Original Article

Comparison of Health Status Indicators in Iran with the Eastern Mediterranean Countries Using Multiple Attribute Decision-Making Methods

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What's Known

• Improving public health is the main goal of healthcare systems across the world. The performance of healthcare systems in different countries can be compared by ranking their health status indicators.
• Healthcare policymakers often utilize the outcome of such comparisons to devise strategies to improve their own public health.

What's New

• In terms of health status among the Eastern Mediterranean countries, Bahrain and Somalia ranked first and last, respectively. Iran ranked fifth with only 415 USD health expenditure per capita.
• Healthcare strategies adopted by top-ranked countries can be used as a model to improve Iran's healthcare system.

Abstract

Background: Improving public health is the main goal of healthcare systems across the world. Healthcare policymakers often use comparisons between different healthcare systems to better position their country and use the outcome to develop novel strategies to improve their own public health. The present study aimed to compare the health status indicators in Iran with those of the Eastern Mediterranean (EM) countries using the multiple attribute decision-making (MADM) methods.

Methods: A descriptive-analytical study was conducted in 2021 at Shiraz University of Medical Sciences, Shiraz, Iran. Data on the ranking of health status indicators in EM countries were obtained from the annual publications of the World Health Organization, World Health Statistics (2016-2020). As part of the MADM mathematical models, the "criteria importance through intercriteria correlation" (CRITIC) model was used to assign weights to health status indicators. In addition, the "multi-criteria optimization and compromise solution" (VIKOR) model was used to rank the EM countries.

Results: The results showed that Bahrain and Somalia ranked first and last on health status indicators, respectively. Iran was ranked fifth among the EM countries. However, while Iran has a better status on all indicators than the mean value of all EM countries, there is a significant gap between the health status in Iran compared to the top-ranked countries.

Conclusion: Health care strategies adopted by top-ranked countries, such as Bahrain and Qatar, can be used by Iran and other EM countries as a model to improve their healthcare system.

Introduction

Public health is central to any society and is associated with the level of productivity, development, and revenue of a country.[1] Due to the importance of this subject, different healthcare systems have been thoroughly studied and compared in the past several decades.[2] According to the World Health Organization (WHO), the main objectives of healthcare systems are to improve the health status, respond to the health care needs of the public, and establish an equitable health financing system. The performance

of the healthcare system of a country is measured by the level at which these objectives are met.[2, 3] Of these objectives, improving health status is most prominent, as it drives the other two. Indicators used to measure health status are life expectancy, maternal mortality, neonatal mortality, mortality associated with chronic diseases, and parameters representing the level of public health.[4]

The success rate of a country in achieving the above-mentioned objectives can be determined by comparing the performance of its healthcare system with that of other countries. Such comparisons allow policymakers to position the health status of their respective countries and propose specific action plans for improvement.[5] The ranking method is commonly used for this purpose, whereby a set of relevant indicators is determined and weighted (based on statistical methods, surveys, or expert consensus), based on which the performance of different health systems is mapped.[6]

In the present study, we specifically focused on the performance of health systems in the Eastern Mediterranean (EM) countries, which is one of the six regions defined by the WHO. EM comprises 22 countries with a combined population of nearly 583 million people, namely Afghanistan, Bahrain, Djibouti, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Pakistan, Palestine, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, United Arab Emirates (UAE), and Yemen.[7] These countries vary in terms of gross domestic product (GDP), demographic characteristics, health status indicators, and the coverage and capability of their healthcare systems.[8]

Several studies compared the healthcare systems of different countries in terms of health status indicators. For example, Cinaroglu determined the efficiency of healthcare systems in Organization for Economic Co-operation and Development (OECD) countries using health status indicators.[9] Boz and colleagues determined Turkey's position among the OECD countries in terms of health status indicators, both before and after its health transition program.[2] In another study, Mberu and colleagues compared urban and rural regions of Bangladesh, Kenya, Egypt, and India based on health status indicators.[10]

Multiple attribute decision-making (MADM) methods refer to mathematical models used to decide on issues, where available alternatives are evaluated with different and at times contradictory indicators.[11] In this method, the main objective is to choose the best alternative for different indicators. Initially,

indicators are assigned certain weights using methods such as the linear programming techniques for multidimensional analysis of preference (LINMAP), least squares method (LSM), Shannon entropy, or criteria importance through intercriteria correlation (CRITIC). Then, the alternatives are ranked using methods such as the technique for order preference by similarity to ideal solution (TOPSIS), elimination and choice translating reality (ELECTRE), or vIekriterijumsko kompromisno rangiranje (VIKOR), which is a Serbian term for multi-criteria optimization and compromise solution.[12] The strengths and weaknesses of each of these methods were described in previous studies.[12, 13] However, it is important to select the most appropriate method, since each method is suited to solve a specific problem.[13, 14] Considering the above, for the first time, we compared the health status indicators in Iran with those of the EM countries using MADM methods.

Materials and Methods

A descriptive-analytical study was conducted in 2021 at Shiraz University of Medical Sciences, Shiraz, Iran. The study was approved by the Ethics Committee of the University (code: IR.SUMS.REC.1398.1234).

The performance of the EM countries healthcare system was assessed according to the framework proposed by Kruk and Freedman.[4] Based on the availability of data for EM countries, seven health status indicators were used, namely "Life expectancy at birth", "Healthy life expectancy (HALE) at birth", "Maternal mortality ratio (MMR)", "Neonatal mortality rate (NMR)"; "Under-five mortality rate (U5MR)", "Probability of dying from any of the cardiovascular diseases (CVDs), cancer, diabetes, or chronic respiratory disease (CRD)"; and "Mortality rate attributed to exposure to unsafe water, sanitation, and hygiene (WASH)". The required data as well as some other indicators (table 1) were obtained from the WHO's annual World Health Statistics report (2016-2020).[15] The report additionally includes the trend in life expectancy, causes of death, progress on the millennium development goals, and other health-related goals. Given the exclusion of Palestine by the WHO, the remaining 21 EM countries were ranked according to the above-mentioned indicators. Mathematical modeling was performed using MADM methods (CRITIC to assign weights to the indicators and VIKOR to rank the countries). Data were analyzed using Microsoft Excel 2019 (Microsoft Corporation, USA).

Table 1: A list of selected indicators in the Eastern Mediterranean countries

Indicators per country	Year 2020				Year 2019	
	Total population (000s)	UHC: Service coverage index (%)	Density of medical doctors#	Density of nursing and midwifery personnel#	CHE per capita (USD)	CHE (%GDP)
Afghanistan	37,172	37	2.8	1.8	57	10.2
Bahrain	1,569	77	9.3	24.9	1,099	4.9
Djibouti	959	47	2.2	7.3	70	3.5
Egypt	98,424	68	4.5	19.3	131	4.6
Iran	81,800	72	15.8	4.4	415	8.1
Iraq	38,434	61	7.1	20.4	153	3.3
Jordan	9,965	76	23.2	28.2	224	5.5
Kuwait	4,137	76	26.5	74.1	1,068	3.9
Lebanon	6,859	73	21	16.7	662	8
Libya	6,679	64	20.9	65.3	-	-
Morocco	36,029	70	7.3	13.9	171	5.8
Oman	4,829	69	20	42	648	4.3
Pakistan	212,228	45	9.8	6.7	40	2.8
Qatar	2,782	68	24.9	72.6	1,827	3.1
Saudi Arabia	33,703	74	26.1	54.8	1,147	5.7
Somalia	150,008	25	0.2	1.1	-	-
Sudan	41,802	44	2.6	7	152	5.7
Syrian	16,945	60	12.9	15.4	-	-
Tunisia	11,565	70	13	25.1	257	7
UAE	9,631	76	25.3	57.3	1,323	3.5
Yemen	28,499	42	5.3	7.9	-	-

#Per 10,000 population, UHC: Universal health coverage, CHE: Current health expenditure, GDP: Gross domestic product.
Source: WHO's annual World Health Statistics report 2019-2020.

Assigning Weights to Indicators Using the CRITIC Method

The process of assigning weights to indicators requires knowledge, experience, and understanding of the problem. As the number of indicators increases, the likelihood of human error and thus doubts about the reliability of the assigned weight increases. To overcome these, objective weighting methods confirmed with real data are used. One such method is CRITIC, as proposed by Diakoulaki and colleagues,[16] which solves the interdependence between criteria based on the correlation between variables. Unlike the Shannon entropy method, it does not solely rely on data distribution but allows proper determination of the role of each factor in the final result. Moreover, in this method, the inverse or direct relationship of indicators with healthiness (known as a negative or positive indicator) does not affect the results.[16]

Among the seven indicators considered in our study, two indicators were positive (life expectancy at birth and HALE at birth) and the remaining five indicators were negative (MMR, NMR, U5MR, probability of dying from diseases, and mortality rate attributed to exposure to unsafe WASH). A description of the main steps in the CRITIC method is presented below.

Step 1: Building a decision matrix composed of health status indicators (seven columns) and EM countries (21 rows).

$$r_{ij} = \frac{x_{ij} - x_j^{min}}{x_j^{max} - x_j^{min}}$$

Step 2: Normalization of the decision matrix.

where r_{ij}, x_{ij}, x_j^{max}, and x_j^{min} denote normalized values, elements of the decision matrix, maximum element in criteria j, and minimum element in criteria j, respectively.

Step 3: Calculation of the initial weight of the criteria.

$$C_j = \sigma_j \sum_{i=1}^{m} (1 - r_{ij})$$

where σ_j is the standard deviation of the jth criterion and r_{ij} is the correlation between i^{th} and j^{th}. Criteria, with higher C_j will be assigned more weight (i.e., a higher value of C_j provides more information about the given criterion).

Step 4: Calculation of the final weight of the criteria.

$$W_j = \frac{C_j}{\sum_{j=1}^{m} C_j}$$

where W_j is the weight of the jth criterion, and C_j is the amount of information of the sum of the jth criterion (j=1, 2, ..., m).

Ranking of Countries using the VIKOR Method

The VIKOR method is used to rank alternatives with criteria and units that are different and at times conflicting.[17, 18] The main feature of this method is the prioritization of alternatives, as an optimal checklist, based on a compromise solution in the presence of conflicting indicators such that only a unique ranking or optimal alternative is not provided. A description of the main steps in the VIKOR method is presented below.

Step 1: Determination of the best f_i^- and worst f_i^- value for all criteria functions (i=1, 2, ..., n)

$$f_i^* = max_j \, f_{ij} \text{ and } f_i^- = min_j \, f_{ij}$$

Step 2: Calculation of S_j and R_j values for j=1, 2, …, J.

$$S_j = \sum_{i=1}^{n} w_i \frac{f_i^* - f_{ij}}{f_i^* - f_i^-}$$

$$R_j = max \left[w_i \frac{f_i^* - f_{ij}}{f_i^* - f_i^-} \right]$$

where minimum *S* value indicates maximum group utility, minimum *R* value shows the minimum individual regret, and W_i indicates the relative weight of each criterion and its relative importance.

Step 3: Calculation of the Q_j value for j=1, 2, …, J.

$$Q_{j=} v \left(\frac{S_j - S^*}{S^- - S^*} \right) + (1 - v) \left(\frac{R_j - R^*}{R^- - R^*} \right)$$

where

$S^* = minS_j, \, S^- = maxS_j, \, R^* = minR_j, \, R^* = maxR_j$

Q is a synergistic value created by combining *R* and *S*, *v*, which is introduced as the weight of the strategy of ''the majority of criteria'' (here *v*=0.5 indicating the priority based on consensus).

Step 4: Ranking of alternatives sorted by the values of *S*, *R*, and *Q* in descending order. Thus, the results are three ranked lists.

Step 5: Proposed a compromise solution for an alternative (α') ranked by minimum *Q* if the two following conditions are satisfied.

● Condition 1: Acceptable advantage, *Q(α")-Q(α')≥DQ*, where *(α")* is an alternative, which has the second rank in the *Q* classified list,

$$DQ = \frac{1}{J - 1}$$

, and *J* is the number of alternatives.

● Condition 2: Acceptable stability in decision-making. The alternative *(α')* should also be the best ranked by *S* or/and *R*. This compromise solution is stable within a decision-making process, which could be the strategy of

''the majority of criteria''.

If one of the conditions is not satisfied, a set of compromise solutions is suggested, which include:

● Alternatives *(α')* and *(α")* if only the second condition is not satisfied.

● Alternatives *(α')*, *(α")*, …, *(α^M)* if the first condition is not satisfied and *(α^M)*is determined by *Q(α^M)-Q(α')<DQ*. For each "*M*", alternative one to *M* will be the optimal solution. The best alternative, ranked by the *Q*, is a value with the minimum value of *Q*.[18]

Results

Five of the several indicators in the EM countries are presented in table 1. Among the countries, Pakistan and Djibouti have the highest and lowest populations, respectively. In terms of the service coverage index, Bahrain and Somalia have the highest and lowest index values, respectively. Kuwait has the highest density of medical doctors (26.5) and nursing and midwifery personnel (74.1) per 10,000 population. Whereas, Somalia has the lowest number of medical doctors (0.2) and nursing and midwifery personnel (1.1). Pakistan ranks the lowest in terms of current health expenditure (CHE) per capita (40 USD) and 2.8% GDP. Whereas, Qatar ranks the highest with a CHE of 1,827 USD and 3.1% GDP.

Based on the data from the WHO's annual World Health Statistics report (2016-2020), the results of the CRITIC weighting method showed that U5MR (in 2016 and 2017) and NMR (in 2018, 2019, and 2020) were assigned the maximum weights compared to other indicators. While, HALE at birth (in 2016 and 2017) and life expectancy at birth (in 2018, 2019, and 2020) were assigned the minimum weights (table 2).

Based on the same annual reports, the mean health status values of the seven indicators in our study were determined for all EM countries, except for Palestine (table 3). As mentioned earlier, indicators one and two were positive, whereas indicators three, four, five, six, and seven were negative. This means that the higher the positive/negative indicator value, the better/worse the health status of the population is. The results showed that Iran has a better status on all indicators than the mean value of all 21 EM countries. Bahrain obtained the best status for life expectancy at birth (78.22), NMR (2.26), U5MR (6.8), and probability of dying from CVDs, cancer, diabetes, or CRD (12.54); and mortality rate attributed to exposure to unsafe WASH (0.09). Kuwait, Qatar, and UAE also obtained the best status for mortality rates attributed to

Table 2: The weights assigned to indicators using the CRITIC method

Indicators	2016	2017	2018	2019	2020
Life expectancy at birth (years)	0.0773	0.0750	0.0760	0.0756	0.0750
Healthy life expectancy at birth (years)	0.0748	0.0727	0.0924	0.0918	0.0911
Maternal mortality ratio (per 100,000 live births)	0.1827	0.1775	0.1759	0.1749	0.1807
Neonatal mortality rate (per 1,000 live births)	0.1769	0.1718	0.1853	0.1893	0.1900
Under-5 mortality rate (per 1,000 live births)	0.1836	0.1783	0.1746	0.1743	0.1715
Probability of dying between age 30 and exact age 70 from diseases* (%)	0.1261	0.1513	0.1270	0.1263	0.1253
Mortality rate attributed to exposure to unsafe WASH (per 100,000 population)	0.1783	0.1732	0.1684	0.1675	0.1661

*Cardiovascular disease, cancer, diabetes, or chronic respiratory disease. WASH: Water, sanitation, and hygiene services. Source: WHO's annual World Health Statistics report 2016-2020.

Table 3: Mean health status values for the seven indicators in each Eastern Mediterranean country

Country	I1	Rank	I2	Rank	I3	Rank	I4	Rank	I5	Rank	I6	Rank	I7	Rank
Afghanistan	61.78	20	52.68	20	444.4	20	37.40	19	76.52	19	30.18	21	22.18	18
Bahrain	78.22	1	67.66	2	14.80	5	2.26	1	6.80	1	12.54	1	0.09	1
Djibouti	63.68	19	56.28	16	232.80	17	32.72	18	63.16	17	19.40	11	29.34	20
Egypt	70.66	13	61.54	13	33.80	10	12.28	13	22.76	13	26.22	19	1.84	12
Iran	75.62	7	65.88	8	23.20	9	9.32	11	15.02	10	15.30	3	0.96	11
Iraq	69.48	14	59.40	14	55.80	12	17.40	15	30.44	15	21.92	16	3.36	15
Jordan	74.22	11	65.84	9	55.60	11	10.16	12	17.28	12	19.40	11	0.76	9
Kuwait	74.76	9	66.10	5	5.60	2	3.76	2	8.32	5	16.40	5	0.09	1
Lebanon	75.74	5	65.94	7	17.80	7	4.66	5	7.94	4	16.90	8	0.64	8
Libyan	72.22	12	62.90	12	21.60	8	6.90	8	12.74	8	19.64	13	0.60	7
Morocco	75.32	8	65.14	11	110.80	15	16.20	14	25.46	14	15.34	4	2.50	13
Oman	76.84	4	66.04	6	17.40	6	5.12	6	11.18	6	17.80	10	0.21	6
Pakistan	66.46	15	57.74	15	170.40	16	44.52	21	77.00	20	23.86	17	20.04	17
Qatar	78.14	2	68.24	1	12.2	3	3.94	3	7.9	3	14.86	2	0.09	1
Saudi Arabia	74.68	10	65.22	10	13	4	6.14	7	11.18	6	16.46	6	0.13	5
Somalia	55.24	21	49.12	21	751.4	21	39.04	20	131.02	21	20.94	14	91.48	21
Sudan	64.7	17	55.78	19	307.8	18	29.6	17	65.66	18	24.22	18	24.22	19
Syrian	64.08	18	55.92	18	60.6	14	8.18	9	15.46	11	21.68	15	2.94	14
Tunisia	75.72	6	66.46	4	58.2	13	8.7	10	14.32	9	16.46	6	0.92	10
UAE	77.16	3	67.18	3	5.4	1	4	4	7.66	2	17.34	9	0.09	1
Yemen	65.46	16	56.14	17	340.8	19	25	16	49.82	16	29.16	20	11.32	16
Mean	70.96		61.77		131.11		15.58		32.26		19.81		10.18	

Source: WHO's annual World Health Statistics report 2016-2020; Indicator I1: Life expectancy at birth (years), I2: Healthy life expectancy (HALE) at birth (years), I3: Maternal mortality ratio (MMR) (per 100,000 live births), I4: Neonatal mortality rate (NMR) (per 1,000 live births), I5: Under-5 mortality rate (U5MR) (per 1,000 live births), I6: Probability of dying from any of CVDs, cancer, diabetes, CRD between age 30 and exact age 70 (%), I7: Mortality rate attributed to exposure to unsafe WASH (water, sanitation, and hygiene services) (per 100,000 population)

exposure to unsafe WASH. The health status values for Iran were 75.62 for life expectancy at birth, 9.32 for NMR, 15.02 for U5MR, and 15.3 for the probability of dying from CVDs, cancer, diabetes, or CRD; and 0.96 for mortality rate attributed to exposure to unsafe WASH. Qatar and the UAE obtained the best status for HALE at birth (68.24) and MMR (5.4), whereas Iran obtained 65.88 and 23.2, respectively. At the other end of the spectrum, Somalia scored the worst health status for life expectancy at birth (55.24), HALE at birth (49.12), MMR (751.4), U5MR (131.02), and mortality rate attributed to exposure to unsafe WASH (91.48). Similarly, Pakistan and Afghanistan did not score well for NMR (44.52 and 37.40, respectively) and the

probability of dying from CVDs, cancer, diabetes, or CRD (23.86 and 30.18, respectively).

The ranking of EM countries in terms of health status indicators was also determined based on the *Q* values of the VIKOR method (table 4). The lower the *Q* value, the higher the rank of a country. In 2016, the *Q* values for Bahrain, Kuwait, Qatar, and Lebanon were low (because the first VIKOR condition was not met) and thus ranked high. This was also the case for Qatar and Bahrain, in 2017, sharing the top rank. However, only Bahrain achieved the top rank from 2018 to 2020. In this context, Iran ranked 8th, 7th, 4th, 3rd, and 5th in 2016, 2017, 2018, 2019, and 2020, respectively. The weighted average method was used and applied to the ranks in

Table 4: Ranking of the Eastern Mediterranean countries based on the Q values of the VIKOR method

2016			2017			2018			2019			2020		
Country	Q	Rank	Country	Q	Rank	Country	Q	Rank	Country	Q	Rank	Country	Q	Rank
Bahrain	0	1	Qatar	0	1	Bahrain	0	1	Bahrain	0	1	Bahrain	0	1
Kuwait	0.010	2	Bahrain	0.007	2	Qatar	0.082	2	Qatar	0.080	2	Qatar	0.079	2
Qatar	0.024	3	UAE	0.070	3	UAE	0.119	3	Iran	0.116	3	Saudi Arabia	0.116	3
Lebanon	0.026	4	Saudi Arabia	0.086	4	Iran	0.120	4	UAE	0.117	4	UAE	0.117	4
Saudi Arabia	0.110	5	Tunisia	0.094	5	Saudi Arabia	0.130	5	Saudi Arabia	0.121	5	Iran	0.119	5
Oman	0.120	6	Oman	0.096	6	Tunisia	0.131	6	Tunisia	0.129	6	Kuwait	0.136	6
Tunisia	0.124	7	Iran	0.097	7	Kuwait	0.139	7	Kuwait	0.135	7	Lebanon	0.146	7
Iran	0.125	8	Kuwait	0.098	8	Lebanon	0.150	8	Oman	0.149	8	Oman	0.148	8
UAE	0.132	9	Lebanon	0.116	9	Oman	0.151	9	Lebanon	0.150	9	Tunisia	0.158	9
Libya	0.134	10	Jordan	0.185	10	Jordan	0.208	10	Morocco	0.202	10	Jordan	0.198	10
Jordan	0.198	11	Libya	0.194	11	Libya	0.225	11	Jordan	0.204	11	Morocco	0.202	11
Syria	0.209	12	Morocco	0.250	12	Morocco	0.251	12	Libya	0.220	12	Libya	0.224	12
Morocco	0.303	13	Iraq	0.312	13	Iraq	0.312	13	Iraq	0.305	13	Iraq	0.300	13
Egypt	0.326	14	Egypt	0.329	14	Syria	0.313	14	Syria	0.308	14	Syria	0.301	14
Iraq	0.340	15	Syria	0.350	15	Egypt	0.421	15	Egypt	0.412	15	Egypt	0.405	15
Yemen	0.467	16	Djibouti	0.589	16	Sudan	0.584	16	Sudan	0.607	16	Yemen	0.585	16
Sudan	0.557	17	Sudan	0.595	17	Djibouti	0.612	17	Djibouti	0.617	17	Sudan	0.603	17
Djibouti	0.590	18	Yemen	0.681	18	Yemen	0.624	18	Yemen	0.618	18	Djibouti	0.636	18
Afghanistan	0.729	19	Pakistan	0.773	19	Afghanistan	0.773	19	Afghanistan	0.778	19	Pakistan	0.786	19
Pakistan	0.752	20	Afghanistan	0.798	20	Pakistan	0.799	20	Pakistan	0.797	20	Afghanistan	0.792	20
Somalia	1	21	Somalia	1	21	Somalia	0.974	21	Somalia	0.961	21	Somalia	0.975	21

Source: WHO's annual World Health Statistics report 2016–2020

table 4 to determine the overall ranking of the EM countries (table 5). In this method, the arithmetic mean of the ranks in 2016-2020 was determined for each country (alternative), based on which the alternatives were prioritized. Alternatives with a lower mean rank will have higher priorities. The results showed that Bahrain and Somalia ranked first and last on health status indicators, respectively. Iran was ranked fifth among the EM countries.

As mentioned in step three of the VIKOR method, the value of v was set to 0.5. To analyze the sensitivity of the country ranking results, the effect of v on Q was examined by changing its value from 0.1 to 0.9 (figure 1). The results showed that changing the v value did not affect the Q value, and the overall position of Bahrain did not alter. Besides, regardless of the v value, the trend of the country ranks remained stable, and no sensitivity to v values was observed.

Discussion

In the present study, 21 EM countries were ranked in terms of seven health status indicators, namely life expectancy at birth, HALE at birth,

Table 5: The final ranking of Eastern Mediterranean countries using the weighted average method

| Country	2016	2017	2018	2019	2020	Weighted average	Final Rank
Bahrain	1	2	1	1	1	1.2	1
Qatar	3	1	2	2	2	2	2
Saudi Arabia	5	4	5	4	3	4.2	3
UAE	9	3	3	5	4	4.8	4
Iran	8	7	4	3	5	5.4	5
Kuwait	2	8	7	7	6	6	6
Tunisia	7	5	6	6	9	6.6	7
Oman	6	6	9	8	8	7.4	8
Lebanon	4	9	8	9	7	7.4	8
Jordan	11	10	10	11	10	10.4	10
Libyan	10	11	11	12	12	11.2	11
Morocco	13	12	12	10	11	11.6	12
Iraq	15	13	13	13	13	13.4	13
Syrian	12	15	14	14	14	13.8	14
Egypt	14	14	15	15	15	14.6	15
Sudan	17	17	16	16	17	16.6	16
Yemen	16	18	18	18	16	17.2	17
Djibouti	18	16	17	17	18	17.2	17
Afghanistan	19	20	19	19	20	19.4	19
Pakistan	20	19	20	20	19	19.6	20
Somalia	21	21	21	21	21	21	21
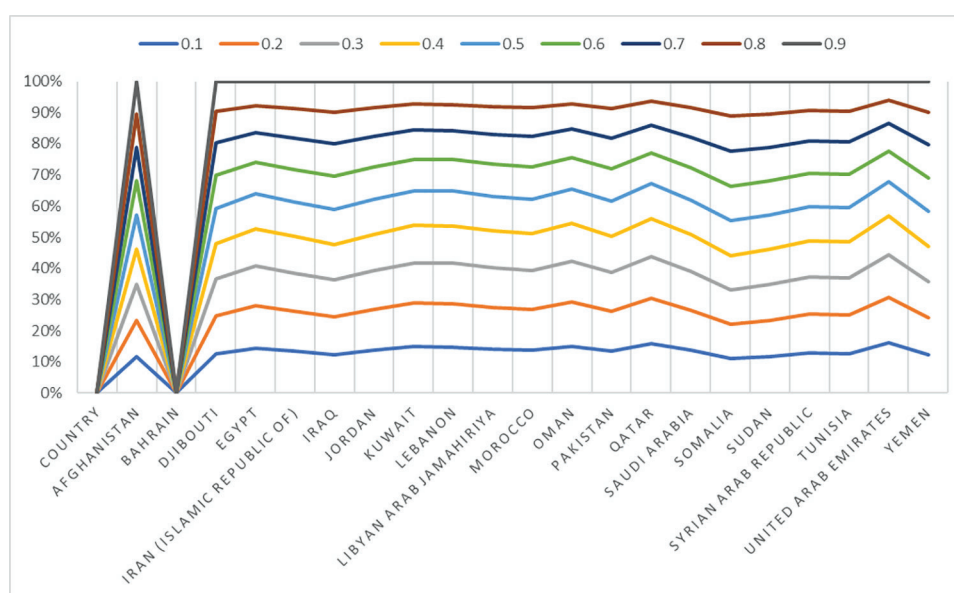
Figure 1: The graph shows sensitivity analysis of the Q value by changing the v value from 0.1 to 0.9. No effect on the Q value was observed and the overall ranking trend of the Eastern Mediterranean countries remained stable.

MMR, NMR, U5MR, probability of dying from CVDs, cancer, diabetes, and CRD; and mortality rate attributed to exposure to unsafe WASH. Among all indicators used by the WHO, the selected indicators will give an overall indication of the health status in the EM countries.

The results showed a significant variation among the EM countries in terms of population, health service coverage, health human resources, health expenditures, and health status. For example, Pakistan has the lowest CHE per capita, which is 45 times lower than that of Qatar. In Somalia, the density of medical doctors and nursing and midwifery personnel (per 10,000 population) is 0.2 and 1.1, respectively. Whereas, in Kuwait, they were 26.5 and 74.1, respectively. Moreover, life expectancy at birth (an important indicator of health status in a country) in Somalia is 23 years lower than Bahrain. In this regard, Iran scored 75.62 years and ranked 7th in the region (after Bahrain, Qatar, the United Arab Emirates, Oman, Lebanon, and Tunisia). Iran scores better on all health indicators than the mean value of the EM countries and therefore has a reasonably good health status. However, there is a significant gap between Iran and the mean values of the top-ranked countries. Previous studies also reported similar differences in health resources and outcomes among the EM countries.[8, 19, 20]

Based on the final ranking of the 21 EM countries, using the weighted average method, the health status in Iran ranked 5th after Bahrain, Qatar, Saudi Arabia, and the UAE. However, another study that used the infant mortality rate (IMR) indicator assigned first place to Qatar.[21] Interestingly, Qatar, UAE, and Saudi Arabia had higher CHE per capita than Bahrain (>1,000 USD), but they were ranked lower in terms of health status. Similarly, Iran ranked 5th with only 415 USD expenditure per capita. This means that a country can spend less, but be more efficient and achieve a better health status. On the other hand, Somalia, Pakistan, and Afghanistan with a minimum CHE per capita had the lowest health status among the EM countries. In a previous study, Pourmohammadi and colleagues used the total health expenditure as an indicator and ranked Iran 10th out of the 19 assessed EM countries. In their study, Qatar and Pakistan had the highest and lowest total health expenditure, respectively.[22] It is clear that CHE per capita is a better indicator for assessing health systems[22] than CHE as a percentage of GDP, because it takes population size into account.[21] The results of other studies also showed a significant relationship between CHE per capita and health status, such that countries that allocated more money per capita to their healthcare systems had significantly lower IMR and U5MR.[21, 23]

Another important indicator for assessing healthcare systems is human resources. According to the WHO report 2000, a sufficient number of medical doctors and nursing and midwifery personnel is important to deliver adequate health services.[24] Typically, countries that were ranked higher in health status than Iran had much more nursing and midwifery personnel than medical doctors (per 10,000 population). In contrast, the number of medical doctors in Iran is much higher than nursing and midwifery personnel. It seems justified to argue that increasing the number of nursing and midwifery staff is a logical step for the Iranian healthcare system towards a better health status. Overall, while CHE per capita is extremely important, a range of other factors also contributes to the health status of a country. This is in line with the findings of other studies stating that quality management and leadership in the healthcare system,[23] sufficiency of skilled personnel,[24] and an effective referral system[4] greatly contribute to the health status of a country.

The results of the present study showed that Bahrain has achieved a high-ranking position among the EM countries during 2016-2020. This is primarily attributed to its adaptation of the Alma-Ata Declaration, which emphasizes a well-organized primary health care (PHC) system as the cornerstone of healthcare services. Bahrain offers a free-of-charge comprehensive package of preventive, promotive, therapeutic, and rehabilitative care services to its nationals, and at heavily subsidized rates to non-citizens. The public sector accounts for approximately 90% of health services in Bahrain.[25] Their PHC team consists of family physicians, nurses (including community nurses, specialist nurses such as diabetes nurses), healthcare staff, medical social workers, and health educators. Accessing secondary health care is possible only through referral and PHC systems, but direct access is foreseen for trauma and emergency patients. The referral process is well-organized, however, the feedback mechanism from secondary to primary care needs improvement.[25, 26] Overall, in several consecutive years, Bahrain has achieved the highest human development index and health indicators in the Arab world, and their healthcare system is comparable to developed countries.[26]

In 2005, Iran initiated the family physician program in small cities (population density <20,000) and rural areas.[27] In 2013, a pilot program was implemented in two Iranian provinces (Fars and Mazandaran) to improve

the referral system and provide equitable and efficient health care.[28] However, there were contradictory reports on its outcomes. Some studies reported a reduction in IMR, NMR, and MMR, whereas others claimed no significant difference between pre- and post-implementation of the program.[29-32] Another study reported that the family physician program was successful in screening diabetes and hypertension.[33] However, Fallah and Rostamzadeh reported that the family physician program was not successful in preventing and reducing the short- and long-term complications in diabetic patients.[34] Nonetheless, Iranian healthcare policymakers remain optimistic that the family physician program will make the healthcare system more efficient and considerably improves Iran's health status indicators.

The main limitation of the study was the review of only some and not all output indicators. Further studies are recommended using a simultaneous review of output and input indicators.

Conclusion

Based on the WHO's annual World Health Statistics report 2016-2020, in terms of the health status in the EMR countries, Bahrain and Iran achieved the first and fifth health status ranking positions among the EM countries, respectively. On the other hand, although Iran has a better status on all indicators than the mean value of all EM countries, there is a significant gap between the health status in Iran compared to the top-ranked countries. Health care strategies used by countries such as Bahrain and Qatar can be used as a model by Iran and other EM countries to improve their healthcare system.

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Authors' Contribution

R.R, Z.K, P.B, P.S, and H.J: Had a contribution to conception and design; N.B: Contributed to data acquisition; R.R, Z.K, P.S, and N.B: Contributed to the data analysis and interpretation; R.R and N.B: Drafted the article. All authors had a contribution to the article revision and its final approval. All authors agree with accountability for all aspects of the work.

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References

1 Margolis SA, Al-Marzouq S, Revel T, Reed RL. Patient satisfaction with primary health care services in the United Arab Emirates. Int J Qual Health Care. 2003;15:241-9. doi: 10.1093/intqhc/mzg036. PubMed PMID: 12803352.

2 Ile Karşılaştırılması MU. Comparison of Health Status Indicators with Multidimensional Scaling and The Multi Objective Optimization by Ratio Analysis. Journal of Health and Nursing Management. 2018;5:179-87. doi: 10.5222/SHYD.2018.179.

3 van Olmen J, Marchal B, Van Damme W, Kegels G, Hill PS. Health systems frameworks in their political context: framing divergent agendas. BMC Public Health. 2012;12:774. doi: 10.1186/1471-2458-12-774. PubMed PMID: 22971107; PubMed Central PMCID: PMCPMC3549286.

4 Kruk ME, Freedman LP. Assessing health system performance in developing countries: a review of the literature. Health Policy. 2008;85:263-76. doi: 10.1016/j.healthpol.2007.09.003. PubMed PMID: 17931736.

5 Bacchus Barua SH, Timmermans I. Comparing Performance of Universal Health Care Countries, 2017. Vancouver: Fraser Institute; 2017.

6 Schutte S, Acevedo PNM, Flahault A. Health systems around the world - a comparison of existing health system rankings. J Glob Health. 2018;8:010407. doi: 10.7189/jogh.08.010407. PubMed PMID: 29564084; PubMed Central PMCID: PMCPMC5857204.

7 Al-Shorbaji N. E-health in the Eastern Mediterranean Region: a decade of challenges and achievements. East Mediterr Health J. 2008;14:S157-73. PubMed PMID: 19205616.

8 Mokdad AH, Forouzanfar MH, Daoud F, El Bcheraoui C, Moradi-Lakeh M, Khalil I, et al. Health in times of uncertainty in the eastern Mediterranean region, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet Glob Health. 2016;4:e704-13. doi: 10.1016/S2214-109X(16)30168-1. PubMed PMID: 27568068; PubMed Central PMCID: PMCPMC6660972.

9 Cinaroglu S. Efficiency in health services based on professionals consensus quality indicators. International Journal of Healthcare Management. 2021;14:993-1001. doi: 10.1080/20479700.2020.1724436.

10 Mberu BU, Haregu TN, Kyobutungi C, Ezeh

AC. Health and health-related indicators in slum, rural, and urban communities: a comparative analysis. Glob Health Action. 2016;9:33163. doi: 10.3402/gha.v9.33163. PubMed PMID: 27924741; PubMed Central PMCID: PMCPMC5141369.

11 Dong Y, Liu Y, Liang H, Chiclana F, Herrera-Viedma E. Strategic weight manipulation in multiple attribute decision making. Omega. 2018;75:154-64. doi: 10.1016/j.omega.2017.02.008.

12 Ceballos B, Lamata MT, Pelta DA. A comparative analysis of multi-criteria decision-making methods. Progress in Artificial Intelligence. 2016;5:315-22. doi: 10.1007/s13748-016-0093-1.

13 Velasquez M, Hester PT. An analysis of multi-criteria decision making methods. International journal of operations research. 2013;10:56-66.

14 Gao R, Nam HO, Ko WI, Jang H. National options for a sustainable nuclear energy system: MCDM evaluation using an improved integrated weighting approach. Energies. 2017;10. doi: 10.3390/en10122017.

15 Organization WH [Internet]. The Global Health Observatory, Explore a world of health data. [cited 17 February 2020]. Available from: https://www.who.int/data/gho/publications/world-health-statistics

16 Diakoulaki D, Mavrotas G, Papayannakis L. Determining objective weights in multiple criteria problems: The critic method. Computers & Operations Research. 1995;22:763-70. doi: 10.1016/0305-0548(94)00059-H.

17 Opricovic S, Tzeng GH. Multicriteria planning of post-earthquake sustainable reconstruction. Computer-Aided Civil and Infrastructure Engineering. 2002;17:211-20. doi: 10.1111/1467-8667.00269.

18 Opricovic S, Tzeng G-H. Compromise solution by MCDM methods: A comparative analysis of VIKOR and TOPSIS. European Journal of Operational Research. 2004;156:445-55. doi: 10.1016/S0377-2217(03)00020-1.

19 Ahmadi AM, Assari-Arani A, Meskarpour-Amiri M. Inequality of health spending and public health outcome in countries of the WHO's Eastern Mediterranean Regional Office (EMRO). International Journal of Travel Medicine and Global Health. 2015;3:137-41. doi: 10.20286/ijtmgh-030479.

20 Baschieri A [Internet]. Health inequities in the eastern mediterranean region selected country case studies. c2014. Available from: https://researchonline.lshtm.ac.uk/id/eprint/2550783

21 Shetty A, Shetty S. The correlation of health spending and infant mortality rate in Asian countries. International Journal of Contemporary Pediatrics. 2014;1:100-5. doi: 10.5455/2349-3291.ijcp20140808.

22 Pourmohammadi K, Shojaei P, Rahimi H, Bastani P. Evaluating the health system financing of the Eastern Mediterranean Region (EMR) countries using Grey Relation Analysis and Shannon Entropy. Cost Eff Resour Alloc. 2018;16:31. doi: 10.1186/s12962-018-0151-6. PubMed PMID: 30237754; PubMed Central PMCID: PMCPMC6142403.

23 Farag M, Nandakumar AK, Wallack S, Hodgkin D, Gaumer G, Erbil C. Health expenditures, health outcomes and the role of good governance. Int J Health Care Finance Econ. 2013;13:33-52. doi: 10.1007/s10754-012-9120-3. PubMed PMID: 23266896.

24 Organization WH. The world health report 2000: health systems: improving performance. Geneva: World Health Organization; 2000.

25 Otoom S, Culligan K, Al-Assoomi B, Al-Ansari T. Analysis of drug prescriptions in primary health care centres in Bahrain. East Mediterr Health J. 2010;16:511-5. PubMed PMID: 20799550.

26 Organization WH. Bahrain health profile 2015. Nasr: World Health Organization. Regional Office for the Eastern Mediterranean; 2017.

27 Hatam N, Joulaei H, Kazemifar Y, Askarian M. Cost efficiency of the family physician plan in fars province, southern Iran. Iran J Med Sci. 2012;37:253-9. PubMed PMID: 23390331; PubMed Central PMCID: PMCPMC3565198.

28 Fardid M, Jafari M, Moghaddam AV, Ravaghi H. Challenges and strengths of implementing urban family physician program in Fars Province, Iran. J Educ Health Promot. 2019;8:36. doi: 10.4103/jehp.jehp_211_18. PubMed PMID: 30993129; PubMed Central PMCID: PMCPMC6432837.

29 Raeissi P, Azar FEF, Roudbari M, Kia H. The impact of family physician program on mother and child health indices in rural population auspices of Mashhad University of Medical Sciences and Health Care Services, Iran; 2009. Journal of Health Administration (JHA). 2011;14.

30 Naderimagham S, Jamshidi H, Khajavi A, Pishgar F, Ardam A, Larijani B, et al. Impact of rural family physician program on child mortality rates in Iran: a time-series study. Popul Health Metr. 2017;15:21. doi: 10.1186/s12963-017-0138-0. PubMed PMID: 28576122; PubMed Central PMCID: PMCPMC5455106.

31 Lankarani KB, Alavian SM, Haghdoost AA. Family physicians in Iran: success despite challenges. Lancet. 2010;376:1540-1. doi: 10.1016/S0140-6736(10)62029-6. PubMed PMID: 21056761.

32 Jabbari Beyrami H, Doshmangir L, Ahmadi A, Asghari Jafarabadi M, Khedmati Morasae E, Gordeev VS. Impact of rural Family Physician programme on maternal and child health indicators in Iran: an interrupted time series analysis. BMJ Open. 2019;9:e021761. doi: 10.1136/bmjopen-2018-021761. PubMed

PMID: 30647030; PubMed Central PMCID: PMCPMC6340439.

33 Khadivi R, Hashemi T, Farrokh Siar E, Rohani M. The Assessment of Family Physicians' Performance in Screening of Hypertension and Diabetes Mellitus in Rural Areas of Isfahan County: A 5-year Survey. Journal of Isfahan Medical School. 2012;30.

34 Fallah S, Rostamzadeh S. Success of the family practice plan in diabetes control. Journal of Health. 2016;7:417-24.