Performance evaluation and ranking of regional primary health care and public health systems in Iran

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RESEARCH

Performance evaluation and ranking of regional primary health care and public health systems in Iran

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Abstract

Background: The present study has been undertaken with the aim to evaluate performance and ranking of various universities of medical sciences that are responsible for providing public health services and primary health care in Iran.

Methods: Four models; Weighted Factor Analysis (WFA), Equal Weighting (EW), Stochastic Frontier Analysis (SFA), and Data Envelopment Analysis (DEA) have been applied for evaluating the performance of universities of medical sciences. This study was commenced based on the statistical reports of the Ministry of Health and Medical Education (MOHME) census data from the Statistical Center of Iran, indicators of Vital Statistics, results of Multiple Indicator of Demographic and Health Survey 2010, and results of the National Survey of Risk Factors of non-communicable diseases.

Results: The average performance scores in WFA, EW, SFA, and DEA methods for the universities are 0.611, 0.663, 0.736 and 0.838, respectively. Based on the ranking of Gilan University, with an average score of 4.75, and Rafsanjan University, with an average score of 0.41, these universities have obtained the first and the last rank in the performance of their primary health care and public health systems, respectively. According to the results of all four models, the Universities of Gilan, Ardebil, and Bojnourd were the strongest ranking in this regard and the Universities of Rafsanjan, Kerman, Ahvaz, and Jiroft ranked weakest in performance.

Conclusions: The average performance of the universities of medical sciences is not acceptable at the present level in which they stand in Iran. Of course, this condition is not prevalent in all universities and there is much dispersion in the performance of universities at the country level today. Designing the evaluation system and annual

ranking of universities of medical sciences by using the methodology of the present study can lead to the improvement of performance of this system and, consequently, the improvement of heath indicators, by attracting the society and attention of policymakers to the domain of primary and public health care and creating a healthy competition among different regions of the country.

Keywords: Performance evaluation, Ranking, Primary health care, Stochastic frontier analysis, Data envelopment analysis, Public health.

Background

The complexity of health organizations, increase of health expenditure, specialization trends, prioritization of customers, and importance of effectiveness and efficiency of services encourage health organizations to apply the performance evaluation [1], so, the demand for information for performance improvement, accountability, and stakeholder decision-making is increasing [2]. Although formal discussions for the collection and publication of performance information have been developed over the past 100 years, their wide application encounters professional, practical and political barriers in health care [3]. Performance evaluation is often used with an ambiguous concept of it in the health care sector [4] and despite the existence of different methods and frameworks for evaluating the performance of health care organizations, there is no consensus in the case of a proper approach in regard to performance evaluation in this sector. There is an endless interest in the design and application of a combination of methods and frameworks for measuring the performance of these organizations [5]. With regard to the obvious relationship between the definition of technical efficiency and the definition of health systems performance, efficiency has been expressed as the most important and prevalent mechanics and key for measurement and evaluation of the performance [1, 6, 7]. The first effort made for evaluating the performance of health systems by applying the concept of efficiency was made by WHO in 2000; having evaluated the efficiency of health systems in 191 countries of the world [8]. The studies made by Hollingsworth [9], Kumbhakar [10], Cheng and Zervopoulos [11], and Grigoli and Kapsoli [12] are of additional efforts made at global level. The comparisons have been performed at restricted scales such

as the level of Organization for Economic Co-operation and Development and the European countries [13-18]. The effort for the analysis of performance of health systems has declined in different regions inside some countries, especially developing countries, where the differences in the health achievements of different regions are totally obvious [19]. The timely management of performance and monitoring and the evaluation of the programs by guaranteeing the continuous improvement of programs is considered to be an important factor in the reduction of regional inequalities in health outcomes [20]. Samples of such studies are observed in Spain [21], Germany [22, 23], India [19, 24, 25], Ghana [26], Brazil [27], Kenya [28], South Africa [29], and Mozambique [30].

During recent years, the subject of performance evaluation has been considerably reflected upon in the great policies of the country, and has been emphasized on in the Health Ministry [31-34]. The execution of these rules in practice and creation, of information management systems, monitoring systems, and performance evaluation with the aim of using its innumerable advantages in the health system need special attention and is the key role of the Health Ministry in this area [35].

During the recent two decades, many national researches have been accomplished in regard to health and population [36-39]. Numerous resources are used in such studies and a large volume of data has been gathered, but there is no considerable use of them [40], whereas these data can be used in the measurement and management of performance of the health systems.

In the health system structure of Iran at the second and third care levels, the performance evaluation systems, having been developed from 1962 with a few standards, were considered completed at the time [41]; but the design and execution of performance evaluation systems is lacking in the structure of primary health care in

the country today; while the nonexistence of some structures for managing the performance is one of the radical reasons for low efficiency and weak quality of primary health care [42].

The Universities of Medical Sciences in Iran, as the largest organizational units of the health system, play an important role as administrators of community health in the provision and expansion of health services and sustainable development of the country [43]. Monitoring and measuring the performance of health deputies in these universities are of special importance as they oversee the widest area of the health system in regard to expansion, activity volume, and servicing scope in the country, as well as governing over the needed health resources. The decision-makers, at all levels, need the qualifications to recognize the differences in performance of the health system, identify those factors that are effective, and adjust policies which lead to better results in different environments. In this regard, the performance of components in the system, such as different regions inside the country, also needs to be evaluated. The meaningful and comparable information in the case of performance of the health system, and the major agents that clarify the difference in the performance of different systems, can lead to scientific policymaking in the health system at both national and regional levels [6]. Therefore, the present study has been undertaken with the aim of assessing performance evaluation and ranking the universities of medical sciences that are responsible for providing first-level services, such as public and primary health care, to the general population [44].

Methods

Data and conceptual framework

In this study, a conceptual framework was designed to match the achieved evaluation to the structure and specific programs of the health deputies of the universities of

medical sciences in the country; exact details of methodology of its extraction having been presented in a study by Jahanmehr and his colleagues [45]. To facilitate the reporting and interpretation of the results, the term "University" is used to refer to the primary health care and public health systems in which services are organized in the form of activities developed by the health deputies of the universities of medical sciences. The health deputy of each university is responsible for providing primary health care and public health services to the population living in a region in their realm. The evaluation and ranking of the performance of health deputies of 45 universities of medical sciences in the country is based on the mentioned framework and data obtained in 2010. This conceptual framework includes two major sections; namely health determinants and results-chain. The results-chain forms several levels including the input indicators based on human resources and health centers, the output and process indicators based on indicators of health services coverage, the outcome indicators based on health behaviors and risk factors, and the impact indicators based on death and communicable and non-communicable diseases (Fig 1).

Figure 1

The data of the present research were collected from statistical reports of MOHME, census data of SCI, indicators of Vital Statistics, results of the Multiple Indicator of Demographic and Health Survey [46], and results of the National Survey of Risk Factors of non-communicable diseases [47].

Models of Performance Evaluation:

In the present study, four models including Weighted Factor Analysis (WFA), Equal Weighting (EW), Stochastic Frontier Analysis (FSFA), and Data Envelopment

188 Analysis (DEA) have been used simultaneously and in parallel form for measuring
189 and ranking the performance of the health deputies.
190
191 The complexity of health systems complicates their performance summarization on
192 a unique scale; therefore, the use of composite indexes has been popular. These
193 indexes combine different functional indicators inside a unique index and, because
194 they provide a wider and more comprehensive image of the performance, are used for
195 ranking or comparing different organizations and systems [3]. In this study, a
196 composite index has been applied for each of the models. This composite index has
197 been obtained based on weighting of different levels of the results-chain (level of
198 process and output, outcome and impact indicators).
199 The WFA and EW indicate the status of performance and total ranking of health
200 deputies without regarding the production resources. In WFA, for obtaining the final
201 composite index, the indicators weight has been considered different and were
202 regarded equal in the EW model. Furthermore, this separation and weighting has been
203 used separately in different domains of the performance in the studies performed in
204 other countries for extracting the composite index [48, 49]. The Stochastic Frontier
205 Analysis and Data Envelopment Analysis, respectively, have been used in SFA and
206 DEA that are the most reliable empirical approaches for the measurement of
207 efficiency. These two methods are different in their approaches to the creation of
208 place and the form of production frontier, and estimation of the status of each system
209 in comparison to that frontier. In some empirical studies, one or both of these methods
210 are used for estimating the efficiency [50].

Model 1. Weighted Factor Analysis (WFA): The number of primary indicators inserted in the WFA model was 41 cases (16 process and output indicators, 16 outcome indicators, and 9 impact indicators). In this model a proper weight was first allocated to all the indicators by the use of factor analysis and then, three indexes of performance were obtained separately sorted by different levels of the results-chain. In the next step, the composite index of performance of health deputies of the universities was extracted by combining three performance indexes with different weights obtained from further factor analyses.

The assumption of this model in weighting uses factor analysis. The main purpose of this method is correlating variables of regular simplification of many numbers into a few numbers of structures or factors. From among different methods of factor analysis, the Principal Component Analysis (PCA) was selected for extracting the factors. The sampling adequacy was studied to achieve the reliable outcomes by the Kaiser-Meyer-Olkin (KMO) test and the suitability of data for reduction and execution of factor analysis was surveyed by Bartlett's Test of Sphericity. The selection of numbers of factors was accomplished based on the criteria of Eigen Value > 1, on the explanation of more than 10% variance of all the data by each selected factors, and the explanation of more than 60% variance in all data, and was also based on the outcomes of the Scree Plot test. After the calculation of the score for performance of each university by using factor analysis, to represent the amount of dispersion of each university from the country mean, the standardized score of each university was considered as the basis of the final ranking.

$$\text{standardized score of each university} = \frac{\textbf{score of each university} - \textbf{country mean}}{\text{standard deviation}} \qquad \text{(Formula 1)}$$

Model 2. Equal Weighting (EW): The evaluation logic, analysis levels, and the indicators studied in this model are similar to WFA; only with this difference that the basis for performance evaluation in EW is the allocation of equal weight to the indicators existing inside every level and was from the accomplished analyses.

Among the four evaluation models, the reason for application of EW, may be questioned due to its simplicity, because the other three models are popular among specific groups due to their relative complexity of methodology, and each one represents many researches in different scopes especially health and treatment [51-56]. The aforementioned question should be answered in this way, that many studies have already been completed by EW, and in different studies this has been defended due to its simplicity with equal emphasis on the indicators [57, 58]. Some researchers believe that although there is an ideal tendency toward the application of different weight values to the indicators based on their degree of importance, there is no reliable basis and criterion in this regard [60]. According to the mentioned background [58], this model was also applied.

For calculating the amount of technical efficiency of health deputies in models 3 and 4, it is assumed that the output, or outcome of each of principal components of the indicators in the results-chain (outputs, outcomes, and final impacts), is a subject of input indicators. With regard to the surplus of number of output indicators in each component of the results-chain, factor analysis was used for the reduction and combination of indicators and the extraction of indicators needed for each evaluation level.

Model 3. Stochastic Frontier Analysis (SFA): Fifty-three primary indicators were inserted in this model. First, the number of indicators at every level was reduced to one indicator by factor analysis, and then, performance indexes (degree of technical efficiency) were obtained separately by Stochastic Frontier Analysis and sorted by different levels of the results-chain. After combining the three performance indexes at different levels (output and process, outcome and impact) of the results-chain, the composite index was extracted of performance of those health deputies of the universities. The Stochastic Frontier Analysis is a method for obtaining the frontier functions needed in the measurement of technical efficiency. The frontier production function represents the maximum services which are possibly produced by using a set of production agents. In this method, the Maximum Likelihood Estimation (MLE) was applied for calculating non-efficiency where efficient estimations are presented for the coefficients of β parameter.

The fundamental structure of model of Stochastic Frontier production function is as following:

$$Y= \beta' X + V- U$$

In such a way that:

$$V \sim N\left(0, \delta_v^{\,2}\right)$$
$$U = \|U\|, U \sim N\left(0.\delta_u^{\,2}\right)$$

$\beta' X$= definite component V= error term (Stochastic)

U= impacts of non- efficiency Y= results of health services in health deputy

X= vector of inputs β= vector of parameters

The deviation of the observed points from the frontier production function depends on the two U and V parts. V indicates the usual error and explains the factors which are out of the control of the health deputy (such as social-economic indicators); U is indicative of non-efficiency that resulted from the issues such as weakness in the skills or slackness of management and employees, informational restrictions, and so on.

Model 4. Data Envelopment Analysis (DEA): Forty-seven primary indicators were inserted in this model. First, factor analysis was performed, the number of indicators at every level was reduced 3 indexes, and then, the performance index (degree of technical efficiency) was obtained separately by applying the data envelopment analysis sorted by different levels of indicators in the results-chain. The composite index of performance of health deputies of the universities was extracted after combining these three performance indexes at different levels (output and process, outcome and impact) of the results-chain.

The data envelopment analysis is a technique of linear planning that calculates the technical efficiency separately sorted by every university using a set of optimizations and under the assumptions of minimization of production factors with a constant return to scale. In this study, the input-based analysis method (input minimization) based on relation 3 was used.

$$Min_{\lambda,OS,IS} - (M1'OS + K1'IS)$$

$$st: \; - \; y_i + Y\lambda - OS = 0$$

$$\theta x_i - X\lambda - IS = 0$$

$$N1' \times \lambda \leq 0 \quad ,\lambda \geq 0 \quad ,OS \geq 0 \quad ,IS \geq 0$$

In the previously stated relation, OS is the vector of output slacks; dimensions M×1, and *IS* is the vector of input slacks; dimensions K × 1, and M_1 and K_1 are the unit vectors; dimensions M × 1 and K × 1. Furthermore, in the linear planning, x_i and $y_{i,}$, respectively, are the input and output vectors in i^{th} and y^{th} Universities. X is the input matrix; dimensions 7 ×43, and Y is the output matrix; dimensions 3 × 43. In addition, θ is the criterion of technical efficiency of the input in this model which selects the values of 0 to 1. If θ be equal to 1, it means that the university is on the production frontier and is efficient. The λ vector; dimensions 1 * 43, is the weight that includes the linear combination of the set of source universities related to the i^{th} University. This math problem needs to be resolved 43 times to calculate and extract the θ value (technical efficiency) for every university.

Results

Table 1 presents the score of performance of the health deputies of universities of medical sciences in Iran based on the results of different models. At the composite index level, the average score of performance of the universities in WFA, EW, SFA, and DEA is 0.611, 0.663, 0.736, and 0.838, respectively. Hence, among the four models, models 1 and 4 have the least and the most value, respectively. In the WFA and EW models, Ilam University and Rafsanjan University showed the best and worst performance, respectively. In the SFA model, the University of Isfahan and Markazi with the score 1, and Zahedan University with the score 0.346 had the best and worst

316 performance, respectively. In DFA model, the universities had the high level of
317 performance in comparison to the other models, and Universities of Ardebil,
318 Bojnourd, Bushehr, Dezful, Gilan, Gonabad and Kordestan have obtained the score 1.
319 The lowest score in this model was related to Kashan University with a score of
320 0.371.

321 **Table 1** Comparison of rank and composite index of performance of universities in 4 evaluation

Rank	WFA		EW		FSFA		FDEA	
	University	**Score**	**University**	**Score**	**University**	**Score**	**University**	**Score**
1	Ilam	1.000	Ilam	1.000	Isfahan	1.000	Ardabil	1.000
2	Bushehr	0.965	Bushehr	0.950	Markazi	1.000	Bojnourd	1.000
3	Birjand	0.863	Golestan	0.935	ChaharM & Bakhtiari	0.971	Bushehr	1.000
4	Gilan	0.840	Qom	0.834	Gilan	0.966	Dezful	1.000
5	Golestan	0.819	Zanjan	0.804	Sabzevar	0.949	Gilan	1.000
6	Shahrud	0.787	Gilan	0.802	Shahid-Beheshti	0.949	Gonabad	1.000
7	Ardabil	0.760	Birjand	0.797	Tehran	0.939	Kurdistan	1.000
8	ChaharM & Bakhtiari	0.756	Bojnourd	0.786	Kermanshah	0.923	Lorestan	0.990
9	Bojnourd	0.749	Mazandaran	0.770	Ardabil	0.918	Neyshabur	0.986
10	Mazandaran	0.733	Ardabil	0.766	Qom	0.908	Qom	0.983
11	Azerbaijan-West	0.725	ChaharM & Bakhtiari	0.742	Kashan	0.907	Shahid-Beheshti	0.982
12	Fasa	0.710	Shahrud	0.725	Bojnourd	0.899	Tehran	0.976
13	Hamadan	0.697	Kermanshah	0.718	Azerbaijan-Eeast	0.889	Torbat-Heidariye	0.970
14	Lorestan	0.666	Sabzevar	0.706	Hamadan	0.887	Kohgiluyeh & BoyerA	0.966
15	Kermanshah	0.641	Qazvin	0.689	Yazd	0.873	Golestan	0.955
16	Gonabad	0.637	Isfahan	0.676	Qazvin	0.868	Hamadan	0.954
17	Sabzevar	0.626	Babol	0.653	Ilam	0.867	Zanjan	0.941
18	Shiraz	0.621	Gonabad	0.651	Golestan	0.867	Zahedan	0.884
19	Isfahan	0.606	Azerbaijan-West	0.645	Azerbaijan-West	0.843	Hormozgan	0.879
20	Mashhad	0.605	Fasa	0.624	Shiraz	0.833	Kermanshah	0.853
21	Jahrom	0.600	Mashhad	0.601	Kurdistan	0.804	Mashhad	0.841
22	Torbat-Heidariye	0.598	Hamadan	0.599	Shahrud	0.769	Zabol	0.826
23	Babol	0.593	Shiraz	0.585	Mazandaran	0.762	Mazandaran	0.810
24	Zanjan	0.593	Torbat-Heidariye	0.576	Lorestan	0.757	Ilam	0.798
25	Kurdistan	0.585	Kohgiluyeh & BoyerA	0.575	Mashhad	0.757	Azerbaijan-West	0.796
26	Azerbaijan-Eeast	0.582	Hormozgan	0.575	Zanjan	0.755	Sabzevar	0.790
27	Hormozgan	0.572	Neyshabur	0.550	Semnan	0.753	Shahrud	0.787
28	Shahid-Beheshti	0.525	Lorestan	0.531	Babol	0.750	Iran	0.783
29	Iran	0.524	Kurdistan	0.523	Fasa	0.748	Birjand	0.776
30	Neyshabur	0.519	Azerbaijan-Eeast	0.507	Jiroft	0.688	Jiroft	0.775
31	Qazvin	0.516	Jahrom	0.491	Ahvaz	0.685	Qazvin	0.760
32	Kohgiluyeh & BoyerA	0.504	Semnan	0.469	Iran	0.650	Fasa	0.753
33	Semnan	0.502	Iran	0.437	Birjand	0.598	ChaharM & Bakhtiari	0.748
34	Qom	0.499	Ahvaz	0.431	Bushehr	0.590	Jahrom	0.772
35	Tehran	0.480	Shahid-Beheshti	0.420	Kohgiluyeh & BoyerA	0.576	Rafsanjan	0.702
36	Ahvaz	0.449	Zabol	0.399	Neyshabur	0.557	Kerman	0.692
37	Zabol	0.406	Kashan	0.394	Gonabad	0.480	Shiraz	0.691
38	Kashan	0.327	Tehran	0.367	Dezful	0.435	Babol	0.673
39	Jiroft	0.269	Dezful	0.280	Rafsanjan	0.430	Markazi	0.663
40	Kerman	0.250	Kerman	0.180	Hormozgan	0.427	Semnan	0.581
41	Dezful	0.245	Markazi	0.155	Jahrom	0.423	Isfahan	0.573
42	Markazi	0.239	Yazd	0.132	Kerman	0.410	Azerbaijan-Eeast	0.546
43	Zahedan	0.127	Jiroft	0.082	Zabol	0.400	Ahvaz	0.525
44	Yazd	0.033	Zahedan	0.013	Torbat-Heidariye	0.351	Yazd	0.444
45	Rafsanjan	0.000	Rafsanjan	0.000	Zahedan	0.346	Kashan	0.371
46	Average	0.563	Average	0.559	Average	0.736	Average	0838

322 Table 2 represents the rank of universities in the four models used in the study and
323 the range of rankings of each university in different models. To achieve a
324 comprehensive agreement on the status of the performance of the universities and

their position in ranking relative to each other, we used the rank of a set of ranking methods that is average of the rank of each university in different models. Gilan University with an average rank of 4.75 and Rafsanjan University with an average rank of 0.41, respectively, have obtained the first and the last rank in the performance of their health deputies. Based on the last two columns of this table in all four models, the Universities of Gilan, Ardebil, and Bojnourd, among 45 universities of the country, were ranked as the best universities, and the Universities of Rafsanjan, Kerman, Ahvaz, and Jiroft were ranked with the weakest performance.

As observed, the WFA, with a relatively high peak, is the main factor among the four models of dispersion of score performance of the universities. The WFA and EW together, and the SFA and DEA combined, reveal similar results due to their similar methodologies. According to the results obtained, the score changes are few in some universities in reference to the Universities of Ahvaz, Fasa, Gilan, Golestan, Shiraz, Shahroud, Shahid Beheshti, and Semnan, but the score changes are high in some universities such as Dezful, Jiroft, Hamedan, Rafsanjan, Torbat-e Heydariye, Yazd, Zabol, and Zahedan. The high score changes in some universities indicates the necessity for using the different models for reducing the uncertainty in their ranking and is a form of creation of reliability distance in the results of performance.

Table 2 Range of rankings of universities in different model

University	WFAM	EWM	FSFAM	FDEAM	Range	Average ranking	Number of times in top 15	Number of times in bottom 15
Gilan	4	6	4	5	4-6	4.75	4	0
Ardabil	7	10	9	1	1-10	6.75	4	0
Bojnourd	9	8	12	2	2-12	7.75	4	0
Bushehr	2	2	34	3	2-34	10.25	3	1
Golestan	5	3	18	15	3-18	10.25	3	0
Ilam	1	1	17	24	1-24	10.75	2	0
ChaharM & Bakhtiari	8	11	3	33	3-33	13.75	2	1
Kermanshah	15	13	8	20	8-20	14.00	2	0
Qom	34	4	10	10	4-34	14.50	2	1
Sabzevar	17	14	5	26	5-26	15.50	2	0
Mazandaran	10	9	23	23	9-23	16.25	2	0

Rank
1-9
10-18
19-27
28-36
37-45

Hamadan	13	22	14	16	13-22	16.25	2	0
Shahrud	6	12	22	27	6-27	16.75	2	0
Birjand	3	7	33	29	3-33	18.00	2	1
Zanjan	24	5	26	17	5-26	18.00	1	0
Azerbaijan-West	11	19	19	25	11-25	18.50	1	0
Lorestan	14	28	24	8	8-28	18.50	2	0
Isfahan	19	16	1	41	1-41	19.25	1	1
Gonabad	16	18	37	6	6-37	19.25	1	1
Shahid-Beheshti	28	35	6	11	6-35	20.00	2	1
Kurdistan	25	29	21	7	7-29	20.50	1	0
Mashhad	20	21	25	21	20-25	21.75	0	0
Tehran	35	38	7	12	7-38	23.00	2	1
Fasa	12	20	29	32	12-32	23.25	1	1
Qazvin	32	15	16	31	15-32	23.50	1	2
Shiraz	18	23	20	37	18-37	24.50	0	1
Torbat-Heidariye	22	24	44	13	13-44	25.75	1	1
Kohgiluyeh & BoyerA	29	25	35	14	14-35	25.75	1	1
Neyshabur	31	27	36	9	9-36	25.75	1	2
Babol	23	17	28	38	17-38	26.50	0	1
Azerbaijan-Eeast	26	30	13	42	13-42	27.75	1	1
Hormozgan	27	26	40	19	19-40	28.00	0	1
Dezful	41	39	38	4	4-41	30.50	1	3
Iran	30	33	32	28	28-33	30.75	0	3
Markazi	42	41	2	39	2-42	31.00	1	3
Jahrom	21	31	41	34	21-41	31.75	0	3
Kashan	38	37	11	45	11-45	32.75	1	3
Semnan	33	32	27	40	27-40	33.00	0	3
Zabol	37	36	43	22	22-43	34.50	0	3
Jiroft	39	43	30	30	30-43	35.50	0	4
Ahvaz	36	34	31	43	31-43	36.00	0	4
Yazd	44	42	15	44	15-44	36.25	1	3
Zahedan	43	44	45	18	18-45	37.50	0	3
Kerman	40	40	42	36	36-42	39.50	0	4
Rafsanjan	45	45	39	35	35-45	41.00	0	4

Figure 2 represents the amount of changes of performance score in four models. As observed, the WFA, with a relatively high peak, is the main factor among the four models of dispersion of score performance of the universities. The WFA and EW together, and the SFA and DEA combined, reveal similar results due to their similar methodologies. According to the results obtained, the score changes are few in some universities in reference to the Universities of Ahvaz, Fasa, Gilan, Golestan, Shiraz, Shahroud, Shahid Beheshti, and Semnan, but the score changes are high in some universities such as Dezful, Jiroft, Hamedan, Rafsanjan, Torbat-e Heydariye, Yazd, Zabol, and Zahedan. The high score changes in some universities indicates the necessity for using the different models for reducing the uncertainty in their ranking and is a form of creation of reliability distance in the results of performance.

Figure 2

Figure 3 presents the country map of ranking the health deputies where the rank of the universities has been placed in five nine-pack packages in a green-colored spectrum; in such a way that the more bright the green color, the better the rank and status of the universities, and the darker the green color, the worse the rank and status of the universities. The score of performance of the universities is recognized on the map as well. As observed in all four models, the universities with lesser area represent performance status and have better rank in comparison to the ones with more area.

Figure 3

Discussion

The present study aimed to evaluate and rank the performance of health deputies of medical sciences universities in Iran. The use of performance information for decision-making, efficiency program improvements and responsibility requires beneficiary assurance from high quality of the evaluation process and validity of its results [59, 60]. In this study, different models have been applied for the performance evaluation with the purpose of increasing result reliability.

The mean score of performance in WFA, EW, SFA and DEA was 0.563, 0.559, 0.736, and 0.838, respectively. These results indicate that individual deputies for public health of the universities of medical sciences in Iran are the main responsible persons for the PHC system and public health, who are considerably distant from access to the high level of performance score 1 in all four models, so they should take steps toward the improvement of performance by clarifying integration strategies. Considerable differences were observed in performance of health deputies at the present level of the country. The accomplished ranking Universities of Gilan, Ardebil,

Bojnourd, Bushehr, and Golestan, are in the group of universities with highest performance; while the Universities of Yazd, Zahedan, Kerman, and Rafsanjan had the lowest level of performance. From among the top large universities in the country, Shiraz, Mashhad, Ahvaz, and Kerman, in the group of 15 higher universities, did not place in one of the models of the study; however, the first top large university that is observed in the ranking is Isfahan University which secured 19th place. These results reveal that the large universities in the country, despite considerable utilization of the physical, financial, and human resources, in comparison to the other universities of the country, have no acceptable performance and should plan integrated strategies to improve the health outcomes of the population under their coverage and make efficient use of the resources in their agenda.

The universities, with low areas of scope under their coverage, have better performance status and rank in comparison to the universities with a vast area. For instance, the Universities of Kerman, Zahedan, Yazd, and Ahvaz cover a vast geographical territory and were placed in the group of 5 universities with the weakest performance. This condition is not that improbable because the provision of services in the vast areas, due to low population densities, can increase the final cost of the service provision and complicate the control and supervision of the management, as well as cause the reduction of performance level. Of course, the good performance of the universities with lesser geographical area is not general, in such a way that Rafsanjan University, despite less geographical area, has been the weakest university regarding the performance of its health deputy. The universities with greater geographical area that had weak performance have often been placed in the areas south and south-east of the country. Movahedi et al. have revealed that the suitability

of indicators in the north and central provinces in Iran and their unsuitability in the eastern and south borders of the country is observed in most of the heath indicators [61]. Furthermore, according to the study of Yazdi and Mahjoub in 2011, Tehran, Gilan and Mazandaran Provinces enjoyed suitable conditions in regard to the indicators of the maternal health; but Kohgiluyeh-and- Boyer-ahmad and Hormozgan Provinces did not have suitable conditions in this regard and Sistan-and-Baluchestan province had difficult conditions.

The WFA and EW represent the performance of health deputies without considering the production resources and based on their achievements. According to their results, only 65 percent and 55 percent of the universities, respectively, had obtained a score higher than the mean. Therefore, the performance of health deputies of the universities in access to the health outcomes is evaluated weak. The study of Shahraz and his colleagues indicates that Iran, in the case of the death index, which is one of the important impact indicators in the conceptual framework of the present research, has secured 12th place among 20 countries of this region [62]. It should be considered that there exists considerable difference in performance in the universities; hence, the performance score in both mentioned models varied from 1 in Ilam University to 0 in Rafsanjan University. Based on these models, the Universities of Ilam, Bushehr, Gilan, Golestan and Birjand had the best performance and Zahedan and Rafsanjan had the weakest performance. The difference in the health outcomes in different regions of the country is not limited to Iran; and such significant differences are observed in different states of the United States, as well [63, 64]. Japan also, despite the success in the reduction of mortality and debility of its citizens from 1990

427 to 2015, has experienced increasing differences in the health outcomes in different
428 parts of the country [65].

429 The SFA and DEA have studied the achievements related to the resources and
430 therefore, they have surveyed the performance evaluation of heath deputies in terms
431 of efficiency. Considerable differences are observed at the country level in these
432 models; thus, performance scores in the SFA include a range between 1 in the
433 Universities of Isfahan and Markazi to 0.346 in Zahedan University. In the DEA
434 model, the performance score varies from 1 in the Universities of Ardebil, Bojnourd,
435 Bushehr, Dezful, Gilan, Gonabad, and Kordestan to 0.371 in Kashan University. A
436 considerable part of the studies took place inside the country in the case of efficiency
437 of health systems where focus was made on the hospitals [5, 7, 66-72] and this has
438 indicated different degrees of inefficiency in the sector of hospital services of the
439 country. Of the studies achieved on a comprehensive scale in regard to the evaluation
440 of performance of the health system in Iran in the case of efficiency of all the scopes
441 (education, research, health, and treatment), reference can be made to the study by
442 Rashdian and his colleagues. According to those results, the average technical
443 efficiency of the medical universities in Iran has been obtained at 0.812 using the
444 DEA technique, which is similar to the score of 0.838 obtained in DEA of the present
445 study [43]. Furthermore, the other studies corresponding to the present research are
446 indicative of the existence of inefficiency in the health system of Iran. Tandon et al.,
447 in addition to the measurement of performance of health systems in 2000, have ranked
448 Iran by a score of 0.659 in 93rd place among the countries of the world [73]. In the
449 study completed by WHO in 2000, the health system of Iran, with a performance
450 score of 0.805, was ranked in 58^{th} place among 191 countries [8]. According to a

451 study by Kumbhakar in 2010, the rank Iran has is based on a different evaluation
452 method and has varied from 55 to 78 among 191 countries [10].

453 The existence of inefficiency in the health system is not limited to Iran. Around
454 the world, there are comprehensive inefficiencies in the process of conversion of
455 resources of health systems into the results that are the reasons for economic waste
456 and increases in expenditures in the health systems of those countries [13]. The past
457 studies have indicated a considerable inefficiency in developing countries and their
458 economies [17, 74-76]. In the evaluation of performance of health systems in 173
459 countries of the world, the average technical efficiency of the health systems was
460 obtained at 0.789 [77]. Furthermore, the report of WHO in 2010 has estimated that
461 presently 20 to 40 percent of all health expenditures is wasted due to lack of
462 efficiency [78].

463 The importance of the present research, based on the use of the two approaches of
464 achievements and efficiency, is revealed when the results obtained from different
465 models of the study are surveyed in a parallel form. Although Ilam University has had
466 the best performance in the scope of achievements; when it is studied by considering
467 the inputs in terms of efficiency, it shows a considerable reduction in performance in
468 such a way that it has been placed 17^{th} and 24^{th} in rank by SFA and DEA,
469 respectively. Although Isfahan University has not ranked as one of the 15 high-level
470 universities in WFA and EW, it has placed 1^{st} in SFA. The difference between the two
471 approaches can be a suitable guide in regard to planning for the improvement of
472 performance at different universities. The universities, which have had proper
473 performance in the scope of achievements but were weak in regard to efficiency, can
474 also improve their efficiency by optimizing their resources, and the ones which have

had optimal efficiency but low achievements should, in addition to preserving the current efficiency in utilizing the resources, take steps to improve their health indicators by using the experiences of the universities that have proper performance in regard to their achievements. Regarding different rank of universities in the different models, ranking based on a set of ranking methods has been used to reduce the uncertainty about the relative position of universities in relation to each other. Mcmillan and Chan have also used this method in the efficiency rankings of Canadian universities [79].

Based on the results of the ranking used in the set of ranking methods, Gilan University has had the best performance, and Rafsanjan University has had the weakest performance among the universities of medical sciences in Iran. Although the system of primary health care in the country has been the main source of fast and considerable improvement in health indicators during recent decades [80], it has been involved in some problems as well, such as: organizational-mechanical structure at local levels, non-concordance of structure with the change in requirements, weakness of informational systems, and lack of strategic management and concentrated systems. Lack of allocation by authorities to the local levels, weakness in comprehensiveness applications and continuation of care, lack of flexibility and responsibility, insufficient provision and inequitable distribution of resources, and lack of motivation in the payment system [81-83] can also be reasons, in the present study, for weak performance of the health deputies. Most of the problems of the health system in Iran, such as the health deputies, result from the lack of integrated systems of information management [84] and the lack of a system of monitoring and performance evaluation. Although many particular efforts have been made in the last years for evaluating the

499 performance of health deputies, this matter has not been perpetuated and it has many
500 shortcomings (46). The evaluation and assessment of the programs is neither perfect
501 nor systematic, so, many efforts should be made to create a comprehensive
502 informational integrated system [35]. The evaluation of existing programs and
503 creation of health-centered competition between the provinces and cities are measures
504 needed to access better outcomes and performance in the case of health deputies [85].
505 The results of the present study, and the models used, can be a basis for beginning the
506 periodical evaluations in the structure of system of primary health care in the country.

507 This study is the first health ranking research of the universities at the country
508 level. Strong points of this study can be mentioned regarding the use of a domestic
509 conceptual framework that has been designed based on the structure of the system of
510 public and primary health care, and its specific programs in the country using four
511 models in the evaluation of the health deputies. The assumptions and different
512 structures of these models from different viewpoints resulted in the study of
513 performance. The calculated composite index has provided the possibility of
514 reflection on a wide set of indicators at different levels of results-chains in the final
515 findings of this study. In fact, the method used in the study has reduced the amount of
516 uncertainty and increased the reliability of the study results by applying an analysis of
517 wide sensitivity. This study had some constraints, however, such as the problem of
518 incomplete or unrecorded data and being regional in part of the existing data.
519 Although in most of the provinces of the country, one medical sciences university is
520 responsible for the presentation of health services to all the population of that
521 province; some provinces such as Tehran, Fars, North Khorasan, Kerman and others
522 having several medical sciences universities. Therefore, access to some data

separately sorted by the medical sciences universities in these provinces was not possible. According to the wide social-economic, geographical, and cultural differences existing in the country, the self-comparison performance of the universities could give a better viewpoint about the performance of universities to the policymakers, but this study was based on the data of one year due to the data restriction. The other dimensions of performance such as social partnership and people satisfaction, intersectional consistency, employee satisfaction and commitment, educational processes and management of financial resources, due to the evaluation board or inaccessibility of the data, have been ignored. This matter is not considered a serious restriction with regard to the major hypothesis of the present study, which is a reflection of all the activities and production resources in the results-chain of the system.

The perception of complex epidemics and the determination of efficiency and effectiveness of the programs in the domain of public health require a continuous, comprehensive, strategic and multi-method evaluation and monitoring system. The national programs of monitoring and evaluation should be regularly studied and updated so that they could be in accordance with the changes in the national strategic programs, and the performance of public health systems could be improved based on the results of periodical evaluations of the evaluation and monitoring system [86]. Ranking the sub national health systems, as was accomplished in the present study, improves the policies related to the clarity and collection of the data and, consequently, the results of such ranking can provide a valuable opportunity for the improvement and considerable motivation for the stimulation of planning processes,

as well as provide the possibility of learning from regions having better performance [21].

Conclusions

The average performance of primary health care and public health in universities of medical sciences at the country level does not possess suitable conditions. Of course, these conditions do not relate to all the universities and there is much dispersion in the performance of universities at this level. The top large universities of the country have had weak performance despite having considerable resources; therefore, improvement is necessary in the managers of the universities and their accountability regarding the methods they use to govern resources, and the amount of achievement that can be seen in their results. The universities with greater geographical area, but limited level of performance, should regulate the method of organization of their services in such a way that it facilitates the control of system performance and the improvement in the level of health indicators in all areas under their jurisdiction. With regard to variation between the levels of performance of universities in different models, every university should apply a special strategy that is suitable for its specific condition of performance. Ranking the health deputies, based on the evidences, can result in the improvement of policymaking in regards to optimal allocation of resources, monitoring the amount of development of the indicators, creation of motivation for healthy competition by attracting the cooperation of managers and policymakers, attracting the attention of cumulative relationship media, and the vast participation of the society in the medium term. Furthermore, in the long term, it would result in the

improvement of system performance, improvement of results and health indicators in the society, and also attract attention toward the scope of primary health care of the country with regard to its high capacities in the improvement of efficiency and effectiveness of the total health system. It is suggested that the methodology of the present study be used for annual ranking of the health deputies in the country. Although the execution of annual ranking, in the beginning, may encounter some constraints in the collection of valid data, and also the resistance of the managers of the universities to accept the study results, it still has countless advantages that can be utilized by reforming the problems.

Abbreviations

WHO: World Health Organization; WFAM: Weighted Factor Analysis Model; EWM: Equal Weighting Model; FSFAM: Factor and Stochastic Frontier Analysis Model; FDEAM: Factor and Data Envelopment Analysis Model; MOHME: Ministry of Health and Medical Education; SCI: Statistical Center of Iran; PHC: primary health care.

Declarations

Ethics approval and consent to participate

Administrative permissions to access and use the data described in this study were not required.

Consent for publication

Not applicable.

Availability of data and materials

The datasets supporting the conclusions of this article are included within the article/tables. The raw data can be requested from the corresponding author on reasonable request.

Competing interests

All authors declare that they have no competing interests.

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Authors' contributions

All authors have contributed to this study. Conception and design(NJ & AR), Acquisition of data(AR & AKh), Analysis and interpretation of data(NJ), Drafting of the manuscript(NJ & SD), Critical revision of the manuscript for important intellectual content(NJ, AR, FF, MSh, AAS & RM), Administrative, technical, or material support(AR & FF). All authors have read and approved the manuscript.

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Figure 1 Conceptual framework of performance evaluation of primary health care and public health systems in Iran

Figure 2 changes of performance score in four models

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Figure 3 Country map of ranking the peformance of universities of medical sciences in different models: A. EWM, B.WFAM, C. FDEAM, D. FSFAM. ***Source:*** *These maps are the result of this study and were drawn by the authors and not extracted from another source.*

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Figures

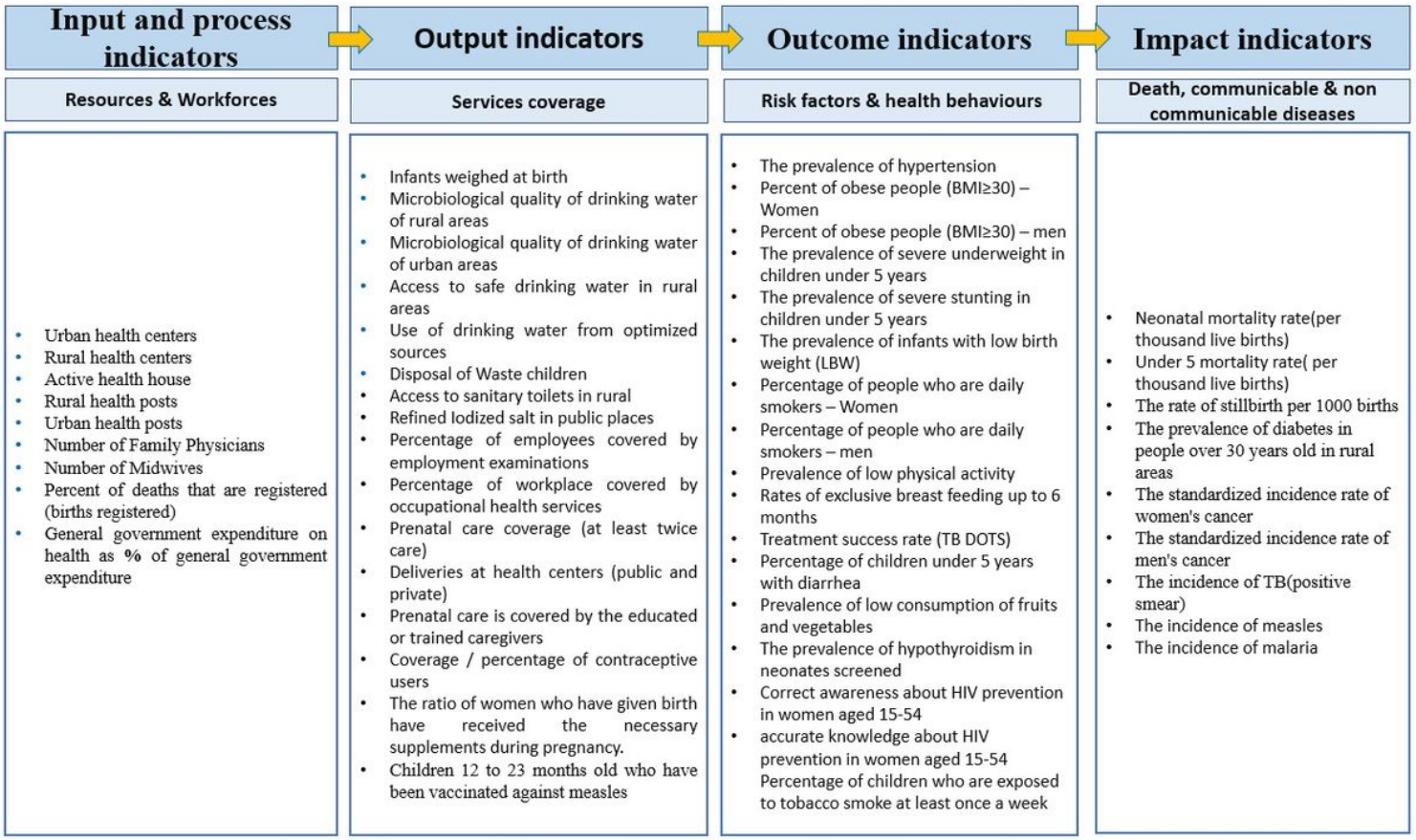

Figure 1

Conceptual framework of performance evaluation of primary health care and public health systems in Iran

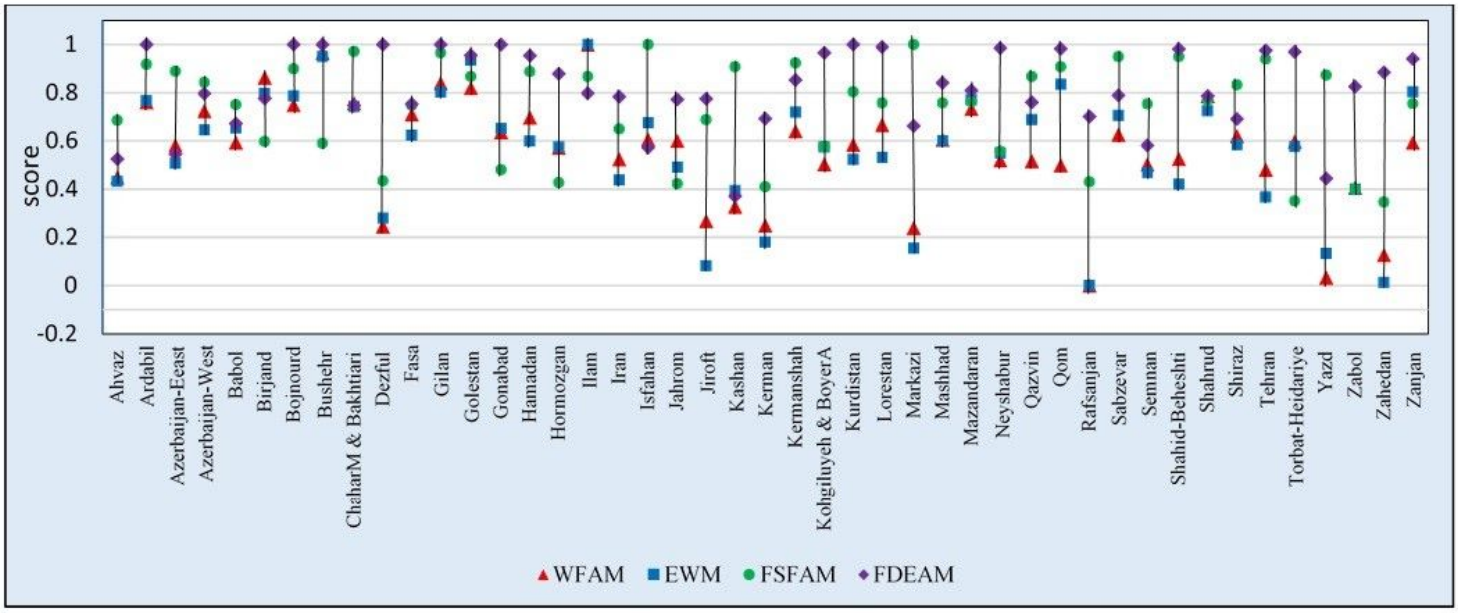

Figure 2

changes of performance score in four models

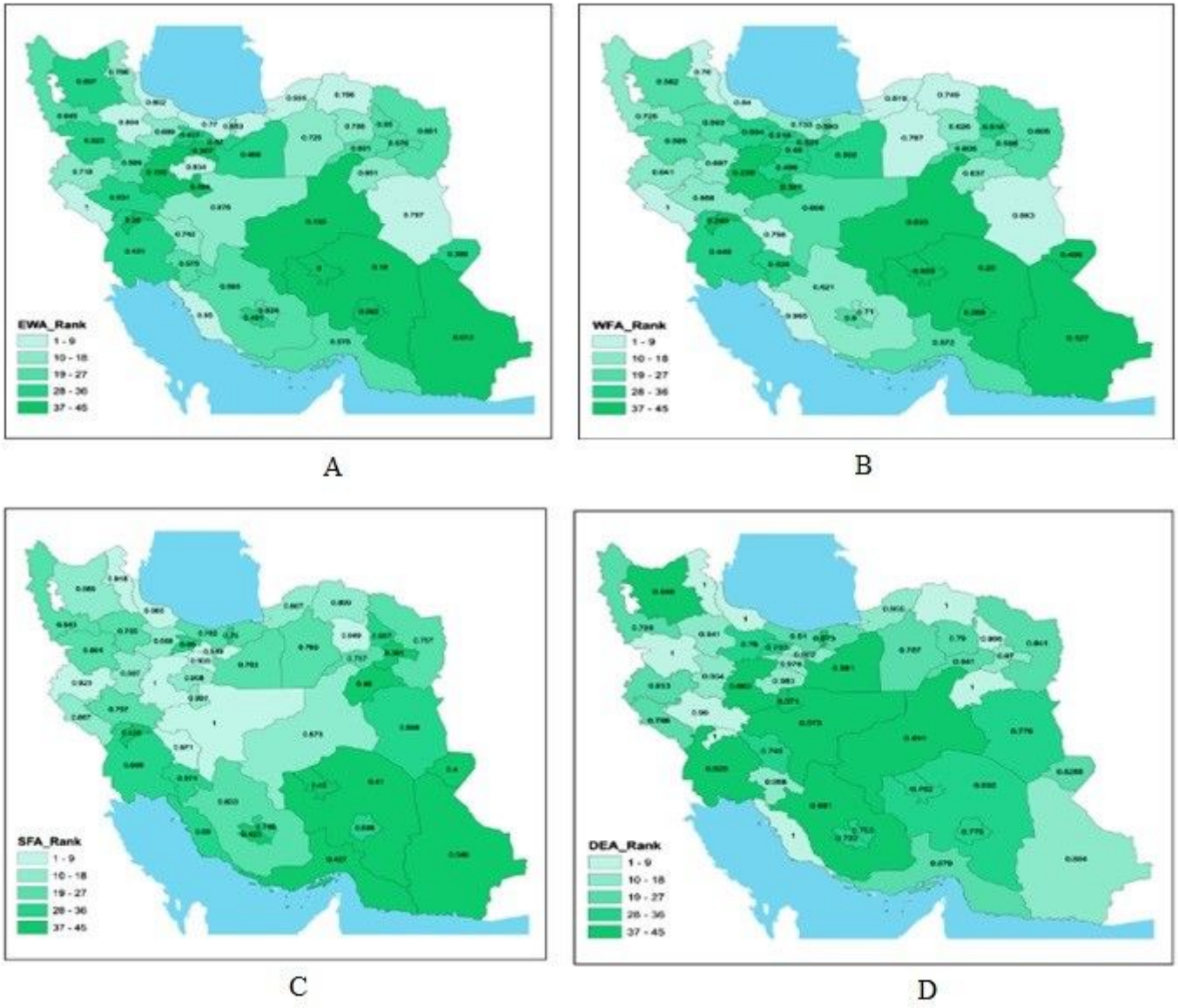

Figure 3

Country map of ranking the peformance of universities of medical sciences in different models: A. EWM, B.WFAM, C. FDEAM, D. FSFAM. Source: These maps are the result of this study and were drawn by the authors and not extracted from another source.