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ORIGINAL ARTICLE

Effect of Chronic Disease Mortality on COVID-19 Fatality Rate

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Abstract

Introduction: COVID-19 is a highly contagious disease that was caused by the coronavirus family SARS-CoV-2 and which emerged in China in 2019. This study aimed to investigate the effect of chronic disease mortality on the COVID-19 fatality rate.

Methods: In our study, a total of 44 countries including 37 OECD countries were evaluated. A model was created with variables including death percentages of cardiovascular disease (CVD), cancer, chronic respiratory system diseases, diabetes and also age, gross domestic product (GDP), and the number of beds and the effect on COVID-19 fatality rate were evaluated. Multiple regression analysis was used to evaluate the model created.

Results: It was determined that the average age and diabetes deaths among the non-communicable disease deaths positively predicted the COVID-19 fatality rate. In the model created in the study, the effect of the number of patient beds, GDP, and deaths due to CVD, cancer, and chronic respiratory diseases on the COVID-19 fatality rate was not determined.

Discussion and Conclusion: In the study, older age and diabetes deaths positively predicted the COVID-19 fatality rate. In regions with high average age and diabetes mortality, additional policies may be required to reduce the COVID-19 fatality rate.

Keywords: COVID-19; mortality rate; non-communicable disease.

Coronavirus disease that emerged in Wuhan, China in December 2019 rapidly spread all over the world. The virus called Severe Acute Respiratory Syndrome Coronavirus 2 (SAR-CoV-2) belongs to the subtype arbovirus in the subfamily Orthocoronavirinae and COVID-19 was defined as the pathogenesis of the disease in January 2020[1].

Although fatality rates of SARS and Middle East Respiratory Syndrome Coronavirus (MERS-CoV) were higher SARS-CoV-2 infection caused a higher number of deaths. Although COVID-19 is asymptomatic in some patients and mild in about 80% of the patients, it is fatal in others.[2] The fatality rate reveals a significant differences among the countries. Although the rates can change with the number of tests performed differences in mortality rates of the countries have been associated with age and comorbid diseases. COVID-19 has caused a very severe number of deaths in cities such as Lombardy, Madrid, and New York[3,4].

Viral clearance can last more than 15 days from the onset of the disease in old patients, patients with hypertension, and male patients[5]. Data obtained from Italy, Spain, Sweden, Switzerland, the United Kingdom, France, the Netherlands, and the USA reveal that severe disease and mortality rates are higher in COVID-19 patients with comorbid disease. In general, the ratio of male to female is 2.7 in critical patients. Hypertension, diabetes, cardiovascular disease (CVD), chronic respiratory disease (CRD),

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weak immune system, cancer, and obesity can be among the underlying diseases in COVID-19 patients admitted to the intensive care unit[6-9].

According to the data from 26 countries in 2012, about 50% of the MERS-CoV patients resulting in 586 deaths had diabetes and hypertension, 30% had a cardiac disease, and 16% had obesity. It is reported that diseases associated with metabolic syndrome such as diabetes, hypertension, CVD, and obesity may be associated with the pathogenesis of MERS-CoV and weaken the immune system against coronavirus disease[10]. Similarly, it is reported that in the case the elderly with comorbidity and patients especially with hypertension, coronary artery disease (CAD), or diabetes are infected with SARS-CoV-2 that they develop severe symptoms. Publications are reporting that those with CVD account for a large part of COVID-19 deaths. According to the mortality data published by the Chinese National Health Commission, 35% of the patients with SARS-CoV-2 infection have hypertension history and 17% have CAD history[11].

Causes of mortality account for the basic data to detect the tendencies of the public toward death and their health conditions. CADs, stroke, lower respiratory tract infections, and CRD have remained the most important causes of death for the last 10 years. Furthermore, dementia and diabetes in high-income countries cause a severe number of deaths[12]. Although the mortality rate of CAD in Western countries has considerably decreased thanks to the improvement of primary protection, diagnosis, and treatment in recent years, metabolic risk factors such as diabetes, hypertension, and obesity have increased[13].

This study aimed to investigate the effect of the causes of non-communicable disease mortality on COVID-19 fatality rate in the Organization for Economic Cooperation and Development (OECD) countries.

Materials and Methods

Participants

This study is observational and descriptive research and aimed to assess the relationship between the dependent variable COVID-19 fatality rate and chronic disease mortality considering the independent variables including average age, gross domestic product (GDP), and the number of patient beds (per 1000 persons). Among chronic disease mortalities, death percentages of CVD, CRD, cancer, and diabetes were included in the study.

A total of 44 countries that are OECD countries and that have data in OECD including South Africa, Russia, China, India, Indonesia, Costa Rica, and Brazil were included in the study. Countries' annual data on chronic disease deaths belonging to the very recent years were obtained as death percentages from the 2016 data of the World Health Organization[14]. The total average age, number of deaths, and country populations of the COVID-19 patients were obtained from Worldometers on the February 16, 2021[15]. The data on the number of hospital beds (per 1000 persons) were obtained from OECD and GDP data of the countries were obtained from the World Bank[16,17].

The fatality rate is calculated with the formula of (Total number of deaths caused by COVID-19/Number of COVID-19 patients)×100.

The study was approved by the Ministry of Health Scientific Research Platform (Approval number: 2020-05-02 T19_21_30).

Statistical Analysis

Statistical analyzes were performed using the Statistical Package for the Social Science-21 (IBM, Armonk, NY, USA) software program published in 2018. Mean and standard deviation were used in the determination of descriptive statistics. Logarithmic transformation was used for the fatality rate and the non-normally distributed dependent variable. Multiple regression analysis was used to assess the effect of independent variables including average age, GDP, number of patient beds, and death percentages of chronic diseases on fatality rate and the dependent variable.

Results

A total of 44 countries were included in the study and the fatality rate, age, the number of patient beds, GDP, and mean mortality rates of the chronic diseases in these countries are given in Table 1.

Table 1. Mean and standard deviation values of the variables in the countries included in the study

n=44	Mean±SD
Fatality rate	2.26±1.35
Average age (Year)	39.71±5.48
Number of beds*	4.29±2.68
GDP (dollar)	35658.79±25672.24
CVD mortality (%)	33.66±9.48
Cancer mortality (%)	24.96±5.73
CRD mortality (%)	6.21±2.22
Diabetes mortality (%)	3.05±2.37

GDP: Gross domestic product; CVD: Cardiovascular disease; CRD: Chronic respiratory disease.

The multiple regression model was created using the independent variables such as average age, the number of beds per thousand persons, GDP, and death percentages of CVD, cancer, CRD, and diabetes in the model to predict the COVID-19 fatality rate of the countries.

As a result of the analysis, a significant regression model was found: F (7, 36) 3.76, p=0.004. Independent variables explained 31% of the variance in the dependent variable (adjusted r^2=0.31).

The variance analysis of the variables affecting the COVID-19 fatality rate and model is shown in Table 2 and the distribution graph in Figure 1.

According to the multiple regression analysis, average age and diabetes deaths in countries analyzed statistically significantly and positively affected the COVID-19 fatality rate, which suggests that the death percentage of diabetes statistically significantly affects the COVID-19 fatality rate in the same direction, ß=0.58, t (36)=3.13, p=0.003, and pr^2=0.21, which means the effect size of diabetes variable on fatality rate is 0.21. Countries' average age statistically significantly affects COVID-19 fatality rate in the same direction as well, ß=0.61, t (36)=2.66, p=0.012, and pr^2=0.12, which means the effect size of average age variable on fatality rate is 0.12. The results of multiple regression analyzes are shown in Table 3.

Number of beds per 1000 persons, GDP and death percentages of CVD, cancer and CRD had no statistically significant effect on COVID-19 fatality rate (ß=0.001, t [36]=0.003, and p:0.997; ß=–0.301, t [36]=–1.803, and p:0.080; ß=0.158, t [36]=0.722, and p:0.475; ß=–0.192, t [36]=–0.911, and p:0.369; and ß=0.311, t [36]=1.777, and p:0.084, respectively).

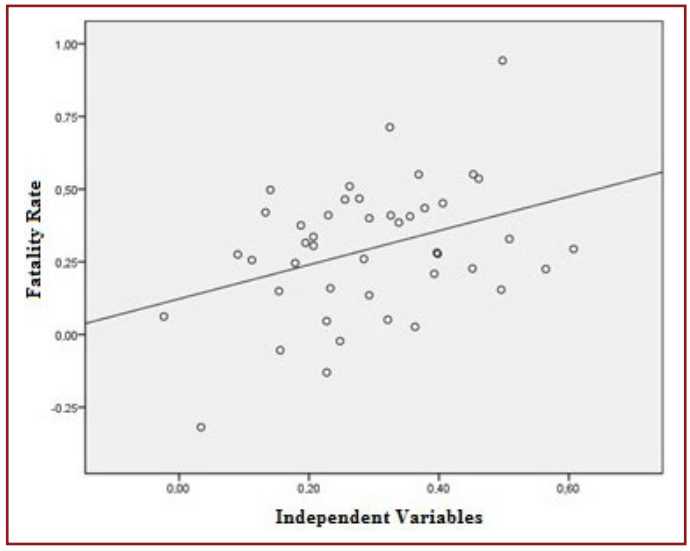

Figure 1. Regression distribution graph.

Table 2. Variance analysis

Model		Total sum of squares	d.f	Mean squares	F	p
1	Regression	0.926	7	0.132	3.762	0.004
	Residual	1.265	36	0.035		
	Total	2.191	43			

Discussion

Advanced age and chronic diseases affect deaths caused by COVID-19[18-20]. According to our study, countries' age average and the number of deaths caused by diabetes had a significant effect on the COVID-19 fatality rate in the same direction.

In a study performed with 906,849 COVID-19 patients in the United States of America, there were four previously available cardiometabolic conditions in most of the patients hospitalized. Of the patients hospitalized due to COVID-19, 30% had obesity, 26% had hypertension, 21%

Table 3. Multiple regression analysis results

Model		R2	Adj. R^2	B	ß	T	p	pr
1	Constant	0.42	0.31	–0.91		–2.249	0.031	
	Average age (year)			0.014	0.611	2.658	0.012	0.34
	Number of beds			<0.001	0.001	0.003	0.997	0.001
	GDP (dollar)			<–0.001	–0.301	–1.803	0.080	–0.29
	CVD Mortality (%)			0.004	0.158	0.722	0.475	0.12
	Cancer Mortality (%)			–0.008	–0.192	–0.911	0.369	–0.15
	CRD Mortality (%)			0.032	0.311	1.777	0.084	0.28
	Diabetes Mortality (%)			0.055	0.576	3.132	0.003	0.46

Dependent variable: Log (10) Fatality Rate, Number of beds: per 1000 persons, B: Unstandardized coefficient, ß: Standardized coefficient, pr: partial correlation, GDP: Gross domestic product, CVD: Cardiovascular disease, CRD: Chronic respiratory disease.

had diabetes, and 12% had heart failure. It was found that 10% of the decrease in cardiometabolic conditions would prevent hospitalizations due to COVID-19 at a rate of 11.1%[21]. Guiterrez et al.[22] reported in their study in Mexico that the mortality rate of COVID-19 was higher in men than in women and increased by age. The mortality rate of COVID-19 was higher in those diagnosed with obesity, diabetes, and hypertension compared to those without these diseases. In the study by Zhou et al.,[19] while there was a difference between deaths due to COVID-19 and survivals in terms of hypertension, CAD, chronic obstructive pulmonary disease, and chronic renal disease, there was no difference in terms of diabetes and cancer diseases.

Patients with diabetes and without diabetes were compared in a retrospective and multicenter cohort trial including 7337 COVID-19 patients in China and it was observed that the incidence of other chronic comorbid diseases and complaints of fatigue and dyspnea were higher in the diabetics. Decreased lymphocyte count, increased neutrophil count, high C-reactive protein (CRP), and elevation of interleukin (IL)-6 accepted as poor prognosis criteria of laboratory tests and mechanical ventilation need was found to be higher in diabetic patients. Moreover, the hospital mortality rate was revealed to be higher in the diabetics in the 28-day follow-up of the patients[23]. Guo et al.[24] investigated the risk factors affecting COVID-19 prognosis in their study and found similar results with the study performed in China. Among 174 COVID-19 patients, those with diabetes (n=24) had more severe pneumonia, the release of mediators caused by tissue injury and inflammation compared to those without diabetes. Hypercoagulability associated with glucose metabolism disorder was detected. Furthermore, serum levels of inflammatory biomarkers such as IL-6, CRP, serum ferritin, coagulation index, and D-dimer are significantly higher in diabetics. Diabetic patients are more sensitive to the inflammatory storm causing the course of COVID-19 to rapidly become more severe. The data support the idea that diabetes must be considered as a risk factor for rapid progress and poor prognosis of COVID-19.

Singh et al.[25] reported that diabetes was common comorbidity in COVID-19 patients and that poor glycemic control increased the mortality rates of COVID-19. Similarly, Zu et al.[23] reported that good glycemic control (3.9–10 mmol/L) decreased mortality rates in diabetic COVID-19 patients[23,25]. In the meta-analysis by Wu et al.,[26] there was a close relationship between diabetes and COVID-19 mortality.

Azarpazhooh et al.[27] assessed the COVID-19 pandemic and burden of non-communicable diseases in 185 countries and found a significant correlation between the burden of CAD and ischemic stroke and COVID-19 deaths. However, the same correlation was not found for total stroke, CVD, and hypertensive heart diseases. In the study by Gaur et al.[20] in India, more than 9.5 million COVID-19 cases and 135,000 deaths were reported at the end of November 2020 and a significant positive correlation was found between the risk factors of non-communicable diseases and COVID-19 deaths. A correlation with the mortality rates of obesity, hypertension, diabetes, CAD, and sociodemographic development indices such as literacy and access to health-care services was also observed. The mortality rate of COVID-19 in India was associated especially with obesity and diabetes among chronic diseases.

In our study, the effects of percentages of deaths due to chronic diseases in OECD countries on COVID-19 fatality rate were assessed and it was found that deaths caused by diabetes affected the COVID-19 fatality rate in the same direction (effect size: 21%), but deaths due to the other chronic diseases such as CVD, CRD, and cancer had no effect on COVID-19 fatality rate.

Age, gender, and comorbidity are basic determinants of the severity and course of COVID-19. Advanced age is a significant risk factor for the severity of COVID-19 disease[28]. In the study performed on 44,672 patients including 19 patients with the final diagnosis of COVID-19, Wu et al.[3] detected 1023 deaths and found the fatality rate as 2.3. This rate was 8% in the age group of 70–79 and 14.8% in the age group of 80 and above. According to the data of the Turkish Ministry of Health, the fatality rate was reported as 2.57% and the highest fatality rate (26.94%) was reported in patients at the age of 80 and above[29]. According to our study, countries' average age affected COVID-19 fatality rate in the same direction (effect size: 12%), which suggests that the COVID-19 fatality rate will be high in regions with a high age average.

In a study in New York, individuals in different income level groups were compared and a significant positive correlation was found between per capita income and negative COVID-19 test result. According to the results of the study, decreasing income increased the risk of getting the disease at a rate of 27%[30]. According to the study by Chung et al.,[31] the hospital bed occupancy rate increased COVID-19 morbidity and mortality. According to the model created in our study, GDP and the number of hospital beds did not have any effect on the COVID-19 fatality rate.

Conclusion

In the study, it was concluded that average age and percentages of diabetes death positively predicted the COVID-19 fatality rate, which suggests that the COVID-19 fatality rate will be high in regions that had a high average age and diabetes deaths. Additional measures may be required to reduce the number of deaths caused by COVID-19 in regions or countries with high average age and diabetes mortality compared with the others.

Limitations of the Study

The records of deaths due to COVID-19 are limited only to PCR-positive individuals in some countries, which may limit the number of deaths caused by this disease. Moreover, the data on independent variables in our study belong to years between 2015 and 2018; however, the COVID-19 epidemic is still present, and mortalities increase, which may require performing this study with up-to-date data after the pandemic.

Ethics Committee Approval: The study was approved by the Ministry of Health Scientific Research Platform (Approval number: 2020-05-02 T19_21_30).

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Authorship Contributions: Concept: A.D.; Design: A.D., E.K.; Data Collection or Processing: A.D.; Analysis or Interpretation: A.D.; Literature Search: A.D., E.K.; Writing: A.D., E.K.

Conflict of Interest: None declared.

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