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An Assessment on Health And COVID-19 Indicators of OECD Countries
OECD Ülkelerinin Sağlık ve COVID-19 Göstergelerine Yönelik Bir Değerlendirme

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Abstract
Objective: The aim of this study is to reveal the cluster distribution and success ranking of OECD countries in the impact of health indicators on COVID-19 indicators.
Material-Method: The universe of the research is 38 OECD countries, and the sample consists of 30 countries that have access to the variables used. Data were obtained from the official websites of OECD and World Bank. In the study, five variables that are considered to represent a country's health indicators and four variables related to COVID-19 were used. Cluster analysis and TOPSIS method were used in the analysis of the data.
Results: It has been seen that the most successful cluster in terms of COVID-19 indicators is the cluster in which Australia and New Zealand are located. In terms of COVID-19 indicators, the most unsuccessful cluster was Israel and the Czech Republic. According to the TOPSIS analysis findings, it was determined that the most successful country in the average of health and COVID-19 indicators was Italy and the most unsuccessful country was Spain.
Conclusion: As a result, when countries are clustered according to COVID-19 indicators and healthindicators, it has been seen that countries with strong health supply power do not mean that the COVID-19 indicators will be good. On theother hand, it does not mean that COVID-19 indicators will be bad in countries with low health supply power.

Keywords: Primary Care, Health Indicators, TOPSIS, Clustering, COVID-19**.**

Özet
Amaç: Bu çalışmada amaç, sağlık göstergelerinin, COVID-19 göstergelerine etkisinde OECD ülkelerinin kümele dağılımının ve başarı sıralamasının ortaya konmasıdır.
Materyal-Metot: Araştırmanın evreni 38 adet OECD ülkesi olup, örneklemi ise kullanılan değişkenlereyönelik erişim sağlanan 30 adet ülke oluşturmaktadır. Veriler OECD ve Dünya Bankasının resmi sitelerinden elde edilmiştir. Çalışmada birülkenin sağlık göstergelerini temsil ettiği kabul edilen beş adet değişken ve COVID-19 ile ilgili olarak dört adet değişken kullanılmıştır.Verilerin analizinde kümeleme analizi ve TOPSIS yöntemi kullanılmıştır.
Bulgular: Covid-19 göstergeleri açısından en başarılı kümeninAvusturalya ve Yeni Zelanda'nın bulunduğu küme olduğu görülmüştür. Covid-19 göstergeleri açısından en başarısız kümenin ise İsrail veÇek Cumhuriyeti'nin bulunduğu küme olmuştur. Ülkelerin kümelenmesinde Covid-19 ölümleri ve Covid-19 vaka sayılarının etkili olduğugörülmüştür. TOPSIS analizi bulgularına göre sağlık ve Covid-19 göstergeleri ortalamasında en başarılı ülkenim İtalya olduğu ve enbaşarısız ülkenin ise İspanya olduğu saptanmıştır.
Sonuç: Sonuç olarak Covid-19 göstergeleri ve sağlık göstergelerine göre ülkeler kümelendiğinde sağlık arz gücü güçlü ülkelerin Covid-19 göstergelerinin de iyi olacağı anlamı taşımadığı görülmüştür. Diğer yandan sağlık arz gücü düşük ülkelerinde Covid-19 göstergelerinin de kötü olacağı anlamına gelmemektedir.

Anahtar Kelimeler: Birinci Basamak, Sağlık Göstergeleri, TOPSIS, Kümeleme, COVID-19.

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Introduction

The COVID-19 epidemic, which first emerged towards the end of 2019 and spread all over the world, is expressed as one of the global challenges. COVID-19, which emerged in Wuhan, China, has been defined as a global epidemic by the World Health Organization. This virus causing the epidemic is a newly discovered disease type and its etiology is not clearly known.[1]

For the first time in the history of humanity, such a wide scale of measures have been taken on a global scale, and more than half of the world's population has experienced a lockdown process with strong containment measures.[2] The sectors that continue their activities are limited to the production, transportation and sale of food products, provided that they comply with certain hygiene, and social distance conditions. On the other hand, basic services such as electricity, natural gas, and water continued. The workload of some sectors has increased significantly. Health services are at the forefront of these sectors.

Due to the unique characteristics of health services, health systems are significantly affected by technological, environmental, political, and economic factors.[3] Many factors such as the technological infrastructure, environmental elements, political structures, approaches to events and historical development of the countries of the world differ from each other. According to the use of these factors, the development, and performance perceptions of health services also differ.[4]

The way and the results of the fight against the epidemic during the COVID-19 process also differ according to the countries.[5] The difference in the health system causes significant difficulties in determining which country is more successful since the health success indicators of the countries change and the way of combating the epidemic changes from country to country.[6] In the literature, it is accepted that factors such as isolation of the basic priorities, active use of diagnosis and follow-up systems, gaining experience in early diagnosis, effective treatment and good care conditions, and maintaining effective surveillance are the prerequisites for a successful struggle.[7]

Important factors like social distance and the extent to which countries have implemented quarantines affect how the epidemic affects different countries in different ways. The majority of the actions attempted to combat the outbreak focused on ways to lessen the sickness. However, this circumstance has negative consequences on the sectors and indirectly has an impact on the economy, output, etc. Situations like declining incomes for the populace, rising unemployment, poverty, and inequality contributed to further deepening. Particularly in the areas of transportation, production, and service provision, it has been observed.[8]

All countries reacted differently to the epidemic, and efforts were made to end the epidemic with minimum damage by taking measures at the national and international level. Not only health institutions, but also local governments have been involved in this process by contributing in different ways.[9] Because effective coordination mechanisms among the state levels against the epidemic are important and strong coordination between all actors responsible for the response at central and regional levels is seen as the basis of an effective response.[10]

Epidemic countries economic, social, health, etc. caused changes in many areas. This study, it is focused on the classification and ranking of the effect of the epidemic on health indicators according to the country's health indicators and COVID-19 indicators. The study, first of all, it is aimed to classify some indicators that determine the potential of countries to provide health services and similar countries in COVID-19 indicators by cluster analysis and to rank the countries by TOPSIS method. It is thought that in the fight against COVID-19, which has recently been spoken about the output of the study rather than the process, providing scientific evidence and categorizing countries by using different analysis techniques, both by classification and ranking, is important in terms of giving a different perspective to the literature and providing new information.

Literature Review

In this section, the findings of the literature review for academic research conducted with the two analysis methods used in the study will be included. In the first part, the studies on clustering analysis, and in the second part, the analyzes using the TOPSIS method are included.

Literature Review for Cluster Analysis

The main purpose of cluster analysis is to classify and give meaning to a set of data whose place is unknown. Therefore, cluster analysis is used to classify units or objects according to their basic properties.[11] In other words, it can be said that clustering analysis is done to distinguish similarities from differences.[12]

In the literature, there are studies on the classification of countries according to various sectors or institutions providing the same services in various sectors by cluster analysis. In this section, articles that evaluate cluster analysis and COVID-19 indicators in the literature will be included.

Khafaie and Rahim performed a cluster analysis based on the cases of death and recovery rates of countries due to COVID-19 in their study. As a result, Italy is the country with the highest case fatality rate, followed by Spain and France, respectively.[13]

Additionally, Cordes and Castro conducted a cluster study on the distribution of risk burden and resource allocation for COVID-19 and health power in the USA. Analysis variables were test rates and positive rates. It has been discovered that the USA has a lot of inequities as a result. High-income, higher education, and white populations were found in the cluster with fewer tests and fewer positive cases, while it was discovered that the black population and uninsured people were more prevalent in the cluster with more tests and more positive cases. In other words, blacks, the poor, and individuals with low education in the USA have suffered more from COVID-19 and received less health care than other groups.[14]

Verelst et al., carried out a cluster analysis for European countries using COVID-19 deaths, number of cases, hospital beds, health workers and health expenditure rates. As a result, it has been seen that the countries with the most strained health system capacity are Italy, Spain, Netherlands and France, respectively. In the process, it was stated that the Netherlands and France experienced more pressure than Italy.[15]

Demircioğlu and Eşiyok evaluated the number of cases, the number of recoveries, and the ratio of the number of tests to the population of the country as a COVID-19 output in their study. As health indicators, the number of doctors, the number of elderly population, the number of beds, the number of intensive care beds, the health expenditure ratio, and the number of nurses were evaluated as inputs. The K-means method was used and the values were analyzed through the WEKA program. Turkey; It has been discovered that the cluster—which includes nations like Germany, Japan, and Denmark is more effective at battling the pandemic than nations like the United States, Germany, Italy, and France.[16]

Kartal et al., in their cluster analysis on COVID-19 indicators (the number of cases, the number of deaths), determined that the countries closest to the cluster centers were Spain, Ukraine and Mongolia, respectively. Although the number of cases and deaths is high in Spain, Italy, France, Germany, and China, the rate of increase has been found to approach zero.[17]

Abdullah et al., in their studies, the risk levels of the provinces in Indonesia to the COVID-19 indicators were tried to be revealed by cluster analysis. The variables were death, number of cases and number of recoveries. As a result, it was seen that three clusters emerged in Indonesia according to the risk group.[18]

Literature Review for TOPSIS Analysis

The logic of the TOPSIS method is to reveal the positive ideal solution and the negative ideal solution, and to rank the alternatives on the basis of relative closeness to the ideal solution. A positive ideal solution is one that maximizes the benefit criterion and minimizes the cost criterion. The negative ideal solution is a solution that minimizes the benefit criterion and maximizes the cost criterion. The most suitable option is the alternative closest to the ideal solution and the farthest from the negative ideal solution.[19]

According to Zeleny, decision-making is expressed as a function to manage, resolve or resolve exchange disputes.[20] Since the basis of decision-making is based on the selection of the alternative with the highest degree of preference, the decision-making process in problems involving a single criterion is highly intuitive. However, when alternatives with more than one criterion are evaluated in decision-making, advanced methods should be applied to overcome some situations (weights of criteria, priority status and disagreement between criteria).[21]

In the literature, there are studies on the success ranking of institutions that provide the same services in various sectors, according to the health indicators of the countries, using the TOPSIS method. In this study, researches using TOPSIS in the health literature related to COVID-19 will be included.

Mohammed et al., determined the criteria for 10 COVID-19 and compared 12 different methods to reveal the diagnosis of COVID-19 with the Entropy and TOPSIS method. As a result, it is foreseen that the ordering of the methods can be performed with TOPSIS and decisions can be made accordingly.[22]

Majumder et al., tried to determine the most risky factors between COVID-19 indicators and death by using the TOPSIS method in their study.[23]

Hezer et al., using data published by Deep Knowledge Group, ranked the security levels of 100 regions in the world in terms of COVID-19 by TOPSIS, COPRAS and VIKOR methods.[24]

Alkan and Kahraman in their study, analyzed ENTROPY and TOPSIS methods in order to rank success among different strategies followed by different countries in the struggle against COVID-19. As a result, it was determined that the best strategy is mandatory quarantine and strict isolation.[25]

In their study, Hezam et al. used the AHP and TOPSIS approach to analyze data in order to identify the risk groups for whom the COVID-19 vaccination should be administered first. The elderly, people with high-risk diseases, healthcare personnel, workers in basic occupations, and pregnant and lactating women were shown to be the riskiest categories as a result.[26]

Material and Method

The Population and Sample of the Research: OECD countries constitute the population of the research. These countries are Germany, USA, Australia, United Kingdom, Denmark, France, Ireland, Israel, Switzerland, Italy, Iceland, Japan, Canada, Costa Rica, Colombia, Korea, Latvia, Lithuania, Luxembourg, Hungary, Mexico, Norway, Sweden, Poland, Spain, Portugal, Netherlands, Slovakia, Finland, Slovenia, Estonia, Chile, Czech Republic, Turkey, Belgium, New Zealand, Austria and Greece.

The sample of the study is Germany, USA, Australia, United Kingdom, Denmark, France, Ireland, Israel, Switzerland, Italy, Canada, Latvia, Lithuania, Luxembourg, Hungary, Mexico, Norway, Sweden, Poland, Spain, Portugal, Netherlands, Finland, Estonia, Chile, Czech Republic, Belgium, New Zealand, Austria and Greece. Iceland, Japan, Costa Rica, Colombia, Korea, Slovakia, Slovenia and Turkey, which are among the OECD countries, were excluded from the study due to missing data on the variables used in the study.

Variables Used in the Research: In determining the variables to be used in the research, previously published reports in the field and academic publications that are partially similar were taken into account. Basic inputs of health services; human resources, capital, technology, raw materials, tools and equipment, and outputs; prolongation of life, survival, treatment of diseases and developments in this regard.[27]

The input or independent variables that best represent a country's health indicators and the best output or dependent variables that show the success in the fight against COVID-19 were tried to be determined. The World Health Organization states that the risk assessment of COVID-19 should be made according to criteria such as the incidence of the disease, the number of deaths, the rate of hospitalization and intensive care unit admission, health care capacity, public health capacity, and accessibility to effective drug therapy.[28]

Within the scope of the literature, it was decided to use a total of 9 variables in the analyzes. Detailed information about the variables used is given below.

Health Indicators (Inputs)

a.Elderly Population: Share of 65+ Population in Total Population in a Country (%).

b.Health Expenditure: Percentage of GDP allocated to health in a country.

c.Number of Beds: Number of total hospital beds per 1,000 people remaining, excluding beds reserved for long-term care, in a given period in a country.

d.Number of Physicians: Number of physicians per 1,000 people in a certain period in the country.

e.Number of intensive care beds: Number of beds reserved for intensive care per 100,000 people in a country.

COVID-19 Indicators (Outputs)

a.COVID-19 deaths: Number of deaths from COVID-19 per 1 million from December 2019 to the end of June 2021.

b.Increase in deaths: Percent increase in average deaths in a country during the COVID-19 period (December 2019-June 2021) over the average death rate in 2015-2019.

c.Number of cases: Per hundred thousand people in a country diagnosed with COVID-19 between December 2019 and June 2021.

d.Vaccination: Proportion of individuals vaccinated against COVID-19 per 100 people in a country's population between December 2019 and June 2021.

Data Collection and Analysis:

Data from 30 countries were used in the study. The data on the elderly population, health expenditure, number of beds, and intensive care beds of the countries in 2019 can be found on the website where the reports published by the OECD are shared, and the data on the number of physicians can be found on the World Bank website. It was obtained from the website.[29,30] Data such as the number of deaths from COVID-19, the percentage increase in total deaths, the number of COVID-19 cases, and the vaccination rate were obtained from the Health at a Glance 2021 report published by the OECD.[31] The variables used in the study and the data of the countries are shared in Table 1.

Table 1.*Countries and Data Constituting the Sample of the Study*

	Input					Output			
Countries	Elderly Population	Health Expenditure	Number of Beds	Number of Physicians	Number of intensive care beds	COVID-19 deaths	Increase in deaths	Number of cases	Vaccination
	-	+	+	+	+	-	-	-	+
Australia	15,8	9,418	3,8	3,76	8,1	36	2,58	437	45,6
Austria	18,9	10,434	7,2	5,21	21,8	1180	9,07	8368	60,1
Germany	21,4	11,697	7,9	4,30	28,2	1095	5,37	5117	64,2
USA	16	16,767	2,8	2,60	21,6	1824	19,85	13197	55,2
Belgium	18,7	10,659	5,6	5,96	17,3	2186	9,39	10867	72,6
United Kingdom	18,3	10,154	2,5	5,82	7,3	2232	11,67	11608	66,0
Czech Republic	19,8	7,835	6,6	4,12	43,3	2838	27,76	15842	55,7
Denmark	19,7	9,956	2,6	4,22	18,5	436	1,38	6190	75,3
Estonia	19,9	6,730	4,5	3,46	38,1	956	7,83	11956	53,5
Finland	22,1	9,159	3,4	4,64	5,4	176	2,31	2572	63,4
France	20,3	11,112	5,8	6,53	16,4	1652	10,01	10438	66,1
Holland	18,9	10,165	3,1	3,70	7,0	1020	10,43	11535	67,6
Ireland	14,2	6,679	2,9	3,35	5,2	1007	9,64	7929	74,2
Spain	19,1	9,132	3,0	4,03	10,4	1710	13,49	10490	78,6
Israel	11,9	7,461	3,0	5,47	12,1	743	9,64	14925	64,4
Sweden	19,9	10,291	2,1	4,33	5,1	1420	4,12	11177	64,2
Switzerland	18,6	11,291	4,6	4,33	9,9	1197	8,98	9810	58,4
Italy	22,8	8,669	3,2	8,01	8,7	2140	12,92	7850	68,3
Canada	17,2	10,844	2,5	2,44	12,1	699	10,57	4347	71,2
Latvia	20,4	6,578	5,4	3,30	11,1	1325	5,27	8473	46,4
Lithuania	19,8	7,006	6,4	5,04	20,4	1573	8,69	12171	60,3
Luxembourg	14,4	5,371	4,3	3,01	21,3	1307	8,64	12510	62,9
Hungary	19,3	6,350	6,9	3,41	11,3	3070	11,83	8443	58,7
Mexican	7,4	5,433	1,0	4,85	3,5	1813	54,79	2857	35,4
Norway	17,4	10,521	3,5	4,89	5,4	148	-2,39	3550	67,0
Poland	17,5	6,462	6,2	2,38	10,1	1978	22,57	7670	51,7
Portugal	21,8	9,531	3,5	2,37	8,9	1663	12,16	10405	85,2
Chile	11,8	9,333	2,0	5,18	7,6	1739	25,70	8669	73,7
New Zeland	15,3	9,069	2,5	3,42	3,4	5	0,83	91	41,5
Greece	21,8	7,838	4,2	6,23	17,5	1188	8,02	6170	59,4

Cluster analysis method and TOPSIS method were used to analyze the data. Cluster analysis was used to classify the countries according to the variables used, and the TOPSIS method was used to rank the countries in order of success. Microsoft Excel and SPSS 25 package programs were used for cluster analysis. Microsoft Excel program was used for TOPSIS method calculations.

Ethical Method and Limitations of the Study

The data used in the research were obtained from the official websites of the OECD and the World Bank. Therefore, there is no need for any ethical committee decision.

The findings and results obtained in the study are valid for the 30 countries that make up the sample, and the research inputs are limited to 2019 and the COVID-19 data to June 2021, after the first outbreak of the pandemic. On the other hand, the variables used in the research were carried out with the assumption that the country's health indicators and COVID-19 represent success. Finally, the classification of countries according to study variables and their success ranking are limited to cluster analysis and TOPSIS method. It is foreseen that it will be useful to approach the findings and results of the study by considering the limitations in question.

Results

The findings obtained in this section are given in two parts as the findings for the cluster analysis and the findings for the TOPSIS analysis.

Findings on Cluster Analysis

The tree graph obtained by the Ward method is shown in Figure 1 below. Accordingly, the resulting shape was evaluated and it was decided that the most appropriate number of clusters was 5.

The five clustering results determined using the Ward method are given below.

1.Cluster: France, USA, Portugal, Belgium, Spain, United Kingdom, Switzerland, Estonia, Lithuania, Holland, Luxembourg and Sweden.

2.Cluster: Czech Republic, Israel

3.Cluster: Australia, New Zeland, Finland, Norway and Mexican.

4.Cluster: Denmark, Greece and Germany. Canada

5.Cluster: Austria, Latvia, Shiite, Ireland, Italy and Poland.

It was decided to divide the OECD countries into five clusters according to the determined health and COVID-19 indicators. Accordingly, it was seen that there were 12 countries in the 1st cluster, 2 in the 2nd cluster, 5 in the 3rd cluster, 4 in the 4th cluster and 7 in the 5th cluster. After the cluster numbers were determined, the k-means clustering analysis technique, which is one of the non-hierarchical clustering analysis methods, was used. Analysis results are shared in Table 2.

Table 2. *Cluster Memberships and Distances by K-means Cluster Analysis*

Countries	Cluster	Distance	Countries	Cluster	Distance
Australia	1	173,725	Sweden	5	355,892
Austria	2	525,716	Switzerland	2	1497,153
Germany	3	777,587	Italy	2	702,782
USA	5	1725,650	Canada	3	109,033
Belgium	5	856,507	Latvia	2	386,565
United Kingdom	5	648,681	Lithuania	5	384,678
Czech Republic	4	1143,609	Luxembourg	5	1063,021
Denmark	3	1825,028	Hungary	2	1366,138
Estonia	5	793,090	Mexican	3	1850,469
Finland	3	1929,949	Norway	3	1067,831
France	5	1050,291	Poland	2	781,080
Holland	5	576,911	Portugal	5	1084,063
Ireland	2	842,609	Chile	2	270,387
Spain	5	1003,452	New Zeland	1	173,725
Israel	4	1143,609	Greece	3	1813,013

In Table 2, the cluster memberships and distances resulting from the K-means cluster analysis are given. Accordingly, the countries included in the analysis were found to be the least distance to Australia (173,725) and New Zealand (173,725) and the maximum to Finland (1929,949). The clusters formed by the countries as a result of the clustering obtained by the K-mean clustering analysis method are given in Table 3.

Table 3. *Clustering Results by K-means Cluster Analysis*

1. Cluster (2)	2. Cluster (8)	3. Cluster (7)	4. Cluster (2)	5. Cluster (11)	
Australia	Austria	Germany	Czech Republic	USA	Spain
New Zeland	Ireland	Denmark	Israel	Belgium	Sweden
	Switzerland	Finland		United Kingdom	Lithuania
	Italy	Canada		Estonia	Luxembourg
	Latvia	Mexican		France	Portugal
	Hungary	Norway		Holland	
	Poland	Greece			
	Chile				

Cluster classification resulting from K-means cluster analysis is given in Table 3. Accordingly, while the 5th cluster is the cluster with the highest number of countries with 11 countries, the 1st cluster and the 4th cluster are the clusters with the least number of countries with 2 countries each. The averages of the health and COVID-19 indicators used in the clustering by clusters are given in Table 4.

Table 4. *Final Cluster Centers*

Variables	1.Cluster	2.Cluster	3.Cluster	4.Cluster	5.Cluster
Elderly Population	15,550	17,938	18,143	15,850	18,827
Health Expenditure	9,244	8,225	9,350	7,648	9,720
Number of Beds	3,150	4,800	3,586	4,800	3,964
Number of Physicians	3,590	4,396	4,510	4,795	4,260
Number of intensive care beds	5,750	10,712	12,943	27,700	15,800
COVID-19 deaths	21	1705	794	1791	1595
Increase in deaths	1,705	13,247	11,436	18,700	10,571
Number of cases	264	8402	4400	15,384	11,487
Vaccination	43,550	61,438	62,271	60,500	66,564
: Best indicator		: Lowest indicator			

In Table 4, it is seen that the cluster with the best ratio in terms of the share of individuals over the age of 65 in the population is the 1st cluster and the cluster with the lowest data is the 5th cluster. From a general point of view, although the 1st cluster was the lowest in 3 indicators (number of beds, number of physicians, number of intensive care beds) in terms of health indicators, it was seen that it was the best cluster in 3 indicators (COVID-19 deaths, increase in deaths, number of cases) in terms of COVID-19 indicators. On the other hand, while the 4th cluster was the best cluster in 3 indicators (number of beds, number of physicians, number of intensive care beds) regarding health indicators, it was seen that it was the cluster with the lowest values in 3 indicators (COVID-19 deaths, increase in deaths, number of cases) in COVID-19 indicators.
In Table 5, the findings of the distances between the last cluster centers are shared.

Table 5. *Distances Between Final Cluster Centers*

Clusters	1	2	3	4	5
1	*	*	*	*	*
2	8039,949	*	*	*	*
3	4208,109	4103,459	*	*	*
4	15222,787	6982,553	11028,237	*	*
5	11332,643	3087,187	7131,455	3901,71	*
:Nearest Clusters			:Farthest Clusters		

According to Table 5, regarding the distance values between the last cluster centers, it is seen that the 2nd and 5th clusters are the closest clusters (3087,187) to each other, while the 1st and 4th clusters are the most distant clusters (15222,787) from each other. In the cluster analysis, ANOVA test was applied to find out the difference between the health and COVID-19 indicator values in terms of clusters.
The results of the ANOVA test for the clusters formed as a result of the K-mean cluster analysis are given in Table 6.

Table 6. *K-mean Cluster Analysis ANOVA Results*

Variables	Mean Squares	df	Error Mean Squares	df	F	p
Elderly Population	7,237	4	12,689	25	0,570	0,687
Health Expenditure	3,754	4	5,740	25	0,654	0,630
Number of Beds	2,190	4	3,319	25	0,660	0,626
Number of Physicians	0,459	4	2,011	25	0,228	0,920
Number of intensive care beds	160,282	4	83,214	25	1,926	0,137
COVID-19 deaths	1938619,112	4	375625,294	25	5,161	**0,004**
Increase in deaths	82,350	4	119,317	25	0,690	0,606
Number of cases	111565699,3	4	1013041,696	25	110,129	**0,000**
Vaccination	229,753	4	105,658	25	2,174	0,101

When the ANOVA results in Table 6 are examined, it is seen that the variables for COVID-19 deaths (p:0,004<0,05) and COVID-19 case rate (p:0,000<0,05), which are among the selected variables, play an important role in the classification of OECD countries under five clusters.
Again, according to Table 6, variables such as the rate of the elderly population, health expenditure, number of patient beds, number of physicians, number of intensive care beds, increase in deaths and COVID-19 vaccine rate does not play a role in the classification of OECD countries under five clusters (p>0,05).

TOPSIS Method

Finally, the TOPSIS method was used to rank the countries according to their health indicators and COVID-19 indicators. TOPSIS method, developed by Chen and Hwang with reference to Hwang and Yoon is a multi-criteria decision-making technique that can be applied on quantitative data.
In this study, seven steps were followed in the use of the TOPSIS method and the success ranking of the countries was made.[32,33] Calculations were made using Excel.
1-Determining the decision matrix: The total effect of the 9 criteria used in the study was equally weighted as 1 and the weight coefficients were determined.
2-Normalization of the decision matrix: The normalized decision matrix is determined by reducing each value in the columns to a single denominator by dividing the sum of the squares of the values in the relevant column by the square root.
3- Weighting of the Normalized Decision Matrix: The standard matrix criteria are multiplied by the weight coefficients and a weighted decision matrix is created.
4- Determination of positive and negative ideal solutions: In the weighted decision matrix, ideal values for the ideal solution and negative ideal values for the negative ideal solution are selected from each column. Accordingly, 5 criteria were determined as positive ideal criteria, health expenditure, number of patient beds, number of physicians, number of intensive care beds and COVID-19 vaccine rate. Negative ideal criteria, on the other hand, were determined as 4 criteria: elderly population, COVID-19 deaths, increase in deaths and number of COVID-19 cases.
5-Calculation of Distance Values (SI+/SI-): The distance values from the positive ideal and negative ideal solution were calculated by subtracting the positive ideal and negative ideal values from the values in the column of each factor.
6-Calculation of Relative Closeness to the Ideal Solution: The average distances of each country from the positive and negative ideal solutions were calculated by taking the square root of the sum of the squares of the distance values of each country. The final convergence (Cj) ratios were found by dividing the negative mean distance of the relevant country by the sum of the positive and negative mean distances. High affinity was considered a priority in the ranking.
7- Ranking of Proximity Values: The ranking of success of 30 countries according to 9 variables using the TOPSIS method is given in Table 7.

Table 7. *Rankings of Countries by TOPSIS Method*

Countries	Sİ+	Sİ-	Cİ	RANKİNG
Italy	0,064584	0,06518	109,3796	1
Holland	0,064192	0,066447	29,46908	2
Ireland	0,064887	0,068638	18,29593	3
Sweden	0,06631	0,071616	13,49712	4
Israel	0,06143	0,069995	8,172245	5
Switzerland	0,057449	0,06974	5,673838	6
Luxembourg	0,057324	0,070421	5,377021	7
Latvia	0,059545	0,073159	5,37377	8
Canada	0,057548	0,072203	4,92683	9
Belgium	0,054839	0,070125	4,587415	10
Lithuania	0,053736	0,072134	3,920758	11
France	0,052128	0,071382	3,707346	12
New Zeland	0,061899	0,087618	3,406721	13
Finland	0,057678	0,084238	3,17162	14
Greece	0,050385	0,074182	3,117286	15
Australia	0,054693	0,086373	2,726401	16
Norway	0,055031	0,089532	2,595075	17
Denmark	0,048442	0,083708	2,373578	19
Estonia	0,048469	0,080792	2,499547	18
Austria	0,044362	0,077046	2,357288	20
Germany	0,037195	0,0861	1,760547	21
Mexican	0,101445	0,037382	-0,58352	22
Chile	0,071485	0,04982	-2,29961	23
Poland	0,069836	0,0539	-3,38238	24
United Kingdom	0,06813	0,061747	-9,67362	25
USA	0,063706	0,059542	-14,2987	26
Hungary	0,069144	0,064972	-15,5726	27
Czech Republic	0,069713	0,065548	-15,739	28
Portugal	0,066688	0,063118	-17,6788	29
Spain	0,064378	0,061197	-19,2413	30

In Table 7, it was seen that Italy was the most successful country in reflecting health variables to COVID-19 indicators according to TOPSIS analysis, followed by the Netherlands and Ireland. It is seen that the most unsuccessful country is Spain, followed by Portugal and the Czech Republic.

Discussion and Conclusion

Important data were obtained in this study, in which OECD countries were classified and ranked according to health and COVID-19 indicators.

According to the results of the cluster analysis, the countries are divided into five clusters in the tree graph made with the Ward method of OECD countries. As a result of the K-mean clustering analysis, the countries with the least distance were Australia and New Zealand, and Finland the most. In other words, while the countries closest to the desired ideal solution are Australia and New Zealand, Finland is the farthest country.

The COVID-19 indicators, which are the COVID-19 deaths, the increase in the deaths, and the COVID-19 cases, have been the best cluster in indicators like the number of, even though the cluster that includes Australia and New Zealand is the lowest cluster in terms of the number of patient beds, the number of physicians, and the number of intensive care beds expressing the health indicators. On the other hand, the cluster that consists of the Czech Republic and Israel is the best cluster in terms of health-related metrics, including the quantity of doctors, the quantity of beds, and the quantity of intensive care beds.. In other words, factors such as the number of physicians, beds and intensive care beds representing the health supply did not have an effect on COVID-19 deaths, the increase in deaths and the number of cases. It has been observed that the opposite is the case. While this situation evaluates the COVID-19 indicators, not only health indicators, but also social, economy, education, etc. It can be said that this may be due to the fact that factors also play an active role.

In the study, regarding the distance values between the last cluster centers, the 2nd cluster (Austria, Ireland, Switzerland, Italy, Latvia, Hungary, Poland and Chile) and the 5th cluster (USA, Belgium, United Kingdom, Estonia, France, Netherlands, Spain), Sweden, Lithuania, Luxembourg and Portugal) are close to each other, while cluster 1 (Australia and New Zealand) and cluster 4 (Czech Republic and Israel) are the most distant clusters from each other. In other words, according to the 9 variables used in the study, the countries in the 2nd cluster and the countries in the 5th cluster are more similar to each other than the other clusters. On the other hand, according to 9 variables, the 1st and 4th clusters showed more differences between them compared to the other clusters.

It has been determined that the variables used in the cluster analysis play an important role in the division of countries into 5 clusters, with the number of COVID-19 deaths and COVID-19 cases. It has been determined that the variables for the elderly population, health expenditure, number of beds, number of physicians, number of intensive care beds, percentage increase in total deaths and COVID-19 vaccine do not play any role in the clustering of countries.

According to the TOPSIS analysis, it has been determined that Italy is the most successful country in terms of health indicators and COVID-19 indicators, followed by the Netherlands and Ireland, and the most unsuccessful country is Spain, followed by Portugal and the Czech Republic.

When evaluated in general, it is obvious that the effect of health supply power variables on Covid-19 indicators is also the effect of public health indicators. The fact that the countries' Covid-19 data do not show parallelism, especially according to the health supply power, is proof of this. Therefore, it is of great importance to consider public health indicators when evaluating Covid-19 data. As a matter of fact, Zhu et al, the best intervention to reduce the contagiousness of the Covid-19 epidemic is to maintain social distance, follow hygiene rules and pay attention to wearing masks.[34] In this respect, when evaluating the Covid-19 indicators, countries The level of compliance with public health rules also needs to be taken into account. This situation can be considered as a limitation of the study. Because the analyzes and variables used in the study should be kept within a certain limit.

The results obtained in the study were examined with the effect of health supply power on Covid-19 indicators and the ranking and clustering of countries were made accordingly. According to Spellbring, an individual's health-related attitudes and behaviors affect himself individually, his family and society in general.[35] This interaction was seen more clearly during the pandemic period. Different studies and analyzes are needed to reveal the effects of these attitudes and behaviors.

It is thought that personal care skills, which are considered as public health indicators, and the confidence given by this, also have an effect on the Covid-19 data. Indeed, Stark et al. they can make their personal lives healthier with the confidence and power of gaining personal care skills.[36] This is thought to have a reducing effect on Covid-19 deaths. Therefore, while evaluating the findings, the behavior of the citizens of the country should be carefully examined.

As a result, when countries are clustered according to COVID-19 indicators and health indicators, it has been seen that countries with strong health supply power do not mean that the COVID-19 indicators will be good. On the other hand, it does not mean that COVID-19 indicators will be bad in countries with low health supply power. As a matter of fact, the findings obtained in the study are in this direction. Because the criteria used in clustering and TOPSIS analyzes are not evaluated individually, they are included in the analysis collectively, they provide values for the average result. In other words, a country whose health supply power is not good can be in good clusters due to its good COVID-19 indicators and its success ranking is also good. On the other hand, developed countries are in a good position in clustering and ranking due to the good health supply power even if the COVID-19 indicators are bad. Therefore, it is predicted that it would be beneficial to consider this situation while conducting the analysis.

It is predicted that it would be beneficial to carry out comprehensive studies by including the countries whose data on the variables used in the study were not obtained. In addition, it is predicted that it will be beneficial to use clustering and different numerical decision-making methods by increasing the number of variables used.

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Conflicts of Interest

The authors declare that they have no competing interests.

References

1. WHO.. World Health Organization, Coronavirus disease (COVID-19) advice for the public, Recieved from: https://www.cdc.gov/coronavirus/2019-ncov/need-extraprecautions/people-at-higher-risk.html. Access Date: 21.08.2022, 2020.
2. OECD. The territorial impact of COVID-19: Managing the crisis across levels of government. http://www.oecd.org/coronavirus/policy-responses/the-territorial-impactof-COVID-19-managing-the-crisis-across-levels-of-government-d3e314e1/, Access Date: 21.09.2022, 2020, 2p.
3. Tengilimoğlu, D., Işık, O., & Akbolat, M. Sağlık İşletmeleri Yönetimi. 8. baskı, Ankara: Nobel Yayıncılık, 2012, 136p.
4. Gedikli, E., Demir Uslu, Y., Yiğit, P., & Yılmaz, E. Türkiye'de COVİD-19 pandemisinin yönetimi ve joinpoint regresyon yöntemiyle analizi. Turkiye Klinikleri J Health 2021;6(4): 911-20.
5. Kringos, D., Carinci, F., Barbazza, E., Bos, V., Gilmore, K., & Groene, O. Managing COVID-19 within and across health systems: why we need performance intelligence to coordinate a global response. Heal Res Policy Syst 2020;18(80): 1-8.
6. Borgert, M., Binnekade, J., Paulus, F., Goossens, A., Vroom, M., & Dongelmans, D. Timely İndividual Audit and Feedback Significantly İmproves Transfusion Bundle Complince-A Comparative Study. Int J Qual Health Care 2016;28(5): 601-607.
7. Tanne, J.H., Hayasaki, E., Zastrow, M., Pulla, P., Smith, P., & Rada, A.G. COVID-19: How Doctors and Healthcare Systems Are Tackling Coronavirus Worldwide. BMJ 2020;368:m1090.
8. International Telecommunication Union. Economic Impact of COVID-19 on digital infrastructure" Report of an Economic Experts Roundtable organized by ITU, Geneva, 2020, 1p.
9. OECD. Coronavirus (COVID-19): Cities policy responses (as of 27 March 2020), https://read.oecd-ilibrary.org/view/?ref=126_126769-yen45847kf&title=CoronavirusCOVID-19-Cities-Policy-Responses. Access Date: 21.12.2022, 2020.
10. World Health Organization. WHO Director-General's opening remarks at the media briefing on COVID-19–11 March 2020 Geneva, Switzerland: World Health Organization; https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-atthe-media-briefing-on COVID-19-11-march-2020.Access Date: 21.12.2022, 2020.
11. Abonyı, J., & Feil, B. Cluster Analysis For Data Mining and System Identification, 1. Edition, Berlin: Birkhauser Verlag AG, 2007, 204p.
12. Everitt, B.S., Landau, S., & Leese, M. Cluster Analysis Arnold. London: A member of the Hodder Headline Group, 2001; 141p.
13. Khafaie, M.A., & Rahim, F. Cross-Country Comparison of Case Fatality Rates of COVID-19/SARSCOV-2. Osong Public Health and Research Perspectives 2020;11(2): 74-80
14. Cordes, J., & Castro, M.C. Spatial analysis of COVID-19 clusters and contextual factors in new york city. Spatial and Spatio-Temporal Epidemiology, 2020; 34, 100355.
15. Verelst, F., Kuylen, E., & Beutels, P. Indications for Healthcare Surge Capacity in European Countries Facing an Exponential Increase in Coronavirus Disease Cases. Eurosurveillance, 25(13), 2000323.
16. Demircioğlu, M. & Eşiyok, S. COVID–19 salgını ile mücadelede kümeleme analizi ile ülkelerin sınıflandırılması. İstanbul Ticaret Üniversitesi Sosyal Bilimler Dergisi 2020;Bahar (Covid19-Özel Ek): 369-389 .
17. Kartal, E., Balaban, M. E. & Bayraktar, B. Küresel COVID-19 Salgınının Dünyada ve Türkiye'de Değişen Durumu ve Kümeleme Analizi. Journal of Istanbul Faculty of Medicine 2020; 84(1): 9-19.
18. Abdullah, D., Susilo, S., Ahmar, A.S., Rusli, R. & Hidayat, R. The Application of K-Means Clustering For Province Clustering in Indonesia of The Risk of The COVID-19 Pandemic Based on COVID-19 Data. Quality & Quantity 2021;56: 1283-1291.
19. Cheng-Ru, W., Chin-Tsaı, L., & Hsuan, P. Financial Service of Wealth Management Banking: Balanced Scorecard Approach. Journal of Social Sciences 2008; 4(4): 255-263.
20. Zeleny, M. MCDM: In search of new paradigms Yong, Shi; Shouyang, Wang; Gang, Kou; Jyrki, Wallenius (Ed.). New State of MCDM in the 21st Century: Selected Papers of the 20th International Conference on Multiple Criteria Decision Making 2009 içinde (3-12). First Edition. Berlin: Springer-Verlag, 2021.
21. Tzeng, G.H., & Huang, J.J. Multiple Attribute decision making: methods and applications. First Edition. New York: CRC Press, 2011, 123p.
22. Mohammed, M. A. et al., 2020. Benchmarking Methodology for selection of optimal COVID-19 diagnostic model based on entropy and TOPSIS methods. in IEEE, 2020; 8: 99115-99131.
23. Majumder, P., Biswas, P., Majumder, S. Application of new TOPSIS approach to ıdentify the most significant risk factor and continuous monitoring of death of COVID-19. Electron J. Gen. Med, 2020; 17(6): em234.

24. Hezer, S., Gelmez, E., & Özceylan, E. Comparative analysis of TOPSIS, VIKOR and COPRAS methods for the COVID-19 regional safety assessment. Journal of Infection and Public Health, 2021; 14(6): 775-786.
25. Alkan, N., & Kahraman, C. Evaluation of government strategies against COVİD-19 pandemic using qrung orthopair fuzzy TOPSIS method, appl. Soft Comput, 2021; 110: 107653.
26. Hezam, I.M., Nayeem, M.K., Foul, A. & Alrasheedi, A.F. COVID-19 Vaccine: A neutrosophic MCDM approach for determining the priority groups. Results Phys, 2021;20: 103654.
27. Tokalaş, S. Kamu Sağlık hizmetlerinin satın alınması, Yüksek Lisans Tezi, Marmara Üniversitesi Sosyal Bilimler Enstitüsü, İstanbul, 2006, 77p.
28. WHO. World Health Organization, "Risk assessment," 2020. Accessed: May 27, 2020. [Online]. Available: https://www. who.int/publications-detail/risk. Access Date: 17.08.2022, 2020.
29. OECD. OECD Data. http://stats.oecd.org/.Access Date: 17.08.2022, 2019.
30. World Bank.World Bank Data. http://data.worldbank.org/indicator Access Date: 17.08.2022, 2019.
31. OECD. Health at a Glance 2019: OECD Indicators. OECD Publishing. Paris, 2021, 209-232 p.
32. Chen, S.J. & Hwang, C.L. Fuzzy multiple attribute decision making methods and applications. Springer-Verlag, Berlin, 1992.
33. Hwang, C.L., & Yoon, K. Multiple attributes decision making methods and applications, Springer, Berlin Heidelberg, 1981.
34. Zhu, N., Zhang, D., & Wang, W. China novel coronavirus ınvestigating and research team. A novel coronavirus from patients with pneumonia in China. Engl J Med, 2020; 82(8): 727-733.
35. Spellbring, M. Nursing role in health promotion. Nurs Clin North Am. 1991; 26(4): 805-814.
36. Stark, M.A., Manning-Walsh, J. & Vliem, S. Caring for self while learning to care for others: A challenge for nursing students. Journal of Nursing Education. 2005; 44(6): 266-270.