ORIGINAL ARTICLE

The Performance of Health Systems: An Assessment Framework and Comparison of Developed and Developing Countries

Erfan Kharazmi[1], PhD; Mohammad Amin Bahrami[1], PhD; Shima Bordbar[1], PhD candidate; Zahra Shayan[2], PhD; Hanie Gholampoor[3], MSc

[1]Health Human Resources Research Center, School of Health Management and Information Sciences, Shiraz University of Medical Sciences, Shiraz, Iran
[2]Department of Biostatics, School of Medicine, Trauma Research Center, Shiraz University of Medical Sciences, Shiraz, Iran
[3]Health Economic, Tehran university of medical sciences, Tehran, Iran

Correspondence:
Erfan Kharazmi, PhD;
School of Management and Medical Information, Diamond Building, Between Palestine St. and Mulla Sadra, Alley 29, Qasr Al-Dasht St., Postal code: 71336-54361, Shiraz, Iran
Tel: +98 71 32340774
Fax: +98 71 32340039
Email: ekharazmi@sums.ac.ir
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Abstract

Background: In recent decades, especially after the publication of the World Health Report in 2000, many efforts have been made to develop assessment tools and improve the performance of health systems at the global and national levels. The purpose of this study was to design a method and assess the performance of health systems in various countries in its use.

Methods: In this retrospective study, health systems were evaluated using the opinions of experts as well as international data. Health system experts expressed their views on appropriate indicators for evaluation. The performance of the studied health systems was ranked using multi-criteria decision-making techniques (SAW & TOPSIS). Collected data were analyzed using multiple regression analysis.

Results: Data related to 38 indexes in eight general areas of macroeconomics, affordability for health costs, disease control, health care financing, health and nutrition, life expectancy, health resources, and mortality rates were collected in 105 countries from 2018 to 2020. According to the findings of country ranking, the health systems of Sweden, Norway, and Japan have the best performance and Afghanistan, Nigeria and Guinea have the weakest performance in the years examined.

Conclusion: Health systems face major challenges around the world. Scientific evaluations show that spending more resources and costs does not necessarily enhance the performance of health systems, yet using and distributing these resources and costs in health systems could enhance the hope for better performance.

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Introduction

Nowadays, health systems face issues like sharp increase in costs; issues related to safety, quality and justice; population aging; epidemiological changes; and increase in public awareness and expectations and are under intense pressure to improve their performance. This has always been one of the main priorities of countries in recent decades.[1, 2]

Enhancing the performance of health systems requires systematic examination of the performance of these systems. Indeed, designing effective strategies to build a strong health system needs access to basic information about the strengths and limitations of the system.[3, 4] This information is obtained by performance evaluation. Performance assessment has four components: collecting evidence and information systematically, interpretating them accurately, judging and evaluating the performance, and finally designing and implementing corrective interventions

to enhance performance. Based on this definition, the performance assessment process generally involves the steps of shaping the assessment, collecting data, analyzing the results, formulating corrective suggestions, and preparing an assessment report.[5]

Assessing the performance of the health system has many advantages, such as potentially providing an opportunity to review the health system and enhancing performance. Moreover, assessing the performance of the health system helps to organize and prioritize the efforts towards setting the goals, encourages policymakers to bring about positive change, strengthens the scientific basis of health policy, improves the quality of decisions, leads to more efficient management of resources, and ultimately helps to accelerate economic and social development by improving community health.[6-12] Thus, in recent decades, and especially after the publication of the World Health Report in 2000, many efforts have been made to develop assessment tools and improve the performance of health systems at the global and national levels.[9, 13, 14] Table 1 summarizes the efforts made to evaluate the health systems.

One of these frameworks used is that introduced by the World Health Organization in many subsequent models.[13] Although the patterns presented have created rich ideas and approaches for assessing the performance of health systems, many of them suffer from two related pitfalls. Some of these patterns are just lists of multidimensional features and often overlap, and some have considered only the existing indexes and created a basis that replicates the conceptual and technical inadequacies of the current standards. Hence, efforts continue in this regard and it seems that there is still room for improvement.[15] The purpose of the present study was to design a new index-based method for assessing the performance of the health system.

Methods

This study was conducted retrospectively and analytically. It is also a combination of quantitative and qualitative methods. The population and sample were all developed and developing countries with updated information registered in the databases of the United Nations and its subordinate organizations, including WHO (world health organization). On the other hand, a group of 30 experts consisting of the following people was used to determine and identify the appropriate set of indexes for evaluation as well as the weights of the indexes in multi-criteria decision-making techniques (Table 2).

The above group of the experts has been selected according to purposive sampling method using the following criteria: at least 5 years of managerial experience and acquisition of a study and research background in health systems assessment. People who were not willing to participate in the study were excluded from the group. Those that were difficult to access were also excluded.

Table 1: Some of the most important studies conducted in health systems assessment

Purpose	Level	Method	Responsible institution
Health systems reform	Government	Long-term, strategic view	Bhore Committee Report
Synergy of decision makers	Government	Review and interview	Joint Annual Reviews, conducted under International Health Partnership program
Health systems reform	Government and civil society	Review and interview	District Health Barometer, South Africa
Learning objectives	International	Various methods	European Observatory Health in Transition series

Table 2: The experts variables in the study

Variable		Number (%)
Gender	Female	(10%)3
	Male	(90 %)27
Age	30-40	(40%)12
	41-50	(40%)12
	51 and more	(20%)6
Marital status	Married	(100%)30
	Single	(0%)0
Education	Ph.D.	(57%)17
	Medical specialist	(43%)13
Academic degree	Assistant Prof.	(27%)8
	Associate Prof.	(43%)13
	Full Prof.	(30%)9
Managerial experience	10-5	(20%)6
	15-11	(46%)14
	20-16	(17%)5
	25-21	(17%)5
Related work area	University staff and management units	(17%)5
	Universities' colleges	(83%)25

All the countries that have the information recorded and updated by the end of 2020 in the databases of the United Nations and its subordinate organizations were included in the analysis of this study. Similarly, the countries whose data were incomplete or unavailable in one or more indexes were excluded from the research sample. The following steps have been taken in conducting this research:

Determining the Assessment Framework

To determine the appropriate framework for assessing of health systems, we used the guidelines of the WHO, as shown in Figure 1.[3]

As seen in the model proposed by the WHO, assessment can be done at two levels: 1- health system functions and 2- its components (governance and leadership, workforce, health information systems, drugs and medical equipment, financing, and service delivery). These levels and components are known as assessment blocks.

As the purpose of the study was to assess the health systems at the macro-level of the countries, only the main block of "health system functions" and its components were included in the assessment process. Moreover, as the research team sought to find the differences between the health systems of various countries, some other indices like some macro-economic and financial components were added to the set of assessment indices. The list of 38 indexes used is displayed in Table 3.

Configuration of the Assessment Criteria/Indexes

In this study, to facilitate the work, we considered three categories of indexes:

- Third level indexes: The smallest component of the indexes used in the studies, the information about which is recorded in the databases of the world health organization (WHO) or other organizations, per country (38 indexes)
- Second level indexes: As Table 2 shows, each group of Level 3 indexes can be grouped as a larger index (The titles, definitions, and formulas associated with the third and second-level indexes have been obtained from the WHO database and have not been tampered with.). For instance, the two indexes "gross domestic product (GDP) per capita" and "Gini coefficient" are classified as "macroeconomic" indexes (8 indexes "The index of demographic variables is included in the calculations related to HDI").
- First level indexes: Using the opinion of experts and reviewing similar studies, two first level indexes have been created and examined in this study:
- "Economics and Financing" components, including "health financing", "macroeconomics" and "resource providing" indexes. These indexes constitute the inputs of the health systems in the study.
- The "health status" index includes the indexes of "people's affordability for healthcare", "life expectancy", "hygiene, sanitation and nutrition", "mortality", and "disease control". These indexes constitute the outputs of the health systems in the study.

Ranking of the Countries

After finalizing the assessment indexes and determining the amounts of each index for each country, it is necessary to determine the weight of the indexes to rank. The Shannon entropy weighting method has been used to obtain the distribution of internal weights of the "third level indexes" in decision matrices.

$$E_j = -k \sum_{i=1}^{m} P_{ij} \times Ln\, P_{ij} \qquad i = 1,2,\dots,m$$

$$dj=1-Ej$$

$$wj=dj/\sum dj$$

As the internal weight of the data scattered in the decision matrix cannot be satisfied, external weights in each of the "third level indexes" are also obtained

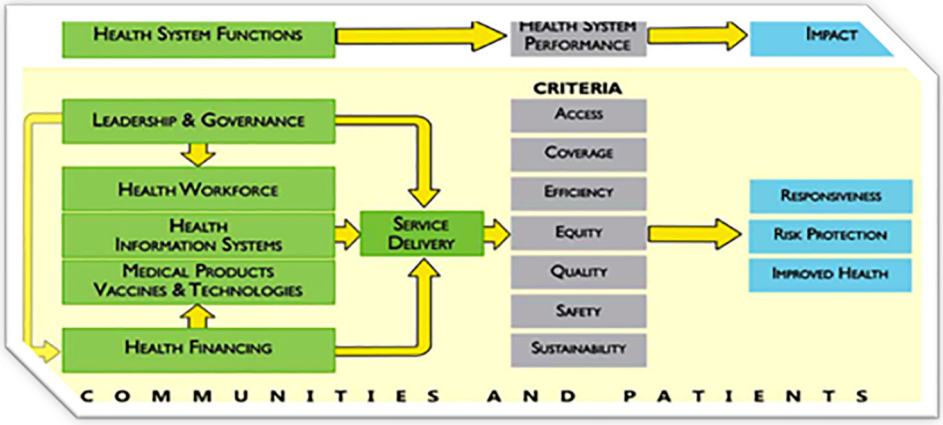


Figure 1: World health organization framework for health systems assessment

Table 3: Indexes used in the evaluation of the health systems

Health Financing							Resource Providing				
Out-of-Pocket Expenditures		Current health expenditure (CHE)			Domestic general government health expenditure (GGHE-D)		Hospital beds	Human Resources			
Out-of-pocket expenditure as percentage of current health expenditure (CHE) (%)	Out-of-pocket expenditure (OOP) per capita in PPP in$	Current health expenditure (CHE) as percentage of gross domestic product (GDP) (%)	Current health expenditure (CHE) per capita in US$	Current health expenditure (CHE) per capita in PPP in$	Domestic general government health expenditure (GGHE-D) as percentage of current health expenditure (CHE) (%)	Domestic general government health expenditure (GGHE-D) as percentage of gross domestic product (GDP) (%)	Hospital beds (per 10 000 population)	Medical doctors (per 10 000 population)	Nursing and midwifery personnel (per 10 000 population)	Dentists (per 10 000 population)	Pharmacies (per 10 000 population)

People Affordability fore health care		Life expectancy		Hygiene , Sanitation and Nutrition							
				Sanitation Index			immunization coverage			Nutrition	
Risk of catastrophic expenditure for surgical care (% of people at risk)	Risk of impoverishing expenditure for surgical care (% of people at risk)	Male Life expectancy at birth (years)	Female Life expectancy at birth (years)	Population using at least basic drinking-water services (%)	Population using at least basic sanitation services (%)	Proportion of population with primary reliance on clean fuels and technologies (%)	DTP3 immunization coverage among 1-year-olds (%)	HepB3 immunization (% of one-year-old children)	Measles-containing-vaccine second-dose (MCV2) immunization coverage by the nationally recommended age (%)	Prevalence of overweight among adults, BMI >= 25 (%)	Low-birthweight babies (% of births)

diseases control						Macro-Economic		Demographic indexes		Mortality			
Communicable diseases			Non Communicable diseases			GDP index	GINI index	Education	Population				
Incidence of tuberculosis (per 100,000 people)	Incidence of malaria (per 1,000 population at risk)	Prevalence of HIV, total (% of population ages 15-49)	Raised blood pressure (%)	Raised total cholesterol (>= 5.0 mol/L) (age-standardized estimate over 25) %	Diabetes prevalence (% of population ages 20 to 79)	GDP per capita (current US$)	GINI (%) - WORLD BANK	Adult Literacy Rate (%)	Population (in thousands)	Maternal mortality ratio (per 100 000 live births)	Neonatal mortality rate (per 1000 live births)	Probability (%) of dying between age 30 and exact age 70 from any of cardiovascular disease, cancer, diabetes, or chronic respiratory disease	Road traffic deaths rate (per 100 000 population)

based on the fashion insights calculation of the expert group. By combining internal and external weights, the final weight of the indexes was calculated. The weights associated with the "second level indexes" in the two decision matrices of "economics and finance" and "health status" were calculated by the following method, using the weights of the "third level indexes":

Wij=wj*(average wi:j/sum wi:j)

Following the completion of this step, for each of the countries examined, using the simple average additive weighting (SAW) technique and in a one-dimensional decision space, 8 separate points/scores were obtained according to the "second level indexes" and 2 separate points/scores were obtained based on two first level indexes of "economy and finance" and "health status". The following formula was used to find the best option, assuming that 1 is the sum of the weights of the indexes in the decision matrix.

$$A^* = \{A_t \mid max \sum_{j=1}^{n} W_i r_j\}$$

The final point/score of each country is obtained based on all the studied indexes using the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) technique and in two-dimensional decision space. The main steps of this technique were as follows:

Vector normalization:

$$n_{ij} = \frac{x_{ij}}{\sqrt{\sum_1^m x_{ij}^2}}$$

Formation of a normal decision matrix

$$N = \begin{bmatrix} n_{11} & n_{12} \cdots & n_{1n} \\ n_{21} & n_{22} \cdots & n_{2n} \\ \vdots & \vdots & \vdots \\ n_{m1} & n_{m2} & n_{mn} \end{bmatrix}$$

Formation of a weighted decision matrix

$$V = \begin{bmatrix} v_{11} & v_{12} \cdots & v_{1n} \\ v_{21} & v_{22} \cdots & v_{2n} \\ \vdots & \vdots & \vdots \\ v_{m1} & v_{m2} & v_{mn} \end{bmatrix}$$

Calculation of the ideal of positive and negative:

$$d_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^+)^2}$$

and

$$d_i^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^-\right)^2}$$

Closeness calculation:

$$CL_i^* = \frac{d_i^-}{d_i^- + d_i^+}$$

The philosophy behind using two-dimensional decision-making space in the final ranking of the countries is the existence of two categories of indexes: "economy and finance" and "health status" in the final ranking. Experts who participated in the study believed that the health system performed better, having succeeded in making the most outcomes of the "health

status" index by making optimal use of the "economic and financing" index. Hence, the two-dimensional decision assumptions (distance from the negative ideal and closeness to the positive ideal) have been true in this ranking. It is essential to consider that in the final ranking of the countries, the decision matrix was re-formed based on all third level and second level indexes and all weighting and calculating steps were performed based on the assumptions of the TOPSIS technique.

According to the rules of SAW and TOSIS methods, all decision tables are non-scored before final calculations. In this study, due to the type of data, the necessary non-scored scaling like linear and norm methods (according to the data type and type of decision technique) were used. Thus, a higher number or score means a better position and performance of that country relative to other countries. The results obtained were reviewed using the opinions of experts and similar research, and the necessary corrections were made in the weights of the indexes to ensure the accuracy of SAW and TOPSIS technique estimates.

Determining the Relationship between the First Level Indexes and the Human Resources Development Index (HDI)

At this step, regression analysis was used to specify the relationship. This relationship was evaluated at two various levels:

- **Level one:** The relationship between "Economic and Financing" index and "Health Status" index
- **Level two:** The relationship between health system performance and HDI

Thus, it was determined how much output each country has reached in the "health status" index based on the inputs of the "Economic and Financing" index, and a deeper examination of some differences in the systems; if this relationship was confirmed by regression analysis, the health systems of various countries were evaluated using the HDI. HDI data was extracted from the United Nations Development Program (UNDP) database.

Results

Among the 200 countries registered in reputable United Nations (UN) databases, the research team was able to collect data on the indexes of 105 countries in full (Table 4). Measuring the mean score obtained in each of the second level indexes indicated the overall performance of the world's health systems from various aspects. As Figure 2 shows, more than 80% of the world's countries perform below average in the "People's affordability to Expenditure" of health index. Nevertheless, in the health and nutrition index, more than 66% of the world's countries have performed higher than the global average.

The score of two first level indexes was obtained by combining the second level indexes and performing ranking calculations. Figure 3 shows that the performance of the health system in most countries has been below the global average.

Combining the two indexes of "economic and financing" and "health status" in a two-dimensional decision-making space provided an integrated assessment of health systems among the countries examined. Thus, 105 countries could be sorted according to the points obtained in the TOPSIS technique.

Based on the results, 48.57% of the countries in the final ranking of the TOPSIS technique outperformed the global average and 51.43% of them were below the global average. The color scheme of Figure 4 can give us more information in this aspect.

Table 4: Ranking of the countries based on all 38 indexes examined in the two-dimensional decision space

1	Sweden	19	Slovenia	37	Kuwait	55	Algeria	73	Nicaragua	91	Kenya
2	Norway	20	New Zealand	38	Uruguay	56	Kyrgyzstan	74	Peru	92	Syrian
3	Japan	21	Australia	39	Chile	57	Lebanon	75	Mexico	93	Gabon
4	Finland	22	Belarus	40	Argentina	58	Armenia	76	Paraguay	94	Philippines
5	Iceland	23	Slovakia	41	Oman	59	Ukraine	77	Egypt	95	Pakistan
6	Switzerland	24	Israel	42	Serbia	60	Tajikistan	78	Honduras	96	Mauritania
7	Ireland	25	UA Emirates	43	Kazakhstan	61	Saudi Arabia	79	Bolivia	97	Sudan
8	Denmark	26	Spain	44	Bulgaria	62	Azerbaijan	80	Iraq	98	Niger
9	Belgium	27	Korea	45	Russian Federation	63	Sri Lanka	81	South Africa	99	Cameroon
10	France	28	Greece	46	Bahrain	64	Iran	82	Tanzania	100	Ethiopia
11	Germany	29	Singapore	47	Bosnia And Herzegovina	65	Republic Of Moldova	83	Namibia	101	Yemen
12	Canada	30	Poland	48	China	66	Libya	84	Indonesia	102	Central African Republic
13	Netherlands	31	Croatia	49	Turkmenistan	67	Colombia	85	Gambia	103	Afghanistan
14	UK	32	Portugal	50	Uzbekistan	68	Mongolia	86	Cambodia	104	Nigeria
15	Austria	33	Romania	51	Turkey	69	Ecuador	87	Myanmar	105	Guinea
16	USA	34	Cyprus	52	Jordan	70	Brazil	88	India		
17	Czechia	35	Hungary	53	Georgia	71	Malaysia	89	Ghana		
18	Italy	36	Qatar	54	Thailand	72	Viet Nam	90	Venezuela		

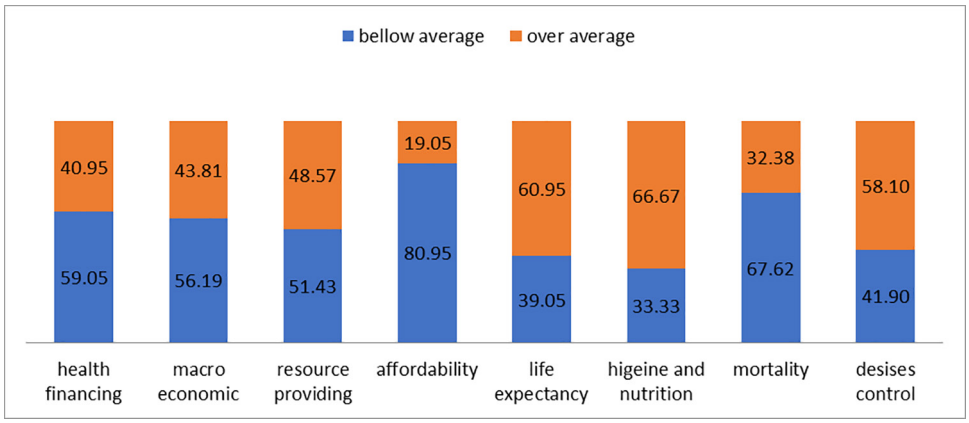
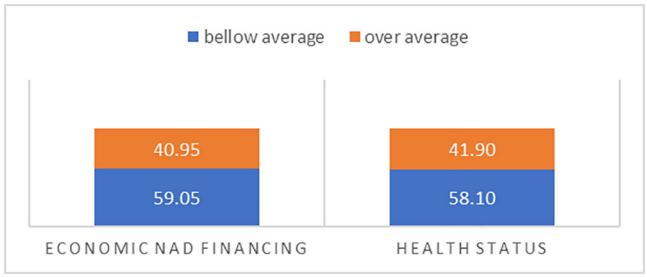


Figure 2: The percentage of countries with the highest and lowest scores in each of the second level indexes according to the global average - based on the research results



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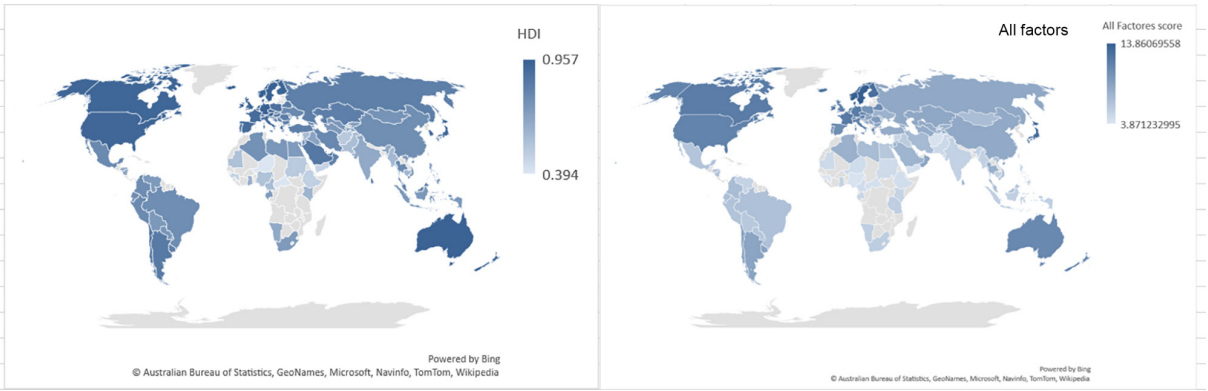

Figure 4: Zoning of the countries in the world according to the performance of the health system and HDI in that country based on the research results

Comparison of the final scores obtained in each country with the HDI revealed that with the decrease of the HDI, the general trend of the performance of health systems decreased as well (Figure 5).

As Figure 6 indicates, the largest difference was seen in the mortality index. This shows that in spite of all the efforts and progress made globally, mortality rate is still not in a good state as one of the most important outputs of the health system.

Regression analysis between health factors and economic factors showed that some countries could reach excellent levels of health factors. The United States has not been able to achieve good health results despite spending a lot of resources. However, the status of countries such as Sweden and Norway is very good.

The position of each country was analyzed with the HDI in that country due to the intervention of uncontrollable and unpredictable factors in the final performance of health systems and to ensure the accuracy of the results in the final ranking. The results show that better performance can be seen in the indexes of the health system of that country if a country has a higher state in terms of development (Figure 7).

The proper R^2 index in these analyses showed a strong correlation between HDI and health system performance.

Discussion and Conclusion

In the recent decades, ranking of the health systems has

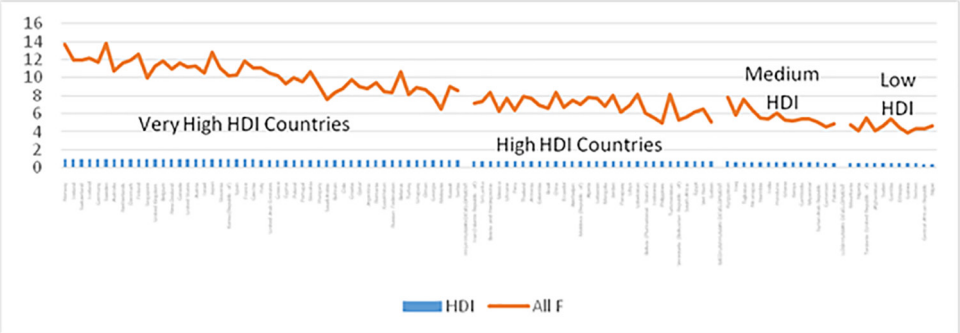

Figure 5: Simultaneous study of human development index (HDI) with the final score of health system performance (all factors [All F]) in the countries examined based on the research results

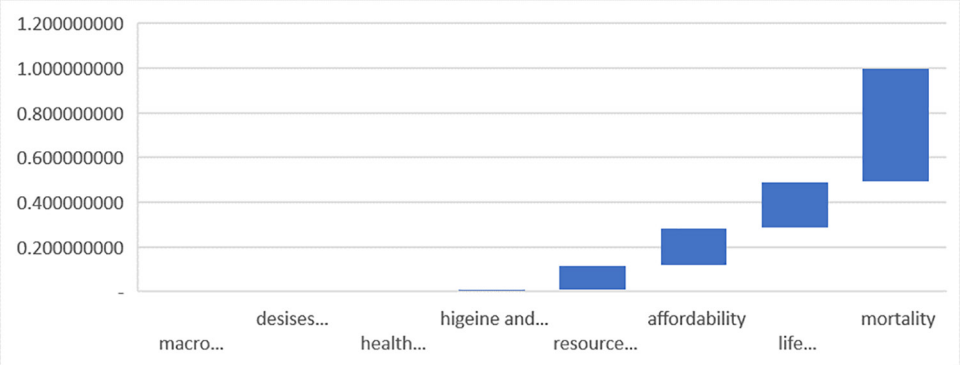

Figure 6: Non-scored waterfall analysis of minimum and maximum scores in the second level indexes in the study based on the research results

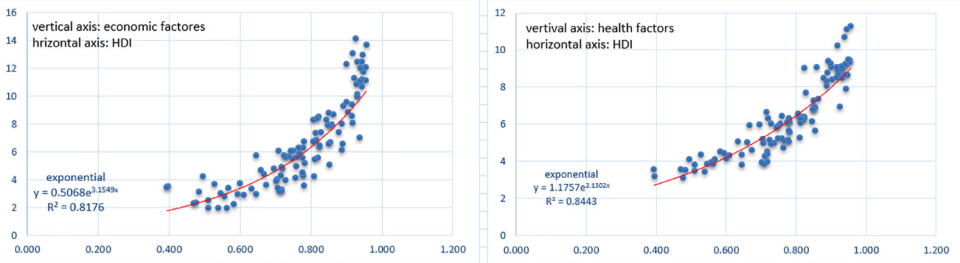

Figure 7: Regression analysis of two indexes "economic and financial" and "health status" with HDI based on the research results

always been the focus and addressed in many studies.[9, 10] Determining the appropriate indexes is one of the key steps in the evaluation. In various studies, the WHO suggests some indexes that can enable a complete and comprehensive evaluation of the health systems.[11-18] As seen in this and similar studies,[19-21] the WHO proposed that evaluation indexes can be used alone or in combination with other indexes. The purpose of the study was to assess the health systems using two categories of indexes "health status" and "economic and financing" together.

As shown in Figure 6 and some studies, factors like wars, natural disasters, epidemics, etc. have led to this huge difference between countries.[22-25]

Regression analysis findings confirm the state obtained in TOPSIS and SAW analyses. The countries like Norway, Sweden and Japan have managed to outperform other countries.[26-29] As Figure 8 shows, these countries have produced more output from their health system inputs than other countries (because of the border function of output), and others like America have produced lower output relative to the inputs used.[30-35]

In the final analysis and based on the confirmation of the regression results, one can state that the Scandinavian countries and Northern Europe have had the best performance in their health systems.[36] The countries located in Central Africa like Nigeria and Guinea, or some Asian countries like Afghanistan and Yemen have to pay close attention to mortality and life expectancy to enhance their health systems.[37] Spending more resources and costs does not necessarily enhance the performance of the health systems, yet using and distributing these resources and costs in the health systems could enhance the hope for better performance.

Limitations

One of the main limitations of this article was the lack of information in some countries.

Another limitation was that the databases were not up to date. Sometimes, the research team had to obtain

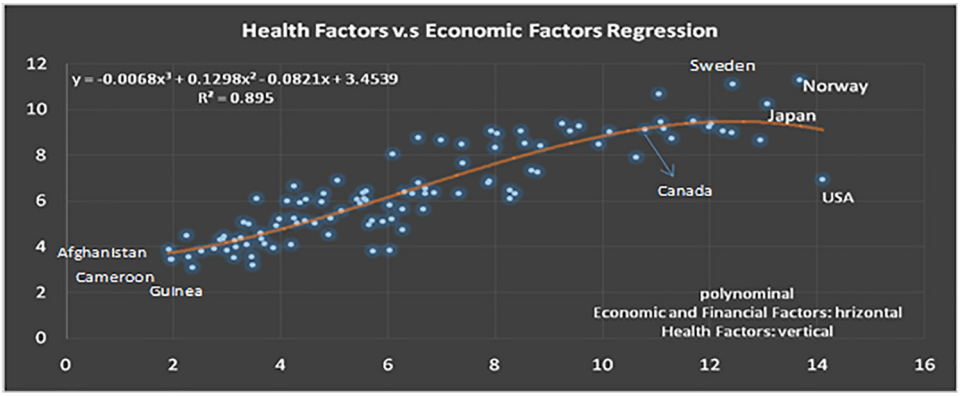

Figure 8: Regression analysis of economic and financial index (input) and health status index (output) based on the research results

information from several databases to determine the accuracy of the information.

Conflict of Interest: None declared.

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