill patients (Yang et al., 2020). In addition, a lower survival rate was observed in those aged ≥75 years, which was identified as a factor that increased the risk of death (Feng et al., 2020). Males had a higher case fatality rate, and the survival rate was lower in men than in women (Alkhouli et al., 2020; Moon et al., 2020). Studies have also shown that the

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survival rate decreases in cases aged >60 years, and those with cerebrovascular disease, diabetes, hematologic disease, neurological disease, kidney disease, etc.; these factors have been shown to affect death (Sousa et al., 2020).

Overseas studies have been conducted on the factors affecting the survival rate and risk of death. Various risk factors of patients diagnosed with COVID-19 have been studied through survival analysis that considered the time course from the time symptoms appeared (Alkhouli et al., 2020; Feng et al., 2020; Sousa et al., 2020). It was difficult to find studies from Korea that were related to survival analysis of COVID-19 patients, and considering the symptoms and number of days from diagnosis to death. Therefore, through survival analysis that reflected the time until death after diagnosis of patients with COVID-19, this study aimed to use basic data to reduce the incidence of COVID-19 and the risk of death. The survival rate was identified by socioeconomic factors and chronic diseases, and factors that affect survival were explored. The study aimed to: identify the survival period and epidemiological characteristics of patients with confirmed COVID-19; check the effect of chronic disease in patients with confirmed COVID-19 on death; determine the survival rate of patients with confirmed COVID-19; and explore various factors affecting the survival of patients with confirmed COVID-19.

Methods

Data reported by the Korea Disease Control and Prevention Agency (KDCA), up to 15 July, when COVID-19 was confirmed were used as research data in combination with the National Health Insurance Service's (NHIS) national health information database (Korea Disease Control and Prevention Agency, 2020; National Health Insurance Sharing Service, 2020). The data reported by the KDCA were of patients who had been confirmed positive by a COVID-19 PCR test at public health centers and medical institutions in the reported area. These reports are epidemiological data collected by the KDCA and created as a database. In addition, data on early COVID-19-confirmed cases in Korea were mostly collected from the outbreaks in Daegu and Gyeongbuk.

Socioeconomic factor variables were extracted from the income level and death status variables reflecting gender, age, residential area, and insurance type by linking with the population tables and the insurance tables of the NHIS database. The variable for the presence of chronic diseases was linked to the claim data table, and a variable for the presence or absence of chronic diseases was made using the cases requested for hospitalization for >3 days, ≥4 outpatient visits, and ≥28 days of medication days due to principal or other diagnosis. In addition, if there was a claim for the confirmed patient, the claim data from the sickness details table were used and the date of initial diagnosis was used as the start date of medical treatment. However, if a confirmed patient's claim did not exist, the initial diagnosis estimate date was made as follows: the first diagnostic estimation date was generated using the sequence of serial numbers and the date before and after the claim existed. In other words, an estimated date was created only if the date without a claim was between the previous date and subsequent dates.

Most initial COVID-19 cases occurred in outbreaks in Daegu and Gyeongbuk in Korea. Due to the lack of beds at medical institutions, some mild patients were treated at the Community Treatment Center designated by the country. COVID-19 patients treated at the Community Treatment Center did not have a first diagnosis date because claim data did not exist. However, since Korea has a national health insurance system, it was possible to identify the socioeconomic factors and chronic diseases of the COVID-19 patients through claim data. The final analysis targets were 12,646 patients with confirmed COVID-19 linked to the corporation data from the confirmed patients reported by the KDCA: 5356 (42.35%) were male and 7290 (57.65%) were female. The study's selection process is shown in Figure 1.

The data reported by the KDCA and the NHIS database were linked to see the difference between the general characteristics of patients with confirmed COVID-19 and whether they died or not,

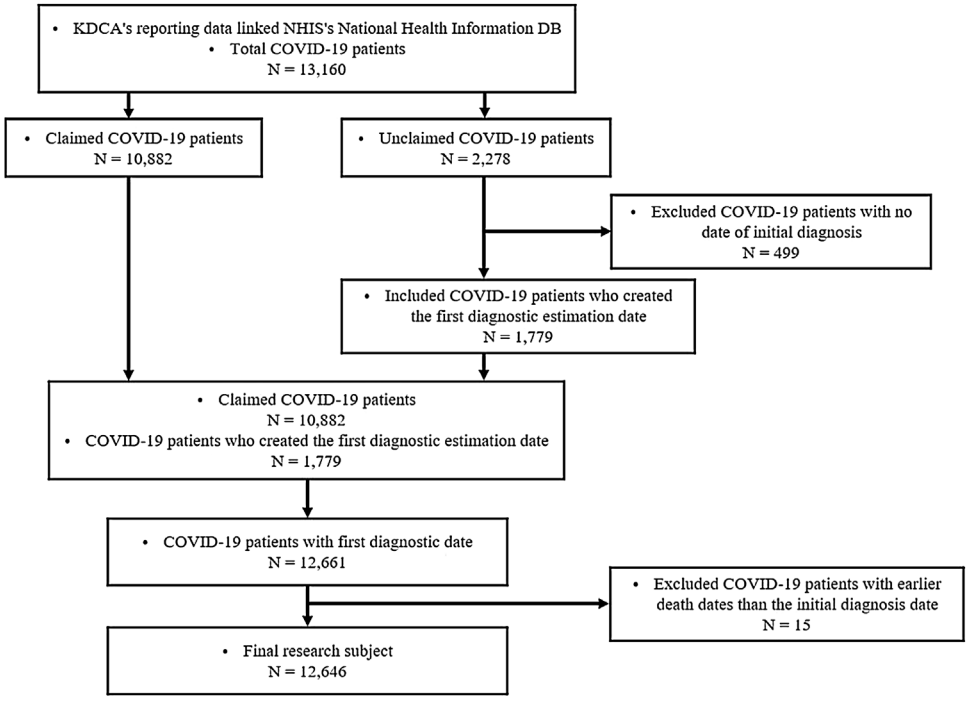

Figure 1. Flow chart of the study subjects.
KDCA, Korea Disease Control and Prevention Agency; NHIS, National Health Insurance Service's; DB, database.

analyzed with Chi-square test (χ^2 test) and the crude death rate (CDR) was found. In addition, multivariable logistic regression was performed to find the chronic diseases that affected the risk of death, and the odds ratio (OR) and 95% confidence interval (95% CI) were calculated. Lastly, the survival rate of patients with COVID-19 was estimated through Kaplan-Meier survival analysis. To search for factors affecting survival, Cox proportional hazard regression analysis was performed and 95% CI was calculated. Time-considered analysis was conducted in order to calculate an accurate result as to whether the presence or absence of chronic diseases affected the mortality hazard ratio.

All analyses were performed using SAS 9.4 (SAS Institute Inc., Cary. NC, USA), and the statistical significance level was expressed as a *P*-value of <0.05.

Results

Epidemiologic characteristics and the elapsed date of death in COVID-19 patients

Using the difference between the estimated date of initial diagnosis and the date of death, the number of patients who died according to the elapsed date of death was the most common, with 20 patients who died the next day after the initial diagnosis (Figure 2). The next highest number of deaths was between 3–11 days, which was 70% of the number of deaths included in the 30th day of death. The case fatality rate was 2.97% for males, which was higher than that for females (Table 1). In age groups, the number of deaths was highest in those aged >80 years, with 162 people, and the case fatality rate was highest in those aged >80 years, with 26.34%, followed by those aged 70–79 year, with 8.93%. According to region, the number of confirmed cases was the highest in metropolitan cities; the case fatality rate was highest with 4.53% in rural areas. On the other hand, the case fatality rate was the lowest in metropolitan cities. In the income level reflecting the type of insurer, the number of confirmed cases was the highest when the income level was the lowest while being an employee. The mortality rate was the highest in medical benefits, with self-employed at the highest level of income at 3.40%, and self-employed at the lowest level of income at 3.19%.

Chronic diseases affecting the death of patients with confirmed COVID-19

After analyzing the comorbidities that affected the risk of death according to 298 disease classification groups, the risk of death was reviewed by grouping the chronic diseases that were statistically significant into the large and medium classification criteria (Supplementary Table 1). Of 30 chronic diseases, 17 affected the risk of death as follows: malignant neoplasm of larynx; malignant neoplasm of trachea, bronchus and lung; other malignant neoplasms of respiratory and intrathoracic organs 5.61 times; Hodgkin's disease; non-Hodgkin's lymphoma; leukemia; other malignant neoplasms of lymphoid, hematopoietic and related tissue 4.30 times; acute and rapidly progressive nephritic syndromes; other glomerular diseases, renal tubulo-interstitial diseases, renal failure 2.50 times; malignant neoplasm of cervix uteri; malignant neoplasm of other and unspecified parts of uterus; other malignant neoplasms of female genital organs; malignant neoplasm of prostate; other malignant neoplasms of male genital organs; malignant neoplasm of bladder; other malignant neoplasms of urinary tract 2.41 times; and diabetes mellitus 2.09 times higher risk of death.

28. -day survival rate according to socioeconomic factors of patients with confirmed COVID-19

When looking at the survival rate by age group for men and women, the 28-day survival rate for men aged >80 years was 77%, 75% at 35 days, and 73% at 42 days, while 83%, 82%, and 81% for women, respectively (Supplementary Table 2, Figures. 3 and 4). In city, county, and district, the survival rate was low in the county, and the survival rate was low in recipients of medical benefits in terms of income level.

28. -day survival rate by chronic disease among patients with confirmed COVID-19

The survival rate was lowest in order as listed: dementia; Parkinson's disease; Alzheimer's disease; malignant neoplasm of larynx; malignant neoplasm of trachea, bronchus and lung; other malignant neoplasm of respiratory and intrathoracic organs; malignant neoplasm of cervix uteri; malignant neoplasm of other and unspecified parts of uterus; other malignant neoplasms of female genital organs; malignant neoplasm of prostate; other malignant neoplasms of male genital organs; malignant neoplasm of bladder; other malignant neoplasms of urinary tract; other hypertensive diseases, intracranial hemorrhage, cerebral infarction, stroke, not specified as hemorrhage or infarction; other cerebrovascular disease (Supplementary Table 3).

Socioeconomic factors affecting the survival of patients with confirmed COVID-19

In Model 2, which calibrated for socioeconomic factors and chronic diseases, the mortality hazard ratio of men was 2.25 times higher than that of women (Table 1). For age groups: 50−59 years were 8.72 times, 60−69 years were 19.36 times, 70−79 years were 64.84 times, and ≥80 years were 150.97 times higher than those aged <49 years. In the case of income level, when only socioeconomic factors were calibrated, the mortality hazard ratio was 1.55 times higher in medical benefits, but when socioeconomic factors and chronic diseases were calibrated, it was not statistically significant.

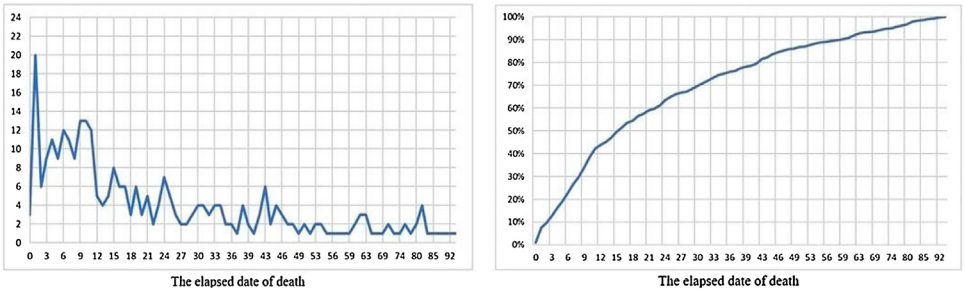

Figure 2. Cumulative proportion and distribution of the elapsed date of death in the mortality group with confirmed COVID-19.

Table 1
Epidemiologic characteristics and socioeconomic factors affecting the survival of patients with confirmed COVID-19.

Socioeconomic factors		COVID-19 patients			Hazard ratio of mortality			
					Model 1		Model 2	
		Confirmed	deaths	CDR	HR (95% CI)[a]		HR (95% CI)[b]	
Sex	Male	5,197	159	0.030	2.08	(1.65–2.62)	2.25	(1.77–2.86)
	Female	7,146	144	0.020	Ref		Ref	
Age group, years	≤49	7,075	5	0.001	Ref		Ref	
	50-59	2,266	17	0.007	11.22	(4.13–30.42)	8.72	(3.20–23.77)
	60-69	1,743	40	0.022	31.68	(12.48–80.38)	19.36	(7.52–49.82)
	70-79	806	79	0.089	134.39	(54.36–332.20)	64.84	(25.47–165.05)
	≥80	453	162	0.263	454.70	(186.29–1,109.86)	150.97	(58.70–388.26)
	Metropolitan	9,097	191	0.021	Ref			
Region	Medium cities	1,960	51	0.025	1.09	(0.80–1.49)	0.98	(0.71–1.34)
	Rural areas	1,286	61	0.045	1.32	(0.98–1.77)	1.12	(0.83–1.53)
Health insurance premium level	Medical aid	940	56	0.056	1.55	(1.03–2.35)	1.42	(0.93–2.18)
	Self-employed lowest	851	28	0.032	1.28	(0.78–2.09)	1.28	(0.77–2.12)
	Self-employed low	692	12	0.017	1.01	(0.52–1.94)	1.11	(0.57–2.14)
	Self-employed middle	610	12	0.019	0.80	(0.42–1.53)	0.83	(0.43–1.59)
	Self-employed high	633	13	0.020	0.95	(0.51–1.80)	1.02	(0.54–1.93)
	Self-employed highest	568	20	0.034	0.97	(0.56–1.67)	1.12	(0.65–1.94)
	Employee lowest	1,935	37	0.019	0.97	(0.61–1.53)	0.98	(0.62–1.55)
	Employee low	1,817	36	0.019	1.11	(0.70–1.77)	1.21	(0.76–1.93)
	Employee middle	1,571	23	0.014	0.79	(0.47–1.32)	0.85	(0.50–1.44)
	Employee high	1,268	28	0.022	0.82	(0.50–1.34)	0.78	(0.47–1.29)
	Employee highest	1,458	38	0.025	Ref		Ref	

CDR = crude death rate, HR = hazard ratio, CI = confidence interval
[a] Model 1: Adjusted HR and 95% CI for socioeconomic factors (sex, age, region, health insurance premium level).
[b] Model 2: Adjusted HR and 95% CI for socioeconomic factors, chronic diseases.

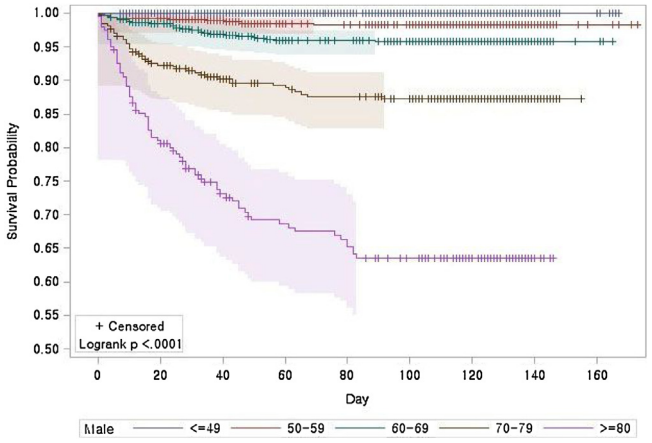

Figure 3. Survival rate according to age group, by male patients with confirmed COVID-19.*.
*The age groups of the survival curve are in the following order from top to bottom: ≤49, 50–59, 60–69, 70–79, ≥80 years

Chronic diseases affecting the survival of patients with confirmed COVID-19

In Model 2, which calibrated for socioeconomic factors and chronic diseases, the following had a high hazard ratio of death: malignant neoplasm of larynx; malignant neoplasm of trachea, bronchus and lung; other malignant neoplasm of respiratory and intrathoracic organs 3.46 times; malignant neoplasm of cervix uteri; malignant neoplasm of other and unspecified parts of uterus; other malignant neoplasms of female genital organs; malignant neoplasm of prostate; other malignant neoplasms of male genital organs; malignant neoplasm of bladder; other malignant neoplasms of urinary tract 2.00 times; acute and rapidly progressive nephritic syndromes; other glomerular diseases; renal tubulo-interstitial diseases; renal failure 1.71 times; diabetes mellitus 1.50 times; dementia; Parkinson's disease; Alzheimer's disease 1.38 times; acute myocardial infarction; other ischemic heart diseases, conduction disorders and cardiac arrhythmias; heart failure and other heart diseases 1.31 times (Table 2).

Discussion

COVID-19 can cause mild to severe symptoms and has a higher risk of progressing to severe conditions in the elderly and/or those with underlying disease. They are likely to require intensive treatment if they have COVID-19, and it is estimated that the duration of death, which begins with infection and progresses to death, will be short (Zhou F et al.). In a retrospective cohort study in Wuhan, China, 54 deaths were found to have developed symptoms and the time to death was 18.5 days, along with 36 confirmed cases with comorbidities (Zhou et al., 2020). In the current study, among 303 deaths, the largest number of patients died within 1 day from the estimated date of initial diagnosis to death, followed by 3–11 days, of which 50% of the deaths within 15 days were included. In the case of domestic deaths, it is necessary to explore the risk factors that cause death, to reduce the number of deaths and increase the survival rate in elderly people and those with underlying diseases because the time to death is short and most of them are accompanied by underlying diseases. Thus, this study identified the survival rate of patients with COVID-19 by socioeconomic factors and chronic diseases, and various factors that influence survival.

It was shown that the survival rate for men and women was lower in all age groups >80 years, and the survival rate was lower in men than in women. In chronic diseases, the survival rate was low in patients with dementia, Parkinson's disease, Alzheimer's disease, sepsis, and malignant neoplasms of the respiratory system. In addition, the mortality hazard ratio was 2.25 times higher in men than in women, and the older the age group, the higher the mortality hazard ratio. In this study, in order to find out the mortality hazard ratio in all age groups, the HR of the elderly age group was high because the reference was set to be under 40. In chronic diseases, the highest risk of mortality was observed in

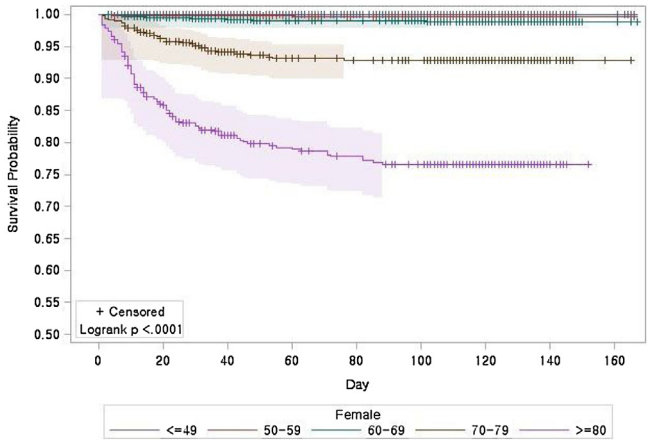

Figure 4. Survival rate according to age group, by female patients with confirmed COVID-19.*.
*The age groups of the survival curve are in the following order from top to bottom: ≤49, 50–59, 60–69, 70–79, ≥80 years

malignant neoplasms of the respiratory and urogenital systems, followed by diseases of the urinary system and diabetes.

In the study by Sousa et al., as a result of a survival analysis by age and with or without comorbidity, elderly, neurologic disease, pneumopathies, and cerebrovascular disease were found to be factors that contributed to the risk of death, which is consistent with the current results that elderly patients and those with comorbidities had a shorter survival period (Sousa et al., 2020). In the results of multiple regression analysis by Moon et al., those aged >70 years, malignancy, and diabetes were contributing factors to death, which were consistent with the results of this study (Moon et al., 2020). In the study by Lee et al., the mortality rate was high in men, and in patient with diabetes, chronic lung disease, and chronic neurologic disease; cancer was not a risk factor. Lee et al. included 98 hospital patients aged ≥65 years in their study; therefore a sufficient number of samples was not available. However, since the current study was conducted on confirmed COVID-19 patients of all ages, it is believed that there is a difference (Lee et al., 2020). In the study by Alkhouli et al., which looked at the gender difference in the mortality rates of COVID-19, the mortality rate of men was also high, and the survival probability before and after PSM (propensity score matching) was shown to be lower in men than in women. It was concluded that this difference cannot be fully explained, as there was a higher prevalence of comorbidities among men. Additional studies are required that stratify males and females to look at the risk of mortality due to various factors (Alkhouli et al., 2020).

In a retrospective Chinese cohort study of 26 cancer patients diagnosed with COVID-19, 53.6% had serious clinical symptoms and 28.6% died, which concluded and explained the deteriorated condition and poor prognosis; it is thought that cancer increases the risk of death among the chronic diseases of patients with confirmed COVID-19 (Zhang et al., 2020). In this study, malignant neoplasm of the respiratory and genitourinary systems increased the HR. However, because the number of deaths for COVID-19 with cancer was small, the confidence interval was wider than that of other chronic diseases. Previous studies have suggested that patients with severe COVID-19 have a high prevalence of diabetes (Arentz et al., 2020; Wang et al., 2020a). In the study by Yan et al., the survival rate of patients with severe COVID-19 with diabetes was lower than for those without diabetes, and the patients who died from severe COVID-19 with diabetes had a high level of inflammation (hsCRP). The large number of patients treated with mechanical ventilation treatment and intensive care unit (ICU) is thought to suggest that diabetes may be a risk factor for death in patients with COVID-19 (Yan et al., 2020). In foreign literature, a high prevalence of kidney and heart disease was observed in patients with COVID-19, and damage to the myocardium had a significant association with a decrease in survival rate. As patients with myocardium damage show high risk of death, both diseases are considered to be variables, with high risk of death in patients with COVID-19 (Arentz et al., 2020; Rodriguez-Morales et al., 2020; Wang et al., 2020b).

According to early studies in China after the outbreak of COVID-19, most deaths from COVID-19 in 2019 were in adults aged >60 years and people with serious underlying diseases. In the case of the United States, according to the results of an initial report, the mortality rate in those aged ≥85 years was highest among the above, followed by 65–84 years, and the number of hospitalizations and ICU admissions was highest among those aged 65–74 years (Anon, 2020a, 2020b). In Korea, the mortality rate was 79% among those aged ≥70 years and in the 296 COVID-19 patients who died, and there were more severe patients in the 70–79 years age group (Korea Disease Control and Prevention Agency, 2021) COVID-19 is a serious disease with high hospitalization, ICU hospitalization, and mortality among the elderly, so it is necessary to be active in policy measures such as social distancing to slow the spread of COVID-19 and to protect elderly subjects.

Limitations of this study were: first, since the NHIS data is billing data, diagnosis information could only be confirmed by the disease code. The diagnosis of comorbidity in patients with COVID-19 was extracted using the conditions of hospitalization for ≥3 days, outpatient visits for ≥4 days, and medication days for ≥28 days as an annual principal or secondary diagnosis, thereby increasing the validity of the diagnosis information of the claim data. Second, if a patient was diagnosed with COVID-19, did not visit a medical institution, and went to a living treatment center to receive treatment, the claim for treatment did not exist, so there was no treatment start date. For these patients, since the initial diagnosis date was the estimated date of the initial diagnosis made using the attempts and serial numbers of the reporting agency, there was a possible slight difference from the actual diagnosis date.

This study established the basis for evaluating the clinical progress of COVID-19 outbreak patients in Korea. Objective and more accurate initial diagnosis date information and various socioeconomic factors, such as income level, death status, residential area, and chronic diseases, can be found by linking COVID-19 patients' report data and health insurance claim data. Based on this, it was possible to submit more rigorous results that corrected the survival rate and factors affecting it, not a simple case fatality rate that did not take time into account. Among the confirmed cases of COVID-19, survival rates were low and the risk of death was high in older patients and those with chronic diseases. Knowing the mortality rate of COVID-19 and the survival rate of patients can identify the risk factors for death. It is therefore possible to provide professional management for prevention of death from COVID-19, and it is expected that measures to minimize the risk of serious progression can be sought. In addition, it is believed that early diagnosis and timely treatment are necessary for the elderly and people with chronic diseases. In this group of patients, since the history of death is short, a rapid treatment delivery system is necessary, which ensures that patients are treated immediately at the time of diagnosis and medical resources are available.

Ethics approval and consent to participate

This study was exempted from deliberation by the Yonsei University Institutional Review Board (IRB) for the exemption from

Table 2
Chronic diseases affecting the survival of patients with confirmed COVID-19.

Classification	Classification of 298 diseases	Chronic diseases (-)	Chronic diseases (+)		Hazard ratio of mortality				
						Model 1	Model 2		
		Confirmed	Deaths	Confirmed	Deaths	HR (95% CI)[a]	HR (95% CI)[b]		
Neoplasms	Malignant neoplasm of larynx; malignant neoplasm of trachea, bronchus and lung; other malignant neoplasms of respiratory and intrathoracic organs	12,313	290	30	13	3.06	(1.73–5.42)	3.46	(1.83–6.56)
	Malignant neoplasm of cervix uteri; malignant neoplasm of other and unspecified parts of uterus; other malignant neoplasms of female genital organs; malignant neoplasm of prostate; other malignant neoplasms of male genital organs; malignant neoplasm of bladder; other malignant neoplasms of urinary tract	12,263	288	80	15	2.02	(1.19–3.42)	2.00	(1.17–3.41)
	Malignant neoplasm of other, ill-defined, secondary, unspecified and multiple sites	12,146	291	197	12	1.71	(0.96–3.05)	1.15	(0.59–2.22)
	Hodgkin's disease; Non-Hodgkin's lymphoma; leukemia; other malignant neoplasms of lymphoid, hematopoietic and related tissue	12,322	300	21	3	3.06	(0.97–9.60)	2.17	(0.65–7.23)
Endocrine, nutritional and metabolic diseases	Diabetes mellitus	11,009	156	1,334	147	1.86	(1.48–2.34)	1.50	(1.18–1.92)
Mental and behavioral disorders	Dementia; Parkinson's disease; Alzheimer's disease	11,876	175	467	128	1.66	(1.26–2.19)	1.38	(1.03–1.84)
	Schizophrenia; schizotypal and delusional disorders; mood disorders; neurotic, stress-related and somatoform disorders	10,333	168	2,010	135	1.42	(1.12–1.80)	1.09	(0.84–1.42)
	Other mental and behavioral disorders; inflammatory diseases of the central nervous system; multiple sclerosis	11,367	222	976	81	1.53	(1.17–2.01)	1.30	(0.97–1.75)
Diseases of the nervous system	Epilepsy; transient cerebral ischemic attacks and related syndromes; cerebral palsy and other paralytic syndromes	11,799	239	544	64	1.29	(0.97–1.71)	1.07	(0.79–1.45)
	Nerve, nerve root and plexus disorders; other diseases of the nervous system	10,467	147	1,876	156	1.45	(1.14–1.83)	1.13	(0.88–1.45)
Diseases of the circulatory system	Essential (primary) hypertension	10,006	78	2,337	225	1.72	(1.31–2.28)	1.30	(0.96–1.75)
	Other hypertensive diseases	11,904	227	439	76	1.55	(1.19–2.04)	1.18	(0.88–1.57)
	Acute myocardial infarction; other ischemic heart diseases; conduction disorders and cardiac arrhythmias; heart failure; other heart diseases	11,516	184	827	119	1.58	(1.24–2.01)	1.31	(1.02–1.69)
	Intracranial hemorrhage; cerebral infarction; stroke, not specified as hemorrhage or infarction; other cerebrovascular diseases	11,696	197	647	106	1.45	(1.13–1.86)	1.16	(0.88–1.52)
	Pulmonary embolism; atherosclerosis; other peripheral vascular diseases; arterial embolism and thrombosis; other diseases of arteries, arterioles and capillaries; phlebitis, thrombophlebitis, venous embolism and thrombosis	11,637	213	706	90	1.36	(1.06–1.76)	1.11	(0.85–1.44)
Diseases of the genitourinary system	Acute and rapidly progressive nephritic syndromes; other glomerular diseases; renal tubulo-interstitial diseases; renal failure	11,846	247	497	56	2.18	(1.62–2.94)	1.71	(1.26–2.32)

HR = hazard ratio, CI = confidence interval
[a] Model 1: Adjusted HR and 95% CI for socioeconomic factors (sex, age, region, health insurance premium level).
[b] Model 2: Adjusted HR and 95% CI for socioeconomic factors, chronic diseases.

IRB deliberation that does not include personally identifiable information (CR320311).

Availability of data and materials

The dataset used and analyzed in this study is provided upon request for data customized to the National Health Insurance Service.

Competing interests

The authors have no potential conflicts of interest to disclose.

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Authors' contributions

Kim J, Byeon KH, and Choi BY designed the study; Kim DW and Cho KD contributed to data acquisition; Kim J, Kim DW, and Byeon KH carried out the statistical analysis; Byeon KH drafted the manuscript; Choi B revised the manuscript. All authors contributed to the interpretation of data and revision of the manuscript. All authors read and approved the final manuscript.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.ijid.2021.02.101.

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