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Chronic Disease and Other Determinants in Deaths Due to COVID-19 From a Health Protection and Promotion Perspective: A Retrospective Analysis

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Abstract

Objective: To examine the age, gender, and chronic disease status of patients who died due to coronavirus disease 2019 (COVID-19) during the pandemic process and the effects of these diseases on their deaths.

Methods: It was a retrospective retrospective analysis with 2715 patients. The statistics of the patients who met the research criteria were evaluated from the hospital database. Patients were evaluated in terms of age, gender, length of hospital stay, presence of chronic disease, and Modified Comorbidity Index Scores.

Results: It was determined that the Modified Charlson Comorbidity Index (MCCI) score mean of the patients was 4.74 ± 2.07 and MCCI scores of 56.9% were serious. There was a statistically significant difference in the length of hospital stay according to the number of diseases the patient had, age, and MCCI score. It was determined that there was a statistically significant, negative and high-level correlation between MCCI score and the length of hospital stay ($r = -0.075$: $P = 0.001$).

Conclusions: Age, comorbidity score, and the number of comorbidities were found to affect the length of hospital stay, ie death. For this reason, it is recommended to use comorbidity indices in health protection and development studies, in the field, as well as in the clinics.

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection first appeared in China at the end of 2019 and has rapidly turned into a global pandemic. The virus spread rapidly around the world, infecting 246 million people as of November 2, 2021, and causing the death of approximately 5 million people.[1]

In the coronavirus disease 2019 (COVID-19) pandemic, which has no defined vaccine and no effective treatment, and is now considered a pandemic, health systems have been overly focused on strategies to prevent infection and prioritize, triage, and treat patients with COVID-19. By focusing almost exclusively on strategies to reduce the infection of COVID-19 pandemic, the important role of primary care in maintaining and managing the health of those with chronic diseases has had to be overlooked. However, studies have identified chronic diseases as one of the most important factors affecting the severity and consequences of COVID-19. In studies examining deaths caused by COVID-19, it was determined that chronic disease and comorbidity affect deaths.[2–9] Despite the studies, there is no definite conclusion on the subject. The patient's sex, age, or comorbid diseases cause adverse clinical outcomes, but their relationship to the risk of death has not been fully established. However, it is anticipated that the disease, patient gender, age, and comorbidity may make these patients more vulnerable to increased mortality or increased risk of infection. Some studies show that COVID-19 is shown higher in men than women, while others show no similar findings.[8,10–13] Although age over 50 y was found to be a risk factor for COVID-19 in some studies, similar findings were not obtained in other studies.[14–17] The prevalence of comorbidities in COVID-19 patients is also highly variable in many studies.[18] Although studies are still ongoing, the effect of social determinants such as chronic diseases, age, and gender on deaths caused by COVID-19 is still being investigated.

Public health professionals have faced 3 main challenges during the pandemic process. First, to determine the impact of COVID-19 on individuals with chronic diseases, to protect them, prevent the disease, and enable them to manage chronic disease processes. Second, only because the process related to COVID-19 was carried out, preventive health services for chronic diseases were not implemented and these diseases could not be diagnosed, prevented, and managed. Finally, the physical, psychological, and social problems created by the COVID-19 pandemic have not yet been identified.[19] For this reason, preventive health services that have been suspended during the pandemic process should be planned and put into operation. To do this, it is necessary to know the factors such as the chronic disease, comorbidity index, age, and gender that cause death due to COVID-19 in the society and to plan the services according to these data. Thus, this study was conducted to examine the age, gender and chronic disease status of patients who died due to COVID-19 during the pandemic process and their effects on their deaths.

Research questions;

1. What is the distribution of age, gender, length of stay in the hospital, chronic disease, and comorbidity indexes of patients who died due to COVID-19?
2. Is there a difference between the age, gender, chronic disease, length of stay in the hospital, and comorbidity indexes of patients who died due to COVID-19?
3. Is there a relationship between the index and number of comorbidities and the length of stay in the hospital?

Methods

Purpose and Type of Research

It was conducted as a retrospective analysis to examine the age, gender, and chronic disease status of patients who died due to COVID-19 during the pandemic process and their effects on their deaths.

Population and Sample of the Research

The population of the study consisted of 2715 patients who lost their lives due to COVID-19 between January 10, 2020, and January 12, 2021, in a City Hospital located in Central Anatolia, which was determined as one of the pandemic hospitals by the Turkish Ministry of Health.

Inclusion Criteria for Research

Inclusion criteria were (1) death caused by a confirmed COVID-19 diagnosis between January 10, 2020, and January 12, 2021; (2) diagnosis of a case by a positive result on any of the COVID-19 tests.

Exclusion Criteria for Research

Exclusion criteria were (1) inability to diagnose a definitive case from any of the COVID-19 tests, and (2) patients with missing data.

Data Collection Tools and Data Collection

The data of the study were collected using a City Hospital database, which was determined as a pandemic hospital in the Central Anatolian region by the Turkish Ministry of Health. The statistics of patients who died due to the diagnosis of COVID-19 between January 10, 2020, and January 12, 2021, were evaluated in the database. The patients were evaluated in terms of age, gender, length of hospital stay, presence of chronic disease, and comorbidity index.

The Modified Charlson Comorbidity Index (MCCI) was created by modifying the Charlson comorbidity Index. The Charlson Comorbidity Index (CCI) is a validated, simple, and easily applicable method for estimating the risk of death from comorbid disease and is widely used as a predictor of long-term prognosis and survival.[20,21] The Charlson Comorbidity Index score system was developed by Mary E. Charlson in 1987. It aimed to objectively classify and score the comorbidities of patients. Charlson, who stated that risk factors such as diabetes, cerebrovascular accident (CVA), cardiovascular disease, and malignancy may also affect survival, and this cannot be ignored when calculating mortality rates during scientific research, developed this scoring system. The Index includes 19 medical conditions scored as 1, 2, 3, and 6 according to the clinical aggravation rate of comorbidity. The total score ranges from 0 to 37. Scoring is based on the 12-mo relative risk of mortality for each disease. CCI can be easily modified according to the age factor. The difference between MCCI and CCI is that 1 point is added to the index for every 10 y over the age of 40. It has been reported in reviews that it correlates well with mortality and gives reliable results.[22,23]

Evaluation of Data

The data obtained in the research were analyzed using the SPSS (Statistical Package for Social Sciences) for Windows 25.0 program. Descriptive statistical methods (number, percentage, mean, standard deviation) were used while evaluating the data. In addition to the normality tests of the data, histogram, Q-Q graph, and box-plot graphs were evaluated with skewness and kurtosis values. In cases where the normal distribution was achieved, the independent sample t-test was used for the 2 groups to compare the quantitative data, while the F-test was used for more than 2 groups. The difference between the 2 groups, in which the normal distribution was not achieved, was analyzed with the Mann Whitney U-test. Moreover, the Kruskal Wallis H test was used for comparison between more than 2 groups. The relationship between continuous variables was examined by spearman correlation analysis.

Ethical Aspect of the Research

Academic permission from the Faculty of Health Sciences of Erciyes University, ethical permission from the Social and Human Ethics Committee (application no: 466; date: December 28, 2021), and institutional permission were obtained.

Results

When the demographic and disease characteristics of the participants were examined, it was found that 55.7% of the patients were male, 41.5% were between the ages of 66 and 79, and 12.1% had no disease. It was determined that the mean MCCI scores of the patients was 4.74 ± 2.07 and the MCCI scores of 56.9% were severe. The length of hospital stay was calculated as 78 ± 13.92 (Table 1).

In Table 2, it was found that there was no statistically significant difference in the length of hospital stay of the patient according to the patient's gender and disease state ($P > 0.05$). However, it was determined that there was a statistically significant difference in the length of hospital stay according to the number of diseases the patient had ($P < 0.05$). It was concluded that individuals with 3 diseases had a shorter hospital stay compared with those with 1 and 2 diseases. Moreover, individuals with 6 diseases were hospitalized in a shorter time than those with 1, 2, 4, and more than 7 diseases. It has been determined that the length of hospital stay varies according to the age of the patient ($P < 0.05$). It was found that people over the age of 80 had a shorter hospital stay than those aged between 18-65 and 65-79.

According to the high MCCI value, there was a statistically significant difference between the duration of hospital stay of the patients ($P < 0.05$). It was determined that individuals with a moderate MCCI score had a longer hospital stay than those with a severe score (Table 2).

It was observed that there was a statistically significant difference between the duration of hospital stay of the patients according

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Table 1. Demographic and disease characteristics of the participants

		n	%
Gender	Female	1204	44.3
	Male	1511	55.7
Age	0-18 y, adolescent	8	0.3
	18-50 y, young adult	193	7.1
	51-65 y, middle adult	530	19.5
	66-79 y, middle-aged	1126	41.5
	≥ 80 y, old	858	31.6
Age → 71.92±13.53			
Total number of diseases	No disease	329	12.1
	1 disease	738	27.2
	2 diseases	810	29.8
	3 diseases	472	17.4
	4 diseases	199	7.3
	5 diseases	65	2.4
	6 diseases	52	1.9
	7 diseases	23	0.8
	8 diseases	20	0.7
	9 diseases	4	0.1
	10 diseases	3	0.1
Disease state	Presence of disease	329	12.1
	Absence of disease	2386	87.9
Modified Comorbidity İndex Scores (MCCI)	None (0)	74	2.7
	Low (1-2)	293	10.8
	Moderate (3-4)	803	29.6
	Severe (<5)	1545	56.9
Modified Comorbidity İndex (MCCI) → 4.74 ± 2.07			
Length of hospital stay (days) → 78 ± 13.92			

to the presence of congestive heart failure and metastatic solid tumor ($P < 0.05$). It was found that patients without congestive heart failure and metastatic solid tumors had longer hospital stays (Table 3).

A statistically significant and negative correlation was found between the number of comorbidities and the length of hospital stay of patients without the disease ($r = -0.122$; $P < 0.05$). A statistically significant, negative correlation was found between the comorbidity index values of patients with a disease and the length of stay in the hospital ($r = -0.113$; $P < 0.05$). It was determined that there was no statistically significant relationship between hospital stay and comorbidity index values of patients with 2 or more diseases ($P > 0.05$) (Table 4).

A statistically significant, negative, and high-level correlation was found between the MCCI score and the length of hospital stay ($r = -0.075$; $P = 0.001$) (Table 5).

Discussion

To date, studies have been conducted to investigate the characteristics of patients and deaths caused by COVID-19. The evaluation of the hospital stay of the patients who died in our study until the death process contributes to the literature. It was found that 55.7% of the patients who died in the study were male and 44.3% were female. Similarly, in the studies conducted by Biswas et al. (2021) and Semenzato et al. (2021), men who had COVID-19 were significantly increased compared with women, and this was associated with an increased risk of mortality.[24,25] Although it is not known for certain, it has been argued in some sources that this situation is due to angiotensin-converting enzyme 2 (ACE2). It is thought that more males die because the expression of ACE2, which is encoded by the ACE2 gene and located on the X-chromosome.[26] Other sources have also suggested that ACE2 may protect patients from organ injury and improve clinical outcomes in infected patients.[27,28] In addition to the higher mortality in male patients, our study found that there was no statistically significant difference in the length of hospital stay according to the gender of the patient ($P > 0.05$). Male individuals may carry a higher risk for morbidity and mortality compared with females, but it can be said that the gender factor does not affect the process from illness to death.

Age is a determinant that can change the course of diseases. The mean age of the patients who died in the study was 71.92 ± 13.53 y, 7.4% were 50 y old or younger, 41.7% were 66-79 y old, and 31.6% were older than 80 y old. Similarly, in the study of Biswas et al. (2021), patients aged ≥50 y were associated with a 15.4-fold higher risk of mortality compared with patients aged <50 y.[24] In our study, it was determined that the length of hospital stay differed according to the age of the patient. The length of stay in hospital for people over 80 y of age was found to be shorter than those aged between 18-65 and 65-79 y. In other words, the deaths of individuals over the age of 80 occur in a shorter time. Natural immunity decreases with age, and the tendency to develop infections increases.[29] Furthermore, they may be vulnerable to adverse drug reactions due to increased comorbidity and decreased organ functions.[30] In the study in 2021, Semenzato et al. found that the risk of in-hospital death associated with COVID-19 increased by more than 100 times in people aged 85 and over compared with people aged 40-44.[25] The results of our study were found to be compatible with the literature, but it is seen that 26.9% of the deceased individuals were 50 y old or younger. It is thought that the evaluation of young people at risk of chronic diseases, their follow-up, and protection will gain importance due to the fact that the risk of death and the length of hospitalization in young patients are longer compared with those of advanced age.

In the study, it was found that 12.1% of the individuals who died did not have a disease, and 87.9% had 1 or more diseases. In the study, the mean score of the MCCI was 4.74 ± 2.07, the index score of 56.9% was severe, 29.6% was moderate, and 10.8% was low. Similarly, in the study of Iaccarino et al. (2020) in which they compared the data of deceased and surviving patients, they found that the Charlson Comorbidity Index scores of those who died were higher than those who survived, and this difference was significant (4.3 ± 0.15 vs 2.6 ± 0.05; $P < 0.001$).[31] In addition, Djaharuddin et al. (2021) found that more than half (52.56%) of patients who died from COVID-19 had comorbidities ≥2 and the rest had only 1 comorbidity.[32] It is thought that the reason for this may be that more chronic diseases cause worse clinical outcomes. Guan et al. (2020) stated that more comorbidities cause worse clinical outcomes, and the hazard ratio was 1.79.[33] In our study, it was determined that there was a statistically significant difference in the length of hospital stay according to the number of diseases the individual had ($P < 0.05$). It was concluded that individuals with 3 diseases had a shorter hospital stay compared with those with 1 and 2 diseases, and patients with 6 diseases were hospitalized in a

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Table 2. Comparison of hospital stay according to demographic and disease characteristics of patients

Length of hospital stay		Mean	SS	Med	Min	Max	Test	*P*-Value	Post hoc
Gender	Female	13.64	10.48	12.0	0.0	78.0	z=-1.001	0.317	———
	Male	14.15	11.03	12.0	0.0	67.0			
Age	0-18 y[1]	10.50	7.29	9.0	1.0	26.0	KW=13.688	0.003*	4<2.3
	18-65 y[2]	14.07	11.11	12.0	0.0	62.0			
	66-79 y	14.25	10.85	12.0	0.0	78.0			
	≥ 80 y[4]	12.76	9.91	11.0	0.0	66.0			
Total number of diseases	1 disease	14.69	11.17	12.0	0.0	67.0	KW=17.159	0.009*	3<1.2 6<4.2.1.7
	2 diseases	14.10	10.94	12.0	0.0	78.0			
	3 diseases	12.76	9.94	10.0	0.0	59.0			
	4 diseases	13.21	9.85	12.0	0.0	53.0			
	5 diseases	13.06	10.04	11.0	0.0	61.0			
	6 diseases	11.73	12.88	6.0	1.0	59.0			
	7 or more	15.28	12.47	12.00	0.0	65.0			
MCCI Value	None[0]	16.03	12.20	13.0	0.0	62.0	13,991	0.003*	2>3
	Low[1]	15.18	12.04	13.0	0.0	64.0			
	Moderate[2]	14.61	10.89	12.0	0.0	67.0			
	Severe[3]	13.23	10.36	11.0	0.0	78.0			
Disease State	Presence of disease	14.18	10.68	12.0	0.0	63.0	z=-0.566	0.572	
	Absence of disease	13.89	10.81	12.0	0.0	78.0			

Abberviations: KW, Kruskal Wallis H test; z, Mann Whitney U test.

Table 3. Comparison of the hospital stay according to the comorbidities of the patients

Comorbidities		Mean	SS	Med	Min	Mak	n	z	*P*-Value
Myocardial infarction	None	13.93	10.75	12.0	0.0	78.0	2533	−0.654	0.513
	Available	13.81	11.40	11.0	0.0	53.0	182		
Congestive heart failure	None	14.03	10.73	12.0	0.0	69.0	2464	−2.364	0.018*
	Available	12.87	11.33	10.0	0.0	78.0	251		
Peripheral vascular disease	None	14.19	10.95	12.0	0.0	78.0	1480	−1.339	0.181
	Available	13.61	10.60	12.0	0.0	69.0	1235		
Cerabrovascular disease	None	13.88	10.74	12.0	0.0	78.0	2590	−0.533	0.594
	Available	14.74	11.83	12.0	0.0	66.0	125		
Dementia	None	13.92	10.73	12.0	0.0	78.0	2510	−0.602	0.547
	Available	13.96	11.53	11.0	0.0	54.0	205		
Chronic pulmonary disease	None	14.06	10.87	12.0	0.0	78.0	2111	−1.008	0.314
	Available	13.44	10.52	12.0	0.0	69.0	604		
Diabetes mellitus (mild)	None	14.09	10.82	12.0	0.0	69.0	1901	−1.490	0.136
	Available	13.53	10.71	11.0	0.0	78.0	814		
Moderately severe kidney disease	None	13.88	10.92	12.0	0.0	78.0	2284	−1.300	0.194
	Available	14.15	10.12	12.0	0.0	61.0	431		
Organ damage diabetes	None	13.86	10.75	12.0	0.0	78.0	2635	−1.751	0.080
	Available	16.03	11.82	14.0	0.0	61.0	80		
Non-metastasized tumor	None	13.96	10.86	12.0	0.0	78.0	2596	−0.285	0.775
	Available	13.12	9.10	12.0	0.0	35.0	119		
Leukemia	None	13.90	10.73	12.0	0.0	78.0	2675	−0.439	0.660
	Available	15.73	14.38	13.5	1.0	65.0	40		
Metastatic solid tumor	None	13.96	10.75	12.0	0.0	78.0	2636	−1.980	0.048*
	Available	12.65	12.23	10.0	0.0	65.0	79		

Abbreviation: z, Mann Whitney U test.

shorter time than those with 1, 2, 4, and more than 7 diseases; this means that they die faster. In the present study, it was found that there was a statistically significant difference between the length of hospital stay of the patients according to the high MCCI score. The fact that patients with moderate MCCI scores have a longer hospital stay, that is, they die later, reveals that knowing the comorbidity score is important for the protection and planning of patients.

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Table 4. Relationship between the length of hospital stay and the number of comorbidities

	n	r	p
No disease	329	**-0.122***	**0.027**
1 disease	738	**-0.113****	**0.002**
2 diseases	810	−0.50	0.155
3 diseases	472	−0.015	0.741
4 diseases	199	−0.027	0.708
5 diseases	65	0.070	0.581
6 diseases	52	0.033	0.814
7 or more diseases	50	0.118	0.415

*Correlation is significant at the 0.05 level.
**Correlation is significant at the 0.01 level.

Table 5. Relationship between length of hospital stay and Modified Comorbidity Index (MCCI)

	Length of hospital stay	MCCI
Length of hospital stay	–	–
MCCI	r=-0.075** $P = 0.001$	–

**Correlation is significant at the 0.01 level.

In the study, it was observed that there was a statistically significant difference between the duration of hospital stay of the patients according to the comorbidities, whether or not they had congestive heart failure and metastatic solid tumor ($P < 0.05$). According to the results, the presence of congestive heart failure and solid tumor causes patients to die in a shorter time. Similarly, in other studies, it was found that the mortality rate was higher in patients with hypertension, diabetes, cardiovascular diseases, obesity diseases, malignancies and comorbidities.[24,32,34–36] It is thought that this finding may be due to the angiotensin-converting enzyme 2 (ACE2), but there is no conclusive evidence.

Comorbidities in the patient affect the chances of survival. In studies, it has been determined that a 1-point increase in the CCI increases the probability of mortality between 16% and 32%, and a higher CCI score is associated with increased mortality and disease severity in COVID-19 patients.[35,37] In our study, a statistically significant and negative correlation was found between the patients who did not have the disease and those who had a disease, and the length of stay in the hospital. Furthermore, a statistically significant, negative, and high-level correlation was determined between the MCCI score and the length of hospital stay (r = −0.075; $P = 0.001$). This situation makes us think that, if the individual has no chronic disease, has 1 disease, or is young, which affects the comorbidity score, the time until death is prolonged, hence, the individual can be treated. However, it can be said that, as the age of the individual increases and the number or score of comorbidity increases, time until the death of the individual accelerates and the chance of intervention decreases.

Conclusions

In the study, it was found that male individuals had a higher risk of disease and mortality compared with females, but the gender factor did not affect the process from disease to death. Therefore, it is recommended to make protective plans for male individuals by considering the gender factor in the society served.

In the study, it was determined that the deaths of individuals over the age of 80 occurred in a shorter time, but 26.9% of the individuals who died were under the age of 50 and the period until death was longer. For this reason, it is important to follow up, treat, and prevent chronic diseases for all age groups. However, measures to be taken to prevent chronic diseases are gaining importance, especially for young and middle-aged individuals. In this process, it focused on the detection and follow-up of COVID-19 disease, and primary health-care and other preventive services were interrupted. For this reason, primary health-care services should be given to the whole group with care and should be maintained. On the other hand, it is thought that the chronic disease follow-up and prevention studies, which are carried out routinely, can be reduced to younger ages to reduce the risks.

In the study, the mean score of the MCCI was 4.74 ± 2.07, and the index score of 56.9% was serious. Moreover, it was found that those with a moderate MCCI score had a longer hospital stay than those with a severe score. In addition, a statistically significant, negative, and high-level correlation was found between the MCCI score and the length of hospital stay in the study. For this reason, it is predicted that creating risk maps for patients by evaluating comorbidity scores in clinics and in the field and performing preventive practices will reduce mortality rates. In the present study, it was found that the presence of congestive heart failure and solid tumor caused patients to die in a shorter time. Because congestive heart failure and metastatic solid tumor accelerate mortality rates, it can be recommended that individuals with this diagnosis be followed up regularly even if they are not infected. Furthermore, it is thought that risk factors will be reduced by performing heart failure and cancer screenings for healthy individuals.

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