RESEARCH ARTICLE

CLASSIFICATION OF EUROPEAN UNION MEMBER AND CANDIDATE COUNTRIES IN TERMS OF HEALTH INDICATORS THROUGH MULTIDIMENSIONAL SCALING AND CLUSTER ANALYSIS

Aylin ALKAYA [*]

ABSTRACT

Health indicators enable statistical comparison of the health status of countries or communities. The objective of this study is to investigate the position and classification of Turkey in European Union (EU) member and candidate countries in terms of health indicators. The study data were obtained from World Bank and United Nations Development Programme data sources. The multidimensional scaling and cluster analysis methods were performed to determine the position and classification of the countries. According to the multidimensional scaling findings, it is determined that Turkey is closely located to the European Union member countries of Bulgaria, Lithuania, Poland, Hungary, Latvia, Romania, Slovakia in terms of health indicators. Cluster analysis results demonstrate that Turkey is classified in the same cluster with European Union member countries of Croatia, Czechia, Hungary, Poland and Slovakia in terms of health indicators. It has been determined that Turkey is not classified among the European Union member countries which have better health indicator values. It has been suggested that Turkey can develop in the field of health by following the progress in countries that are successful in health indicators.

Key Words: *Health indicators, European Union member and candidate countries, Cluster analysis, Multidimensional scaling*

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ARAŞTIRMA MAKALESİ

SAĞLIK GÖSTERGELERİ AÇISINDAN AVRUPA BİRLİĞİNE ÜYE VE ADAY ÜLKELERİN ÇOK BOYUTLU ÖLÇEKLEME VE KÜMELEME ANALİZİYLE SINIFLANMASI

Aylin ALKAYA *

ÖZ

Sağlık göstergeleri, ülkelerin veya toplulukların sağlık durumlarının istatistiksel olarak karşılaştırılmasını sağlar. Bu çalışmanın amacı, sağlık göstergeleri açısından Türkiye'nin Avrupa Birliği (AB) üye ve aday ülkelerindeki konumunu ve sınıflandırmasını incelemektir. Çalışma verileri Dünya Bankası ve Birleşmiş Milletler Kalkınma Programı veri kaynaklarından elde edilmiştir. Ülkelerin konum ve sınıflandırılmasını belirleyebilmek için çok boyutlu ölçekleme ve kümeleme analizi yöntemleri uygulanmıştır. Çok boyutlu ölçekleme bulgularına göre sağlık göstergeleri açısından Türkiye, Avrupa Birliği üye ülkelerinden Bulgaristan, Litvanya, Polonya, Macaristan, Letonya, Romanya, Slovakya'ya yakın bir konumdadır. Kümeleme analizi sonuçları, sağlık göstergeleri açısından Türkiye'nin Avrupa Birliği üye ülkelerinden Hırvatistan, Çekya, Macaristan, Polonya ve Slovakya ile aynı kümede sınıflandırıldığını göstermektedir. Türkiye'nin daha iyi sağlık göstergesi değerlerine sahip Avrupa Birliği üyesi ülkeler arasında sınıflanmadığı tespit edilmiştir. Türkiye'nin sağlık göstergelerinde başarılı olan ülkelerdeki ilerlemeleri takip ederek sağlık alanında gelişim gösterebileceği önerilmiştir.

Anahtar kelimeler: *Sağlık göstergeleri, Avrupa Birliği üye ve aday ülkeler, Kümeleme analizi, Çok boyutlu ölçekleme*

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I. INTRODUCTION

Health is a fundamental resource of life. Economic situations, social, environmental and biological conditions are fundamental determinants of health. In Alma Ata Declaration, the World Health Organization (WHO) declared that "the attainment of the highest possible level of health is a most important world-wide social goal whose realization requires the action of many other social and economic sectors in addition to the health sector" (World Health Organization, 1978). Development in health is one of the most important achievements of the twentieth century. Health is a main component of human development. Human development focuses on people and their choices and opportunities, and is about expanding the affluence of human life rather than economic growth (United Nations Development Programme, 2021). Human development encompasses the expansion of all human choices, whether social, cultural, economical or political. There has been an increasing impression that human development strategies are mainly concerned with social development expenditures, notedly in education and health (Haq, 1995).

Human development indicators which are annually published by United Nations Development Programme (UNDP) are used for measuring human development and its dimensions. They give information more about human well-being than income. UNDP include health indicators as one of a tool of human development indicators. Health indicators are summary measures of the health status of a given population. They are used for monitoring population health and assessing health status. The health status can be measured by life expectancy, mortality and morbidity from communicable and non-communicable diseases, health expenditure, and many other indicators. Health indicators provide information about health improvements or deteriorations acquired over time. They enable statistical comparison of the health status of countries or communities.

The European Union (EU) is a political and economic union between 27 European countries (European Union, 2021a). The EU was created to foster peace, prosperity, stability and European values across the continent. The EU have helped raise living standards for all its citizens, and contributes the creation of more and better jobs in Europe (European Union, 2020). A European country that wants to access the opportunities provided by the EU desire to become a member of the EU. There are accession criteria (European Union, 2021b) to be a member of the EU. The EU was founded in 1957 by 6 European countries. Enlargements continued in years and EU has grown from 6 countries to 27 (European Union, 2020). The EU member countries are; Austria, Bulgaria, Belgium, Cyprus, Croatia, Czechia, Denmark, Estonia, France, Finland, Greece, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden. The EU candidate countries are; Albania, Montenegro, North Macedonia, Serbia and Turkey. Turkey in 1987, Bulgaria and Romania in 1995, and Croatia in 2003 applied for association to the EU. Although Bulgaria and Romania became a member in 2007 and Croatia became a member in 2013, Turkey has not been accepted as a member of the EU yet.

In strategy and policy determination countries use health indicators as a measure of socioeconomic development. Health indicators are an important tool in evaluating the accession process of the EU candidate countries. They give an idea about the level at which that country meets the criteria for being a member of the EU (Altıntaş, 2012). Being a member of the EU is one of Turkey's most important strategic goals (T. C. Dışişleri Bakanlığı Avrupa Birliği Başkanlığı, 2021). The aim of the study is to determine the classifications of the EU member and candidate countries and to evaluate the classification of Turkey with EU member and candidate countries according to the health indicators. Health indicators included in the scope of UNDP are used in the analysis. Statistical methods of multidimensional scaling and cluster analysis are used for classification of the EU member and candidate countries. Analyzes were performed on IBM SPSS 26.0 software.

II. METHOD

Multidimensional scaling and cluster analysis methods were used in the study.

Multidimensional Scaling (MDS), refers to a class of techniques, which the techniques use proximities among any kind of objects as input and that the techniques allow a researcher to reveal the hidden structure of databases (Kruskal and Wish, 1978). MDS is a multivariate technique that reveals proximities data on a one-, two- or more dimensional map. Proximities express the similarity, dissimilarity, closeness or relatedness between data objects, subjects, or stimuli (Borg et al., 2013). In MDS data is represented as distances in a low-dimensional (d dimensional) space in order to make data accessible to exploration and visual inspection (Borg and Groenen, 2005). A matrix of proximities represented by a configuration of points in low dimensional space (Kruskal, 1977). The primary purpose of the MDS is to place the original data in a coordinate system with as low dimensions as possible (Johnson and Wichern, 1999). Multidimensional scaling analysis is a method that aims to obtain the demonstration of objects in a k-dimensional (k <p) space based on the distances determined according to p variables between n objects or units, thus determining the relationships between objects (Özdamar, 2004). MDS viewed as a problem of statistical fitting under given dissimilarities, it is desired to find the configurations whose distances fit them best (Kruskal, 1964). Euclidean distance is an inter-point distance measure that in d dimensions its value for two stimuli i and j, represented by d-dimensional coordinates X_i and X_j, is given as follow (Everitt and Dunn, 2001):

$$d_{ij} = \left[\sum_{k=1}^{p} (x_{ik} - x_{jk})^2 \right]^{1/2} \quad (1)$$

In the literature the techniques which used the original Euclidean coordinates that are depend on the derived Euclidean distances for scaling was brought by Torgerson (1952) (Cox and Cox, 2000). The method developed by Torgerson (1952) is termed metric MDS. The intended purpose of the metric MDS is to assess interval and ratio scaled data. In MDS, R^2 is a measure of how well the raw data fit the MDS model. The higher the R^2 value, the better the fit ($0 \leq R^2 \leq 1$) (Hair et al., 2014). Kruskal (1964), perform a monotone regression of distance upon dissimilarity, and use the residual variance, suitably normalized, as quantitative measure for any given configuration and call this the stress. How well the configuration matches the data is measured by the stress. It is a residual sum of squares and so that it is positive and the smaller the better it is (Kruskal, 1964). The verbal evaluation is suggested by Kruskal (1964):

Stress	20%	10%	5%	2½%	0%
Goodness of fit	Poor	Fair	Good	Excellent	Perfect

Cluster Analysis (CA) as can be called classification analysis classify similar units (or objects, or individuals, or variables) into the unknown groups called clusters. In CA between clusters dissimilarity (heterogeneity) and within clusters similarity (homogeneity) is tried to be achieved. CA is usually done in an attempt to combine cases into clusters when the group membership, group structure need not be known prior to the analysis (Wilmink and Uytterschaut, 1984; Tatlıdil, 1996; Afifi et al., 2020). A large data set can be summarized by a classification scheme and then the group labels may provide a very concise description of patterns of similarities and differences in the data (Everitt et al., 2011). There are different clustering methods that generally be grouped under two headings as hierarchical and non-hierarchical clustering methods. In hierarchical cluster analysis at the beginning of the clustering process, there are n clusters equal to the number of units. In the second step, the most similar units are combined into the same cluster. The clustering process is continued in a way that units combined in a cluster are combined with other clusters at the next step. At the end of the clustering process, all units are brought together in one cluster. The basic assumptions of cluster analysis are that there is not have multicollinearity among variables. In the case of highly correlated

variables, one of the suggested methods is to continue to study with only one of these variables. Another way is to obtain a new variable by summing the values of the two highly correlated variable (Alpar, 2013). In the study, hierarchical cluster analysis was used as the classification method in the analysis. Euclidean distance, one of the most frequently used distance measures, was used in the analyzes to measure distances.

Human development indicators related to the health of the EU member and candidate countries have been drawn for each country from World Bank (WB) and UNDP databases. The health dimension of human development indicators which are consist of seventeen indicators was used as variables in the analysis. The health indicators of HIV prevalence, stunting (moderate or severe) (% under age 5), child malnutrition, malaria incidence data were not available for all countries, thus these indicators excluded from the study. The variables (indicators) that are included in the analysis are as follow:

- CHE: Current health expenditure (% of GDP)
- ASMRF: Age-standardized mortality rate attributed to noncommunicable diseases (per 100.000 population), female
- ASMRM: Age-standardized mortality rate attributed to noncommunicable diseases (per 100.000 population), male
- ILIDTP: Infants lacking immunization, DTP (% of one-year-olds)
- ILIM: Infants lacking immunization, measles (% of one-year-olds)
- LEAB: Life expectancy at birth (years)
- LEABF: Life expectancy at birth, female (years)
- LEABM: Life expectancy at birth, male (years)
- LEI: Life expectancy index
- MRF: Mortality rate, female adult (per 1,000 people)
- MRM: Mortality rate, male adult (per 1,000 people)
- MRI: Mortality rate, infant (per 1,000 live births)
- MRUF: Mortality rate, under-five (per 1,000 live births)
- TI: Tuberculosis incidence (per 100,000 people)

The availability period of the indicators is as follow: LEAB, ILIDTP, ILIM, LEABF, LEABM, LEI for 2019; CHE, MRI, MRUF, TI for 2018, ASMRF, ASMRM, MRF, MRM for 2016.

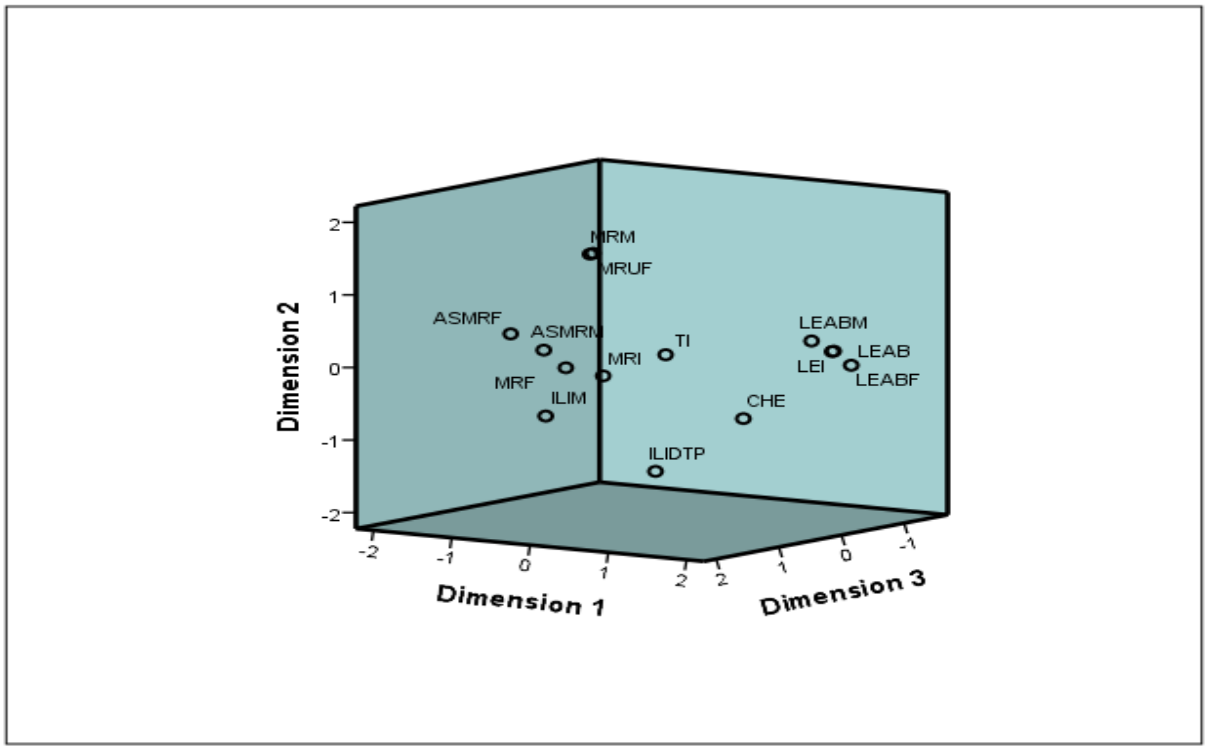
III. RESULTS

3.1. Multicollinearity Examination

Multicollinearity affects CA results and conclusions via CA can be inappropriate (Hair et al., 2014). Therefore, it would be true path to investigate the multicollinearity between the variables before the cluster analysis. High level of correlations between variables causing multicollinearity problem can be determined by MDS and correlation coefficients. Pearson and Spearman correlation coefficients can be used to determine the correlations between two variables. In order to decide which correlation coefficient to use, it should be investigated whether the data is normally distributed. While Pearson correlation coefficient is used for normally distributed data, Spearman correlation coefficient can be used for non-normally distributed data. The Shapiro-Wilk test (SW) is used to assess normality distribution of the data. The null hypothesis for SW is that the data are normally distributed. In the case of SW, if significance values (p) are less than 0.05, the null hypothesis will be rejected. For all health indicators except LEABF show statistical significance values (The SW results are not included in our study). It can be concluded that only LEABF data follows a normal distribution ($p=0.083>\alpha=0.05$). Thus, violation of normality assumption, Spearman correlation coefficients are used to investigate the correlations between health indicators.

In this study the MDS two-dimensional solution has stress of 0.18110 (goodness of fit is between poor-fair) and stress goes down to 0.08687 (goodness of fit is between fair-good) in three dimensions. Stress values improved as more dimensions are used. The two-dimensional solution has R^2=0.91558 value and the three-dimensional solution has R^2=0.96663. It is concluded that three-dimensional representation is better appropriate.

Figure 1. Visualization of Health indicators in Three Dimensions by Multidimensional Scaling (Euclidean Distance Model)



It can be seen from Figure 1 that LEAB and LEI indicators are overlapped, and LEABM and LEABF indicators are located very close to these indicators. The Spearman correlation coefficient values of LEAB and LEI; LEAB and LEABM; LEAB and LEABF are 0.999; 0.943; 0.974 respectively. It is seen that all life expectancy indicators LEAB, LEABF, LEABM, LEI form a group. It is also seen from Figure 1 that the mortality rate indicators of MRM and MRUF are overlapped. However, the mortality indicators of MRF and MRI are not included in this group. The Spearman correlation coefficient value of MRM and MRUF; MRM and MRF; MRUF and MRI; MRF and MRI are 0.995; 0.489; 0.443; 0.892 respectively.

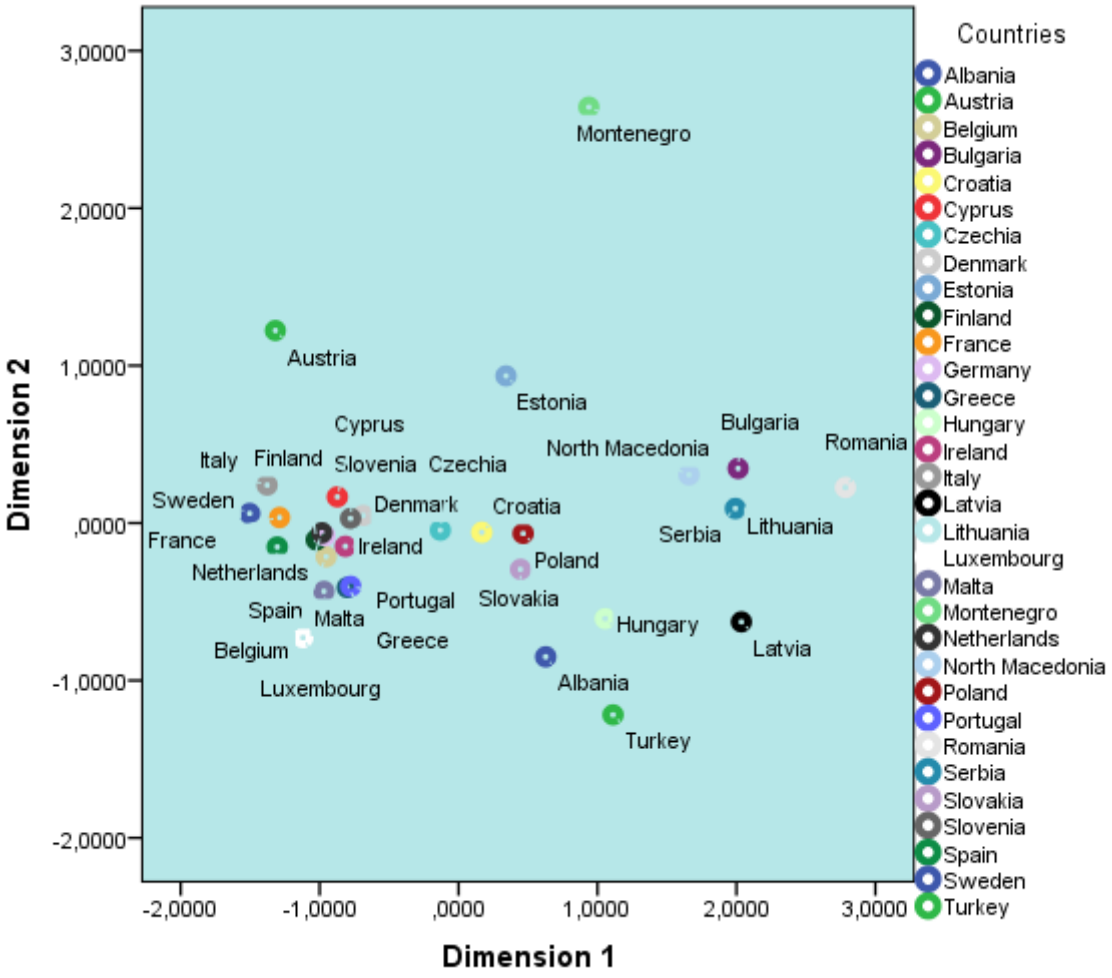
To overcome multicollinearity only the LEAB, MRUF, MRF, MRI, CHE, ASMRF, ASMRM, ILIDTP, ILIM, TI indicators will be included in the analysis of MDS and CA.

3.2. Multidimensional Scaling for Country Classifications

The stress values for two-dimensional, three-dimensional, and four-dimensional solutions were found to be 0.13124, 0.12851, and 0.12992, respectively. The two-dimensional solution has only slightly more stress than three-dimensional and four-dimensional solutions. The R^2 value for two-, three-, and four-dimensional solutions were found to be 0.95711, 0.96133, and 0.96147, respectively. There are slight changes in R^2 values. Therefore, according to the stress and R^2, the two-dimensional solution can be executed. As a result of MDS analysis, similar countries according to their health indicators are gathered together. Countries with similar and dissimilar health indicators are mapped in a two-dimensional space given by Figure 2. In multidimensional scaling analysis, distance calculations

change according to the measurement levels of the data. Since the health indicator variables used in the analysis are measured at the ratio level, the Euclidean distance was used in the distance calculations. Figure 2 shows the configuration of points produced by metric MDS.

Figure 2. Visualization of Countries in Two Dimensions by Multidimensional Scaling (Euclidean Distance Model)



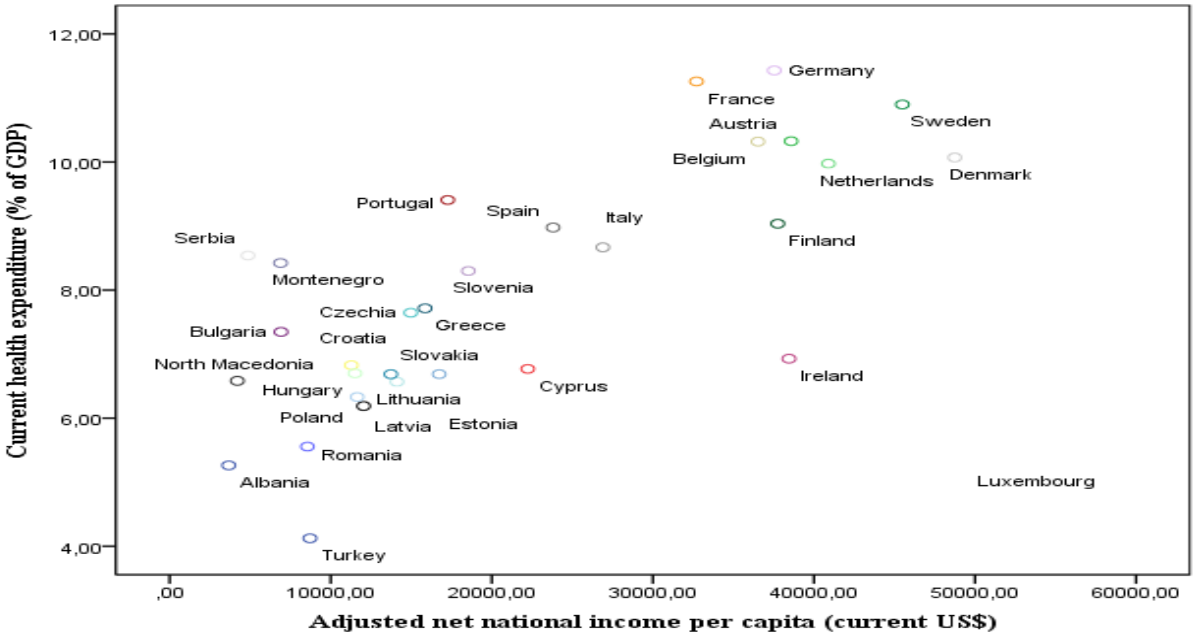
In Figure 2 countries located around the zero points of intersection of the two dimensions are countries that have similar characteristics according to the health indicators. Those countries which are located left-hand side of the Dimension 1 have better LEAB, MRUF, MRF, MRI, CHE, ASMRF, ASMRM and TI values than those countries located on the right-hand side.

Albania, Bulgaria, Montenegro, N. Macedonia, Romania, Serbia and Turkey are all upper middle-income countries and the rest of other countries are high income countries (World Bank, 2021a). It is observed from Figure 2 that upper middle-income countries are fall on the right-hand side and most of the high-income countries are fall on the left- and middle-hand side of the figure. Examining the CHE, it is determined that the countries fall on the right-hand side of the zero point of Dimension 1 have lower CHE than that of the countries on the left-hand side of the zero point of Dimension 1 (except CHE of Serbia and Montenegro is closer to the left-hand side of the countries).

At this point the income and health expenditures of the countries are illustrated on Figure 3. Pearson correlation coefficient r = +0.55 is significant at 0.05 level (p=0.001). There is a positive relationship between income and current health expenditure. It can be inferenced from the Figure 3

that although the national income of Turkey is higher than Albania, North Macedonia, Serbia, Montenegro, Bulgaria and Romania, Turkey has the lowest health expenditure.

Figure 3. The Relationship Between Current Health Expenditure and Income Distribution



Data Source: World Bank (2021b)

The MDS results of stimulus coordinates are showed by Table 1.

Table 1. Stimulus Coordinates

STIMULUS	DIMENSION	
COUNTRIES	1	2
Albania	0.6271	-0.8496
Austria	-1.3181	1.2227
Belgium	-0.9528	-0.2140
Bulgaria	2.0117	0.3467
Croatia	0.1675	-0.0591
Cyprus	-0.8728	0.1658
Czechia	-0.1314	-0.0454
Denmark	-0.6868	0.0484
Estonia	0.3415	0.9346
Finland	-1.0239	-0.1064
France	-1.2880	0.0351
Germany	-0.9624	-0.0808
Greece	-0.8014	-0.4097
Hungary	1.0553	-0.6069
Ireland	-0.8150	-0.1478
Italy	-1.3775	0.2408

STIMULUS	DIMENSION	
COUNTRIES	1	2
Latvia	2.0357	-0.6281
Lithuania	2.0318	0.1512
Luxembourg	-1.1198	-0.7276
Malta	-0.9691	-0.4333
Montenegro	0.9380	2.6423
Netherlands	-0.9839	-0.0619
N. Macedonia	1.6584	0.3063
Poland	0.4648	-0.0665
Portugal	-0.7765	-0.4013
Romania	2.7842	0.2258
Serbia	1.9920	0.0923
Slovakia	0.4459	-0.2940
Slovenia	-0.7773	0.0292
Spain	-1.3050	-0.1516
Sweden	-1.5035	0.0612
Turkey	1.1114	-1.2184

From Table 1 in Dimension 1 the lowest score belongs to Sweden (-1.5035) and the highest score belongs to Romania (2.7842). In Dimension 2, the lower scores belong to Turkey, Albania, Luxembourg, Latvia and Hungary; and the higher scores belong to Montenegro, Austria and Estonia, respectively. It is determined from the data that the scores of ILIDTP, ILIM are higher, MRF, MRI and MRUF are lower (are better values) for Montenegro, Austria and Estonia than Turkey, Albania, Luxemburg, Latvia and Hungary.

In MDS optimally scaled data disparity is a measure of similarity/dissimilarity between two observations. The higher the disparity value, the higher the dissimilarity between two compared countries. Table 2 demonstrates the disparities for EU candidate countries.

Table 2. Optimally Scaled Data Disparities for EU Candidate Countries

	Disparities				
Countries	Albania[2]	N. Macedonia[2]	Montenegro[2]	Serbia[2]	Turkey[2]
Albania[2]	0.000	1.300	3.121	1.970	0.473
Austria[1]	2.814	3.141	3.058	3.360	3.354
Belgium[1]	2.079	2.653	3.149	2.741	2.342
Bulgaria[1]	2.062	1.693	2.732	1.740	1.648
Croatia[1]	1.161	1.708	2.658	2.018	1.274
Cyprus[1]	1.891	2.500	2.771	2.803	2.185
Czechia[1]	1.535	2.059	2.713	2.209	1.648
Denmark[1]	1.969	2.465	2.963	2.591	2.185
Estonia[1]	2.194	2.328	2.318	2.525	2.185
Finland[1]	2.191	2.802	3.068	2.831	2.471
France[1]	2.378	2.826	3.134	2.993	2.861
Germany[1]	2.193	2.673	3.112	2.685	2.471
Greece[1]	1.743	2.512	3.235	2.804	1.912
Hungary[1]	1.740	1.848	2.950	1.591	1.359
Ireland[1]	1.761	2.477	2.970	2.781	1.912
Italy[1]	2.341	2.969	3.142	3.215	2.861
Latvia[1]	2.244	2.273	3.188	1.979	1.757
Lithuania[1]	2.298	2.273	2.866	2.155	1.912
Luxembourg	2.021	2.915	3.463	3.152	2.185
Malta[1]	1.687	2.45	3.331	2.896	1.912
Montenegro[2]	3.121	2.395	0.000	2.673	3.796
Netherlands[1]	2.067	2.614	3.053	2.739	2.342
N. Macedonia[2]	1.300	0.000	2.395	1.597	1.067
Poland[1]	1.375	1.775	2.652	1.962	1.274
Portugal[1]	2.005	2.734	3.294	2.848	2.339
Romania[1]	2.434	2.432	3.207	2.629	2.185
Serbia[2]	1.970	1.597	2.673	0.000	1.912
Slovakia[1]	1.215	1.596	2.842	1.840	1.067
Slovenia[1]	2.020	2.629	2.945	2.736	2.342
Spain[1]	2.248	2.988	3.377	3.166	2.735
Sweden[1]	2.444	3.048	3.339	3.096	3.083
Turkey[2]	0.473	1.345	3.391	2.214	0.000

1: EU country, 2: EU candidate country

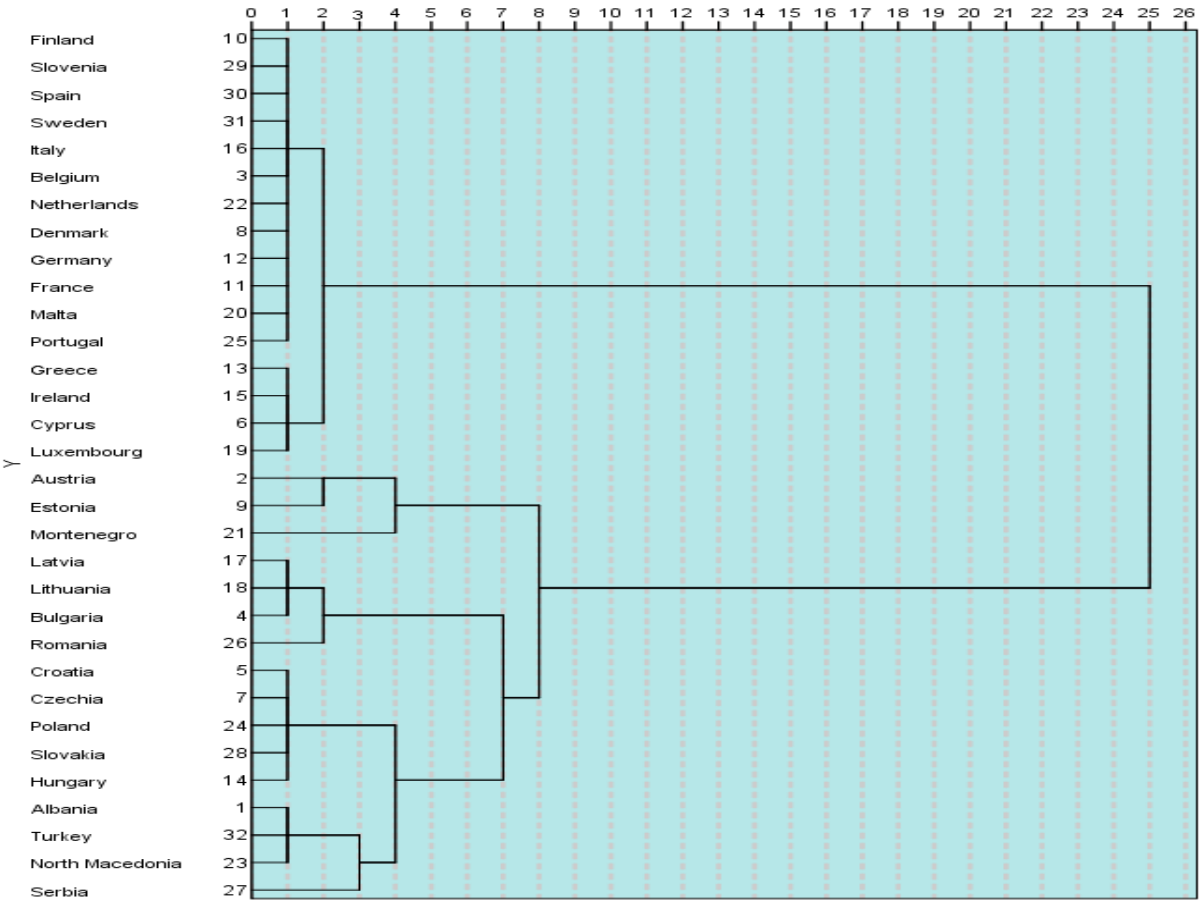
: The closest to EU country : The farthest to EU country

It can be seen from Table 2 that Turkey is the closest country to EU member countries of Bulgaria, Lithuania, Poland, Hungary, Latvia, Romania, Slovakia; and Albania is the closest to the rest of the EU countries. The most similar country to Turkey is Albania (0.473) and the most dissimilar country to Turkey and Albania is Montenegro. Turkey is most dissimilar to the EU member country of Austria.

3.3. Cluster Analysis for Country Classifications

Using hierarchical cluster analysis and Ward linkage cluster method, all countries have been classified into 7 clusters at the second level (Figure 4).

Figure 4. Dendogram using Ward Linkage (Rescaled distance cluster combine)



In CA similar countries classified into the same cluster. The results of clustering are shown in Table 3.

Table 3. The Classification of Countries According to The Health Indicators into Seven Cluster

Cluster 1	Cluster 2		Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7
Albania	Belgium	Luxembourg	Austria	Bulgaria	Croatia	Montenegro	Serbia
N. Macedonia	Cyprus	Malta	Estonia	Latvia	Czechia		
Turkey	Denmark	Netherlands		Lithuania	Hungary		
	Finland	Portugal		Romania	Poland		
	France	Slovenia			Slovakia		
	Germany	Spain					
	Greece	Sweden					
	Ireland						
	Italy						

As a result of the cluster analysis in Table 3, EU candidate countries are classified in clusters separated from EU member countries. EU candidate countries of Albania, N. Macedonia and Turkey classified into a cluster, Montenegro classified in one another cluster and Serbia classified in one another cluster. There are similar results according to the CA and MDS results. MDS results in Figure 2 illustrates that Albania and Turkey are closely located, and Montenegro is located far away from the rest of the countries. As classified into the same cluster, Bulgaria, Latvia, Lithuania and Romania are located at the right-hand side of the Figure 2. Classified into the Cluster 5, Croatia, Czechia, Hungary, Poland and Slovakia are located nearby the center of the Dimension 1 in Figure 2. Belgium, Cyprus,

Denmark, France, Finland, Greece, Germany, Italy, Ireland, Luxembourg, Malta, Netherlands, Portugal, Spain, Sweden and Slovenia clustered into the Cluster 3 are all located at the right-hand side and the nearby the center of Dimension 2 in Figure 2. In Figure 2 Serbia is located nearby Lithuania.

SW was conducted to determine whether the underlying distributions are normal for health indicators in each cluster, and it is found that the distributions are normal ($p>\alpha=0.05$). Thus, the means are used as a central tendency measure for indicators to assess final cluster centers. In Table 4 the means of health indicator are reported for each cluster. The means of health indicators taken into consideration and comparisons are made between clusters as follow.

Table 4. Cluster Means of Health Indicators

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7
CHE	5.32	9	8.51	6.42	6.84	8.42	8.54
LEAB	77.37	82.14	80.15	75.55	78.2	76.9	76
ASMRF	467.57	270.91	303.65	432.67	369.92	474.9	748.7
ASMRM	688.3	411.54	535.4	785.9	639.3	673.4	717.7
ILIDTP	1.33	1.94	9	4.25	1.4	6	1
ILIM	11	5	9	6.25	5.4	58	13
MRF	58	42.81	49	80.75	61.6	66	75
MRI	110.67	78.5	117	199.5	140.2	125	142
MRUF	9.77	3.48	3.05	5.58	4.48	2.5	5.5
TI	15.67	8.17	10.05	40.75	8.4	15	17

: Best value of health indicator : Worst value of health indicator

Cluster 1 is composed of EU candidate countries of Albania, N. Macedonia and Turkey. In all of the clusters the lowest CHE belongs to this cluster. According to the 2000-2019 annually data, although in years the CHE rises for these countries, they have not caught the EU countries yet. The minimum CHE belongs to Turkey, Turkey spent 4.12 percent of its' GDP on health. ASMRF and ASMRM are high for this cluster. Compared to the other clusters ILIDTP value is better on the contrary ILIM value is not so better. The highest values of MRUFs belong to this cluster.

Cluster 2 is composed of 16 EU member countries. According to the indicators of CHE, LEAB, ASMRF, ASMRM, ILIM, MRF, MRI, and TI this is the most successful countries cluster. The values for ILIDTP and MRUF indicator values are not so high as compared to their best values.

Austria and Estonia are classified into Cluster 3. The second order best values of LEAB, ASMRF, ASMRM, and MRF belong to this cluster. The worst value of ILIDTP belongs to this cluster and the value of ILIM is not good for this cluster.

Cluster 4 is composed of Bulgaria, Latvia, Lithuania and Romania. It can be seen from Table 4 that the worst values of LEAB, ASMRM, MRF, MRI, and TI belong to this cluster. The second order minimum value of CHE belong to this cluster. It can be interpreted that Bulgaria, Latvia, Lithuania and Romania are not prospered in indicators of ASMRM MRI, TI, and LEAB.

Cluster 5 is composed of Croatia, Czechia, Hungary, Poland and Slovakia. The means for this cluster is at the average level of all the clusters. It can be interpreted that the next best cluster after Cluster 2 in terms of health indicators of ILIM and TI is this cluster.

Montenegro is the only country classified into Cluster 6. The best value of MRUF belongs to Montenegro. The worst value of ILIM which is so high compared to other clusters belongs to Montenegro.

Serbia is classified into Cluster 7. The best value of ILIDTP belongs to Serbia. The worst value of ASMRF belongs to Serbia. The next best cluster after Cluster 2 in terms of health indicator of CHE is this cluster. The next worst cluster after Cluster 4 in terms of health indicator of ASMRM, TI, MRF and MRI is this cluster.

In order to determine how the EU candidate countries can be classified with the EU candidate countries, 4 cluster classifications in the fourth level of the CA in Figure 4 were evaluated. The classification results are shown in Table 5. Montenegro merged with Austria and Estonia in a cluster; Albania, N. Macedonia, Serbia and Turkey merged with Croatia, Czechia, Hungary, Poland, Slovakia in a cluster.

Table 5. The Classification of Countries According to The Health Indicators into Four Cluster

Cluster 1	Cluster 2		Cluster 3	Cluster 4
Albania	Belgium	Italy	Austria	Bulgaria
N. Macedonia	Cyprus	Luxembourg	Estonia	Latvia
Serbia	Denmark	Malta	Montenegro	Lithuania
Turkey	Finland	Netherlands		Romania
Croatia	France	Portugal		
Czechia	Germany	Slovenia		
Hungary	Greece	Spain		
Poland	Ireland	Sweden		
Slovakia				

From Table 4 and Table 5 it seen that in both seven and four classifications, the second clusters comprise of the same countries; and the fourth clusters comprise of the same countries. It is seen that Montenegro merged with Austria and Estonia into the same cluster, and the rest of the other EU candidate countries are all merged with Croatia, Czechia, Hungary, Poland and Slovakia into the same cluster at the fourth level of clustering.

Table 6. Final Cluster Centers of Four Classifications

	Cluster 1	Cluster 2	Cluster 3	Cluster 4
CHE	6.52	9	8.48	6.42
LEAB	77.68	82.14	79.07	75.55
ASMRF	444.56	270.91	360.73	432.68
ASMRM	664.34	411.54	581.4	785.9
ILIDTP	1	1.94	8	4.25
ILIM	8.11	5	25.33	6.25
MRF	61.89	42.81	54.67	80.75
MRI	130.6	78.5	119.7	199.5
MRUF	6.36	3.48	2.87	5.58
TI	11.8	8.17	11.7	40.75

: Best value of health indicator : Worst value of health indicator

Also, for the four clustering SW was conducted to determine whether the underlying distributions are normal for health indicators in each cluster, and it is found that the distributions are normal ($p>\alpha=0,05$). Thus, means are used as a central tendency measure for indicators to assess final cluster centers. The final cluster centers of four classifications are given above in Table 6.

It can be concluded from Table 5 and Table 6 that Belgium, Denmark, Cyprus, France, Finland, Greece, Germany, Italy, Ireland, Malta, Luxembourg, Netherlands, Portugal, Spain, Slovenia and Sweden are the countries with the most successful health indicators of CHE, LEAB, ASMRF, ASMRM, ILIM, MRF, MRI, TI. Albania, N. Macedonia, Serbia, Turkey, Croatia, Czechia, Hungary,

Poland and Slovakia and Sweden are the countries with the most successful health indicator of ILIDTP. Austria, Estonia and Montenegro are the countries with the most successful health indicator of MRUF.

3.4. Changes in Health Indicators Over the Years in Turkey and Average Values of EU Member Countries

The data available for the period 2000-2019 are given in Table 7.

Table 7. Changes in Health Indicators Over the Years in Turkey and Average Values of EU Member Countries

	Country	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
LEAB	EUA*	75.9	77.2	78.5	78.7	79	79.2	79.4	79.63	79.81	80	80.1	80.3
	Turkey	70	72.4	74.5	74.9	75.4	75.8	76.2	76.5	76.9	77.2	77.4	77.7
CHE	EUA	6.89	7.69	8.44	8.33	8.37	8.36	8.32	8.209	8.25	8.18	8.18	
	Turkey	4.6	4.89	5.02	4.65	4.44	4.37	4.33	4.117	4.285	4.18	4.12	
MRI	EUA	6.66	5.32	4.26	4.11	3.97	3.86	3.74	3.633	3.541	3.42	3.32	3.22
	Turkey	31.4	22.3	15.6	14.6	13.6	12.7	11.9	11.1	10.5	9.8	9.2	8.6
MRUF	EUA	8	6.38	5.1	4.93	4.76	4.6	4.48	4.337	4.222	4.11	3.99	3.87
	Turkey	38.6	26.5	18.2	17	15.8	14.8	13.8	13	12.1	11.4	10.7	10
MRF	EUA	75	68.6	60.6	59.7	57.8	57	54.8	52.85	50.55	42.2		
	Turkey	100	87.7	78.6	77.2	75.7	74.3	72.9	71.53	70.13	68.7		
TI	EUA	30.6	24.8	19.2	18.3	17.8	17.2	15.9	15.44	14.83	13.8	13.2	
	Turkey	33	33	25	24	22	20	20	18	18	17	16	
ILIM	EUA	9.48	6.7	6.44	6.04	5.37	5	5.33	5.815	6	5.63	5.52	5.56
	Turkey	13	9	3	2	4	2	6	3	2	4	4	3
ASMRF	EUA	429		351					325.2	315.6			
	Turkey	573		464					421.1	414.3			
ILIDTP	EUA	2.19	2.41	2.11	2.3	2	1.96	2.37	2.333	2.37	2.33	2.74	2.7
	Turkey	8	8	2	2	3	1	3	2	1	2	1	1

Data Source: World Bank (2021b) and UNDP (2021) data, *EUA: EU member countries average value

It can be seen from Table 7 that Turkey's health indicators except CHE have improved over time. Turkey's health expenditure has increased from 2000 to 2010, and since 2011 there has been a decrease in health expenditure. ILIM values are better than EU average, since 2010 the other health indicator values are behind the EU average values. The changes of ASMRF, ASMRM, MRF and TI over the years has been similar both for Turkey and EU average. However, the values of these indicator are higher for Turkey than EU average.

IV. DISCUSSION AND CONCLUSION

According to the findings in MDS similar countries are located closely in terms of the health indicators. It was determined that Turkey is not located among the countries with the best values of LEAB, MRUF, MRF, MRI, CHE, ASMRF, ASMRM and TI values. It has concluded that most of the health indicator values of high-income countries are better than upper middle-income countries. There is a positive relationship between income and health expenditure. It is observed from Figure 3 that for most of the countries those with high income spend more on health and the lowest health expenditure belongs to Turkey.

According to the MDS results of stimulus coordinates MRF, MRI and MRUF are higher (are not good values), ILIDTP, ILIM are lower (are better values) for Turkey, Albania, Luxemburg, Latvia and Hungary compared to Montenegro, Austria and Estonia. In the study data the worst values of infant mortality rate (MRI), under-five mortality rate (MRUF) and female adult mortality rate (MRF) are belonged to Turkey.

The United Nations accepts death rates and causes of death as development indicators for countries (Gürler et al., 2020). In 2019, the top three causes of death in women in Turkey were circulatory system diseases, benign and malignant tumors and respiratory system diseases (Türkiye İstatistik Kurumu, 2021). In 2017 the top three causes of death for under five children were prematurity (32%), congenital anomalies (29%), other neonatal causes (10%). Out of every 1000 babies born alive, 10.2 in 2014 and 9.2 in 2018 died in their first year of life. There are regional disparities in infant and under-5 mortalities in Turkey. While the highest number of deaths occurred in the Southeastern Anatolia region in 2014 and 2018, the lowest deaths were in the East Marmara region in 2014 and the West Marmara region in 2018 (Tokuç and Eskiocak, 2020).

As an indicator of a country health, infant mortality rate is often considered as a barometer of community or country overall welfare (Gonzalez and Gilleskie, 2017). Infant mortality rate, which is seen as a development criterion in many academic studies was worst for Turkey than EU countries also in the study of Altıntaş (2012). The findings of Lorcu and collegues (2012) gives that Turkey is positioned separately from EU countries, and in terms of the average values of child and maternal health Turkey is at the worst position compared to EU countries. However, in the Lorcu and collegues (2012) study Turkey has the highest vaccination rates. It has observed in the study of Köksal and collegues (2016) that the health indicators of crude birth rate, infant mortality rate, mortality rate under age five, maternal mortality rate, LEAB, the share of health from general budget, health expenditure per capita, number of physicians, nurses, midwifes and hospital beds for Turkey are not as good as the EU average values. In MDS optimally scaled data disparity results show that Turkey is closely located to the EU member countries of Bulgaria, Lithuania, Poland, Hungary, Latvia, Romania, Slovakia. Turkey is most dissimilar to the EU member country of Austria. In comparison of health indicators Austria's values are better than Turkey’s values in all health indicators except ILIM and ILIDTP.

In CA countries firstly classified into 7 clusters. In this classification Turkey was in the same cluster with Albania and N. Macedonia. These countries have the lowest CHE. According to the 2000-2019 annually data, although in years the CHE rises for these countries, they have not caught the EU countries yet. The minimum CHE is belonged to Turkey, Turkey spent only 4.12 percent of its’ GDP on health. ASMRF and ASMRM are high for this cluster and the highest values of MRUFs belong to this cluster.

ILIDTP values are better on the contrary ILIM values are not so better for this cluster. In this classification Belgium, Cyprus, Finland, Denmark, France, Greece, Germany, Italy, Ireland, Luxembourg, Netherlands, Malta, Portugal, Sweden and Slovenia countries classified into the same cluster. This is the most successful cluster in terms of CHE, LEAB, ASMRF, ASMRM, ILIM, MRF, MRI, and TI. Turkey can follow the developments of these countries in the field of those health indicators.

In order to determine EU candidate countries classifications with EU member countries at fourth level of CA has taken into consideration and 4 clusters were formed in this classification. Turkey, Albania, N. Macedonia and Serbia merged with Croatia, Czechia, Hungary, Poland, Slovakia in a cluster. Montenegro merged with Austria and Estonia in a cluster. Turkey is classified with EU member countries in a group, but the health indicators of this group are not as good as the group of other EU member countries.

In the literature studies have been conducted to determine the classification and location of Turkey among EU member countries with regards to the different health indicators. In the study of Sığırlı and others (2006), (MDS) results show that Turkey is closely located to Romania and Bulgaria. Altıntaş (2012) determined that Turkey has not yet reached the EU level in terms of health indicators. In the study of Lorcu and Bolat (2012), the analysis reveals significant similarities between EU member countries of Bulgaria, Romania and Turkey. Lorcu and others (2012) determines that Turkey is positioned separately from EU member countries. In the study of Girginer (2013) Turkey classified into the same group with Bulgaria, Hungary, Latvia, Estonia, Lithuania, Poland and Romania. The study results of Alptekin (2014) reveals that Turkey classified into the same group with Lithuania, Poland, Estonia, Hungary, Romania, Slovakia, Latvia, Bulgaria and Cyprus. Köksal and others (2016) according to the health indicators identified significant differences between Turkey and average value of EU member countries. In the study of Şahin (2017) Turkey was placed in the same cluster with Bulgaria, Czechia, Croatia, Estonia, Lithuania, Poland, Romania, Hungary, Latvia and Slovakia in both years of 2000 and 2014. Yalçın-Balçık and others (2021) examines health indicators of EU member, EU candidate and EFTA countries and in this study Turkey, Albania, Bulgaria, Bosnia Herzegovina, Hungary, Latvia, Estonia, Lithuania, Poland, Montenegro, Macedonia, Romania, Serbia, Slovakia classified into the same cluster. The findings obtained from this study are in parallel with the existing literature. In all these studies and also in this study, Turkey was not classified among the EU member countries which have better health indicator values.

In both MDS and CA, Turkey is classified with EU member countries of Hungary, Poland, Slovakia. Despite the developments over the years in the health sector and classified into the same class with the EU member countries, it has been determined that Turkey lags behind the EU countries which are successful in health indicators. It is essential to make improvements in the field of health to accelerate Turkey's accession to the EU.

From both developing and developed countries, there is strong empirical evidence that improved health significantly increases economic productivity and growth, and also economic growth improves health (Atun and Fitzpatrick, 2005). Increasing health expenditures positively affects economic growth and development (Giray and Çimen, 2018). One of the most important factors affecting the health level positively is the increase in health expenditures. Important issues that determine health policies are the shares of health expenditures and financing from the economies of countries (Güven et al., 2020). In Turkey, more effective investments should be made to achieve goals in the field of health.

Infant, under-five and female adult mortality rates have to be on the top of the agenda of Turkish health policymakers and scientists. In order to prevent deaths, it is necessary to determine the causes of deaths. The causes of diseases or risk factors that adversely affect the noncommunicable disease of adults, the health and life of women, infants and children under the age of 5 should be investigated and necessary precautions should be taken to reduce deaths. Priorities should be given to preventive health services and health trainings should be given to individuals. Equal access to healthcare resources should be provided in all regions of Turkey. A healthy society can be formed by developing in the field of health, and thus community welfare can be provided.

The latest data are used in the analysis of this study. Health indicators for 2020 and 2021 years not yet published are expected to show reductions in life expectancy and rises in mortality rates due to the COVID 19 pandemic. Since January 2020, most of the health spending has been used for resolving health problems caused by the pandemic. It will be essential to re-examine and compare changes in health indicators of Turkey and the EU, and to evaluate Turkey's success during this pandemic process.

Ethical Approval: The data used in the study were obtained from open sources, therefore, ethics committee approval is not required.

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