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Hospitalization of COVID-19  
in South Korea:  
a nationwide individual-level study

코로나19의 입원기간: 국내 개인수준 연구

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# Hospitalization of COVID-19 in South Korea:

a nationwide individual level study

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# Abstract

**Background:** Since the first case of a novel coronavirus 2019(COVID-19) was reported in January 20th 2020, COVID-19 in South Korea has continuously. As a result, the lack of medical resources, especially the hospital beds, has become a serious problem. Therefore, this study aims to contribute to an efficient distribution of medical resources by identifying variables related to hospitalization, admission to intensive care units, and death of patients with COVID-19 using a nationwide individual-level COVID-19 data provided by the Korea Center for Disease Control and Prevention.

**Methods:** This study uses individual-level COVID-19 clinical data to assess the risk factors' association with hospitalization, admission to intense care units, and death. The generalized linear model with gamma distribution was performed.

**Results:** Distribution of the hospitalization of patients with COVID-19 was right skewed and followed gamma distribution. The mean hospitalization of patients with COVID-19 was 25.75 days. The age of the patients was significantly associated with the hospitalization(25.3(95% CI: 24.6, 26) days for age 0-39, 27(95% CI: 26.2, 27.7) days for age 40-59, 28.3(95% CI: 27.6, 29.2) days for age 60-79, and 26.5(95% CI: 25.1, 27.9) days for age>80), admission to ICU(RR=2.0(95% CI: 1.0, 3.7) for age 40-59, 7.4(95% CI: 4.1, 13.4) for age 60-79, and 11.0(95% CI: 5.4, 22.3) for age>80, compared to age 0-39), and death(RR= 5.9(95% CI: 3.4, 10.3) for age 60-79, 58.6(95% CI: 32.3, 106.3) for age>80, compared to age 40-

59). Also, clinical symptoms on admission, including cough(27.6(95% CI: 25.2, 26.6) days; compared to 25.9), myalgia(27.3(95% CI: 26.5, 28.2) days; compared to 26.2), and vomiting(27.2(95% CI: 26.3, 28.3) days; compared to 26.3) were significantly associated with longer hospitalization. However, association between underlying disease or past history of the patient with hospitalization were not significant. Also, males were at higher risk for admission to ICU(RR=2.6(95% CI: 1.9, 3.6)) and death(RR=2.3(95% CI: 1.6, 3.1)) than females. Also, underlying disease or past history including diabetes(RR=2.2(95% CI: 1.6, 3.1)), chronic kidney disease(2.4(95% CI: 1.1, 5.1)), and cancer(2.4(95% CI: 1.3, 4.4)) were significantly related to a death.

**Conclusion:** This study found several demographic and clinical characteristics associated with the duration of hospitalization, usage of the intensive care units, and mortality. These findings can provide evidence to distribute medical resources more efficiently.

**Keywords:** Hospitalization, COVID–19 Epidemiological data, Intensive Care Units, Death, South Korea, Generalized Linear Model

**Student ID:** 2019–20320

## 초록

# COVID-19의 입원기간: 국내 개인수준 연구

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**연구배경:** 2020년 1월 첫 확진자 이후, 대한민국의 코로나19 유행은 끝이지 않고 있다. 이로 인해 병상 등 한정된 의료자원의 부족이 심각한 문제로 대두되고 있다. 이에 본 연구는 질병관리본부가 제공하는 전국단위 개인수준 임상자료인 코로나19 확진자 임상역학정보를 이용하여 코로나19 확진자의 입원기간 및 중환자실 사용, 사망 여부 등과 상관이 있는 변수를 파악함으로써 보다 효율적인 의료자원 분배에 기여하고자 한다.

**연구방법:** 본 연구는 코로나19 확진자 임상역학정보를 이용하여 코로나19 확진자가 보유한 위험요인들과 입원기간, 중환자실 사용여부, 그리고 사망여부의 관계를 확인했다. 이를 위해서 감마 분포 일반화 선형모형을 사용하였다.

**연구결과:** 코로나19 확진자의 입원기간은 우측으로 꼬리가 긴 감마 분포를 따랐으며, 평균 입원기간은 25.75일이었다. 확진자의 연령은 입원기간(0-39세: 25.3일(95% 신뢰구간: 24.6, 26), 40-59세: 28.3일(95% 신뢰구간: 27.6, 29.2), 60-79세: 26.5일(95% 신뢰구간: 25.1, 27.9), 80세+: 26.5일(95% 신뢰구간: 25.1, 27.9))을 비롯해서 중환자실 사용여부(40-59세:  $RR=2.0$ (95% 신뢰구간: 1.0, 3.7), 60세-79세:  $RR=7.4$ (95% 신뢰구간: 4.1, 13.4), 80세+:  $RR=11.0$ (95% 신뢰구간: 5.4, 22.3))와 사망여부(60-79세:

RR=5.9(95% 신뢰구간: 3.4,10.3), 80세+: RR=58.6(95% 신뢰구간: 32.3,106.3))에도 유의한 영향을 주는 것을 확인할 수 있었다. 또한 입원기간의 경우 기침(27.6일(95% 신뢰구간: 25.2, 26.6); 기침 없을 시 25.9일), 근육통(27.3일(95% 신뢰구간: 26.5,28.2); 없을 시 26.2일), 구토(27.2일(95% 신뢰구간: 26.3,28.3); 없을 시 26.3일) 여부와 같은 입원 시점에서의 증상이 유의하게 영향을 주는 것을 확인할 수 있었다. 하지만 확진자의 기저질환 또는 과거력이 입원기간에 주는 영향은 유의하지 않았다. 반면 중환자실 사용여부(RR=2.6(95% 신뢰구간: 1.9,3.6))와 사망여부(RR=2.3(95% 신뢰구간: 1.6,3.1))는 남성이 여성에 비해 취약한 것을 확인할 수 있었다. 또한 당뇨(RR=2.2(95% 신뢰구간: 1.6,3.1)), 고혈압(RR=1.4(95% 신뢰구간: 1.0,2.0), 만성 신장 질환(RR=2.4(95% 신뢰구간: 1.1,5.1)), 암(RR=2.4(95% 신뢰구간: 1.2,4.4)) 등의 기저질환과 과거력이 사망에 유의한 영향을 주는 것을 확인할 수 있었다.

**결론:** 본 연구는 입원기간, 중환자실 이용 및 사망과 관련된 몇 가지 인구통계학적, 임상적 특성을 발견했다. 이러한 발견은 의료 자원을 보다 효율적으로 분배할 수 있는 증거를 제공할 수 있다.

**Keywords :** 입원기간, 코로나19 확진자 임상역학정보, 중환자실, 사망, 대한민국, 일반화 선형모형

**Student Number :** 2019-20320

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# Chapter 1. Introduction

Since the first observation of pneumonia caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in Wuhan, China in December 2019 [1], the novel coronavirus disease (hereafter COVID-19) has rapidly spread to 190 countries, recording about 54 million global cases and 1.3 million deaths worldwide, as of November 15<sup>th</sup>, 2020 [2]. As a result, The World Health Organization (WHO) has declared its third pandemic [3].

The first confirmed case in South Korea (hereafter, Korea) was identified on 20 January 2020, and 24,410 cases were observed through 15 November [4]. Although it seemed that the epidemic of COVID-19 in Korea reached a ‘plateau’ in April to August [5], after a mass demonstration in August, several mass infections occurred repeatedly, thus the trend of COVID-19 in Korea has not stabilized until November [4].

This implies that demand for critical care, including hospital beds and intensive care units (here after, ICU), is expected to increase steadily with the rising number of patients with COVID-19 [6]. Not only that, as opposed to the first mass

infection in Daegu, the ratio of elderly patients with underlying disease is much higher in current cases. About 28% of the confirmed cases are in the age group of 60 or higher, as of November 2020[7], which might worsen the lack of critical cares including ICU.

This study's goal is to investigate the brief distribution of hospitalization of COVID-19 patients and assess individuals' information as risk factors that might have association with hospitalization duration, usage of ICU, and mortality due to COVID-19. The Korea Centers for Disease Control and Prevention(hereafter KCDC) opened the epidemiological data of confirmed cases of COVID-19 in June 2020[8]. The data is nationwide individual-level data including various clinical and epidemiological variables. It contains vital signs, clinical symptoms on admission, underlying disease and past history of the patients with COVID-19.

The results of this study can provide scientific evidence for public health policymaking, prioritizing the distribution of medical resources.

## Chapter 2. Data and Methods

### 2.1. Data

#### 2.1.1. COVID–19 Epidemiological Data

The KCDC has provided an epidemiological data for patients diagnosed with COVID–19. The data has been collected nationwide by the Central Disease Control Headquarters and the National Medical Center, along with the KCDC. The data covers all of the patients (5,628 patients) who have been diagnosed to have COVID–19 and released from hospitalization, as of April 30, 2020. All the information of this data was anonymized and private variables, such as diagnosis date and region of residence, were not provided.

The data contains demographic information, outcome of COVID–19 (death or recovery), duration of hospitalization, vital signs, clinical symptoms, underlying disease, medical history and ICU usage. All the patients (n=522) with missing values were omitted. As a result, the study population of 5,098 were left with 21 variables. Further information about the variables can be found at Table 1.

Variables	Number of Patients(%)	Variables	Number of Patients(%)
Age groups	0-39	Cough(+Sputum)	2,504(49.1)
	40-59	Myalgia(+Malaise)	878(17.2)
	60-79	Vomiting(+Diarrhea)	623(12.2)
Sex	>80	Diabetes	663(13)
	Male	Hypertension	1,138(22.3)
	Female	Heart Failure	56(1.1)
Outcome	Recovered	Chronic Heart Disease (except for Heart Failure)	173(3.4)
	Death	Asthma	122(2.4)
Admission to ICU	184(3.6)	COPD	39(0.8)
Systolic Blood Pressure	>140	Chronic Kidney Disease	54(1.1)
Heart rate	>100	Cancer	141(2.8)
Temperature	>37.5	Chronic Liver Disease	81(1.6)

Table 1. Characteristics of 5,098 patients with COVID–19

## 2.2. Methods

### 2.2.1. Distribution of Hospitalization

Three parametric distributions (Gamma, Lognormal and Beta) were applied to hospitalization to identify the distribution of hospitalization duration. Goodness of fit of these distributions were assessed through the R-square ( $R^2$ ) and 10-fold cross validation (root mean square error ( $RMSE$ ) and absolute mean bias).

### 2.2.2. Risk Factors for Hospitalization Duration

Through the goodness of fit tests, a generalized linear model (GLM) with gamma distribution was used to identify factors associated with the duration of hospitalization. Log function was used as a link function is used to calculate the relative risk of each factor.

### 2.2.3. Risk Factors for Death and ICU

Logistic regression was used to assess the risk factors for ICU usage and death, respectively. Log link function is used to calculate Odd' s ratio for each risk factor.

All of the analysis were performed using RStudio Server(Ver. 4.0.3) and repeated by sub-population(sex and age groups).

R packages including ‘fitdistrplus(fit of a Parametric Distribution to Non-Censored or Censored Data)’ , ‘emmeans(estimated marginal means)’ were used.

The study was approved by the institutional review board of Seoul National University and the independent review board of Central Disease Control Headquarters.

## Chapter 3. Results

### 3.1. Distribution of Hospitalization

Figure 1 displays the distribution of hospitalization duration for all patients with each potential distribution(Gamma, Lognormal, and Beta). The mean of hospitalization of all the patients was 25.8, and the inter quantile range(IQR) was (18,32). The distribution of hospitalization showed right-skewed distribution.

Table 2 is a result of goodness of fit test for each distribution. Gamma distribution was the best distribution under all the criteria( $R^2$ ,  $RMSE$ , and absolute mean error).

Figure 2 and 3 shows the fitted gamma distribution of hospitalization of different sex and age groups. We couldn't find an evident heterogeneity between sex; however, each age group showed different distributions; the oldest group showed a relatively short hospital duration compared to other age groups.

### 3.2. Risk Factors for Hospitalization

Table 3 shows the result of gamma regression for hospitalization. Age was a highly significant factor with p-value less than 0.001 (25.3 (95% CI: 24.6, 26) days for age 0–39, 27 (95% CI: 26.2, 27.7) days for age 40–59, 28.3 (95% CI: 27.6, 29.2) days for age 60–79, and 26.5 (95% CI: 25.1, 27.9) days for age >80); that is, the older the patient, the more likely they would be hospitalized for longer. Higher temperature (26.3 (95% CI: 25.7, 26.9) days for temperature <37.5 °C, and 27.2 (95% CI: 26.3, 28.1) days for temperature >37.5 °C), cough (merged with sputum; 27.6 (95% CI: 26.9, 28.3) days compared to 25.9 (95% CI: 25.2, 26.6) days), myalgia (merged with fatigue; 27.3 (95% CI: 26.5, 28.2) days compared to 26.2 (95% CI: 25.6, 26.8) days), and risk factors for longer hospitalization.

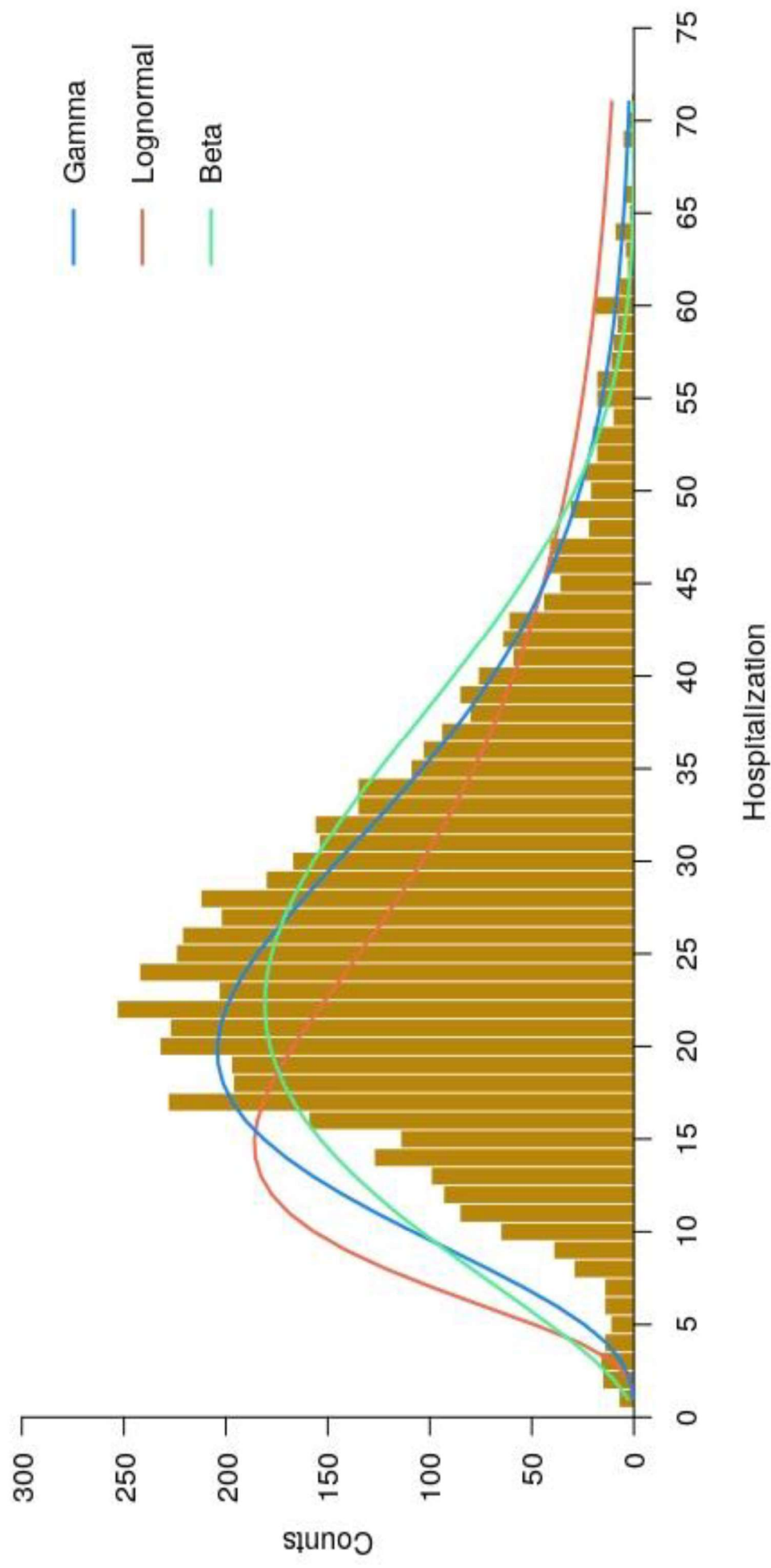


Figure 1. The Histogram and Fitted Distributions of Hospitalization.



	Lognormal Distribution	Gamma Distribution	Beta Distribution
$R^2$	0.62	0.82	0.76
$RMSE$	5.02	3.43	4.00
Absolute Mean Bias	3.66	2.46	2.93

Table 2. 10–fold cross validation of distributions fitted to hospitalization.

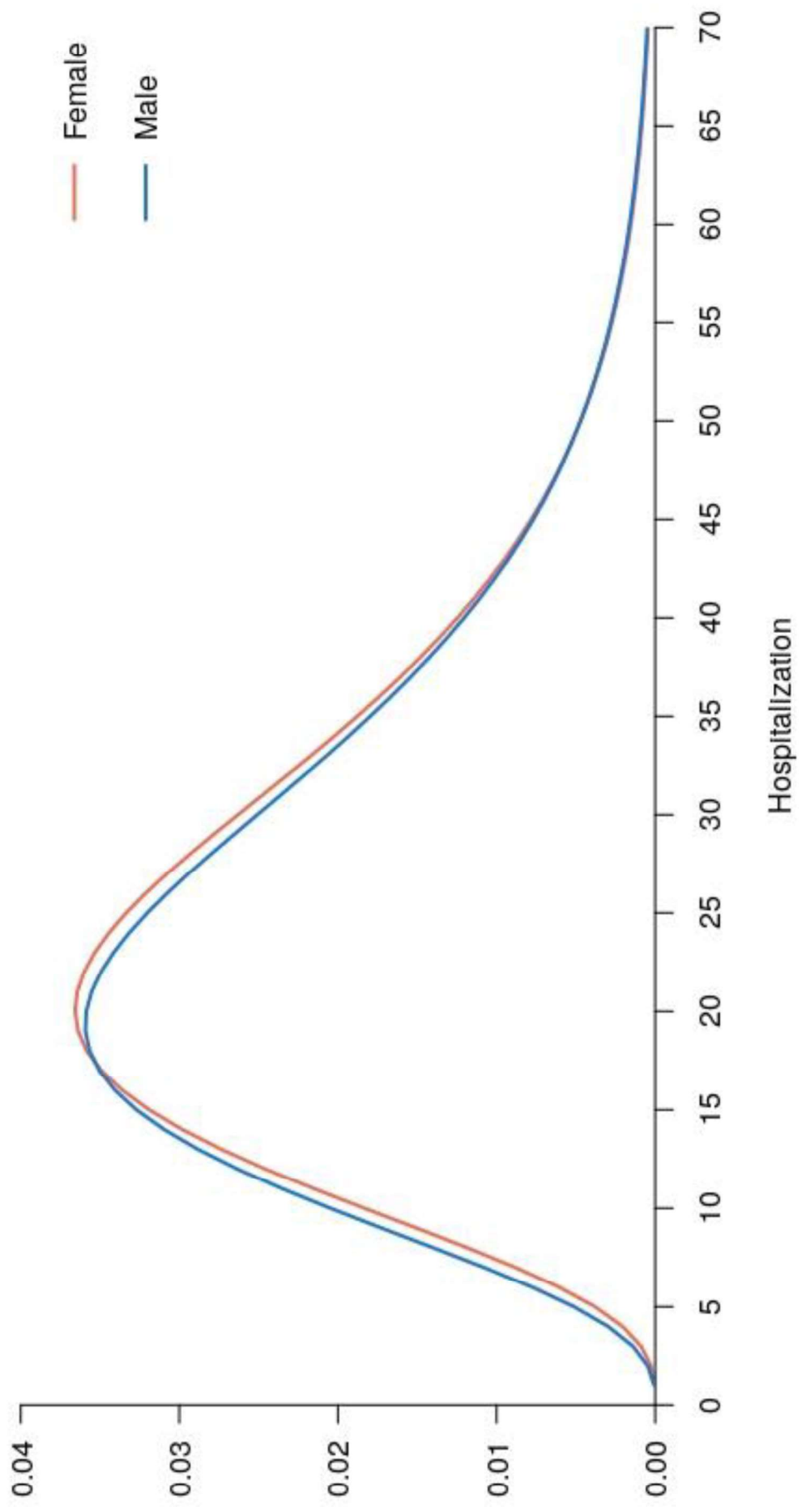


Figure 2. Fitted Distribution of Hospitalization of Sexes.

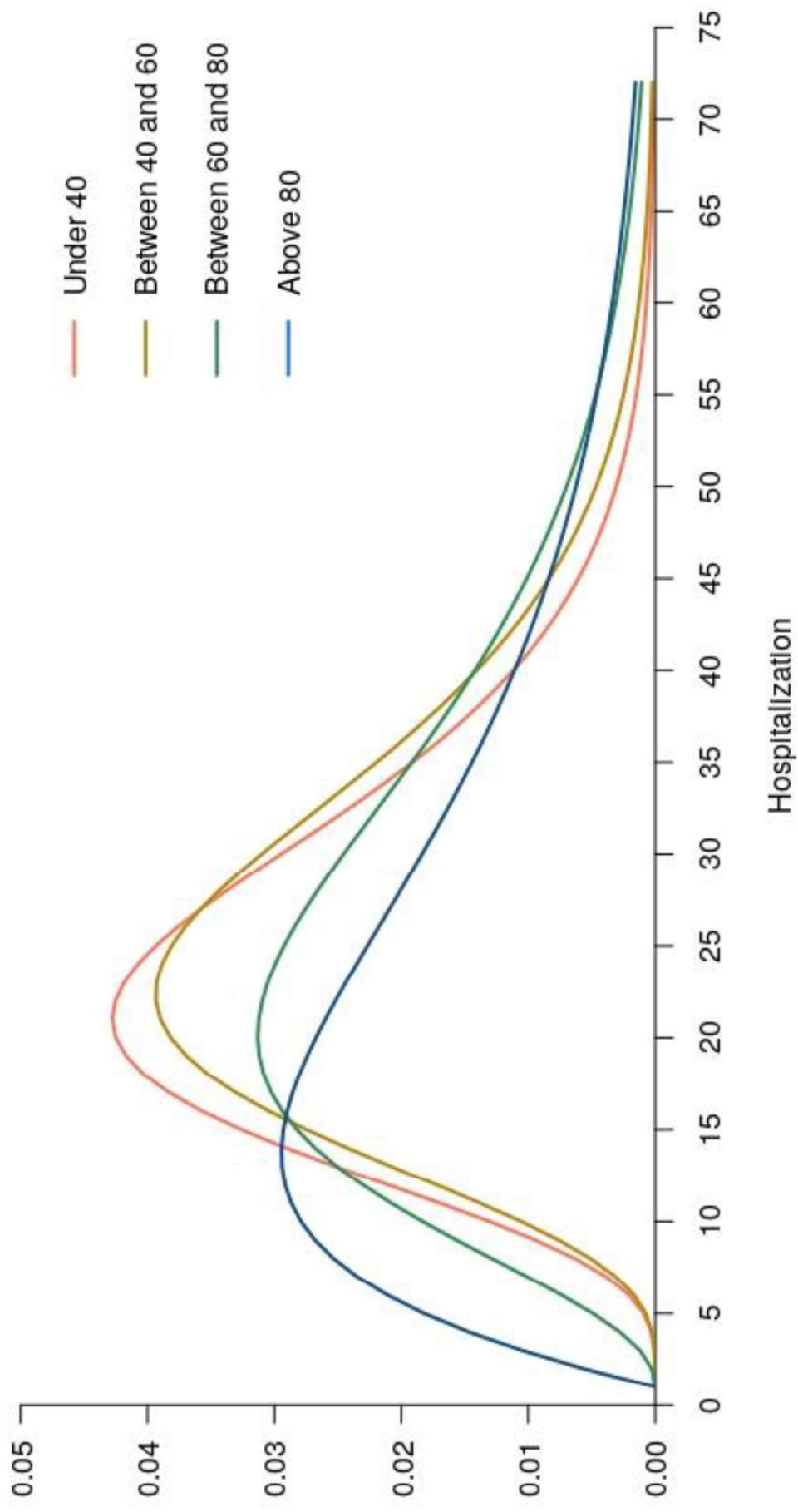


Figure 3. Fitted Distribution of Hospitalization of Age Groups

The analysis was repeated by using only the cases in which the patient recovered because death might confound the association between risk factors with hospitalization; cases that the patient died had significantly shorter hospitalization (mean of 16.0 days), compared to ones who recovered (25.8 days). However, the result was similar, except for the underlying diabetes becoming significant.

Results of subgroup analyses are table 3–1~14. The result didn't vary much by sex or age; male showed less significance for all of the variables.

### 3.3. Assessing Risk Factors for Death and ICU

Table 4 shows the result of logistic regression for the admission to ICU. Similar to the result from hospitalization analysis, age (RR=1.9 (95% CI: 1.0, 3.7) for age 40–59, 7.4 (95% CI: 4.1, 13.4) for age 60–79, and 11.0 (95% CI: 5.4, 22.3) for age >80, compared to age <40), temperature (RR=3.1 (95% CI: 2.2, 4.3) compared to temperature <37.5) and cough (95% CI: 1.4 (1, 1.9)) were significant risk factors.

However, males showed higher risk (2.6 (95% CI: 1.9, 3.6)) of

Variable	Mean(days)	RR	p-value	Variable	Mean(days)	RR	p-value
Age groups	0-39	25.3(24.6,26.0)		Diabetes	No	26.6(26.0,27.3)	
	40-59	27.0(26.2,27.7)	1.1(1.0,1.1) 0.000		Yes	27.3(26.2,28.3)	1.0(1.0,1.0) 0.273
	60-79	28.3(27.6,29.2)	1.1(1.1,1.2) 0.000	Hypertension	No	26.7(26.0,27.4)	
	>80	26.5(25.1,27.9)	1.0(1.0,1.1) 0.200		Yes	26.9(26.0,27.7)	1.0(1.0,1.0) 0.932
Sex	Female	26.7(26.0,27.3)		Heart Failure	No	26.8(26.1,27.4)	
	Male	26.9(26.2,27.7)	1.0(1.0,1.0) 0.531		Yes	26.1(23.3,29.3)	1.0(0.9,1.1) 0.620
Systolic Blood Pressure	<140	26.7(26.0,27.4)		Chronic Heart Disease	No	26.7(26.1,27.4)	
	>140	26.9(26.1,27.7)	1.0(1.0,1.0) 0.567		Yes	27.3(25.5,29.1)	1.0(1.0,1.1) 0.609
Heart rate	<100	26.8(26.1,27.4)		Asthma	No	26.7(26.1,27.4)	
	>100	26.7(25.8,27.6)	1.0(1.0,1.0) 0.726		Yes	27.5(25.4,29.7)	1.0(1.0,1.1) 0.498
Temperature	<37.5°C	26.3(25.7,26.9)		COPD	No	26.7(26.1,27.4)	
	>37.5°C	27.2(26.3,28.1)	1.0(1.0,1.1) 0.032		Yes	27.6(24.1,31.6)	1.0(0.9,1.2) 0.676
Cough (+sputum.)	No	25.9(25.2,26.6)		Chronic Kidney Disease	No	26.8(26.1,27.4)	
	Yes	27.6(26.9,28.3)	1.1(1.0,1.1) 0.000		Yes	26.5(23.6,29.8)	1.0(0.9,1.1) 0.752
Myalgia (+malaise)	No	26.2(25.6,26.8)		Cancer	No	26.7(26.1,27.4)	
	Yes	27.3(26.5,28.2)	1.0(1.0,1.1) 0.005		Yes	26.9(25.0,29.0)	1.0(0.9,1.1) 0.871
Vomiting (+diarrhea)	No	26.3(25.7,26.8)		Chronic Liver Disease	No	26.7(26.1,27.4)	
	Yes	27.2(26.3,28.3)	1.0(1.0,1.1) 0.045		Yes	27.3(24.8,30.1)	1.0(0.9,1.1) 0.701

Table 3. Variables' association with hospitalization

Variable		RR	p-value	Variable	RR	p-value
Age groups	0-39			Diabetes	No	
	40-59	2.0(1.0,3.7)	0.037		Yes	1.3(0.9,1.9)
	60-79	7.4(4.1,13.4)	0.000	Hypertension	No	
	>80	11.0(5.4,22.3)	0.000		Yes	1.3(1.0,1.9)
Sex	Female			Heart Failure	No	
	Male	2.6(1.9,3.6)	0.000		Yes	1.4(0.5,3.4)
Systolic Blood Pressure	<140			Chronic Heart Disease	No	
	>140	1.0(0.7,1.3)	0.820		Yes	1.0(0.5,1.8)
Heart rate	<100			Asthma	No	
	>100	1.8(1.3,2.6)	0.002		Yes	1.3(0.5,3.1)
Temperature	<37.5°C			COPD	No	
	>37.5°C	3.1(2.2,4.3)	0.000		Yes	0.4(0.1,1.9)
Cough (+sputum)	No			Chronic Kidney Disease	No	
	Yes	1.4(1.0,1.9)	0.050		Yes	4.1(1.9,8.7)
Myalgia (+malaise)	No			Cancer	No	
	Yes	1.2(0.8,1.7)	0.332		Yes	1.5(0.7,2.9)
Vomiting (+diarrhea)	No			Chronic Liver Disease	No	
	Yes	1.1(0.7,1.7)	0.664		Yes	0.6(0.2,1.9)

Table 4. Variables' association with admission to intense care units.

minute (1.8 (95% CI: 1.3, 2.6)), and underlying chronic kidney disease (4.1 (95% CI: 1.9, 8.7)) were significant risk factors of using ICU as well.

Table 5 shows the result of logistic regression for the outcome; either death or recovery. Age was a highly significant factor for death (RR=5.9 (95% CI: 3.4, 10.3) for age 60–79, and 58.6 (95% CI: 32.3, 106.3) for age >80, compared to age 40–59). Male (2.3 (95% CI: 1.6, 3.1)), higher heartrate (2.5 (95% CI: 1.7, 3.7)) and higher temperature (2.7 (95% CI: 1.9, 3.9)) were significant factors as well.

Oddly enough, unlike former regressions, most of underlying diseases or past histories of the patient showed higher risk for death. Among these, diabetes (RR=2.2 (95% CI: 1.6, 3.1)), hypertension (1.4 (95% CI: 1.0, 2.0)), heart failure (2.1 (95% CI: 1.1, 4.3)), chronic kidney diseases (2.4 (95% CI: 1.1, 5.1)), and cancer (2.4 (95% CI: 1.3, 4.4)) were significant.



Variable	RR	p-value	Variable	RR	p-value
Age groups	0-39	-	Diabetes	No	-
	40-59	-		Yes	2.17(1.55,3.05)
	60-79	5.92(3.4,10.3)	Hypertension	No	-
	>80	58.63(32.34,106.28)		Yes	1.41(1.01,1.98)
Sex	Female	-	Heart Failure	No	-
	Male	2.25(1.62,3.12)		Yes	2.12(1.05,4.31)
Systolic Blood Pressure	<140	-	Chronic Heart Disease	No	-
	>140	0.93(0.68,1.28)		Yes	0.89(0.51,1.56)
	<100	-	Asthma	No	-
Heart rate	>100	2.54(1.74,3.7)		Yes	1.72(0.8,3.71)
Temperature	<37.5°C	-	COPD	No	-
	>37.5°C	2.72(1.87,3.94)		Yes	1.14(0.43,3.07)
Cough (+sputum)	No	-	Chronic Kidney Disease	No	-
	Yes	0.98(0.71,1.36)		Yes	2.4(1.12,5.14)
Myalgia (+malaise)	No	-	Cancer	No	-
	Yes	0.7(0.45,1.09)		Yes	2.36(1.28,4.36)
Vomiting (+diarrhea)	No	-	Chronic Liver Disease	No	-
	Yes	1.03(0.64,1.65)		Yes	0.85(0.29,2.48)

Table 5. Variables' association with death.



## Chapter 4. Discussion

This study investigated the epidemiological features' association with hospitalization of COVID-19 in Korea. Also the features' association with the admission to ICU and death was analyzed. Vital signs and clinical symptoms on admission seemed to be related with the longer hospitalization and admission to ICU, while underlying diseases/past history of the patient showed significant association with the death.

It is known that older the patient, the higher the risk for severe illness from COVID-19 [10]. The study could confirm that the age has significant association with not only death, but also hospitalization and admission to ICU. Also, the distributions of hospitalization of each age group differed; hospitalization of patients in the older age group seems to vary more. It seems that the higher fatalities for the older group might be the reason; 113 patients out of 315 (35.87%) were dead in the age group of more than 80, while 6.67%, 9.42%, and only one for age group of 60-80, 40-60, and under 40, respectively. Dead patients' mean hospitalization was 16.03 days, which was much shorter than the overall mean (25.75 days). Except for the

distribution of hospitalization, there were no significant difference between all age groups.

There were no significant evidence for the association of sex and hospitalization. Many studies already reported higher risk of severe COVID-19 of male than female [11–13], and the result showed the same result; 5.5% (211/2,111) for males, and 3.55% (106/2,987) for females. Not only that, males showed higher risk of requiring an ICU (RR=2.5).

Systolic blood pressure, heartrate showed no significant association with hospitalization. The conjecture is that multicollinearity with other variables, including underlying diseases (hypertension) might have caused the loss of significance. However, heartrate was significantly associated with the admission to ICU and death. This result confirms the former knowledge that poor vital signs might lead to more severe status [14–17].

Clinical symptoms in admission, including cough, sputum, myalgia and GI symptoms showed significant association with longer hospitalization. However those variables were not significantly associated with the admission to ICU and death, except for cough. The result was similar in both sexes. It may be possible to interpret these results as the signs in admission,

which contains both vital signs and clinical symptoms, are more important features for explaining individuals' hospitalization, rather than the underlying disease and past history.

The death may have caused the above results, given that the hospitalization of patients who are dead is shorter than that of the recovered. That is, death might have a mediation effect on both hospitalization and risk factors. To avoid that, subgroup analysis of only recovered cases are done, and the result of the subgroup analysis using only the recovered cases (table 3–1) showed no difference from the original analysis; no underlying diseases, except for the cancer in the age group under 40, were significant while most of the clinical symptoms, especially cough, stayed significantly related to the longer hospitalization. Vital signs and clinical symptoms in admission were less or not significant when it came to explaining the admission to ICU and death. Among those, heartrate and temperature showed significant association with death. Unlike those, underlying diseases (diabetes, hypertension, heart failure, chronic kidney disease and cancer) were significantly associated with death. Interestingly, females showed significant risk for and asthma as well.

The study has several limitations. First of all, the COVID–19

epidemiological data gathers up only the first 5800 confirmed cases in Korea, which is focused on February and March, 2020. There might be a significant difference between the COVID-19 of that time and right now. Also, the socio-economic situation differs, resulting different aspects of infection, including difference in the age range of confirmed people[4]. Such differences might cause different results if this study is interpreted without concerns.

Secondly, the COVID-19 epidemiological data has its own limitations. Because of the personal identification issue, many of the variables are excluded, including the date of infection, source of infection, and the region of residence where he or she live. Because of this reason, both temporal and regional factors couldn't be considered, despite the fact that COVID-19 is known to have spatiotemporal characteristics[5].

Despite such limitations, this study has several strengths. First of all, there are few studies concerning hospitalization of COVID-19. This topic is valuable in current situation, where so called 'second', or 'third wave' of COVID-19 is the main issue. The findings may give some inference about the patients who are expected to stay in hospital for longer period, and if ICU is needed or not. Previous studies demonstrated that

underlying disease and past history of the patient maybe related to the higher risk of severity of COVID-19[9]; the findings show that symptoms on admissions are rather more significant factors than the underlying disease to longer hospitalization and admission to ICU. Such result can be applied to efficient distribution of medical resources, where lack of beds and ICUs is becoming one of the best medical concerns. Also, this study shares the strength of using COVID-19 epidemiological data. This data is a nationwide total survey clinical data. It contains various clinical and epidemiological variables in individual scale. Not only that, the fact that the data is gathered by KCDC confirms the credibility of the data. In conclusion, this study describes the brief distribution of hospitalization of patients with COVID-19. Also the risk factors that might have an association with longer hospitalization were assessed. It was found that age, vital signs(blood pressure), and clinical symptoms on admission(cough or sputum, myalgia or fatigue, and gastrointestinal symptoms) are significantly associated with longer hospitalization. Such factors' association with admission to ICU and death were assessed as well. Males showed higher risk of using ICU and death than the females. Age of the patient was also one of the main factors

that is associated with the admission to ICU and death.

However, unlike hospitalization, underlying disease and past history of the patient (diabetes, chronic kidney disease, and cancer) were more significant than the symptoms on admission for death.

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Variable	Mean(days)	RR	p-value	Variable	Mean(days)	RR	p-value
Age groups	0-39	26.1(25.3,27.0)		Diabetes	No	28.4(27.7,29.1)	
	40-59	27.9(27.1,28.7)	1.1(1.0,1.1)		Yes	30.0(28.8,31.2)	1.1(1.0,1.1) 0.017
	60-79	29.6(28.8,30.5)	1.1(1.1,1.2)		No	29.0(28.1,29.9)	
	>80	33.5(31.6,35.6)	1.3(1.2,1.4)		Yes	29.4(28.4,30.5)	1.0(1.0,1.1) 0.392
Sex	Female	28.9(28.0,29.7)		Heart Failure	No	29.1(28.3,30.0)	
	Male	29.5(28.6,30.4)	1.0(1.0,1.1)		Yes	30.8(27.0,35.0)	1.1(0.9,1.2) 0.444
Systolic Blood Pressure	<140	29.2(28.3,30.1)		Chronic Heart Disease	No	29.1(28.3,29.9)	
	>140	29.2(28.3,30.1)	1.0(1.0,1.0)		Yes	30.1(28.1,32.3)	1.0(1.0,1.1) 0.412
Heart rate	<100	29.1(28.2,29.9)		Asthma	No	29.1(28.3,30.0)	
	>100	29.6(28.5,30.7)	1.0(1.0,1.1)		Yes	30.4(28.1,32.9)	1.0(1.0,1.1) 0.304
Temperature	<37.5°C	28.4(27.6,29.1)		COPD	No	29.1(28.3,30.0)	
	>37.5°C	30.0(28.9,31.1)	1.1(1.0,1.1)		Yes	31.5(27.2,36.4)	1.1(0.9,1.2) 0.336
Cough (+sputum)	No	28.2(27.4,29.1)		Chronic Kidney Disease	No	29.2(28.4,30.0)	
	Yes	30.2(29.3,31.1)	1.1(1.0,1.1)		Yes	29.1(25.6,33.2)	1.0(0.9,1.1) 0.841
Myalgia (+malaise)	No	28.6(27.8,29.5)		Cancer	No	29.1(28.3,30.0)	
	Yes	29.7(28.7,30.8)	1.0(1.0,1.1)		Yes	30.2(28.0,32.6)	1.0(1.0,1.1) 0.365
Vomiting (+diarrhea)	No	28.6(27.9,29.4)		Chronic Liver Disease	No	29.2(28.4,30.0)	
	Yes	29.7(28.6,30.9)	1.0(1.0,1.1)		Yes	29.9(27.2,32.8)	1.0(0.9,1.1) 0.652

Table 3-1. Variables' association with hospitalization(recovered cases)

Variable	Mean(days)	RR	p-value	Variable	Mean(days)	RR	p-value
Age groups	0-39	1.0(0.2,5.0)		Diabetes	No	7.6(5.0,11.7)	
	40-59	15.5(10.3,23.3)	0.001		Yes	8.1(5.2,12.7)	0.150
	60-79	17.5(14.7,20.8)	0.001	Hypertension	No	7.9(5.1,12.2)	
	>80	13.7(11.5,16.3)	0.001		Yes	7.6(4.9,11.9)	0.315
Sex	Female	7.2(4.6,11.4)		Heart Failure	No	7.8(5.2,11.9)	
	Male	8.0(5.2,12.3)	0.518		Yes	6.2(3.5,10.9)	0.090
Systolic Blood Pressure	<140	7.1(4.7,10.9)		Chronic Heart Disease	No	7.8(5.1,11.9)	
	>140	8.5(5.4,13.3)	0.134		Yes	7.9(4.6,13.4)	0.514
Heart rate	<100	8.6(5.6,13.1)		Asthma	No	7.8(5.1,11.9)	
	>100	7.1(4.5,11.2)	0.116		Yes	8.8(4.7,16.2)	0.339
Temperature	<37.5°C	7.8(5.1,12.0)		COPD	No	7.8(5.1,11.9)	
	>37.5°C	7.8(4.9,12.3)	0.938		Yes	5.8(2.8,11.7)	0.174
Cough (+sputum)	No	7.7(5.0,11.9)		Chronic Kidney Disease	No	7.7(5.1,11.8)	
	Yes	7.9(5.1,12.4)	0.925		Yes	9.4(5.2,16.8)	0.090
Myalgia (+malaise)	No	7.8(5.1,11.9)		Cancer	No	7.7(5.0,11.8)	
	Yes	8.1(4.8,13.5)	0.888		Yes	8.6(4.9,15.0)	0.508
Vomiting (+diarrhea)	No	7.8(5.1,11.9)		Chronic Liver Disease	No	7.3(4.6,11.7)	
	Yes	8.5(5.1,14.2)	0.516		Yes	9.2(4.6,18.4)	0.366

Table 3–2. Variables' association with hospitalization (dead cases)



Variable	Mean(days)	RR	p-value	Variable	Mean(days)	RR	p-value
Age groups	0-39	25.0(24.1,26.0)		Diabetes	No	27.2(26.4,28.1)	
	40-59	27.8(26.9,28.7)	0.000		Yes	28.1(26.7,29.6)	1.0(1.0,1.1) 0.216
	60-79	28.8(27.8,29.8)	0.000	Hypertension	No	27.4(26.5,28.3)	
	>80	28.0(26.3,29.8)	0.004		Yes	27.4(26.2,28.5)	1.0(1.0,1.0) 0.697
Systolic Blood Pressure	<140	27.3(26.4,28.2)		Heart Failure	No	27.4(26.6,28.2)	
	>140	27.5(26.5,28.5)	0.685		Yes	27.0(23.4,31.1)	1.0(0.9,1.1) 0.806
Heart rate	<100	27.3(26.5,28.2)		Chronic Heart Disease	No	27.3(26.5,28.1)	
	>100	27.6(26.4,28.8)	0.760		Yes	28.7(26.1,31.4)	1.1(1.0,1.2) 0.275
	<37.5°C	26.4(25.7,27.2)		Asthma	No	27.3(26.5,28.1)	
Temperature	>37.5°C	28.4(27.2,29.6)	0.001		Yes	29.1(26.4,32.1)	1.1(1.0,1.2) 0.212
Cough (+sputum)	No	26.5(25.6,27.4)		COPD	No	27.4(26.6,28.2)	
	Yes	28.2(27.3,29.2)	0.000		Yes	26.8(21.6,33.3)	1.0(0.8,1.2) 0.744
Myalgia (+malaise)	No	26.7(25.9,27.5)		Chronic Kidney Disease	No	27.4(26.6,28.2)	
	Yes	28.1(27.0,29.2)	0.009		Yes	25.9(22.0,30.4)	0.9(0.8,1.1) 0.460
Vomiting (+diarrhea)	No	26.7(26.0,27.4)		Cancer	No	27.3(26.5,28.1)	
	Yes	28.1(26.9,29.4)	0.030		Yes	28.4(26.0,31.1)	1.0(1.0,1.1) 0.444
				Chronic Liver Disease	No	27.3(26.6,28.2)	
					Yes	29.8(25.7,34.5)	1.1(0.9,1.3) 0.279

Table 3–3. Variables' association with hospitalization (all female)

Variable	Mean(days)	RR	p-value	Variable	Mean(days)	RR	p-value
Age groups	0-39	25.0(24.3,25.7)		Diabetes	No	25.2(24.6,25.9)	
	40-59	25.4(24.6,26.3)	1.01(0.96,1.06)		Yes	25.6(24.3,26.9)	1.0(1.0,1.1) 0.685
	60-79	27.5(26.5,28.5)	1.09(1.03,1.15)	Hypertension	No	25.2(24.4,25.9)	
	>80	23.5(21.6,25.6)	0.93(0.84,1.02)		Yes	25.6(24.6,26.7)	1.0(1.0,1.1) 0.504
Systolic Blood Pressure	<140	25.3(24.5,26.1)		Heart Failure	No	25.3(24.7,26.0)	
	>140	25.3(24.5,26.2)	1(0.97,1.04)		Yes	24.3(20.1,29.3)	1.0(0.8,1.2) 0.664
Heart rate	<100	25.4(24.7,26.1)	0.867	Chronic Heart Disease	No	25.3(24.7,26.0)	
	>100	24.9(23.7,26.1)	0.98(0.93,1.03)		Yes	25.3(23.1,27.8)	1.0(0.9,1.1) 0.971
	<37.5°C	25.4(24.7,26.1)	0.478	Asthma	No	25.3(24.7,26.0)	
Temperature	>37.5°C	24.9(23.7,26.2)	0.98(0.93,1.03)		Yes	24.5(21.6,27.7)	1.0(0.9,1.1) 0.566
	No	24.4(23.6,25.1)		COPD	No	25.3(24.6,25.9)	
Cough (+sputum)	Yes	26.3(25.5,27.2)	1.08(1.04,1.12)		Yes	27.4(23.1,32.6)	1.1(0.9,1.3) 0.318
Myalgia (+malaise)	No	25.2(24.5,25.9)		Chronic Kidney Disease	No	25.3(24.6,25.9)	
	Yes	25.9(24.6,27.1)	1.03(0.98,1.08)		Yes	26.5(22.5,31.2)	1.0(0.9,1.2) 0.8
Vomiting (+diarrhea)	No	25.3(24.6,26.0)		Cancer	No	25.4(24.7,26.0)	
	Yes	25.5(24.0,27.1)	1.01(0.95,1.07)		Yes	23.9(21.2,27.0)	1.0(0.8,1.1) 0.434
			0.817	Chronic Liver Disease	No	25.3(24.7,26.0)	
					Yes	24.6(21.8,27.9)	1.0(0.9,1.1) 0.719

Table 3-4. Variables' association with hospitalization (all male)



Variable	Mean(days)	RR	p-value	Variable	Mean(days)	RR	p-value
Age groups	0-39	27.0(25.3,28.8)		Diabetes	No	29.6(28.0,31.3)	
	40-59	29.8(28.1,31.7)	1.1(1.1,1.1)		Yes	32.0(29.9,34.3)	1.1(1.0,1.1) 0.007
	60-79	31.0(29.2,32.9)	1.1(1.1,1.2)	Hypertension	No	30.7(28.9,32.5)	
	>80	36.1(33.2,39.2)	1.3(1.2,1.4)		Yes	31.0(29.1,33.1)	1.0(1.0,1.1) 0.697
Systolic Blood Pressure	<140	30.7(29.0,32.6)		Heart Failure	No	30.8(29.0,32.6)	
	>140	30.9(29.1,32.9)	1.0(1.0,1.0)		Yes	32.9(27.8,38.9)	1.1(0.9,1.3) 0.500
Heart rate	<100	30.7(28.9,32.5)		Chronic Heart Disease	No	30.7(29.0,32.5)	
	>100	31.3(29.3,33.4)	1.0(1.0,1.1)		Yes	32.7(29.5,36.3)	1.1(1.0,1.2) 0.226
Temperature	<37.5°C	29.5(27.9,31.2)		Asthma	No	29.6(28.6,30.6)	
	>37.5°C	32.1(30.1,34.3)	1.1(1.0,1.1)		Yes	32.1(29.0,35.5)	1.1(1.0,1.2) 0.119
Cough (+sputum)	No	29.8(28.0,31.6)		COPD	No	30.7(29.0,32.6)	
	Yes	31.9(30.1,33.8)	1.1(1.0,1.1)		Yes	34.2(26.8,43.5)	1.1(0.9,1.4) 0.439
Myalgia (+malaise)	No	30.1(28.4,31.9)		Chronic Kidney Disease	No	30.8(29.1,32.6)	
	Yes	31.5(29.6,33.5)	1.1(1.0,1.1)		Yes	30.5(24.9,37.2)	1.0(0.8,1.2) 0.737
Vomiting (+diarrhea)	No	30.1(28.5,31.9)		Cancer	No	30.7(29.0,32.5)	
	Yes	31.5(29.5,33.6)	1.0(1.0,1.1)		Yes	32.1(29.0,35.5)	1.0(1.0,1.1) 0.409
				Chronic Liver Disease	No	30.8(29.1,32.6)	
					Yes	33.2(28.6,38.5)	1.1(0.9,1.2) 0.323

Table 3–5. Variables' association with hospitalization (recovered female)

Variable	Mean(days)	RR	p-value	Variable	Mean(days)	RR	p-value
Age groups	0-39	25.0(24.3,25.7)		Diabetes	No	27.0(26.2,27.9)	
	40-59	25.6(24.8,26.5)	1.0(1.0,1.1)		Yes	27.6(26.1,29.2)	1.0(1.0,1.1) 0.543
	60-79	28.5(27.5,29.5)	1.1(1.1,1.2)	Hypertension	No	26.9(26.0,27.8)	
	>80	29.6(26.7,32.9)	1.2(1.0,1.3)		Yes	27.6(26.4,28.9)	1.0(1.0,1.1) 0.326
Systolic Blood Pressure	<140	27.2(26.3,28.1)		Heart Failure	No	27.1(26.3,27.9)	
	>140	27.0(26.0,28.0)	1.0(1.0,1.0)		Yes	28.1(22.7,34.7)	1.0(0.8,1.3) 0.720
Heart rate	<100	27.1(26.2,27.9)		Chronic Heart Disease	No	27.1(26.3,27.9)	
	>100	27.4(26.1,28.9)	1.0(1.0,1.1)		Yes	27.5(25.0,30.3)	1(0.9,1.1) 0.928
	<37.5°C	27.0(26.2,27.9)		Asthma	No	27.1(26.3,28.0)	
Temperature	>37.5°C	27.6(26.1,29.1)	1.0(1.0,1.1)		Yes	26.4(23.3,29.9)	1.0(0.9,1.1) 0.650
	No	26.2(25.3,27.1)		COPD	No	27.1(26.2,27.9)	
	Yes	28.1(27.1,29.1)	1.1(1.0,1.1)		Yes	29.1(24.4,34.8)	1.1(0.9,1.3) 0.416
Cough (+sputum)	No	27.0(26.2,27.9)		Chronic Kidney Disease	No	27.1(26.3,27.9)	
	Yes	27.7(26.3,29.1)	1.0(1.0,1.1)		Yes	28.3(23.8,33.6)	1.0(0.9,1.2) 0.839
Myalgia (+malaise)	No	27.0(26.2,27.9)		Cancer	No	27.1(26.3,27.9)	
	Yes	27.7(26.3,29.1)	1.0(1.0,1.1)		Yes	27.2(23.7,31.1)	1.0(0.9,1.2) 0.921
Vomiting (+diarrhea)	No	27.1(26.3,27.9)		Chronic Liver Disease	No	27.1(26.3,28.0)	
	Yes	27.6(26.0,29.4)	1.0(1.0,1.1)		Yes	26.7(23.5,30.2)	1.0(0.9,1.1) 0.786

Table 3–6. Variables' association with hospitalization(recovered male)

Variable	Mean(days)	RR	p-value	Variable	Mean(days)	RR	p-value
Sex	Female 33.1(26.6,41.1)			Diabetes	No 34.2(27.5,42.5)		
	Male 35.4(28.4,44.1)	1.1(1.0,1.1)	0.001	Yes 31.0(23.3,41.4)	0.9(0.8,1.1)	0.351	
Systolic Blood Pressure	<140 34.2(27.5,42.5)			Hypertension	No 34.3(27.6,42.7)		
	>140 34.3(27.5,42.7)	1.0(1.0,1.1)	0.970	Yes 32.8(25.1,42.9)	1.0(0.8,1.2)	0.704	
Heart rate	<100 33.7(27.1,41.9)			Chronic Heart Disease	No 29.2(25.4,33.6)		
	>100 34.8(27.9,43.3)	1.0(1.0,1.1)	0.253	Yes 40.1(27.9,57.6)	1.4(1.0,1.9)	0.080	
Temperature	<37.5°C 33.4(26.9,41.4)			Asthma	No 34.0(27.3,42.2)		
	>37.5°C 35.0(28.0,43.8)	1.0(1.0,1.1)	0.158	Yes 36.4(28.1,47.0)	1.1(0.9,1.2)	0.398	
Cough (+sputum)	No 32.9(26.5,41.0)			COPD	No 34.2(27.5,42.5)		
	Yes 35.5(28.6,44.2)	1.1(1.0,1.1)	0.001	Yes 25.5(13.8,47.4)	0.8(0.4,1.3)	0.324	
Myalgia (+malaise)	No 34.1(27.4,42.4)			Chronic Kidney Disease	No 34.2(27.5,42.5)		
	Yes 34.9(28.0,43.7)	1.0(1.0,1.1)	0.388	Yes 33.9(20.1,57.0)	1.0(0.6,1.6)	0.986	
Vomiting (+diarrhea)	No 33.9(27.2,42.1)			Cancer	No 28.8(24.3,34.1)		
	Yes 35.2(28.1,44.0)	1.0(1.0,1.1)	0.319	Yes 40.6(29.4,56.0)	1.4(1.1,1.8)	0.020	
				Chronic Liver Disease	No 34.2(27.5,42.5)		
				Yes 34.2(25.0,46.9)	1.0(0.8,1.3)	0.985	

Table 3–7. Variables' association with hospitalization (age<40)

※ There were no patients with heart failure in this age group



Variable		Mean(days)	RR	p-value	Variable	Mean(days)	RR	p-value
Sex	Female	33.0(26.6,41.0)			Diabetes	No	34.2(27.5,42.5)	
	Male	35.4(28.4,44.1)	1.1(1.0,1.1)	0.001		Yes	31.0(23.3,41.3)	0.9(0.8,1.1)
Systolic Blood Pressure	<140	34.2(27.5,42.5)			Hypertension	No	34.3(27.6,42.7)	
	>140	34.2(27.5,42.7)	1.0(1.0,1.1)	0.978		Yes	32.8(25.1,42.9)	1.0(0.8,1.2)
Heart rate	<100	33.7(27.1,41.9)			Chronic Heart Disease	No	29.2(25.4,33.6)	
	>100	34.8(27.9,43.3)	1.0(1.0,1.1)	0.259		Yes	40.1(27.9,57.5)	1.4(1.0,1.9)
Temperature	<37.5℃	33.4(26.9,41.4)			Asthma	No	34.0(27.4,42.2)	
	>37.5℃	35.0(28.0,43.7)	1.0(1.0,1.1)	0.155		Yes	36.4(28.1,47.0)	1.1(0.9,1.2)
Cough (+sputum)	No	32.9(26.5,41.0)			COPD	No	34.2(27.6,42.5)	
	Yes	35.5(28.6,44.2)	1.1(1.0,1.1)	0.001		Yes	25.5(13.8,47.3)	0.8(0.4,1.3)
Myalgia (+malaise)	No	34.1(27.4,42.4)			Chronic Kidney Disease	No	34.2(27.5,42.5)	
	Yes	34.9(28.0,43.6)	1.0(1.0,1.1)	0.391		Yes	33.9(20.1,56.9)	1.0(0.6,1.6)
Vomiting (+diarrhea)	No	33.9(27.2,42.1)			Cancer	No	28.8(24.3,34.1)	
	Yes	35.2(28.1,44.0)	1.0(1.0,1.1)	0.322		Yes	40.6(29.4,56.0)	1.4(1.1,1.8)
					Chronic Liver Disease	No	34.2(27.5,42.5)	
						Yes	37.0(26.8,51.0)	1.1(0.9,1.4)

Table 3–8. Variables' association with hospitalization(recovered age<40)

※ There were no patients with heart failure in this age group



Variable	Mean(days)	RR	p-value	Variable	Mean(days)	RR	p-value
Sex	Female 28.9(26.8,31.1)			Hypertension	No 28.0(26.0,30.2)		
	Male 27.7(25.7,29.9)	1.0(0.9,1.0)	0.067		Yes 28.6(26.5,30.9)	1.0(1.0,1.1)	0.328
Systolic Blood Pressure	<140 27.6(25.7,29.7)			Heart Failure	No 28.3(26.4,30.4)		
	>140 29.0(26.9,31.3)	1.1(1.0,1.1)	0.032		Yes 26.2(17.5,39.3)	0.9(0.6,1.4)	0.764
Heart rate	<100 28.3(26.3,30.4)			Chronic Heart Disease	No 26.9(25.9,27.8)		
	>100 28.3(26.1,30.7)	1.0(0.9,1.1)	0.731		Yes 29.8(26.0,34.1)	1.1(1.0,1.3)	0.127
Temperature	<37.5 °C 28.1(26.2,30.2)			Asthma	No 28.3(26.3,30.4)		
	>37.5 °C 29.1(26.8,31.6)	1.0(1.0,1.1)	0.186		Yes 29.8(25.3,35.0)	1.1(0.9,1.2)	0.446
Cough	No 27.4(25.4,29.5)			COPD	No 28.3(26.3,30.4)		
(+sputum)	Yes 29.2(27.1,31.4)	1.1(1.0,1.1)	0.003		Yes 27.6(20.6,36.9)	1.0(0.7,1.3)	0.835
Myalgia	No 27.6(25.7,29.6)			Chronic Kidney Disease	No 28.4(26.4,30.5)		
(+malaise)	Yes 29.0(26.8,31.4)	1.0(1.0,1.1)	0.077		Yes 25.5(20.8,31.3)	0.9(0.7,1.1)	0.285
Vomiting	No 28.1(26.2,30.2)			Cancer	No 28.2(26.3,30.3)		
(+diarrhea)	Yes 29.1(26.7,31.8)	1.0(1.0,1.1)	0.277		Yes 29.5(26.0,33.5)	1.1(0.9,1.2)	0.425
Diabetes	No 27.5(25.7,29.5)			Chronic Liver Disease	No 28.3(26.3,30.4)		
	Yes 29.1(26.7,31.7)	1.1(1.0,1.1)	0.123		Yes 28.6(24.4,33.6)	1.0(0.9,1.2)	0.842

Table 3–9. Variables' association with hospitalization (age between 40 and 59)

Variable	Mean(days)	RR	p-value	Variable	Mean(days)	RR	p-value
Sex	Female 29.5(27.4,31.8)			Hypertension	No 28.7(26.6,31.0)		
	Male 28.6(26.4,30.8)	1.0(1.0,1.0)	0.126		Yes 29.5(27.2,31.9)	1.0(1.0,1.1)	0.250
Systolic Blood Pressure	<140 28.5(26.4,30.7)			Heart Failure	No 29.1(27.0,31.3)		
	>140 29.6(27.4,32.0)	1.0(1.0,1.1)	0.083		Yes 26.9(18.0,40.2)	0.9(0.6,1.4)	0.700
Heart rate	<100 28.9(26.8,31.2)			Chronic Heart Disease	No 27.5(26.5,28.6)		
	>100 29.3(27.0,31.9)	1.0(1.0,1.1)	0.719		Yes 30.6(26.7,35.1)	1.1(1.0,1.3)	0.137
Temperature	<37.5 °C 28.3(26.3,30.4)			Asthma	No 29.0(27.0,31.2)		
	>37.5 °C 29.8(27.4,32.4)	1.1(1.0,1.1)	0.064		Yes 30.6(26.0,35.9)	1.1(0.9,1.2)	0.469
Cough (+sputum)	No 28.2(26.1,30.5)			COPD	No 29.1(27.0,31.3)		
	Yes 29.9(27.7,32.2)	1.1(1.0,1.1)	0.007		Yes 28.0(21.0,37.4)	1.0(0.7,1.3)	0.768
Myalgia (+malaise)	No 28.5(26.5,30.7)			Chronic Kidney Disease	No 29.1(27.0,31.3)		
	Yes 29.6(27.3,32.0)	1.0(1.0,1.1)	0.140		Yes 27.1(22.0,33.4)	0.9(0.8,1.2)	0.508
Vomiting (+diarrhea)	No 28.9(26.8,31.1)			Cancer	No 29.0(26.9,31.2)		
	Yes 29.8(27.3,32.6)	1.0(1.0,1.1)	0.308		Yes 30.5(26.8,34.7)	1.1(0.9,1.2)	0.352
Diabetes	No 28.0(26.0,30.0)			Chronic Liver Disease	No 29.0(27.0,31.3)		
	Yes 30.1(27.6,32.9)	1.1(1.0,1.1)	0.046		Yes 29.0(24.6,34.1)	1.0(0.9,1.2)	0.968

Table 3–10. Variables' association with hospitalization (recovered age between 40 and 59)

Variable	Mean(days)	RR	p-value	Variable	Mean(days)	RR	p-value
Sex	Female 32.2(28.3,36.7)			Hypertension	No 32.3(28.3,36.8)		
	Male 32.4(28.5,36.9)	1.0(1.0,1.1)	0.640		Yes 32.3(28.4,36.8)	1.0(1.0,1.1)	0.771
Systolic Blood Pressure	<140 32.6(28.7,37.1)			Heart Failure	No 32.4(28.5,36.8)		
	>140 32.0(28.1,36.4)	1.0(0.9,1.0)	0.398		Yes 31.6(25.9,38.6)	1.0(0.8,1.2)	0.794
Heart rate	<100 32.5(28.6,36.9)			Chronic Heart Disease	No 32.5(28.6,37.0)		
	>100 31.4(27.4,36.0)	1.0(0.9,1.0)	0.284		Yes 31.3(27.0,36.4)	1.0(0.9,1.1)	0.343
Temperature	<37.5°C 31.7(27.9,36.0)			Asthma	No 32.3(28.4,36.7)		
	>37.5°C 33.0(28.9,37.7)	1.1(1.0,1.1)	0.109		Yes 34.5(28.8,41.5)	1.1(0.9,1.2)	0.321
Cough (+sputum)	No 31.1(27.3,35.4)			COPD	No 32.3(28.4,36.7)		
	Yes 33.6(29.6,38.2)	1.1(1.0,1.1)	0.001		Yes 33.0(26.3,41.5)	1.0(0.8,1.3)	0.857
Myalgia (+malaise)	No 31.5(27.7,35.7)			Chronic Kidney Disease	No 29.0(27.9,30.1)		
	Yes 33.2(29.1,38.0)	1.1(1.0,1.1)	0.049		Yes 36.0(28.1,46.2)	1.2(1.0,1.6)	0.093
Vomiting (+diarrhea)	No 31.3(27.5,35.5)			Cancer	No 32.3(28.5,36.7)		
	Yes 33.4(29.2,38.3)	1.1(1.0,1.1)	0.050		Yes 31.3(26.5,37.0)	1.0(0.9,1.1)	0.548
Diabetes	No 31.7(27.8,36.1)			Chronic Liver Disease	No 32.3(28.4,36.7)		
	Yes 33.0(28.9,37.5)	1.0(1.0,1.1)	0.163		Yes 33.6(27.7,40.8)	1.1(0.9,1.2)	0.541

Table 3–11. Variables' association with hospitalization (age between 60 and 79)



Variable	Mean(days)	RR	p-value	Variable	Mean(days)	RR	p-value
Sex	Female 33.5(29.1,38.5)				No 33.6(29.2,38.7)		
	Male 34.4(29.9,39.5)	1.0(1.0,1.1)	0.227	Hypertension	Yes 34.1(29.7,39.2)	1.0(1.0,1.1)	0.463
Systolic Blood Pressure	<140 34.6(30.1,39.8)			Heart Failure	No 33.9(29.5,38.9)		
	>140 33.1(28.8,38.1)	1.0(0.9,1.0)	0.034		Yes 33.9(27.3,42.2)	1.0(0.8,1.2)	0.963
Heart rate	<100 33.9(29.5,38.9)			Chronic Heart Disease	No 34.0(29.6,39.0)		
	>100 33.6(29.0,39.0)	1.0(0.9,1.1)	0.707		Yes 33.5(28.7,39.2)	1.0(0.9,1.1)	0.633
Temperature	<37.5 °C 32.8(28.5,37.6)			Asthma	No 33.9(29.5,38.9)		
	>37.5 °C 35.0(30.3,40.4)	1.1(1.0,1.1)	0.017		Yes 35.0(29.0,42.3)	1.0(0.9,1.2)	0.579
Cough (+sputum)	No 32.6(28.4,37.5)			COPD	No 33.4(29.1,38.4)		
	Yes 35.2(30.6,40.4)	1.1(1.0,1.1)	0.001		Yes 37.8(29.7,48.2)	1.1(0.9,1.4)	0.291
Myalgia (+malaise)	No 33.0(28.7,37.9)			Chronic Kidney Disease	No 29.9(28.8,31.0)		
	Yes 34.8(30.2,40.2)	1.1(1.0,1.1)	0.042		Yes 38.4(29.3,50.4)	1.3(1.0,1.7)	0.108
Vomiting (+diarrhea)	No 33.0(28.8,37.9)			Cancer	No 33.9(29.5,38.9)		
	Yes 34.7(30.0,40.2)	1.1(1.0,1.1)	0.104		Yes 33.3(27.9,39.6)	1.0(0.9,1.1)	0.716
Diabetes	No 33.0(28.7,38.0)			Chronic Liver Disease	No 33.9(29.5,38.9)		
	Yes 34.8(30.2,40.0)	1.1(1.0,1.1)	0.086		Yes 34.6(28.5,42.1)	1.0(0.9,1.2)	0.749

Table 3–12. Variables' association with hospitalization (recovered age between 60 and 79)

Variable	Mean(days)	RR	p-value	Variable	Mean(days)	RR	p-value
Sex	Female 19.6(16.0,24.0)			Hypertension	No 19.9(16.2,24.5)		
	Male 17.6(14.3,21.6)	0.9(0.8,1.0)	0.116		Yes 17.3(14.2,21.1)	0.9(0.8,1.0)	0.083
Systolic Blood Pressure	<140 19.7(16.1,24.0)			Heart Failure	No 18.6(15.3,22.6)		
	>140 17.5(14.3,21.5)	0.9(0.8,1.0)	0.091		Yes 17.5(13.2,23.4)	0.9(0.7,1.2)	0.540
Heart rate	<100 21.0(17.4,25.2)			Chronic Heart Disease	No 18.2(15.0,22.2)		
	>100 16.5(12.9,21.0)	0.8(0.7,1.0)	0.026		Yes 19.3(15.1,24.6)	1.1(0.9,1.3)	0.513
Temperature	<37.5 °C 18.7(15.3,22.7)			Asthma	No 20.5(17.5,24.1)		
	>37.5 °C 18.0(14.0,23.1)	1.0(0.8,1.2)	0.696		Yes 16.8(12.6,22.4)	0.8(0.6,1.0)	0.058
Cough (+sputum)	No 18.6(15.3,22.6)			COPD	No 18.5(15.2,22.5)		
	Yes 18.5(14.9,23.1)	1.0(0.9,1.1)	0.889		Yes 19.5(13.7,27.9)	1.1(0.8,1.6)	0.511
Myalgia (+malaise)	No 18.1(14.9,22.1)			Chronic Kidney Disease	No 18.6(15.3,22.5)		
	Yes 20.5(15.9,26.2)	1.2(0.9,1.4)	0.173		Yes 16.6(12.3,22.5)	0.9(0.7,1.1)	0.343
Vomiting (+diarrhea)	No 18.8(15.5,22.8)			Cancer	No 20.8(17.9,24.2)		
	Yes 16.6(12.8,21.5)	0.9(0.7,1.1)	0.241		Yes 16.6(12.2,22.4)	0.8(0.6,1.0)	0.068
Diabetes	No 18.9(15.6,23.1)			Chronic Liver Disease	No 18.6(15.3,22.5)		
	Yes 17.8(14.3,22.3)	0.9(0.8,1.1)	0.398		Yes 15.1(8.9,25.9)	0.8(0.5,1.4)	0.513

Table 3–13. Variables' association with hospitalization (age 80 or higher)

Variable	Mean(days)	RR	p-value	Variable	Mean(days)	RR	p-value
Sex	Female	29.9(24.4,36.5)			No	29.7(24.0,36.7)	
	Male	28.0(22.8,34.5)	0.9(0.8,1.1)	Hypertension	Yes	28.9(23.7,35.2)	1.0(0.9,1.1)
Systolic Blood Pressure	<140	29.9(24.5,36.5)			No	27.0(22.7,32.1)	
	>140	28.0(22.8,34.4)	0.9(0.8,1.0)	Heart Failure	Yes	31.5(24.3,40.8)	1.1(0.9,1.4)
Heart rate	<100	29.1(24.0,35.4)			No	29.2(24.0,35.6)	
	>100	29.4(22.5,38.3)	1.0(0.8,1.2)	Chronic Heart Disease	Yes	28.3(22.2,36.2)	1.0(0.8,1.2)
Temperature	<37.5°C	27.1(22.4,32.6)			No	29.0(23.9,35.3)	
	>37.5°C	31.4(24.7,39.8)	1.2(1.0,1.4)	Asthma	Yes	26.8(19.5,37.0)	0.9(0.7,1.2)
Cough (+sputum)	No	29.0(23.8,35.4)			No	28.7(23.6,34.9)	
	Yes	29.5(23.7,36.6)	1.0(0.9,1.1)	COPD	Yes	33.9(24.6,46.7)	1.2(0.9,1.6)
Myalgia (+malaise)	No	28.7(23.5,34.9)			No	31.9(26.8,37.9)	
	Yes	31.3(24.8,39.7)	1.1(0.9,1.3)	Chronic Kidney Disease	Yes	26.6(20.3,34.9)	0.8(0.6,1.0)
Vomiting (+diarrhea)	No	29.2(24.0,35.5)			No	32.5(27.8,38.1)	
	Yes	27.4(21.2,35.6)	0.9(0.8,1.1)	Cancer	Yes	26.1(19.5,34.9)	0.8(0.6,1.1)
Diabetes	No	28.7(23.5,35.0)			No	29.2(24.0,35.5)	
	Yes	30.1(24.3,37.3)	1.1(0.9,1.2)	Chronic Liver Disease	Yes	24.6(13.9,43.5)	0.8(0.5,1.5)

Table 3–14. Variables' association with hospitalization (recovered age 80 or higher)



Variable	RR	P-value	Variable	RR	P-value
Age groups	0-39		Diabetes	No	
	40-59	2.0(1.0,3.7)	Diabetes	Yes	1.3(0.9,1.9) 0.137
	60-79	7.4(4.1,13.4)	Hypertension	No	
	>80	11.0(5.4,22.3)	Hypertension	Yes	1.3(1.0,1.9) 0.100
Systolic Blood Pressure	<140		Heart Failure	No	
	>140	1.0(0.7,1.3)	Heart Failure	Yes	1.4(0.5,3.4) 0.519
Heart rate	<100		Chronic Heart Disease	No	
	>100	1.8(1.3,2.6)	Chronic Heart Disease	Yes	1.0(0.5,1.8) 0.903
	<37.5°C		Asthma	No	
Temperature	>37.5°C	3.1(2.2,4.3)	Asthma	Yes	1.3(0.5,3.1) 0.593
	No		COPD	No	
Cough (+sputum)	Yes	1.4(1.0,1.9)	COPD	Yes	0.4(0.1,1.9) 0.246
	No		Chronic Kidney Disease	No	
Myalgia (+malaise)	Yes	1.2(0.8,1.7)	Chronic Kidney Disease	Yes	4.1(1.9,8.7) 0.000
	No		Cancer	No	
Vomiting (+diarrhea)	Yes		Cancer	Yes	1.5(0.7,2.9) 0.269
	No		Chronic Liver Disease	No	
	Yes	1.1(0.7,1.7)	Chronic Liver Disease	Yes	0.6(0.2,1.9) 0.366

Table 4 – 1. Variables' association with admission to intense care units (female).

Variable	RR	P-value	Variable	RR	P-value
Age groups	0-39		Diabetes	No	
	40-59	0.6(0.2,1.6)		Yes	1.0(0.4,2.4)
	60-79	1.7(0.7,4.2)	Hypertension	No	
	>80	2.2(0.6,8.4)		Yes	1.9(0.9,4.0)
Systolic Blood Pressure	<140		Heart Failure	No	
	>140	1.3(0.7,2.4)		Yes	did not converge
	<100	0.491	Chronic Heart Disease	No	
	>100	0.655		Yes	0.5(0.1,4.1)
Heart rate	<37.5°C		Asthma	No	
	>37.5°C	0.002		Yes	0.9(0.1,7.1)
	No		COPD	No	
	Yes	1.3(0.7,2.5)		Yes	did not converge
Cough (+sputum)	No		Chronic Kidney Disease	No	
	Yes	0.372		Yes	did not converge
	No		Cancer	No	
	Yes	1.2(0.6,2.4)		Yes	1.7(0.4,7.1)
Myalgia (+malaise)	No		Chronic Liver Disease	No	
	Yes	0.608		Yes	0.503
	No			No	
	Yes	0.444		Yes	did not converge

Table 4-2. Variables' association with admission to intense care units (male).



Variable		RR	P-value	Variable	RR	P-value
Sex	Female					
	Male	3.7(1.6,8.2)	0.002	Hypertension		
Systolic Blood Pressure	<140			Yes	1.6(0.7,3.9)	0.266
	>140	0.4(0.2,0.9)	0.034	Heart Failure		
Heart rate	<100			Yes	did not converge	
	>100	3.0(1.4,6.6)	0.007	Chronic Heart Disease		
Temperature	<37.5°C			Yes	1.3(0.2,10.5)	0.800
	>37.5°C	5.4(2.4,12.1)	0.000	Asthma		
Cough (+sputum)	No			Yes	1.9(0.2,19.0)	0.568
	Yes	1.1(0.5,2.3)	0.910	COPD		
Myalgia (+malaise)	No			Yes	5.4(0.5,60.6)	0.174
	Yes	1.3(0.6,3.0)	0.554	Chronic Kidney Disease		
Vomiting (+diarrhea)	No			Yes	3.2(0.5,21.3)	0.228
	Yes	1.4(0.5,3.8)	0.544	Cancer		
Diabetes	No			Yes	0.9(0.1,7.1)	0.887
	Yes	1.2(0.5,3.2)	0.714	Chronic Liver Disease		
				Yes	3.8(0.8,19.1)	0.103

Table 4–3 Variables' association with admission to intense care units (age between 40 and 59)

※Age group of under 40 and 60–79 did not converge.

Variable		RR	P-value	Variable	RR	P-value
Sex	Female			Hypertension		
	Male	2.0(0.9,4.5)	0.087	Yes	0.7(0.3,1.5)	0.323
Systolic Blood Pressure	<140			Heart Failure		
	>140	0.8(0.4,1.9)	0.663	Yes	did not converge	
Heart rate	<100			Chronic Heart Disease		
	>100	0.7(0.2,2.7)	0.622	Yes	0.2(0.0,1.3)	0.088
Temperature	<37.5°C			Asthma		
	>37.5°C	1.4(0.5,4.3)	0.564	Yes	2.8(0.5,15.1)	0.229
Cough (+sputum)	No			COPD		
	Yes	1.9(0.8,4.5)	0.144	Yes	did not converge	
Myalgia (+malaise)	No			Chronic Kidney Disease		
	Yes	0.8(0.2,2.7)	0.673	Yes	4.6(1.4,15.6)	0.013
Vomiting (+diarrhea)	No			Cancer		
	Yes	1.1(0.3,3.8)	0.865	Yes	2.6(0.6,11.1)	0.209
Diabetes	No			Chronic Liver Disease		
	Yes	1.4(0.6,3.5)	0.497	Yes	3.1(0.3,36.9)	0.376

Table 4 – 4 Variables' association with admission to intense care units (age 80 or higher)

Variable	RR	P-value	Variable	RR	P-value
Age groups	40-59		No		
	60-79	4.7(2.4,9.1)	Hypertension		
	>80	49.5(22.6,108.4)	Yes	1.9(1.1,3.1)	0.015
Systolic Blood Pressure	<140		No		
	>140	1.1(0.7,1.7)	Heart Failure		
	<100		Yes	2.5(1.0,6.3)	0.050
Heart rate	>100	2.7(1.6,4.5)	Chronic Heart Disease		
	<37.5°C		Yes	0.8(0.3,1.9)	0.596
Temperature	>37.5°C	3.3(2.0,5.4)	Asthma		
	No		Yes	2.7(1.1,6.7)	0.036
Cough (+sputum)	Yes	0.8(0.5,1.3)	COPD		
	No		Yes	2.1(0.4,10.4)	0.383
Myalgia (+malaise)	Yes	1.1(0.6,2.0)	Chronic Kidney Disease		
	No		Yes	4.7(1.7,13.0)	0.003
Vomiting (+diarrhea)	Yes	1.2(0.6,2.4)	Cancer		
	No		Yes	1.5(0.5,4.3)	0.495
Diabetes	Yes	2.4(1.5,3.8)	Chronic Liver Disease		
	No		Yes	0.9(0.1,7.4)	0.937

Table 5–1. Variables' association with death(female).

Variable		RR	P-value	Variable	RR	P-value
Age groups	40-59			No		
	60-79	4.7(2.4,9.1)	0.000	Hypertension		
	>80	49.5(22.6,108.4)	0.000	Yes	1.1(0.7,1.8)	0.593
Systolic Blood Pressure	<140			No		
	>140	1.1(0.7,1.7)	0.750	Heart Failure		
	<100			Yes	1.5(0.5,4.7)	0.540
Heart rate	>100	2.7(1.6,4.5)	0.000	Chronic Heart Disease		
	<37.5°C			No		
	>37.5°C	3.3(2.0,5.4)	0.000	Yes	0.9(0.4,1.9)	0.766
Cough (+sputum)	No			No		
	Yes	0.8(0.5,1.3)	0.394	Asthma		
	No			Yes	0.7(0.2,3.1)	0.640
Myalgia (+malaise)	Yes	1.1(0.6,2.0)	0.700	COPD		
	No			No		
	Yes			Yes	1.1(0.3,3.8)	0.913
Vomiting (+diarrhea)	No			Chronic Kidney Disease		
	Yes	1.2(0.6,2.4)	0.585	Yes	0.8(0.2,2.9)	0.787
	No			No		
Diabetes	Yes	2.4(1.5,3.8)	0.000	Cancer		
	No			Yes	3.5(1.6,7.5)	0.002
	Yes			Chronic Liver Disease		
	No			Yes	0.9(0.3,3.1)	0.853

Table 5-2. Variables' association with death (male).

Variable		RR	P-value	Variable	RR	P-value
Sex	Female					
	Male	3.9(1.1,13.6)	0.034	Hypertension	No	
Systolic Blood Pressure	<140				Yes	1.5(0.4,5.0) 0.553
	>140	0.5(0.2,1.7)	0.260	Heart Failure	No	
Heart rate	<100				Yes	did not converge 0.998
	>100	6.3(1.9,20.3)	0.002	Chronic Heart Disease	No	
Temperature	<37.5 °C				Yes	4.4(0.5,41.7) 0.192
	>37.5 °C	9.1(2.7,30.9)	0.000	Asthma	No	
Cough (+sputum)	No				Yes	did not converge 0.993
	Yes	0.7(0.2,2.1)	0.506	COPD	No	
Myalgia (+malaise)	No				Yes	did not converge 0.996
	Yes	0.1(0.0,1.0)	0.049	Chronic Kidney Disease	No	
Vomiting (+diarrhea)	No				Yes	4.3(0.4,50.4) 0.247
	Yes	0.6(0.1,5.3)	0.671	Cancer	No	
Diabetes	No				Yes	3.9(0.6,24.2) 0.138
	Yes	2.2(0.6,7.3)	0.218	Chronic Liver Disease	No	
					Yes	6.4(0.7,60.0) 0.102

Table 5–3 Variables' association with death (age between 40 and 59)

※ Age group of under 40 did not converge.



Variable	RR	P-value	Variable	RR	P-value
Sex			Hypertension		
Female			No		
Male	2.5(1.5,3.9)	0.000	Yes	1.6(1.0,2.5)	0.054
Systolic Blood Pressure			Heart Failure		
<140			No		
>140	0.8(0.5,1.2)	0.305	Yes	4.6(1.6,13.4)	0.006
Heart rate			Chronic Heart Disease		
<100			No		
>100	2.5(1.5,4.0)	0.000	Yes	0.8(0.3,1.8)	0.566
Temperature			Asthma		
<37.5°C			No		
>37.5°C	2.4(1.5,3.9)	0.001	Yes	1.9(0.6,6.1)	0.261
Cough (+sputum)			COPD		
No			No		
Yes	1.0(0.6,1.5)	0.883	Yes	2.8(0.8,10.1)	0.116
Myalgia (+malaise)			Chronic Kidney Disease		
No			No		
Yes	1.0(0.6,1.7)	0.888	Yes	3.9(0.9,16.7)	0.067
Vomiting (+diarrhea)			Cancer		
No			No		
Yes	1.0(0.5,1.9)	0.919	Yes	3.1(1.4,6.8)	0.006
Diabetes			Chronic Liver Disease		
No			No		
Yes	1.9(1.2,3.1)	0.006	Yes	0.3(0.0,2.0)	0.195

Table 5–4 Variables' association with death (age between 60 and 79)

Variable		RR	P-value	Variable	RR	P-value
Sex	Female			Hypertension		
	Male	1.7(1.0,2.9)	0.042			
Systolic Blood Pressure	<140			Heart Failure		
	>140	1.2(0.7,2.0)	0.486			
Heart rate	<100			Chronic Heart Disease		
	>100	1.8(0.8,3.8)	0.135			
Temperature	<37.5°C			Asthma		
	>37.5°C	1.8(0.9,3.8)	0.124			
Cough (+sputum)	No			COPD		
	Yes	1.2(0.7,2.1)	0.506			
Myalgia (+malaise)	No			Chronic Kidney Disease		
	Yes	0.6(0.2,1.3)	0.166			
Vomiting (+diarrhea)	No			Cancer		
	Yes	1.2(0.6,2.7)	0.619			
Diabetes	No			Chronic Liver Disease		
	Yes	2.2(1.3,3.9)	0.005			

Table 5–5 Variables' association with death (age 80 or higher)