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Research Article

COMPARISON OF HEALTHCARE SYSTEMS PERFORMANCES IN OECD COUNTRIES

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Abstract: *Health spending is increasing every day around the world. Because of this, efficient use of resources (human, technology, material, etc.) becomes more important. This study aimed to compare the health efficiencies of the Organization for Economic Co-operation and Development (OECD) countries. In order to consider the trend of efficiency of the countries in the observed period (2014-2018), window analysis is chosen as the most appropriate input-oriented Data Envelopment Analysis (DEA) technique. The DEA window method was chosen since it leads to increased discrimination on findings and enables year-by-year comparisons. Input and output variables used in the study were determined by examining other studies in the literature. In this respect, the input variables were identified as the number of physicians per thousand people, the number of nurses per thousand people, the number of hospital beds per thousand people, health spendings (% of GDP); and output variables were expected life expectancy at birth, and rate of surviving infants. According to the results of the DEA window analysis, only Mexico was found to be efficient. Other countries with an efficiency score of more than 90% are Turkey (0.999), Japan (0.991), Korea (0.974), Luxembourg (0.937). On the other hand; Austria (0.591), Switzerland (0.545), and Germany (0.511) were the last countries in the efficiency score ranking. In these countries, which produce high health output, their inputs are also high, so they are at the end of the ranking of efficiency scores.*

Keywords*: OECD Countries, Healthcare Performance, DEA Window, Efficiency*

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1. Introduction

Societies must have a healthy generation to sustain their existence. It is expected that societies consist of healthy individuals will make positive contributions to the power of production. Because of this, health services should be available when they are needed by all segments of citizens. Health problems and policies are one of the most important issues of the people and states in accordance with the understanding of the social state [1].

Health indicators are one of the most important parameters used in determining the level of development and socioeconomic development of countries. According to the Organization for Economic Co-operation and Development (OECD); summary indicators of population health and health system performance include; risk factors for health (smoking, alcohol, air pollution ext.), health care resources (health spending, doctors, nurses ext.), quality of care, access to care, health status (life expectancy, mortality ext.) [2].

Efficiency analyses can be performed with the data selected from these indicators. It is possible to have information about the performance of health systems of regions, various organizations, or countries. Changes in the health status of society can be followed. Regional or international comparisons can be made and lead to remedial policies in the health sector. The public can easily notice changes in the health sector (positive or negative). Improvements or declines in the health sector are easily understandable. Citizens constantly commute to medical facilities for their illnesses or checks. From this point of view, health administrators need to pay attention to feedback from the public. Inter-country benchmarks, which include the activities of the health sector, are also important.

When the world's practices are examined, it can be said that each country has its health systems. Although various classifications are made, the most widely accepted is the classification for the financing of Health Services. Taxes, social insurance premiums, out-of-pocket payments, or private health insurance can be used to finance health services. A key feature of the Beveridge model is that health care is funded based on taxes. It is used in countries such as the United Kingdom, Denmark, Finland, Ireland, Spain, Sweden, Italy, Norway, Portugal, Greece. In the Bismarck model, the contributions of employees and employers constitute resources. It is practiced in Germany, Austria, Belgium, France, the Netherlands, and Switzerland. The most well-known country that implements private health insurance is the United States. Although various applications are made in countries, whichever is the most commonly used method is evaluated in that class [3].

All over the world, while health care costs are increasing, patients' expectations are also changing. States are also making efforts to eliminate factors that disrupt public health while trying to facilitate access to health care. As people's interest in healthy living increases, demands diverge. Health care providers are being challenged in the face of increasing demand for services from day today. Countries have to meet the health needs of the people by using their resources most effectively. All people have the right to live in healthy conditions. Currently, one of the most important elements that make countries competitive is a human investment. Because the healthier individuals are, the more they can contribute to themselves and the country they are in.

The aim of this study is to address the levels of efficiency in health care of OECD member countries and to make recommendations for solving problems. In the study, the health services offered to the citizens of OECD countries, including Turkey, were evaluated comparatively.

2. Data and Methodology

This study focused on the performance of the health systems of OECD countries. States must provide quality, effective and efficient health care to their citizens. For this reason, efficiency values between countries have been studied comparatively.

In this context, the study aimed to compare the health efficiencies of OECD countries. OECD countries with similar goals have been selected as decision-making units (DMUs). The analysis was conducted using the DEA-Solver program. The input-oriented Data Envelopment Analysis (DEA) technique–window analysis (with constant returns to scale (CRS) assumption) method was used. The sample used in the study and the variables determined is given below.

2.1. Study design, sample and variables

The study aimed to use the most up-to-date data from OECD countries. For this reason, the 5 years between 2014-2018 have been determined. In variables determined as input and output, countries that do not have incomplete data were included in the study. Finland, Czech Republic, New Zealand, Colombia, Greece, Portugal, Netherlands, and Chile were not included in the research due to incomplete data. The lack of complete 2019 and 2020 data and the fact that it only covers OECD countries is one of the limitations of the study.

In DEA analysis, the choice of DMUs that produce similar outputs with similar inputs is important. OECD countries also participate in this organization for similar purposes. In addition, in the

DEA method, all inputs and outputs must be selected in a positive or negative direction. In this study, all of the input variables and one of the output variables (life expectancy at birth) were positive.

One of the output variables, infant mortality rates (IMR), is negative. Instead, infant survival rate (ISR) was used as a positive directional variable. The formula used for the ISR calculation method is as follows [4].

$$\text{Infant Survival Rate (ISR)} = (1000\text{-IMR})/\text{IMR} \quad (1)$$

The study examined 29 OECD countries. The data used in the analysis were obtained from OECD Health Statistics [5]. The variables used were determined by reviewing the literature. For example; In their work in OECD countries, Afonso and Aubyn, have 3 outputs (the infant survival rate, life expectancy, and potential years of life not lost) and 4 inputs (the number of practicing physicians, practicing nurses, acute care beds per thousand habitats and high-tech diagnostic medical equipment) were used [4]. Hadad et al. aimed to identify health activities in OECD countries. They determined "practicing physicians per 1000 population, inpatient beds per 1000 population, total expenditure on health per capita, GDP per capita and consumption of fruit and vegetables" as input variables in their study [6]. Life expectancy at birth (years) and infant mortality (deaths per 1000 live births) are the output variables.

2 output and 4 input variables used in the research and their descriptions are listed in Table 1.

Table 1. Input and Output Variables

	Indicators		Definition
Input	**PHY**	The number of physicians	The number of practicing, professionally active, or licensed to practice physicians per 1000 population.
	NUR	The number of nurses	The number of practicing, professionally active, or licensed to practice nurses per 1000 population.
	HB	The number of hospital beds	All hospital beds are regularly maintained, staffed, and immediately available per 1000 population
	HS	Health spending	% of Gross Domestic Product (GDP), current $
Output	**LE**	Life expectancy at birth	The average number of years that a person at birth is expected to live, assuming that age-specific mortality levels remain constant.
	ISR	Infant Survival Rate	Computed via equation using IMR. IMR is the number of deaths in children under 1 year of age per 1000 live births that occurred in a given year.

2.2. DEA Window Analysis

DEA is a non-parametric and linear programming-based efficiency measurement method that measures the relative efficiency of homogeneous DMUs using the same inputs and outputs [7, 8]. DEA is a technique that provides information to administrators for more efficient use of resources. In addition, window analysis allows us to include the time dimension in efficiency analysis.

DEA window analysis is a DEA technique that can measure multi-period performance. Allows you to measure how the efficiency scores of DMUs change over different periods [9]. DEA window analysis developed by Charnes, Clark, Cooper, and Golany [10], first used in 1984 [11]. The performance of DMU in the studied period is compared with its own performance in other periods and the performance of other DMUs [12].

In this perspective, it is assumed that there were no significant technical changes during the analysis period (the technological limit is constant) [13]. In traditional DEA applications, each DMU is observed only once, as cross-sectional data is used. It can be said that DEA window analysis is useful in determining performance changes in the specified period [14]. A window length is determined in the analysis. DMUs data at different times are considered to be of a different unit. Each DMU is compared to both itself and other DMUs. In the analysis, the DMU in the first year is calculated as another DMU for the second year [15].

T (t = 1,..., T) in the time period, N pieces *(n = 1,...,N)* suppose it is DMU. *r* denotes the number of inputs and *s* denotes the number of outputs. The observation of *n* (DMU_t^n) in the *t*-period has an *r*-dimensional input vector $x_t^n = (x_{1t}^n, x_{2t}^n, \dots, x_{rt}^n)'$ and an *s*-dimensional output vector $y_t^n = (y_{1t}^n, y_{2t}^n, \dots, y_{st}^n)'$. Assume that the window starts at *k* time *1≤k≤T* and that the window width *w* is *1≤w≤T-k*. Each window is shown with k_w. The matrices created for a window analysis in this structure can be written as follows [16].

Input matrix;

$$X_{k_w} = (x_k^1, x_k^2, \dots, x_k^N, x_{k+1}^1, x_{k+1}^2, \dots, x_{k+1}^N, x_{k+w}^1, x_{k+w}^2, \dots, x_{k+w}^N), \quad (2)$$

Output matrix;

$$Y_{k_w} = (y_k^1, y_k^2, \dots, y_k^N, y_{k+1}^1, y_{k+1}^2, \dots, y_{k+1}^N, y_{k+w}^1, y_{k+w}^2, \dots, y_{k+w}^N). \quad (3)$$

This analysis assumes that DMUs are a different unit in each period [17]. Substituting the above inputs and outputs of DMU_t^n into relevant models will generate the results of DEA window analysis.

3. Results

The study analyzed the health system efficiencies of 29 OECD countries. The input-oriented DEA window model was used. In this study, efficiency scores were calculated with 5-year data (from 2014 to 2018) and selected window analysis as the most appropriate DEA technique to take into account the efficiency trend of countries during the observed period. The reason for this is to determine whether OECD countries have experienced a change in effectiveness over the 5-year period with DEA window analysis.

The data is arranged in accordance with the analysis. For solving the specified DEA model (Window-I-C) the software DEA-Solver-LV has been used. The results at window length level 3 were interpreted. Table 2 shows the minimum, maximum, and average values of input and output variables and which countries have them.

Tablo 2. Input and Output Variables (Min., Max., Avg.)

PHY	2014	Country	2015	Country	2016	Country	2017	Country	2018	Country
Min.	1.76	Turkey	1.81	Turkey	1.83	Turkey	1.87	Turkey	1.88	Turkey
Max.	5.05	Austria	5.09	Austria	5.13	Austria	5.18	Austria	5.24	Austria
Avg.	3.27	-	3.30	-	3.35	-	3.40	-	3.45	-
NUR	**2014**	**Country**	**2015**	**Country**	**2016**	**Country**	**2017**	**Country**	**2018**	**Country**
Min.	1.85	Turkey	1.95	Turkey	1.93	Turkey	2.07	Turkey	2.34	Turkey
Max.	16.89	Norway	17.34	Norway	17.49	Norway	17.67	Norway	17.74	Norway
Avg.	8.78	-	8.89	-	8.97	-	9.09	-	9.21	-
HB	**2014**	**Country**	**2015**	**Country**	**2016**	**Country**	**2017**	**Country**	**2018**	**Country**
Min.	1.03	Mexico	1	Mexico	1	Mexico	0.99	Mexico	0.98	Mexico
Max.	13.21	Japan	13.17	Japan	13.11	Japan	13.05	Japan	12.98	Japan
Avg.	4.97	-	4.93	-	4.91	-	4.88	-	4.83	-
HS	**2014**	**Country**	**2015**	**Country**	**2016**	**Country**	**2017**	**Country**	**2018**	**Country**
Min.	4.35	Turkey	4.14	Turkey	4.31	Turkey	4.21	Turkey	4.16	Turkey
Max.	16.41	United States	16.71	United States	17.05	United States	17.00	United States	16.89	United States
Avg.	8.72	-	8.72	-	8.80	-	8.77	-	8.79	-
LE	**2014**	**Country**	**2015**	**Country**	**2016**	**Country**	**2017**	**Country**	**2018**	**Country**
Min.	74.3	Latvia	74.5	Lithuania	74.7	Latvia	74.8	Latvia	74.9	Latvia
Max.	83.7	Japan	83.9	Japan	84.1	Japan	84.2	Japan	84.3	Japan
Avg.	80.4	-	80.3	-	80.6	-	80.7	-	80.8	-
IMR	**2014**	**Country**	**2015**	**Country**	**2016**	**Country**	**2017**	**Country**	**2018**	**Country**
Min.	1.8	Slovenia	1.6	Slovenia	0.7	Iceland	1.9	Japan	1.6	Estonia
Max.	13.6	Mexico	13.6	Mexico	13.4	Mexico	13.5	Mexico	12.9	Mexico
Avg.	4.0	-	3.9	-	3.9	-	3.8	-	3.7	-

In Table 2; Mexico is the only country that is fully efficient in all 3 periods: 2014-2016, 2015-2017, and 2016-2018. In the average efficiency scores of all periods, the top 5 ranked countries are Mexico (1), Turkey (0.999), Japan (0.991), Korea (0.974), and Luxembourg (0.937). The efficiency scores of these 5 countries are over 90%. The worst results were found in France (0.636), Norway (0.602), Austria (0.591), Switzerland (0.545), and Germany (0.511). It can be said that the lower ranking of these countries (since input-oriented DEA window analysis is used) is due to high input values.

According to OECD data for 2019, United States has the highest total health spending per capita ($11,072). Among the countries covered by the study, the lowest total health expenditures per capita were in Mexico ($1,154) and Turkey ($1,337). In OECD countries, the average per capita health spending is $ 4,224 [5]. For example, in PHY (the number of physicians) of input variables, countries such as Turkey, Mexico, Japan, Korea, and Luxemburg have values below the OECD average. When LE (life expectancy at birth) values were examined, it was found that Latvia and Lithuania had the lowest values. Japan, on the other hand, is noted for its longest life span. Turkey's expected life year at birth is about 78. In the infant mortality rates (IMR), Turkey and Mexico are the countries with the worst values in the sample. The reason why they rank high in the efficiency scores can be explained by the fact that their input values are lower than in other OECD countries, rather than producing the highest health output with the least input.

Countries that are probed in the ranking based on efficiency scores must go to the regulations in the use of their inputs. If these countries do not make the necessary administrative decisions, the investments they will spend (capital, labor, medical equipment, technology, etc.) can remain unrequited. Investments that do not positively change outcomes return as ineffectiveness as time progresses. Given the public opinion, it is negative to see that the return on investment is insufficient. This can lead to various restrictions in the field of Health. DEA Window-I-C (input CRS) analysis results (length of the window: 3) are shown in Table 3.

Tablo 3. Results DEA Window-I-C (lenght of window: 3)

Country	2014	2015	2016	2017	2018	Average	C-Average
	0.662	0.659	0.652			0.657	
Australia		0.669	0.662	0.643		0.658	0.656
			0.667	0.648	0.645	0.653	
	0.600	0.584	0.587			0.590	
Austria		0.588	0.591	0.614		0.598	0.592
			0.563	0.584	0.613	0.587	
	0.708	0.701	0.697			0.702	
Belgium		0.713	0.709	0.692		0.705	0.702
			0.716	0.698	0.681	0.698	
	0.849	0.846	0.845			0.847	
Canada		0.862	0.861	0.858		0.860	0.855
			0.867	0.864	0.847	0.859	
	0.634	0.642	0.647			0.641	
Denmark		0.656	0.660	0.629		0.648	0.643
			0.662	0.631	0.630	0.641	
	0.802	0.786	0.814			0.800	
Estonia		0.786	0.818	0.807		0.803	0.825
			0.812	0.801	1.000	0.871	
	0.639	0.628	0.628			0.632	
France		0.640	0.640	0.631		0.637	0.637
			0.646	0.636	0.640	0.641	
	0.519	0.509	0.502			0.510	
Germany		0.518	0.511	0.507		0.512	0.511
			0.516	0.512	0.507	0.512	
	0.620	0.642	0.638			0.634	
Hungary		0.642	0.638	0.673		0.651	0.650
			0.637	0.671	0.689	0.666	
	0.737	0.736	1.000			0.824	
Iceland		0.736	1.000	0.704		0.813	0.821
			1.000	0.708	0.766	0.824	
	0.806	0.762	0.764			0.777	
Ireland		0.771	0.771	0.778		0.773	0.780
			0.776	0.784	0.807	0.789	
	0.855	0.856	0.848			0.853	
Israel		0.866	0.858	0.845		0.856	0.856
			0.859	0.847	0.872	0.859	
	0.758	0.746	0.727			0.744	
Italy		0.753	0.734	0.732		0.740	0.738
			0.736	0.734	0.723	0.731	
	0.990	1.000	0.976			0.989	
Japan		1.000	0.978	0.978		0.985	0.991
			1.000	1.000	0.994	0.998	
	0.983	0.992	0.963			0.980	
Korea		1.000	0.972	0.953		0.975	0.974
			0.987	0.968	0.945	0.967	
	0.811	0.771	0.738			0.773	
Latvia		0.771	0.740	0.731		0.748	0.763
			0.740	0.733	0.835	0.770	

Table 3. Continued.

Country	2014	2015	2016	2017	2018	Average	C-Average
	0.714	0.672	0.653			0.679	
Lithuania		0.672	0.653	0.725		0.683	0.684
			0.650	0.723	0.696	0.690	
	0.936	0.964	0.933			0.944	
Luxembourg		0.964	0.933	0.943		0.946	0.937
			0.930	0.940	0.893	0.921	
	1	1	1			1	
Mexico		1	1	1		1	1
			1	1	1	1	
	0.613	0.602	0.591			0.602	
Norway		0.607	0.600	0.596		0.601	0.602
			0.602	0.598	0.609	0.603	
	0.844	0.843	0.816			0.834	
Poland		0.855	0.828	0.839		0.841	0.840
			0.838	0.850	0.851	0.846	
	0.623	0.640	0.622			0.628	
Slovak Republic		0.640	0.622	0.658		0.640	0.637
			0.620	0.656	0.655	0.644	
	0.902	0.918	0.805			0.875	
Slovenia		0.926	0.816	0.780		0.841	0.841
			0.821	0.785	0.819	0.808	
	0.880	0.878	0.856			0.871	
Spain		0.886	0.864	0.838		0.863	0.859
			0.866	0.840	0.827	0.844	
	0.686	0.666	0.676			0.676	
Sweden		0.679	0.677	0.721		0.692	0.700
			0.677	0.717	0.801	0.732	
	0.541	0.533	0.539			0.538	
Switzerland		0.542	0.548	0.546		0.545	0.545
			0.553	0.551	0.554	0.553	
	1	1	0.996			0.999	
Turkey		1	1	0.992		0.997	0.999
			1	1	1	1	
	0.829	0.831	0.837			0.832	
United Kingdom		0.846	0.852	0.846		0.848	0.845
			0.858	0.852	0.849	0.853	
	0.800	0.799	0.799			0.800	
United States		0.814	0.815	0.802		0.810	0.808
			0.822	0.810	0.813	0.815	

As shown in Table 3; according to the results of the DEA window analysis, Germany, France, Norway, etc. failure of countries with high health outcomes to be effective may not be enough to qualify the health system of these countries as a failure. Although these countries produce high health output, their inputs are also high, so they are at the end of the efficiency scores ranking.

High input usage detected in inefficient countries is undesirable from the point of view of resource allocation. But when health efficiencies are examined, it is debatable which input and output variables should take precedence. States must provide their citizens with the highest quality health care. For this reason, more attention can be given to outputs or inputs can sometimes remain in the background. In health studies, input-oriented analyses are often recommended due to the difficulty of changing outputs. The input-oriented model is valuable in public institutions because it encourages savings. It can be said that this analysis is important to show that output can be achieved with less labor, capital, and medical supplies.

In countries with lower than average infant mortality rates from output variables (e.g. Japan, Slovenia, Estonia ext.) the high performance of the health system is in line with expectations. But some countries with a low-efficiency score (for example, Germany, Switzerland, Austria ext.) are the exception. Figure 1 shows the ranking of average scores (2014-2018), starting with the highest efficiency score.

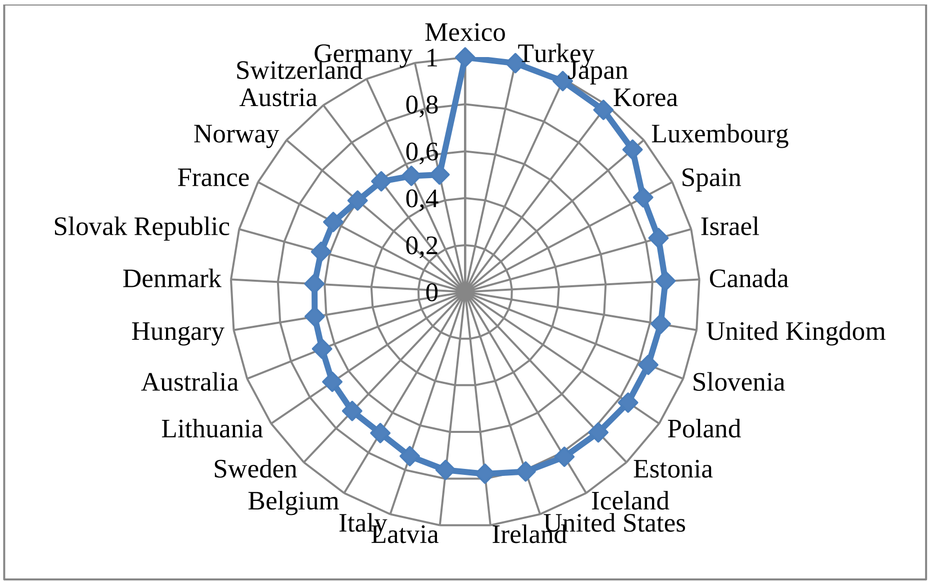

Figure 1. Ranking of DEA window average scores

When the windows in the analysis are examined (without taking into account efficiency score levels), there are some countries that are constantly increasing between periods. These countries are Estonia, France, Hungary, Israel, Lithuania, Poland, Slovak Republic, Sweden, Switzerland, UK, and US. Efficiency scores tend to increase from 2014-2016 to 2016-2018. Although some of these countries have below-average scores, it is positive that they record regular increases. When evaluating the rankings with average scores in Figure 1; the findings are valuable in terms of demonstrating the relative strengths and weaknesses of different OECD countries.

4. Discussion

DEA window analysis is often used in the banking, economy, energy, tourism, and healthcare sectors. Domestic and foreign literature is examined in the field of health and some of it is summarized below.

In a study that examined the level of efficiency of OECD countries in combating COVID-19, Italy, Spain, United States, Great Britain, Northern Ireland, and France were the countries with the lowest scores. Among the efficient countries, Slovakia, Mexico, and Iceland ranked in the top 3 in the CCR model [18]. The active presence of Mexico parallels this study.

In a study in which efficiency calculations were performed over two different models, output variables were determined as life expectancy and infant survival rate. According to the research results, countries that striving to improve their healthcare systems' efficiency should aim to impact population behavior and well-being rather than only ensure adequate medical care [6]. Life expectancy at birth (years) and infant mortality (deaths per 1000 live births) were determined as output variables in this study.

In another study, indicators of health resources were determined as a variable. Cluster and TOPSIS analyses were used. According to the findings, the countries most similar to Turkey are South

Korea, Mexico, and Poland. Also in the rankings are the US, Japan, and Canada at the top [19]. Similarly, Japan ranked high in this study with an average activity score of 0.99.

Asandului, Roman, and Fatulescu (2014) examined the health system of 30 European countries. In the analysis, the CRS efficiency average was 0.74 and 0.77 for VRS. According to the CRS, only 5 out of 30 countries (Bulgaria, Cyprus, Romania, UK, and Sweden) have been efficient. Countries with below-average efficiency scores are Germany, France, Lithuania, the Czech Republic, and Hungary [20]. In this study, the inefficiency of Germany and France is similar.

The study, written by Kocaman, Mutlu, Bayraktar, and Araz, (2012), measured the efficiency analysis of the health systems of OECD countries. In the study, 34 countries measured the efficiency of 34 countries' health systems using the DEA input-oriented CCR method. Of 34 countries, 29.4% (n=10) were technically efficient. Efficient countries were Turkey, Sweden, Estonia, Australia, Japan, Mexico, Luxembourg, Portugal, Slovenia, and Chile. The lowest is Austria's event score of 0.4093 [21]. Mexico, Turkey, Japan, and Luxembourg also found high efficiency in this study. Also in this study, Austria is at the bottom with an average efficiency score of 0.591. Close results were obtained.

DEA was used in another study that measured the regional effectiveness of healthcare facilities in Slovakia (2008-2015). The results of the analysis showed an indirect dependence between the values of the input-output variables over time and the results of the estimated efficiency in all regions [22]. In countries with high rates of health spending in GDP, it is not right to expect good performance from health systems. Effective use of health expenditures is required. Because the countries that allocate a high share to the Health System (USA, France, Sweden, Germany, Netherlands, etc.) are in the last group in efficiency scores [23]. Countries that produce high output with low inputs are also in the upper group in this study. The importance of using limited resources in the most efficient way is clear.

5. Conclusion

The aim of this study was to evaluate the efficiency of OECD member countries in their health systems. These countries have focused on stable economic development. They act for the same purposes. Special attention is given to health by the organization and member states are encouraged. The research provides a comparison of the health efficiencies of OECD countries with the latest published data. In the input and output variables determined, it is thought that it will contribute to the literature in terms of comparisons between countries.

In the analysis, country comparisons were used to determine the causes of inefficiency in health systems. Therefore, it is not possible to say that the countries that are efficient are the countries with the best health system. But based on the DMU comparison results in the model, it can be said that countries have relatively efficient health systems.

A study comparing the levels of efficiency in health care in 29 OECD member countries shows that some developed countries have low-efficiency scores. On the other hand, it has been found that countries such as Mexico and Turkey have higher health care efficiency scores. This is due to the fact that developing countries such as Turkey and Mexico have achieved similar outputs with fewer resources. Increasing the weight of the private sector in the financing and delivery of health services brings competition. It is of great importance that policymakers deploy resources and services in the most effective way.

For countries that are inefficient; objective determination of the goals that need to be achieved in burden assessments and health indicators can be recommended. In addition, resource allocation in health care needs to be done with scientific data. In subsequent studies, performance rankings, qualitative elements (resource use, organization, etc.) can participate in calculations. It may also be recommended to use output-oriented analyses. It is aimed that countries produce high health output with minimal input. But what policies can be implemented, each country must decide with its own internal dynamics.

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The compliance to the Research and Publication Ethics: This study was carried out in accordance with the rules of research and publication ethics.

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