Measuring the Efficiency of Health Systems: A Case of Mental Health in Middle East and North Africa Countries

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Abstract

Background: Mental disorders and problems put a heavy burden on communities. Since resources allocated to the mental health systems are finite, it seems necessary to assess the efficiency of mental health systems. In this study, we assess the efficiency of mental health care systems across 12 Middle East and North Africa (MENA) countries in 2014.

Methods: We used data envelopment analysis (DEA). The number of psychiatrists and nurses working in the mental health sector, the number of beds in mental hospitals, and the healthcare expenditures were included as inputs. The disability-adjusted life years (DALYs) of mental and substance use disorders was considered as the output. This approach is an input-oriented and a variable returns to scale.

Results: Countries such as Egypt, Iraq, Lebanon, and Qatar with the efficiency scores of 1.00 are entirely efficient. However, Bahrain and Iran with the efficiency scores of 0.50 and 0.58 are the most inefficient countries, respectively. After measuring the efficiency model, the radial super-efficiency showed that Egypt and Lebanon with the efficiency scores of 4.73 and 4.09 were ranked as the first and second by far. Qatar and Iraq compared with the previous analysis, and with the efficiency scores of 1.72 and 1.58, were ranked as the third and fourth. Bahrain and Iran were as inefficient as the previous model.

Conclusion: This study depicted a general portrait of the performance of mental health systems across MENA countries. Countries performed efficiently, have taken advantage of comprehensive programs in mental health sector. Countries are strongly recommended to complement their datasets of mental health to make future studies able to evaluate mental health systems more accurately and perfectly.

Keywords: Data envelopment analysis (DEA); Efficiency; Mental health systems; Health expenditures

Introduction

Mental health has an effective impact on individuals' physical status. Societies should ensure that people receive mental and physical care well; since people expect to have access to the best evidence-based and suitable care needed when their diseases and mental disorders developed. Mental health should be considered at the forefront of the concerns and priorities of all age groups in every country (1). All communities need to have a national mental health policy in order to provide, plan and deliver health services to people with mental disorders and illnesses (2).

Mental disorders and problems put a heavy burden on communities (3). The global burden of mental illnesses is underestimated and this is actually greater than amounts reported so far. The global burden of mental illnesses accounts for 13% of disability-adjusted life years (DALYs) and 32.4% of years with disability (YLDs) which are more than one third higher than previous reports (4). WHO in 2015 ranked depression and anxiety as the first and sixth largest contributors to global YLDs, respectively (5). According to the Global Burden of Diseases statistics (GBD 2016), DALY

rates of mental disorders among MENA countries are extremely alarming and considerable. As depicted in Fig.1, Iran with the rate of almost 3108 has the highest DALY of mental disorders among MENA countries. Morocco and Qatar with a relatively great difference from Iran are at the second and third rank, respectively. However, Djibouti has the lowest DALY rate (approximately 1761). This report indicates how much assessing the performance of countries in the mental health sector can explain these differences.
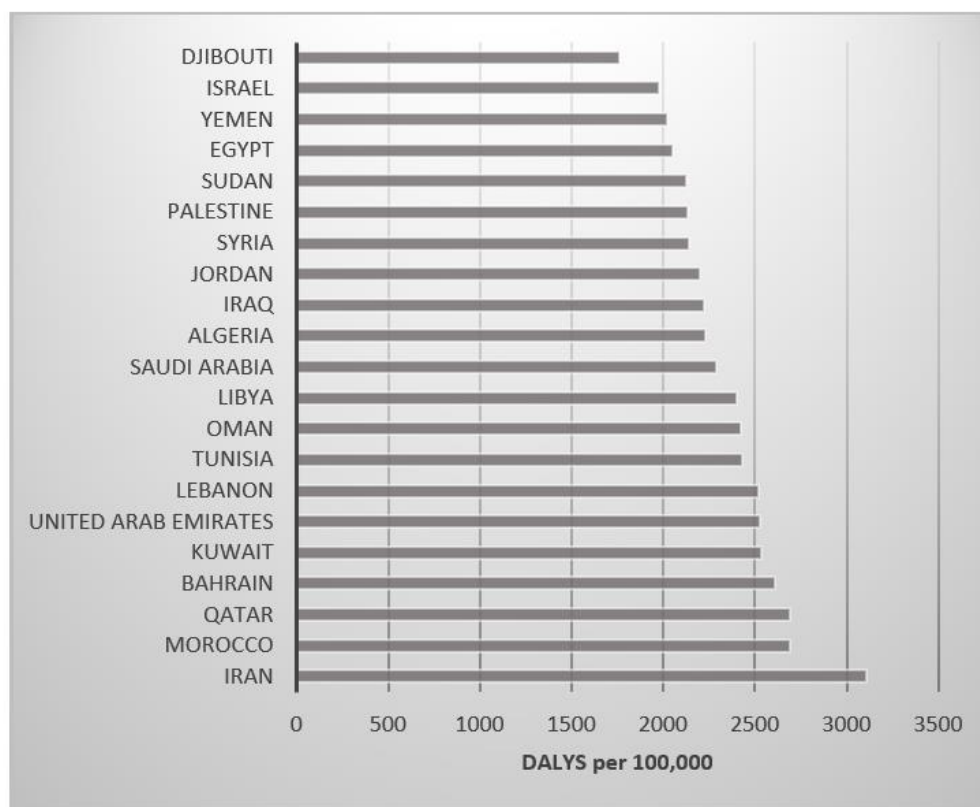

Fig.1: *Mental disorders DALYs of MENA countries* (Source: Global Burden of Diseases 2016)

On the other hand, there is a huge gap between resources allocated to the mental health sector and its desirable and ideal level (6). As reported by the WHO (Atlas 2014), financial resources devoted to mental health have been unnoticeable and about 2$ per capita in 2013 across low and middle-income countries (LMICs); whereas it has been more than 58$ per capita in high-income countries

(HICs) (7). Of course, allowance of high financial resources in HICs than LMICs, albeit having an essential role, cannot necessarily correlate with their higher income. This is because health expenditures per capita in HICs is 200 times greater than LMICs; while their gross national income per capita is only 76 times higher than those (8). Therefore, efficiency plays an important role in the

allocation of resources. Human resources and beds available in mental health centers vary from lower than 1 per 100,000 people in LMICs to more than 50 in HICs, and also lower than 5 beds per 100,000 people in LMICs to more than 50 beds in HICs (7). In general, 67% of mental health expenditures are assigned to mental hospitals worldwide (World Bank classification) (8).

Various studies have been already done with the purpose of assessing healthcare systems performance of different countries in the area of physical health (9, 10); but there are few studies focusing on mental health systems performance. One of the main reasons is unavailability or lack of mental health information (11).

Many researchers have frequently employed Data Envelopment Analysis (DEA) to assess efficiency of mental health care services in national level (12-14), but it has been rarely applied for cross-national comparison studies. For instance, Moran et al. implemented a cross-country study which is one of the first studies conducted by DEA to measure the efficiency of inpatient mental health care services (15). Today, given that resources devoted to this important sector are limited and under other conditions that mental healthcare sector bears a greater burden of diseases, the current study aimed to measure the efficiency of mental health care systems across MENA countries in 2014 using DEA.

Methods

DEA is a non-parametric approach that is used for measuring the efficiency of one or more Decision Making Units (DMUs) with multiple inputs and outputs (16, 17). In 1984, a model was introduced by Banker, Charnes and Cooper (BCC) which evaluates the efficiency based on the assumption of variable returns to scale (VRS). In other words, this model (known as the BCC model) measures the efficiency as well as identifies increasing, decreasing and constant returns to scale (18).

In this study, inputs are categorized into capital and human resources groups (19). The number of psychiatrists and nurses working in the mental health sector per 100,000 populations were considered as proxies for human resources. The number of beds in mental hospitals per 100,000 population was also regarded as the capital (15). To determine the mental health care expenditures as the financial resources for the capital group of the inputs, the WHO Atlas 2014 was carefully scrutinized. However, the coverage of data was very low and insufficient (7). In order to overcome this limitation, as Kujawska included health expenditures in input variables to evaluate the performance of healthcare systems through OECD countries, in this study healthcare expenditures (as % of GDP) was included instead of mental health care expenditures (20).

To assess the efficiency of healthcare systems, the main concern is about choosing the accurate measurement of the outcome of the healthcare system. Some health indicators only represent a narrow status of the health system but are potentially able to give the feasibility to the model so that evaluates the efficiency of all process of health production, from payment to the outcome. DALY is one of these kinds of indicators suggested for comparing the performance and efficiency of healthcare systems. Therefore, the DALYs of mental and substance use disorders per 100,000 population was used as the output (19). Based on the researchers' scrutiny of the current study, DALY has been never utilized as an output in mental healthcare efficiency assessments. Most of the healthcare system efficiency research have exploited intermediate variables such as the number of discharges (15), or final variables like life expectancy at birth as outputs (20). Consequently, this could be considered the novelty of the present study.

It must be noted to maintain the positive notion of outputs in the DEA models, DALYs of mental disorders were converted into "$\frac{1}{DALY}$" and entered the model (21). The data of the number of nurses, beds, and psychiatrists were taken from the WHO website and Atlas 2014 (7). Total health expenditures were obtained from the World Development Indicators (WDI) (22). The statistical source used for DALYs of mental illnesses is GBD (23). All

the data were for year 2014 and this analysis covered 12 MENA countries. Actually, countries such as Libya, Syria, Sudan, Djibouti, Emirates, Algeria, Yemen, Tunisia, and Palestine were excluded owing to the lack of data coverage. In order to have a strong DEA model, satisfying enough number of degrees of freedom, the number of DMUs (n) should be several times greater than the number of inputs (m) and outputs (s). It is specifically suggested a rough rule of thumb which implies the "n" should be equal to or greater than the $Max\{m*s, 3*(m+s)\}$ (24). Consequently, to satisfy this assumption, the sum of the number of nurses and psychiatrists were entered into the model as one variable. Then the rough rule of thumb for this study is calculated 12 $\{12 = 3*(2+2)\}$ which equal the number of "n" (DMUs). Finally, since the dataset used for inputs and outputs are defined as the ratios, BCC (VRS) approach was identified as an appropriate approach to be adopted (25).

Now it is necessary to ascertain the orientation of the model, with regard to the definitions of input-oriented and output-oriented. Input-oriented is an approach aiming to minimize available inputs to provide given levels of outputs; while the output-oriented approaches fulfill the maximum outputs using a given level of inputs, to reach higher efficiency fronts (21). With this explanation, because most countries, especially MENA countries, are usually faced with a shortage of resources and they are likely willing to prioritize or even ration their resources, the input-oriented was preferred. Therefore, an input-oriented BCC model was chosen to measure the efficiency of mental health services across MENA countries (15). The dual formulation of linear-programming of the input-oriented BCC (VRS) model will be as below (26):

$$Minimize\left(\theta - \varepsilon\left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+\right)\right)$$

Subject to:

$$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = \theta x_{io} \qquad i = 1,2,…,m$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = y_{ro} \qquad r = 1,2,…,s$$

$$\lambda_j \geq 0 \qquad j = 1,2,…,n$$

$$\sum_{j=1}^{n} \lambda_j = 1 \qquad j = 1,2,…,n$$

Where θ indicates the efficiency score, y outputs, and x inputs. The sign λ is weight given to units, and "o" is the indicator of the focal DMU. Moreover, s_i^- and s_r^+ show the slacks of inputs and outputs respectively. The sign "ε" in the target function is called non-Archimedean, defined infinitely small or less than any positive integer.

Within using the DEA model, it is possible that results might be such a way that more than one DMU get the efficiency score of unity and become efficient. The radial super-efficiency presents an analysis which is able to rank even efficient DMUs separately as well. In this study, the radial super-efficiency was conducted as a supplementary assessment in order to rank the efficient DMUs (24, 27, 28).

Results

The total number of the nurses and psychiatrists, and the number of beds allocated to mental hospitals of MENA countries, also descriptive statistics of these variables have been depicted in Table 1. The average number of beds, nurses, and psychiatrists are 11.04 and 11.69 per 100,000 members of a population respectively. The average of health expenditures is 5.34% of GDP per capita. Table 2 shows the results of the countries' efficiency ranging, from countries with the efficiency scores of 1.00 to the least efficiency score. The average of the efficiency scores is 0.87 and their standard deviation equals 0.17. Countries such as Egypt, Iraq, Lebanon, and Qatar are entirely efficient. The countries including Israel and Oman tend to be fully efficient. Kuwait and Saudi Arabia with the efficiency scores of 0.96 and 0.90 respectively are close to the efficient countries. However, Bahrain and Iran with the efficiency scores of 0.50

and 0.58 are the most inefficient countries respectively. By the way, the countries like Iran, Iraq, Lebanon, Morocco, and Qatar had constant returns-to-scale; the rests were all decreasing returns-to-scale. No country was with the increasing returns-to-scale.

Table 1: Descriptive statistics of the inputs and outputs variables

Decision maker units	Inputs			Outputs
	Psychiatrists and nurses working in the mental health sector (per 100,000)	Beds in mental hospitals (per 100,000)	Health expenditures (% of GDP)	DALYS per 100,000
Bahrain	27.52	16.81	4.98	2623.4
Egypt	3.78	6.55	5.64	2041.6
Iran	10.60	7.51	6.89	3075.9
Iraq	1.82	3.86	5.53	2211.1
Jordan	5.22	6.92	7.45	2179.9
Kuwait	22.56	17.24	3.04	2522.4
Lebanon	1.63	0.84	6.39	2508.4
Morocco	4.54	4.23	5.90	2695.3
Oman	15.02	5.60	3.55	2403.6
Qatar	11.77	3.04	2.18	2697.7
Saudi Arabia	12.62	19.50	4.68	2262.4
Israel	23.20	40.42	7.80	1990.9
Max	27.52	40.42	7.80	3075.9
Min	1.63	0.84	2.18	1990.9
Average	11.69	11.04	5.34	2434.3
St Dev	8.50	10.61	1.67	315.3

Bahrain with 27.52 nurses and psychiatrists, is a country where it has allocated the most human resources to the mental health; in comparison to Qatar with the efficiency score of unity and with the available number of 11.77 nurses and psychiatrists. Although Bahrain has invested approximately 15 units more than Qatar (Tables 1 and 2), but their DALYs of mental disorders are almost the same (Table 1).

DEA models show the slacks of each DMU specifically. In fact, the slacks of the profoundly efficient DMUs will be zero. This is a great advantage of the DEA models which identifies the excess and shortfall related to inputs and outputs (26). The slacks of Iraq, Egypt, Lebanon, and Qatar are all zero because of being efficient. Israel with the mental disorders DALYs of 1990.9, was among the least after Yemen and Djibouti (Table 1). Considering the slacks of the beds, nurses, and psychiatrists of Israel, this country can reach complete efficiency by decreasing the human resources and beds by only 0.005 and 0.009 respectively. Of course, Israel with allocating 9% of GDP to the health sector has the most financial resources in the healthcare system among MENA countries (Table 1). On the other hand, Bahrain with the

DALY of 2623.4 and the most inefficient country, is one of the countries with the highest DALY of mental disorders (Table 1). Bahrain can reduce the number of beds, nurses, and psychiatrists by 5.06 and 2.70 respectively to be efficient. The slacks of the health expenditures and also the output of the model ($\frac{1}{DALY}$) were zero.

Table 2: Results of efficiency model

Row	DMUs	Rank	Score	Returns to scale	Slack			
					Psychiatrists and nurses working in the mental health sector (per 100,000)	Beds in mental hospitals (per 100,000)	Health expenditures (% of GDP)	1/DALYs per 100,000
1	Egypt	1	1	Decreasing	0	0	0	0
2	Iraq	1	1	Constant	0	0	0	0
3	Lebanon	1	1	Constant	0	0	0	0
4	Qatar	1	1	Constant	0	0	0	0
5	Israel	2	0.99	Decreasing	0.005	0.009	0	0
6	Oman	3	0.98	Decreasing	6.077	1.142	0	0
7	Kuwait	4	0.96	Decreasing	11.714	12.829	0	0
8	Saudi Arabia	5	0.90	Decreasing	4.475	12.574	0	0
9	Morocco	6	0.83	Constant	0	0	0	0
10	Jordan	7	0.70	Decreasing	0	0.004	0	0
11	Iran	8	0.58	Constant	0	0.922	0	0
12	Bahrain	9	0.50	Decreasing	2.702	5.060	0	0
13	Average	_	0.87	_	2.0811	2.711	0	0
14	Max	_	1	_	11.714	12.829	0	0
15	Min	_	0.50	_	0	0	0	0
16	St Dev	_	0.17	_	3.686	4.882	0	0

After measuring the efficiency model, the radial super-efficiency showed more explicitly the results. The radial super-efficiency ranked the efficient DMUs and their differences were diagnosed very well (Table 3). The average of the radial super-efficiency scores was 1.55 and their standard deviation was 1.33. In this model, Egypt and Lebanon with the efficiency scores of 4.73 and 4.09 were ranked as the first and second by far. Qatar and Iraq compared with the previous analysis, and with the efficiency scores of 1.72 and 1.58, were ranked as the third and fourth. Bahrain and Iran were as inefficient as the previous model. Israel remained at the fifth rank with no change (Table 3). The results of both efficiency and radial super-efficiency are depicted in Fig. 2.

Table 3: Results of radial super-efficiency model

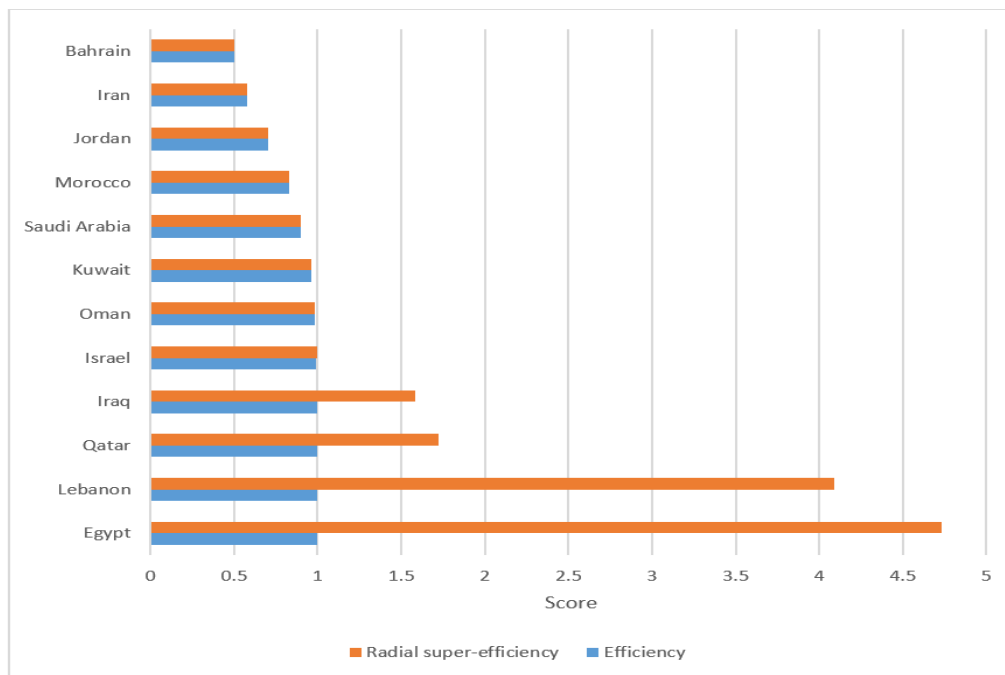| Row	DMU	Rank	Score	Slack			
				Excess Psychiatrists and nurses working in the mental health sector (per 100,000) S-(1)	Excess Beds in mental hospitals (per 100,000) S-(2)	Excess Health expenditures (% of GDP) S-(3)	Shortage 1/DALYs per 100,000 S+(1)
1	Egypt	1	4.73	0	0	19.269	0
2	Lebanon	2	4.09	0	0	22.253	1.3847E-05
3	Qatar	3	1.72	6.27	0	0	4.4038E-05
4	Iraq	4	1.58	0	1.92	2.845	0
5	Israel	5	1	0	0	0	0
6	Oman	6	0.98	6.07	1.14	0	0
7	Kuwait	7	0.96	11.71	12.82	0	0
8	Saudi Arabia	8	0.90	4.47	12.57	0	0
9	Morocco	9	0.83	0	0	0	6.2076E-05
10	Jordan	10	0.70	0	0.003	0	0
11	Iran	11	0.58	0	0.92	0	9.0986E-05
12	Bahrain	12	0.50	2.70	5.05	0	0
13	Average	_	1.55	_	_	_	_
14	Max	_	4.73	_	_	_	_
15	Min	_	0.50	_	_	_	_
16	St Dev	_	1.33	_	_	_	_

Fig. 2: Efficiency and radial super-efficiency results

Discussion

This research determined the efficiency of the mental health care systems across 12 countries of MENA region using cross-sectional data of year 2014. In order to analyze the available data, DEA method with two approaches, the efficiency, and radial super-efficiency models was utilized. First, the efficiency model was run to generally recognize the efficient and inefficient countries. Then, the radial super-efficiency was applied to rank the efficient countries separately. The results of the efficiency model exhibited that Egypt, Iraq, Qatar, and Lebanon were efficient with the efficiency score of unity and the rests were inefficient but in a compact and competitive range.

Oman, Kuwait, Saudi Arabia, and Bahrain were faced with the most surplus of the allocated beds, nurses and psychiatrists; policymakers can move the mental health care systems towards the more efficient levels by revision or redistribution of resources. Bahrain and Iran, which have lower efficiency scores, can increase their efficiency by modeling and taking advantage of the experience and performance of the efficient DMUs. However, DEA also allows to recognize the efficient DMUs considered as the appropriate samples for inefficient DMUs to refer (20). Although the results of the cross-country studies provide worthwhile clues for policymakers of inefficient countries, it is not enough to only change the resources for the purpose of modeling and improving mental health. In fact, many items can explain improving mental health. Hence, it seems necessary to investigate the strategies of Egypt, Lebanon, Qatar, and Iraq which were efficient. Based on our investigations, the countries which acquired high scores of efficiency in mental health care performance followed purposeful programs that will be discussed. Based on the WHO reports (2006), in the mental health care of Egypt, all kinds of mental illnesses and disorders have been covered by social insurance caused an increase in access to mental health care services. Essential psychotropic medications are accessible for at the minimum 80% of the Egyptian people for free. Approximately 5% of

the training provided to medical doctors for improving their knowledge and skills is allocated to mental health. To improve equity of access to mental health care services, some actions such as the development of community-based psychiatric units and outpatient facilities have been taken in each district around the country. Moreover, some programs have been designed to train children in schools, psychologists and social workers in order to prevent mental disorders and promote mental health (29).

The National Mental Health Program was initiated by the Ministry of Public Health of Lebanon with the target of ameliorating mental health care in Lebanon and delivering services beyond medical treatment at the society. The strategy has 5 realms: 1) effective and strong leadership for mental health; 2) preparing plenary and responsive mental health services for all inhabitants, 3) especially susceptible groups; 4) conducting key activities for prevention and promotion of substance use disorders and mental health; 5) gathering and providing evidence-based information and knowledge in order to implement mental health policies and development of services through a functional health information system and coordinated national research practice (30).

The Ministry of Public Health of Qatar established a national mental health commission in 2008. In 2013, this committee considered the mental health plans in the overall package of government policy as a national mental health strategy. The key goals of this strategy included increasing the public awareness of mental health, providing available and widely mental health information, development of specialist services with regard to individuals' needs, development of accomplished specialists in the mental health sector and legislating mental health laws (31).

Finally, Iraq has launched the mental health program since 2003 with several financial sources and aids. Many national and international gatherings have been held on mental health. The national mental health strategy started and developed during 2008-2013, has been reviewed and updated. In Iraq, 6 facilities have been established specifically for trauma throughout five different cities, had a

huge impact on Iraqi people's mental health improvements (Iraqi Ministry of Health) (32).

Therefore, efficient countries have suitable strategies on mental health promotion. However, improving the health levels of a community and increasing the health outcomes levels and outputs, generally wouldn't be so expensive in low-income and developing countries on account of increasing returns-to-scale (33). Most of the MENA counties are also developing countries. International health system comparisons already suffer from some constraints and challenges. Accordingly, it is needed to make some evidence-based information on these challenges about data, methodology, and conclusions from international comparison studies for policymakers and discuss them. For instance, some countries might have had inseparable health systems reported mental health information in other sectors of health.

One limitation of the current study was that because of the poor mental health expenditures data, the total health expenditures were employed instead. If there had been sufficient coverage of mental health expenditures data, the result would have been concluded stronger results. By reason of the lack of rich database several countries were excluded and eventually, fewer inputs and outputs were taken into account in the model due to the rough rule of thumb mentioned in the methodology section. Thus, more complete mental health data would result in improving the quality and quantity of mental health research.

Conclusion

This study depicted a general portrait of the performance of mental health systems across MENA countries. Countries performed efficiently, have taken advantage of comprehensive programmes in mental health sector. Countries are strongly recommended to complement their datasets of mental health to make future studies able to evaluate mental health systems more accurately and perfectly. Most of the European countries are promoting and improving the quality and quantity of the database related to mental health. However,

this is still out of the spotlight in the MENA and other developing countries. Despite the existence of some limitations like few countries included, a single-output analyzed, use of total health expenditures instead of mental health expenditures, and a single-year analysis, this measurement can be regarded as the first and an initiating point for more research in the mental health performance among the MENA countries which has been far from researchers' attention.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The authors declare that there is no conflict of interest.

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