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Contagious Effect of COVID-19 Pandemic by High Speed Train Transportation in Turkey

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ABSTRACT

The transportation sector was affected by the Covid-19 pandemic all over the world. In this study, the relationship between the passenger density at high-speed train points and the spread of the Covid-19 epidemic was examined. In addition, the temporal situation of the pandemic was examined by evaluating based on a year and month. In this context, high-speed train passenger movement is mathematically modelled using regression analysis. Strong relation between number of patient and number of passenger. As a result, it was observed that the number of patients increased as the number of passengers increased. In order to limit the epidemic, it may be recommended to increase measures especially in transportation centres.

1. INTRODUCTION

Towards the end of December, the Chinese government reported an outbreak of a novel coronavirus disease (COVID-19) in Wuhan city, Hubei Province, China [1]. The outbreak rapidly spread from Wuhan into all provinces of China and then at least 24 countries, which led the WHO (World Health Organization) to declare the coronavirus disease 2019 (COVID-19) outbreak a pandemic on March 11, 2020, when the disease was confirmed to have reached Turkey. Since then, COVID-19 had spread all over [2-4]. Transportation developments in the industry can reach many parts of the World. But when it comes to a disaster such as a pandemic, global transportation networks can contain significant threats [5]. Especially in long-distance travel, because of limited space in transportation the risk of disease transmission was increasing [6]. Pandemics are often seeing where places in mobile population, and transportation systems due to high population density [7]. Global transportation points such as airports, ports, and stations, can become easily the center of disease distribution. The reason for the rapidly spread of the Spanish Flu around the world is that the transportation systems are developed at the global level [8]. In a pandemic disease such as SARS, air and sea travels have a great effect on the spread of the disease [9]. Shen et. al., studied the experience of the prevention and control measures for public transportation in China to promote the global response to COVID-19 [10]. Setiawan et.al. studied constructs and visualizes bibliometric networks research in Covid19, Sustainable Mobility And Transportation Research [11]. Ballard in his study obtained that roadway and rail transportation further spread the infection across cities and countries [12].

Chechulin et al. in their study showed that the highest rate of spread of disease was seen in intercity public transportation and private transportation [13]. Public transport systems, cause it to be seen rapidly and intensely in megacities the spread of the virus by creating serious risks in the spread of diseases and the formation of pandemics [14,15]. Transportation developments in the industry can reach many parts of the World. But when it comes to a disaster such as a pandemic, global transportation networks can contain significant threats.

Considering the past experiences, epidemic diseases are primarily spread from global transportation networks, then from central transportation points to cities and rural areas. Domestic transportation systems are an indispensable part of human activities. High-speed trains bring convenience to people's life and are generally considered one of the most sustainable developments for public transportation. In Turkey, the Ankara-Eskişehir section, the first phase of the Ankara-İstanbul High-Speed Railway Project, was put into service in 2009, and the Eskişehir-İstanbul section in 2014 in order to reduce the travel time between Ankara and İstanbul, which are the biggest cities of Turkey. The high-speed train operation is being successfully performed over a corridor of 1,213 km, covering 13 cities and 42 percent of the population in Turkey, with combined transportation between Ankara, Istanbul,

Eskişehir, and Konya. More than 52 million people have travelled on these lines (see Fig. 1) [16].

Figure 1. Destinations of high-speed trains in Turkey.

Ankara is the capital city of Turkey and the country's second-largest city after Istanbul and most important the high-speed train operation hub in Turkey. High-speed train destinations constitute approximately 90% of the total population of Turkey.

The aim of this study examined the relationship between the passenger density at high-speed train points and the spread of the COVID 19 pandemic. In this context, high-speed train passenger movement is mathematically modeled using regression analysis. The number of trips and the number of patients was examined by months and by 2020 and 2021. In order to evaluate the effect of public transportation in the spatial transmission of COVID 19, it was examined that daily High-speed trains from Ankara to these cities.

2. MATERIAL AND METHODS

2.1. Regression Analysis

There are two separate purposes of multiple linear regression analysis:

- By means of indicators that are determined to affect the dependent indicator
- To determine the rate at which the independent indicators are thought to affect the dependent indicator [17].

According to multiple linear regression analysis, there should be at least two independent indicators. Y relationship model between the dependent indicator and p number of independent indicators. This is shown in equation (1).

$$Y = b_0 + (b_1 \, x \, i_1) + (b_2 \, x \, i_2) + \ldots + (b_p \, x \, b_p) + e_i \quad (1)$$

In there b0, b1,...,bp unknowns part are regression coefficients.

2.2. Estimation of Coefficients İn Multiple Linear Regression Analysis

The simple linear regression model may be suitable for many situations, but in real life, explanatory variables are needed to explain many models. More than one Model with explanatory variables is called a multiple regression model. Multiple In the regression model, there is a single dependent variable and two or more independent variables. The relationship between the variables is investigated. A dependent indicator showing normal distribution is a random variable [18]. The relationship between dependent and independent variables in multiple linear regression analysis shows the strength of the multi-correlation coefficient and has an unlimited number of explanations for the dependent variable [19].

2.3. Statistical Analysis Methods

In the analysis of data; descriptive statistics are presented with mean and standard deviation values. Mann Whitney U test and Kruskall Wallis test were applied to examine the measurements according to the study groups. The All-pairwise method was used to evaluate the measurements that differed from the Kruskall Wallis test. Correlation analyzes were applied to determine the relationship between the measurements. Regression analysis was performed to examine the relationship between the number of patients and the number of passengers at multiple levels. Analyzes were made with SPSS (Statistical Package for the Social Sciences) 25.00 package program.

3. FINDINGS AND DISCUSSION

The purpose of multiple regression analysis is to explain and predict the effect of change in independent variables on the dependent variable. In the study, the analysis results of the relationship between the number of passengers and the number of patients are expressed with tables and figures.

TABLE I
EVALUATION OF THE NUMBER OF PASSANGER and PATIENTS by MONTH AND YEAR

		Total number of passenger		Total number of patients	
		X+s.s (arithmetic mean)	p	X+s.s. (arithmetic mean)	p
Month	1	4704.82+1333.67	0.34	5699.18+2594.34	0.08
	11	4876.17+377.51		6991.50+460.59	
	12	4222.26+1661.94		5096.45+2141.60	
Year	2020	4328.30+1543.11	0.11	5403.76+2086.38	0.19
	2021	4704.82+1333.67		5699.18+2594.34	

In the study, it was determined that the total number of passengers was not at different levels according to the months, and the total number of passengers in the 1st, 11th, and 12th months was found to be at similar levels (p=0.34). Similarly, it was determined that the total number of patient was not at different levels according to the months, and the total number of the patients in the 1st, 11th, and 12th months were found to be at similar levels (p=0.08).

According to the study, it was determined that the total number of passengers was not at different levels according to the years, and the total number of passengers in 2020 and 2021 was at similar levels in the study (p=0.11). And, it was determined that the total number of cases was not at different levels according to the years, and the total number of cases in 2020 and 2021 were found to be at similar levels (p=0.19).

TABLE II
RELATIONSHIP BETWEEN PATIENT and PASSANGER NUMBER in 2020 and 2021

Year			Total number of patients
2020	Total number of passenger	r	0.89*
		p	0.01
2021	Total number of patients	r	0.95*
		p	0.01
Total	Total number of passenger	r	0.90*
		p	0.01

*Correlation analysis was performed.

It has been observed that there is a very strong and positive relationship between the total number of passengers and the number of patients for the period of 2020 and 2021. It can be stated that increase number of passengers will increase the number of patients. (r=0.90, p=0.01). (correlation coefficient takes a value between -1<r<1.

TABLE III
MODELING THE PATIENT and PASSANGER NUMBER RELATIONSHIP in 2020 and 2021

Year	Dependent Variable	Independent Variables: Total number of passenger (β)	F_{Model}	R^2
2020	Total number of patients (Y)	0.89 t=11.48 p=0.01	F=131.68 (p=0.01)	0.78
2021	Total number of patients (Y)	0.95 t=13.52 p=0.01	F=175.1 (p=0.01)	0.89
2020	Total number of patients (Y)	0.90 t=9.29 p=0.01	F=233.19 (p=0.01)	0.80

** Regression analysis was performed.

In the study, regression analysis was performed in order to determine whether there is a multiple relationship between the number of cases and the number of passengers in all three models made at the 2020-2021.

All three models obtained in the study were found to be significant (p=0.01). The coefficients (β) of the variable of the number of passengers in the model were found to be significant for 2020, 2021 and the total period (p=0.01). The explanatory ability of the model for 2020 was 78% (R2 =0.78), the explanatory ability for 2021 was 89% (R2 =0.89), and the explanatory ability for the total model was 80% (R2 =0.80).

In general, it was observed that there was a very strong and positively relationship between the number of patients and the number of patients in both of the 2020 and 2021 periods (p=0.01). But the relationship in 2021 is stronger than in 2020.

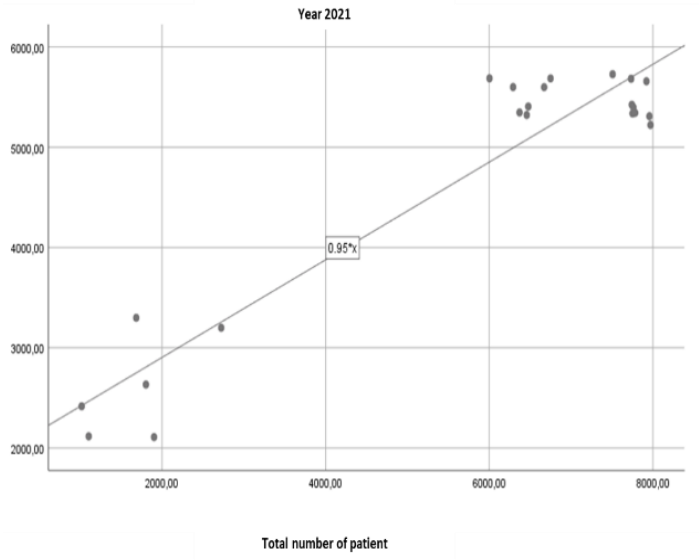

Figure 2. Modeling the Patient and Passenger Number relationship for 2020.

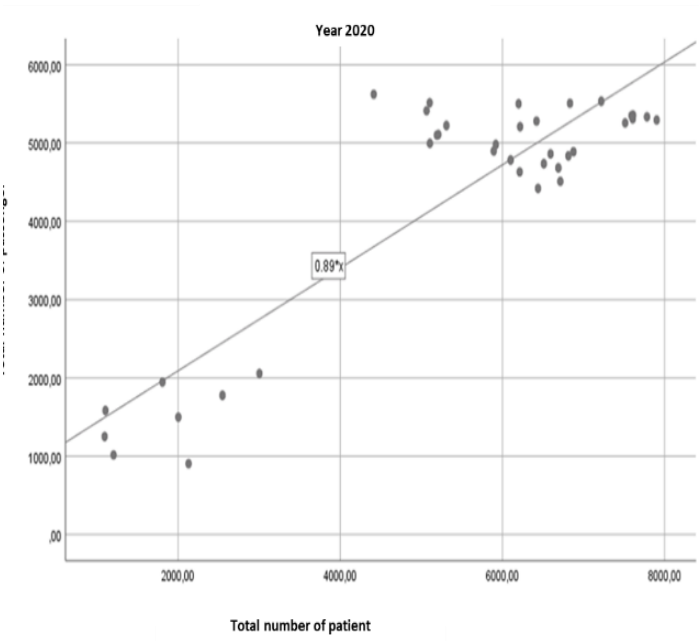

Figure 3. Modeling the Patient and Passenger Number relationship for 2021.

The model was obtained according to these results:

2020 Total number of patients (Y)= (0,89)* Total number of passenger

2021 Total number of patients (Y)= (0.95)* Total number of passenger

Total number of patients (Y)= (0.90)* Total number of passenger

The increase in the number of passengers for all three models caused an increase in the number of patients However, the most increasing effect occurred in 2021. It has been observed that the effect of the number of passengers has a high effect on the number of patients.

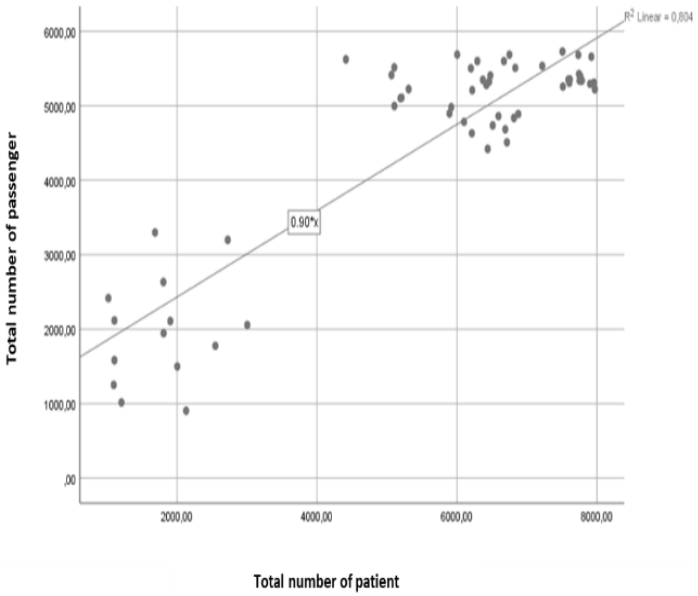

Figure 4. Modeling the Patient and Passenger Number Relationship for Total Period.

4. CONCLUSION

It has been determined that there is an increase in the number of covid 19 cases in the settlement provinces where the number of high-speed train passengers is dense. When we look at the types of transportation in general, they are vehicles such as buses, taxis, minibuses, trains and planes. Depending on the nature of the microorganism that causes the disease in public transportation vehicles, the ways of transmission are differentiated as direct contact, indirect contact, droplet contact or airborne transmission. Direct transmission is the transmission of the microorganism responsible for the disease by physical contact. Increasing contact in increasingly crowded public transport environments also increases the possibility of transmission of the disease. Indirect transmission, on the other hand, refers to the transmission of the disease when it comes into contact with a contaminated surface, although it depends on the type of microorganism, the material of the surface, and the frequency of cleaning and spraying the surface.

In order to limit the pandemic, it may be recommended to increase measures especially in transportation centers. After the pandemic, the developments enabled us to experience urban mobility in extraordinary conditions such as epidemics, reminding once again that it is inevitable to make urban transportation durable and sustainable. Considerable efforts to reduce transmission will be required to control outbreaks. Measures to prevent or reduce transmission should be implemented in travel populations at risk. As a result of this, applications to open more space for pedestrian and bicycle transportation, which are the main components of sustainable transportation, started to increase all over the world

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BIOGRAPHIES

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