https://dergipark.org.tr/tr/pub/ijhmt Doi Number: 10.31201/ijhmt.938495

Int Journal of Health Manag. And Tourism 2021

JHMT Editorial

International Journal of Health Management and Tourism

EXAMINATION OF COVID-19 DEATHS IN G-7 COUNTRIES BY PANEL DATA ANALYSIS METHOD

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Received: 17.05.2021
Accepted: 27.07.2021
Research Article

Abstract

The Covid-19 epidemic continues today as a pandemic that affects all societies. Thousands of people have died from the virus in question. With the cooperation of national and international organizations, a struggle is being made to get rid of this pandemic. As part of the struggle, tests are carried out to detect infected people, while vaccination programs are applied to ensure permanent recovery. But deaths from Covid-19 are increasing inexorably. In this context, the number of tests applied, the number of vaccine doses administered, the number of cases encountered and the number of deaths from Covid-19 in the 7 most developed countries of the world were analyzed by panel data analysis method. Panel data analysis method is an econometric method that can analyze time series and cross-section data simultaneously. It was predicted that the vaccines administered could reduce deaths from Covid-19. It was estimated that if each dose of vaccine administered was increased, deaths from Covid-19 could decrease by 0.57 units. On the

other hand, it was observed that the increase in the number of cases led to an increase in deaths from Covid-19. The importance of the number of tests applied in the fight against Covid-19 was also determined. As a result, the importance of vaccination activities in the fight against Covid-19 has been scientifically demonstrated with the model obtained. On average, it is estimated that both vaccines can save a person's life.

Keywords: Covid-19, Covid-19 Vaccine Number, Covid-19 Death Number, Panel Data Analysis, G-7 Countries

Introduction

The Covid-19 pandemic in the first quarter of the 21st century has affected the whole world in all its aspects. As of March 11, 2020, the World Health Organization (who) announced the declaration of a pandemic, with the outbreak caused by the Covid-19 virus starting to appear in many countries. The covid-19 epidemic, which quickly spread to all countries of the world, has taken over humanity. Death rates increased at the same rate as the outbreak increased and intensified. On May 10, 2021, nearly 160 million cases and nearly 3 million 300 thousand deaths due to Covid-19 were detected all over the world (covid19.who.int). It is known that this epidemic causes more deaths, especially in the elderly, people with chronic conditions, and weak immune systems. In addition, it is obvious that it causes serious damage in healthy people, both physiologically and psychologically.

States, on the one hand, are fighting the epidemic, and on the other hand, they are conducting various drug and vaccine studies to find a cure for this disease. The most important factor in protecting humanity from the Covid-19 epidemic and overcoming the epidemic is the vaccine. With the onset of the Covid-19 epidemic and turning into a pandemic, vaccination studies have also started. Many countries and institutions have entered the vaccine development process and the first vaccine was found within a year. With the implementation of the first vaccine in England on December 8, 2020, humanity took a step forward in the fight against the Covid-19 outbreak. With the discovery and proliferation of vaccines, states have started to vaccinate their citizens. As of May 10, 2021 (covid19.who.int), nearly 1 million 200 thousand vaccines have been administered in the world. There have been declines in death rates with the introduction of

vaccines. Death rates were very high, especially in developed countries such as America[1] and the United Kingdom[2] before the vaccine was found, while death rates fell significantly as vaccination rates increased. At the same time as vaccination rates increased, Covid-19 case rates decreased significantly. Similar situations exist in other countries (covid19.who.int). As can be seen, the most important source of fighting the covid-19 epidemic is vaccines. People who are vaccinated with the protective effect of vaccines have a low level of this disease. People who are sick get over it easily. Thus, the mortality rate decreases. It is an important issue to scientifically demonstrate the effects of the applied vaccines. This research tries to reveal the effect of vaccines within the framework of mathematical modeling and analysis.

On the other hand, although there is fluctuation in the number of cases seen in countries, it is seen that it tends to increase in general. Case increases are not unique to developed countries, but are also seen in other country groups. Although the epidemic is common in all countries, there are differences in the methods of struggle. Each country is in the process of developing different treatment methods according to its own possibilities and perspective against the disease (Gennaro et al., 2020: 41; Lipsitch, Swerdlow and Fineli, 2020: 1195). The most preferred vaccine method is preferred in the epidemic treatment method. Although the degree of effectiveness of each vaccine is different, it is important to econometrically reveal how it has a reducing effect on epidemic prevention and deaths.

On the other hand, one of the important means of combating the Covid-19 epidemic is the number of tests applied. With the increase in the number of tests, more sick individuals are diagnosed. Thus, it is used as an important parameter both in the treatment process and in preventing contamination to other individuals. In other words, the more tests performed as a society, the faster the sick individuals are diagnosed. After the patients are diagnosed early, their treatment starts early. Mortality rates of patients receiving early treatment are also decreasing. In addition, the rate of transmission decreases by quarantining individuals diagnosed with the disease, isolating them from society, and following contact traces. In this way, the increase of the epidemic is prevented. The more tests are performed, the more cases are reached. Therefore, the ratio of test

[1] https://covid19.who.int/region/amro/country/us
[2] https://covid19.who.int/region/euro/country/gb

numbersprovides an important function in terms of reducing cases and deaths. In this context, the impact of both vaccine and test numbers on death numbers is an important issue to examine and focus on.

1. Research Methodology

In this part of the research, firstly, the aim of the study, the sample group, the data set and the findings of the panel models obtained will be included.

1.1. The Objective and Scope of the Research

The purpose of this study is to evaluate the number of deaths from Covid-19, the number of tests performed, the number of cases encountered and the number of vaccines applied, which cause significant changes and loss of life world-wide. The secondary aim of the study is to determine the effect of vaccines on deaths.

1.2. Model and Data

6 of the G-7 country group have been included in this research. Countries included; USA, UK, France, Italy, Japan, and Canada. The covid-19 death cases of these countries will be evaluated within the framework of the number of tests performed, the number of vaccines administered and the number of cases encountered. Using the panel data analysis method, the universe of this study is composed of G-7 countries. Among the G-7 countries, Germany was not included in the sample due to missing data on the time dimension covered by the study. The other 6 countries were included in the research. The reasons for the inclusion of G-7 countries in the study are that these countries are the most developed group of countries, as well as the high capacity to conduct vaccines and tests, and the availability of data for research purposes. The time dimension of the research covers the periods of 01.03.2021-30.04.2021 and the data type is daily. The data used within the scope of the research were obtained from https://ourworldindata.org/covid-vaccinations.

Table 1. Definition of Variables

Variables	Symbol
Covid-19 Deaths per Day	lnolum
Daily Number of Vaccines	lnasisayisi
Number of Tests Performed per Day	lntest
Number of Covid-19 Cases Detected Daily	dlnvaka

The variables to be used in the model are shown in table 1. In the research, the number of deaths from Covid-19 was selected as the dependent variable as the dependent variable. The variables of daily number of vaccines, number of daily tests and number of cases encountered per day are the independent variables. First, natural logarithmic transformation was applied to the series due to the fact that the numerical values of the variables were large. Other variables, except for the number of cases, were found to be stationary at the level, and the series was made stationary by taking the difference in the number of cases variable.

Since the main purpose of the study is to examine deaths from Covid-19, a single dependent variable will be used and a single model will be produced. The mathematical representation of the model in question is shown in the table below.

Table 2. Mathematical Representation of the Model

Model Equation	Program Output
$lnolumi,t = c + \alpha1(lnasisayisi)i,t + \alpha2(dlnvaka)i,t + \alpha3(lntest)i,t + \varepsilon i,t$	LNOLUM = 0.573153227381*LNASISAYISI + 1.44962663207e-05*DVAKA + 0.166077617292*LNTEST - 4.47446570328

As shown above, while the first column of the table 2 contains the equation of the model, the second column contains the equation output of the model by the program. The left sides of the equations represent the dependent variable. On the right side of the equations, c represents the constant variable, α represents the estimator coefficients of the independent variables, ε represents the error term, i represents the horizontal section, and finally t represents information about the period. In panel data analysis modeling, the dependent variable cannot be estimated at 100%. There

are also different factors affecting deaths caused by Covid-19. But in this study, variables that are thought to be most closely related to Covid-19 deaths were included in the analysis. In addition, the effect of variables that we cannot predict within the model or are not included in the model is summed up in the error term ε.

1.3. Determination of Panel Data Model Methods

When the literature is examined, it is seen that the cross-section and time series data are analyzed separately. When the researches are examined, it is seen that either only the cross-section data is used or only the time dimension of the data is concerned. However, due to the fact that there are many factors affecting a situation today, the necessity of multidimensional analyzes has emerged. To meet this emerging need, a panel data analysis method has emerged, which can examine the data both in terms of cross-section and time series. At the point reached in the studies, besides the multitude of data types, there are also many types of analysis that examine the data in question. The panel data analysis method, on the other hand, is based on three basic approaches. This three different approaches are encountered when modeling in a panel data study. These approaches are the random effects approach the constant effects approach and the pooled model approach. Different tests have been developed to determine which model the data set considered as part of the research fits. First, the F test is applied to see which is valid between the fixed effects model and the pooled model. If the fixed effects model is valid as a result of this test, the next step is to determine which of the random effects and fixed effects model is valid. The determination in question is made thanks to Hausman test statistics. After the necessary tests, the most suitable model for the data set is determined.

2. Analysis

The validity and reliability of the results obtained in panel data studies depend on the models providing basic assumptions. Firstly, it is desired that the model obtained does not have a multi-linear connection problem. Different methods and tests have been developed to test the multiple linear connection problem in a model. One of the methods in question is the calculation of variation Inflation Factor (VIF) values. Having a multiple linear connection problem in a model will result in the calculation of incorrect estimator coefficients (Gujarati, 2004: 342). In order to prevent this problem, care should be taken not to use variables with high correlation with each other within the same model. VIF values of the variables are calculated in order to detect multiple linear problems.

The way of calculating VIF values is obtained by using the formula ($1/1-R^2$) (Brien, 2007: 673). It has been stated that the mentioned VIF threshold value can be accepted as 4 in some studies, 5 or even 10 in some studies (Açıkgöz et al., 2015: 427).

Table 3. Variance Inflation Factor Values of the Variables

Variable	R^2	VIF Value
lnolum	0.35	1.53
lnasisayisi	0.66	2.94
lntest	0.62	2.63
dlnvaka	0.17	1.20

In Table 3, the VIF values of the variables to be used in the model are given. It was found that all variables included in the analysis had VIF values even lower than the smallest threshold value of 4. In other words, there are no variables in variables included in the model that will cause the problem of multiple linear connections. For this reason, all variables will be included in the analysis.

In panel data analysis, it is necessary to determine which of the three different approaches is best suited for the research in question. In order to determine this, it is necessary to apply the tests related to the developed model and examine the test results.

Table 4. Panel Data Model Identification Tests

Model / Test	Model 1 (Lnunderfivemortality)	
	Statistics Value	Probability Value
F-Fixed Effects	34.21	0.000
Hausman Test	24.82	0.15

The model was first tested to whether the pooled model was valid. The established H_0 hypothesis that unit effects are equal to zero has been rejected. In other words, the pooled model was found to be unsuitable. In order to determine which of the constant effects and random effects are valid, the Hausman test was also performed. The H_0 hypothesis, which tests the validity of the random-effects model, has been accepted and the model must be formed by the random effects approach. Another assumption that should not be in the model is the testing of the presence of autocorrelation.

3.1. Autocorrelation Test

Panel data models developed should not be autocorrelated. Effective estimator coefficients cannot be obtained in the case of autocorrelation in the model. Different tests have been developed to detect the presence of autocorrelation in Panel data models. To detect the presence of autocorrelation in the model developed in this study, Bhargava et al. The Durbin Watson test and the Baltagi-Wu LBI test will be applied.

Table 5. Autocorrelation Test Results in Models

Model / Test	Model 1 (Lnunderfivemortality)	
	Statistics Value	Probability Value
Baltagi-Wu's Local Best Fixed Test	**1.41**	**0.000**
Durbin-Watson Test	**1.37**	**0.000**

As seen in Table 5 above, autocorrelation test results of the model are given. According to the results of two different autocorrelation tests, the H_0 hypothesis for zero of the autocorrelation coefficients was rejected. On the other hand, these test values are asked to take a value close to 2. The fact that the test values are lower than 2 indicates that the model has been autocorrelated.

After testing the other assumptions of the model, the problem of autocorrelation in question will be corrected using robust correction tests. Another issue that should be considered in the model after testing the autocorrelation is whether there is a changing variance or not.

Table 6. Changing Variance Heteroskedasite

Model / Test	Model 1 (Lnunderfivemortality)	
	Chi2	p
W_0	**8.38**	**0.0000**
W_{50}	**7.95**	**0.000**
W_{10}	**7.96**	**0.000**

Models established in panel data modeling are based on constant variance. The fact that there is a changing variance in an established model causes the correct estimator coefficients to not be obtained. The H_0 hypothesis, established as “variance of units equals”, is rejected by comparing Levente, Brown, and Forsythe's Test statistics (W0, W50, and W10) with the Snedecor F table with the degree of freedom (5, 354). In other words, there is a problem of variance that changes in the model. Another basic assumption that needs to be checked in Panel data analysis is to check whether there is horizontal cross-section dependence.

Table 7. Cross Section Dependency Test

Test \ Model	Model 1 (Lnunderfivemortality)	
	Statistic	Prob
Breusch-Pagan LM	**156.28**	**0.000**
Pesaran Scaled LM	**25.79**	**0.000**
Pesaran CD	**10.14**	**0.000**

Finally, whether the resulting model meets the horizontal cross-section dependence was checked by 3 different tests. As a result of each test, the absence hypothesis, which was established as no horizontal cross-section dependence, was rejected. In other words, it was observed that there is a problem of horizontal cross-section adherence in the model. When it is checked whether the model meets the basic assumptions, it is seen that there is autocorrelation, changing variance, and cross-sectional dependencies. Driscoll and Kraay estimators from robust correction tests were used to eliminating these problems. Thanks to the robust correction test, the model was cleared of these errors and more resistant estimators were obtained.

Table 8. Panel Data Results for Driscoll and Kraay Standard Faulty Model 1

Dependent Variable: Lnunderfivemortality				
Method: Regression with Driscoll-Kraay standard errors				
Period: 2000-2019				
Horizontal Section: 49				
Total Number of Observations: 980				
Variable	**Coefficient**	**Standard Error**	**t-Statistic Value**	**Probability Value**
lnasisayisi	0.106	1.4429	-4.75	0.000
lntest	-0.3060	1.2425	2.47	0.01
dlnvaka	-1.284	5.342	13.64	0.000
C	-1.318	1.187	2.28	0.000
R^2 : 0.59	**F-statistic:** 125.29		**Prob (F-Statistic):** 0.0000	

Table 8 shows the result table for the model created. The values in question were obtained by purifying the errors of the basic assumptions. The number of deaths from Covid-19 was taken as the dependent variable in the model. Independent variables are the number of vaccines administered daily, the number of tests administered daily, and the number of cases detected daily. Whether the model created with these variables provided the basic assumptions was checked one by one. Autocorrelation, variance and cross-section dependence problems were found in the model. Driscoll and Kraay estimator of resistant robust tests were used to solve these problems. The values obtained with the applied robust correction test were cleared of errors and more effective predictive coefficients were obtained. When the significance of the model as a whole is examined, it is seen that the model is significant since the F statistic value is 125.29 and the F probability value is 0.000. The R^2 value of the model is seen to be 0.59. Thus, the percentage of explanation for dependent variables of the independent variables used in the model was found to be 0.59.

Although there are different reasons affecting the deaths from Covid-19, the main focus of this study is to reveal the relationships between the variables in question and Covid-19 deaths in line with the purpose of the study. It is seen that the test and case number variables are in a positive relationship with the variable of death from Covid-19. In case of an increase in the number of tests and cases detected, it is predicted that there may be an increase in the number of deaths from Covid-19. Increases in the number of tests performed enable more Covid-19 patients to be detected. At-risk patients diagnosed are treated early, preventing an increase in the number of deaths. At the same time, increasing the number of tests, patients diagnosed earlier are quarantined and the rate of transmission to society is also reduced. There is a negative relationship between the vaccine number variable and the number of deaths from Covid-19. In other words, it has been determined econometrically that the more the number of vaccines increases, the number of deaths from Covid-19 may decrease in that size.

It is seen that all the variables included in the model are significant at the 1% significance level. When the findings are examined, it is predicted that if each unit increase in the number of cases occurs, it may increase the deaths from Covid-19 by 0.13 units. On the other hand, it is seen that the increase in the number of tests has positively reflected in the fight against Covid-19. Thanks to the increase in the number of tests, it is predicted that it can increase the number of potential

patients and increase at the level of 0.21. Thanks to the test, it is predicted that there will be a decrease in mortality rates thanks to the application of the relevant treatment method to people diagnosed with Covid-19. On the other hand, it is predicted that if there is an increase by each unit in the number of vaccines administered, deaths from Covid-19 can be reduced by 0.57 units. The importance of vaccination activities in the fight against Covid-19 can be seen from the model obtained. It is predicted that both vaccines administered on average could save a human life. It is a fact that the main factor that ensures the transmission of Covid-19 and the mild transmission after the transmission is the vaccine. Vaccines have played and continue to play an important role in humanity's destiny. This situation is clearly seen in the Covid-19 outbreak. In this study, the importance of this has been scientifically demonstrated.

3. Conclusion and Recommendations

It is seen that the relationship between coovid-19 deaths and the number of vaccines and tests performed has not been clearly demonstrated in the literature to date. Examining the relationship between Covid-19 tests and the cases encountered, Çıraklı et al. (2021) measured how the number of tests could affect the cases. As a result of the study, they stated that if there is an increase in the number of tests, there will be no decrease in the number of cases. In this study, it was revealed econometrically how the deaths caused by covid-19 are related to the encountered cases, tests and vaccines.

The fight against the covid-19 vaccine, which affects the whole world, is very important. Different vaccines and drugs are being developed to combat the epidemic in question. Although different vaccines have been developed by different countries in the fight against the epidemic, an effective solution has not been found at the point reached. Although vaccine studies have been accelerated in order to intervene early in the epidemic, the effectiveness of vaccines has not been adequately measured. On the other hand, it is important to econometrically examine the relationship between vaccinations and deaths. In this study, the relationship between the deaths caused by Covid 19, the vaccine applied, the test applied and the number of cases encountered was examined econometrically.

The Covid-19 pandemic stands before us today as the biggest global health problem. When infectious diseases on a global scale are studied historically, Covid-19 can be seen as the fastest and most widely spread outbreak since the Spanish flu. The covid-19 pandemic has affected and continues to affect almost all countries of the world in many different areas, especially in the economic, social, and cultural areas. However, success has not yet been achieved in the face of the epidemic in question. The Covid-19

pandemic and its effects continue to be examined and investigated by researchers from different aspects. In this study, its relationship with the variables specified in the model was examined. As can be seen at the end of the research, the importance of the vaccine in the fight against Covid-19 was once again understood. When the results are examined, it is seen that both vaccines performed on average can prevent a death caused by Covid-19. On the other hand, it seems that increases in the number of tests lead to the detection of more potential Covid-19 patients. By detecting more patients, it allows you to detect more Covid-19-related deaths in the deaths that occur.

The contribution of vaccination to human health is an undeniable fact. Childhood vaccinations have prevented many children from dying and being disabled. The last century of human history has experienced this by living. Today, child mortality rates are quite high due to the lack of vaccines such as measles, pertussis, diphtheria, mumps, smallpox, tetanus, cholera, hepatitis B, and yellow fever in still underdeveloped countries. Humanity's salvation from these diseases has been through vaccination. In the Covid-19 epidemic, the most important weapon of struggle is vaccines. As a result of this study, the importance of this and the positive effect of the vaccine on deaths were revealed.

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