Hospital Efficiency in the Eastern Mediterranean Region: A Systematic Review and Meta-Analysis

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Keywords: Efficiency, Meta-Analysis, Hospital, Eastern Mediterranean Countries

Posted Date: January 13th, 2020

DOI: https://doi.org/10.21203/rs.2.20685/v1

Abstract

Background: Recent rising costs and shortages of healthcare resources make it necessary to address the issue of hospital efficiency. Increasing the efficiency of hospitals can result in better and sustainable achievement of their organizational goals.The purpose of the present research is to examine hospital efficiency in the Eastern Mediterranean Region (EMR).

Methods: This study is a systematic review and meta-analysis of all articles published on hospital efficiency in Eastern Mediterranean countries between January 1999 and May 2018, identified by searching three databases (PubMed through MEDLINE, Web of Science, and Embase) and two search engines (Google and Google Scholar). The reference lists of these articles were checked for additional relevant studies. Fifty articles were finally selected, and data was analyzed through the Comprehensive Meta-Analysis Software (v.2.2.064).

Results: Using the random-effects model, the mean hospital efficiency in Eastern Mediterranean hospitals was 0.829 ± 0.026 at 95% CI. Three approaches were used to measure hospital efficiency: data envelope analysis (DEA), stochastic frontier analysis (SFA), and Pabón Lasso Analysis. Different mean and standard deviation values were obtained from DEA (0.428±0.024), DEA and Pabón Lasso Analysis (0.925±0.029), Pabón Lasso Analysis (0.790±0.086) and SFA (0.594±0.056), due to the different inputs and outputs used in these methods. Technical efficiency (TE) was higher in some countries such as Iraq (0.976±0.035), Oman (0.926 ± 0.032), Jordan (0.924±0.060) and Saudi Arabia (0.917±0.023).

Conclusion: Efficiency plays a significant role in hospital growth and development. It is therefore important for healthcare managers and policymakers in the EMR to identify the causes of inefficiency, to improve TE and develop cost-effective strategies.

Background

Health systems today represent one of the largest sectors in global economy, making economic analysis essential for health policymakers. Global spending on healthcare accounts for about 8% of world gross domestic product (GDP) [1]. Countries in the Eastern Mediterranean Region (EMR) spent US$ 92 billion on health in 2008, 34% of which were spent by the Region's five high-income countries such as Saudi Arabia, United Arab Emirates, Kuwait, Bahrain, Qatar that only account for 6.6% of the Region's population [2].

Hospital costs account for 50 to 80% of total healthcare expenditure [3]. A 2009 study conducted by the World Health Organization (WHO) showed that hospital performance is poor in the EMR due to weak management, lack of incentives, reward systems, and comprehensive appraisal systems, low bed occupancy rates (BOR), long average lengths of stay (ALS), and a high incidence of hospital-associated infections [4]. Meanwhile, hospitals' financial resources are affected by rising healthcare costs. Some strategies for the optimal use of healthcare resources include increasing the efficiency of healthcare resource use, improving resource allocation, optimimizing cost management, and making health a priority in the public budget [5].

Efficiency is defined as the ratio of outputs to inputs: ratios greater than one indicate high levels of efficiency. Efficiency aims at minimizing the cost of achieving a specific benefit. TE and allocative efficiency are the two types of efficiency commonly used in economics. Allocative efficiency is allocating resources in a way that provides the optimal mix and amount of goods and services to maximize the benefits to society, while TE is using the least amount of resources or the right combination of inputs to produce a given amount of goods and services [6].

Various methods such as data envelopment analysis (DEA), stochastic frontier analysis (SFA), and performance indicators have been used to measure hospital efficiency [7]. As a non-parametric approach, DEA measures technical efficiency (TE) in the economic sector, based on the input (minimizing input) and output (maximizing output for a given input) values [8]. DEA can be used to calculate the Malmquist productivity index in organizational performance analysis. The Malmquist index measures the change in productivity of a DMU between two time periods [9]. Several studies have used DEA to measure hospital efficiency in the EMR [10-11].

In a stochastic frontier analysis (SFA), efficiency is measured based on the difference between the predicted and the observed performance of the organization [12]. As with DEA, several studies have examined hospital efficiency in the EMR using SFA [13, 14]. Hospital efficiency can also be measured using performance indicators. Pabón Lasso (1986) introduced a model for measuring relative hospital performance using three indicators: BOR, bed turnover rate (BTR), and ALS [15]. Some studies have used this approach to examine hospital efficiency in the EMR [16-17].

A study of BOR and ALS in EMR shows that hospital resources are not used efficiently compared to developed countries [4]. Increasing hospital efficiency can lead to lower costs, improved quality, higher patient satisfaction, and higher employee motivation, which in turn leads to hospital growth and development [6].

In recent years, various studies have been conducted on hospital efficiency in the EMR, with varying results [10, 13, 16]. However, there are no systematic reviews of hospital efficiency in this region. It is essential to review and integrate the results of published studies to help hospital managers and policymakers make evidence-based decisions. The purpose of the present study is to fill the gap through a systematic review and meta-analysis of hospital efficiency in the EMR.

Methods

The present research is a systematic review and meta-analysis conducted in 2018. It followed the preferred reporting items for systematic review and meta-analysis (PRISMA) guidelines [18]. This meta-analysis was independently carried out by searching international databases (PubMed through MEDLINE, Web of Science, and Embase) and search engines (Google and Google Scholar) for literature published between January 1999 and May 2018. Search terms included efficiency, productivity, inefficiency, organizational efficiency, Pabón Lasso, Stochastic Frontier Analysis, Data Envelopment Analysis, and hospital, in Eastern Mediterranean countries, including Afghanistan, Bahrain, Djibouti, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Pakistan, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, United Arab Emirates, Yemen and Palestine.

Studies had to meet all five of the following criteria for inclusion: 1- included mean technical efficiency (TE) or the data needed to calculate it; 2- the unit of analysis was the hospital; 3- the data needed for analysis were available (by access to the full text of the publication or by request from authors); 4- hospitals studied were located within the the EMR; 5- the study was published in English. Moreover, exclusion criteria included articles in any language other than English, articles published before 1999 and after May 2018, incomplete texts, redundant studies, and dissertations (lack of access).

Data were collected using a data extraction form that was designed based on the objectives of the study. This form included entries on the author, publication year, country, research purpose, sample size, data collection method, number of hospitals examined, efficiency indicators, factors affecting efficiency, and mean and standard deviation of hospitals' TE.

The initial search resulted in 1466 articles. After excluding duplicates and irrelevant articles, 1071 studies were selected for abstract examination. 1007 articles were removed after reviewing their abstracts. 14 were removed after examining the full texts. Finally, 50 articles were found eligible for inclusion in this systematic review and meta-analysis. The reference lists of these 50 articles were manually searched, but no additional studies were included.

The quality of the 50 included articles was assessed independently by two authors using the 15-point instrument of Mitton et al. [19]. Each item was given a score of 0 (not present or reported), 1 (present but low quality), 2 (present and mid-range quality), or 3 (present and high quality). Criteria for quality assessment included: literature review and identification of research gaps; research questions, hypotheses and design; population and sampling; data collection process and instruments; and analysis and reporting of results. Disagreements were resolved through discussion or by consulting a third reviewer if necessary. Only studies considered of moderate and high quality were finally included in this review and meta-analysis.

Data were analyzed using the Comprehensive Meta-Analysis Software (v.2.2.064). Cochran's Q test and the I^2 index were used to test for study heterogeneity. The I^2 index was 99.4%, indicating the heterogeneity of the studies (I^2 values below 25%, between 25-75%, and above 75% indicate low, medium, and high heterogeneity respectively). Therefore, a random-effects model was used in the meta-analysis. Publication bias was examined using Egger's test and a p-value of 0.90 was obtained, indicating that publication bias was not statistically significant (Figure 2).

Covariates between variables were examined using the meta-regression function. Point estimates of medical error were calculated in forest plots at the 95% confidence interval, where the size of the box indicates the weight of each study and the lines on its sides represent the 95% CI.

One of the limitations of this study was that not all studies had reported TE as mean and standard deviation. Therefore, we tried to calculate and analyze mean and standard deviation values for other studies with the information available in each article using the SPSS software.

Results

Over half of the studies had been published after 2010, with most having been conducted in 2014, 2016, and 2017 (Figure 3). Studies were only conducted in 11 of the 22 EMR countries. In total, the included studies examined 1767 hospitals, the overwhelming majority of which are located in Iran (n = 651), Saudi Arabia (n = 553), and Tunisia (n = 266).

Data envelopment analysis (46 percent), Pabón Lasso Analysis (18 percent) and stochastic frontier analysis (14 percent) were the most commonly used methods used for measuring hospital efficiency (Table 1).

Table 1. Frequency and percentage of methods used to measure hospital efficiency in EMR countries

(%) Percentage	Frequency	Method
46	23	DEA
18	9	Pabón Lasso
14	7	Frontier Analysis
8	4	DEA and Pabón Lasso
2	1	Malmquist Index
12	6	(Other Method (Lean, Use indicators, Cobb-Douglas production function
100	50	Total

Measuring efficiency requires a set of input and output variables. Table 2 provides a list of input and output variables that have been used in the reviewed studies.

Table 2. Input and output variables used to measure hospital efficiency in Eastern Mediterranean countries

Variable	Indicators	Frequency (Percentage)
Input	Number of employees (including full-time and part-time physicians, full-time and part-time nurses, midwives, non-medical staff, and dentists)	41 (73.21%)
	Number of active beds	42 (75%)
	Total costs	3 (5.36%)
	Hospital size	2 (3.75%)
	Medical equipment, technological capacity, and budget	1 for each indicator (1.79%)
Output	Number of outpatient visits	30 (53.57%)
	Number of inpatient admissions and number of inpatient days	21 (37.5%)
	Number of inpatients	8 (14.19%)
	Number of emergency visits	7 (12.5%)
	Number of surgeries and ratio of large surgeries to total surgeries	18 (32.14%)
	Total number of medical interventions	3 (5.36%)
	Bed occupancy rate	28 (48.21%)
	Bed turnover rate	18 (32.14%)
	Average length of stay	27 (48.21%)
	Employee costs	3 (5.36%)
	Number of imaging tests	4 (7.14%)
	Number of laboratory tests	3 (5.36%)
	Number of ambulances	2 (3.57%)
	Hoteling costs	1 (1.79%)
	bed-day costs	1 (1.79%)
	per capita costs	1 (1.79%)
	survival rate	1 (1.79%)
	number of discharged patients	1 (1.79%)

The mean and standard deviation of TE in Eastern Mediterranean hospitals is 0.829 ± 0.026 at the 95% significance level (Figure 4).

According to the random-effects model, TE was higher in some countries, such as Iraq (0.976±0.035), Oman (0.926 ± 0.032), Jordan (0.924±0.060) and Saudi Arabia (0.917±0.023). Moreover, different means and standard deviations were obtained using DEA (0.428±0.024), DEA and Pabón Lasso Analysis (0.925±0.029), Pabón Lasso Analysis (0.790±0.086), Malmquist productivity index (0.992±0.037), and SFA (0.594±0.056) (Table 3). Studies examining fewer hospitals for estimations reported higher efficiency scores compared to studies using more hospitals. Studies published from 2010 onwards reported, on average, lower efficiency scores compared to studies published before this year.

Table 3. Subgroup analysis of efficiency scores by country and method of analysis

Variable		Number of studies	Mean and standard error	95% CI	I^2	P-value
Countires	Iraq	1	0.976±0.035	0.907-1.04	0.000	0.000
	Afghanstan	1	0.883±0.016	0.851-0.915	0.000	0.000
	Iran	32	0.842 ±0.016	0.810-0.875	96.07	0.000
	Jordan	4	0.846±0.076	0.696-0.995	94.61	0.000
	Oman	1	0.926±0.032	0.862-0.990	0.000	0.000
	Pakistan	1	0.786±0.046	0.696-0.876	0.000	0.000
	Palestine	1	0.550±0.032	0.486-0.614	0.000	0.000
	Saudi Arabia	4	0.917±0.023	0.871-0.963	90.24	0.000
	Tunisia	4	0.809±0.11	0.575-1.04	99.16	0.000
	United Arab Emirates	1	0.638±0.021	0.597-679	0.000	0.000
Method	DEA	23	0.871±0.014	0.844-0.899	95.84	0.000
	Cobb-Douglas	1	0.428±0.024	0.381-0.475	0.000	0.000
	DEA and Luenberger productivity indicator	1	0.976±0.035	0.907-1.04	0.000	0.000
	DEA and Pabón Lasso	4	0.925±0.029	0.868-0.981	69.79	0.000
	DEA and the bootstrap approach	1	0.924±0.033	0.859-0.989	0.000	0.000
	DEA and Tobit regression	1	0.883±0.016	0.851-0.915	0.000	0.000
	Performance Indicators	1	0.680±0.025	0.631-0.729	0.000	0.000
	Lean	1	0.790±0.069	0.654-0.926	0.000	0.000
	Malmquist index	1	0.992±0.037	0.920-1.06	0.000	0.000
	Pabón Lasso	9	0.790±0.086	0.622-0.959	99.41	0.000
	Stochastic frontier analysis	7	0.757±0.078	0.603-0.910	97.23	0.000
Number of hospitals	≤30	38	0.867±0.012	0.844-0.890	92.99	0.000
	>30	12	0.786±0.067	0.655-0.917	99.77	0.000
Publication	≤2010	8	0.857±0.030	0.799-	89.56	0.000

year				0.915		
	>2010	42	0.826±0.033	0.763-0.890	99.52	0.000

The results of the heterogeneity test indicate a high level of heterogeneity between the studies (Q = 9654.049; P = 0.0001). Therefore, potential sources of heterogeneity were examined using the meta-regression function. The results are displayed in Table 4, indicating that the year of publication has caused heterogeneity between the reviewed studies.

Table 4. The results of the heterogeneity test (meta-regression model)

Suspicious Variables	Coefficient	SE	P-Value
Publication Year	-0.002	0.0005	0.0001
Sample Size	-0.00001	0.0032	0.81

Figure 5 shows that the correlation between the publication year and the mean TE of the hospitals was statistically significant ($p < 0.05$). On the otherhand, hospital efficiency decreases by 0.002% as the publication date increases by one year.

Discussion

Several systematic reviews have been conducted on hospital efficiency worldwide [20-21]. For example, a 2018 study reviewed 57 articles using DEA [20] and a 2014 study reviewed 23 articles using DEA, SFA, and balanced scorecard [21]. To our knowledge, this is the first attempt to measure hospital efficiency using meta-analysis in Eastern Mediterranean countries. There was a growing trend in recent years to measure the efficiency of hospitals using different methods. In this study, we reviewed studies that measured the TE of hospitals in EMR countries. Fifty articles which calculated hospital efficiency were eligible for inclusion in the meta-analysis.

It must be noted that the vast majority of studies on hospital efficiency were conducted in Iran. This may partly be due to the Iranian Ministry of Health and Medical Education’s attempt at reducing hospital costs. In addition, efficiency and strategies for improving it have become a key priority for the Iranian government.

A mean TE of 0.829 ± 0.026 was obtained for Eastern Mediterranean countries. This finding is consistent with the results of previous studies in other countries [6, 22- 23]. In the study conducted by Du (2017) on Chinese hospitals, a mean efficiency of 0.74, 0.902, and 0.805 was obtained for hospitals in the Central, Eastern, and Western regions of the country respectively [22]. Blatnik et al. (2017) examined hospital efficiency in Slovenia and reported a mean TE of 0.936 [23]. In general, hospital efficiency varies by country.

Mean hospital efficiency varied in high-income countries such as Saudi Arabia, Oman, the United Arab Emirates, and Bahrain. For example, Oman and Saudi Arabia had the highest mean hospital efficiency rates and the United Arab Emirates had the highest mean TE. According to the 2017 WHO report on “Eastern Mediterranean Region Framework for health information systems and core indicators for monitoring health situation and health system performance” Bahrain and Oman had the highest general government expenditure on health as percentage of general government expenditure (10.5% and 6.8% respectively) among the four countries [24]. In addition, mean hospital efficiency varied in low- and middle-income countries such as Pakistan, Afghanistan, Iran, Jordan, Tunisia, Palestine, and Iraq. For example, among these countries, Iraq and Jordan had the highest mean TE and Pakistan had the lowest mean TE. The 2017 WHO report showed that among these four countries, Iran had the highest and Pakistan the lowest general government expenditure on health as percentage of general government expenditure (17.5% and 4.7% respectively) [24]. Therefore, hospital managers and policymakers must focus on improving efficiency and reducing healthcare costs in regions that have lower rates of hospital efficiency.

The development of outpatient care, the strengthening of hospital management, and modeling based on efficient hospitals are recommended as effective strategies to increase hospital efficiency. In addition, hospitals can serve as productive business entities through health system structure reform at the macro level, proper implementation of healthcare stratification, and responsiveness of insurance companies. This allows hospitals to increase patient satisfaction and provide safe, high-quality care.

Although there are many studies on hospital efficiency in the EMR, their results have been highly heterogeneous. One reason for the observed inconsistencies may be the different methods used to measure hospital efficiency, leading to different results.

Most studies on hospital efficiency have employed DEA, Pabón Lasso Analysis and SFA. Here, about 46% of the reviewed studies used the DEA approach. This is in line with previous international findings [25-26]. For example, Rasool et al. (2014) investigated hospital efficiency in Pakistan and obtained a mean hospital efficiency of 0.703 using DEA [25]. Also, about 14% of the articles had used SFA to measure hospital efficiency. For example, Goudarzi et al. (2014) estimated a mean hospital efficiency of 0.684 in Iranian hospitals using the SFA approach [26]. In addition, about 18% of the studies employed Pabón Lasso Analysis. For example, Younsi (2014) used this approach in his study on 40 Tunisian hospitals and reported that 27.5% had a high level of efficiency (high BOR and high BTR) [16]. In the present review, mean TE values obtained through DEA, DEA plus Pabón Lasso Analysis, Pabón Lasso Analysis, and SFA were 0.947, 0.960, 0.860, and 0.713 respectively. Therefore, based on the approach used to measure hospital efficiency, the calculation can yield different results. However, differences in measurement may not only be due due to differences in methodology. Indeed, methodology can affect results, and inputs and outputs can as well. As an example, a study in Iran showed that DEA was the dominant method of measurement of efficiency Iranian hospitals. The results of this articles demonstrated that the ability to handle multiple inputs and outputs in different units of measurement was the main explanation for using DEA as the dominant method of measurement [27].

The measurement of hospital efficiency is done through a set of input and output variables. The present findings show that the most commonly used input variables used in studies on hospital efficiency in the EMR are the number of employees and the number of beds, while the most commonly used output variables are the number of inpatient admissions, the number of inpatient days, BOR, BTR, and ALS. For example, in a study on hospital efficiency in Oman, Ramanathan (2005) used out-patient visits, in-patient services, and surgical operations as outputs, and the number of beds and manpower as inputs [10]. In addition, some studies have used other inputs such as work hours, non-labor costs (i.e. equipment, food, drugs), and the area of the hospital in cubic meters [28-29], and outputs such as mortality rate, number of nursing students, number of medical students, number of nursing and medical training weeks, and number of scientific publications [30-31]. Researchers must use more input and output variables when measuring hospital efficiency to increase the accuracy of their findings.

In some countries, mean efficiency has increased significantly in recent years. For example, Helal et al. (2017) showed a significant improvement in the average efficiency of Saudi hospitals in 2014 compared to 2006, with hospital efficiency reaching 92.3% in 2014 [32].

The present review showed that, on average, small hospitals [33] and government and teaching hospitals [34] did not have a desirable level of efficiency. For example, Chaabouni and Abednnadher (2016) examined Tunisian public hospitals and showed that cost-effectiveness decreases with hospital size. They found that mean cost-effectiveness was 0.995 in large hospitals compared to 0.875 in small hospitals [33]. In a study on Iranian hospitals, Ketabi (2011) showed that CCUs in 83.3% of teaching hospitals and 60% of private hospitals perform inefficiently. This was attributed to the excess of medical equipment as well as personnel and technological capabilities. Teaching hospitals were less efficient because of bureaucratic processes and private hospitals had lower BORs [35]. There is a larger demand for care in public hospitals than private hospitals, and thus public hospital managers in particular must make optimal use of their resources [36].

The finding of the meta-regression showed that there were significant differences in measurement efficiency scores among different methods. This finding was in line with previous studies [36]. As an example, Kontodimopoulos et al. [37] showed lower efficiency scores for DEA compared with SFA, while Gannon [7] reported the opposite.

The present review showed that hospital efficiency decreases by 0.002% as the publication date increases by one year. In other words, the time sequence of studies on hospital efficiency indicates lower levels of efficiency in recent years compared to previous years.

The results of this article should, however, be cautiously interpreted. Hospital efficiency has only been studied in a limited number of Eastern Mediterranean countries. This gap in the literature indicates that the reviewed studies are not comprehensive in terms of coverage and methodology. Other variables, such as ownership or type of hospital, that can impact the measurement of hospital efficiency, but a small sample size restricts control of this variable.

Conclusion

In recent years, the number of studies on efficieny have significantly increased, likely due to the increase in interest on the subject due to resource scarcity. To enable effective and efficient hospital management and improvement in hospital efficiency, health managers and policymakers must identify the causes of hospital inefficiency. An effective way of increasing hospital efficiency is by using evidence-based interventions. Therefore, health policymakers in Eastern Mediterranean countries must first identify the causes of hospital inefficiency and take necessary remedial actions to facilitate the optimal use of scarce resources.

Abbreviations

Eastern Mediterranean Region (EMR), bed occupancy rate (BOR), bed turnover rate (BTR), average length of stay (ALS), high-income countries (HICs), Data Envelopment Analysis (DEA), Stochastic Frontier Analysis (SFA), World Health Organization (WHO), low- and middle-income countries (LMICs), Ministry of Health (MoH), Full Time Employee (FTE).

Declarations

Ethics approval and consent to participate: Not applicable.

Consent for publication: Not applicable.

Availability of data and material: Not applicable.

Competing interests: The authors declare that they have **no competing interests.**

Funding: This study has reveived no funding.

Authors' contributions: MA and HR designed the research; MA, AMA and PI conducted it; MA and PI extracted the data; and MA, HR, VDB, AMA and PI wrote the paper. MA had primary responsibility for final content. All authors read and approved the final manuscript.

Acknowledgements: Not applicable.

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DOI:10.1186/1478-7547-5-14

Figures

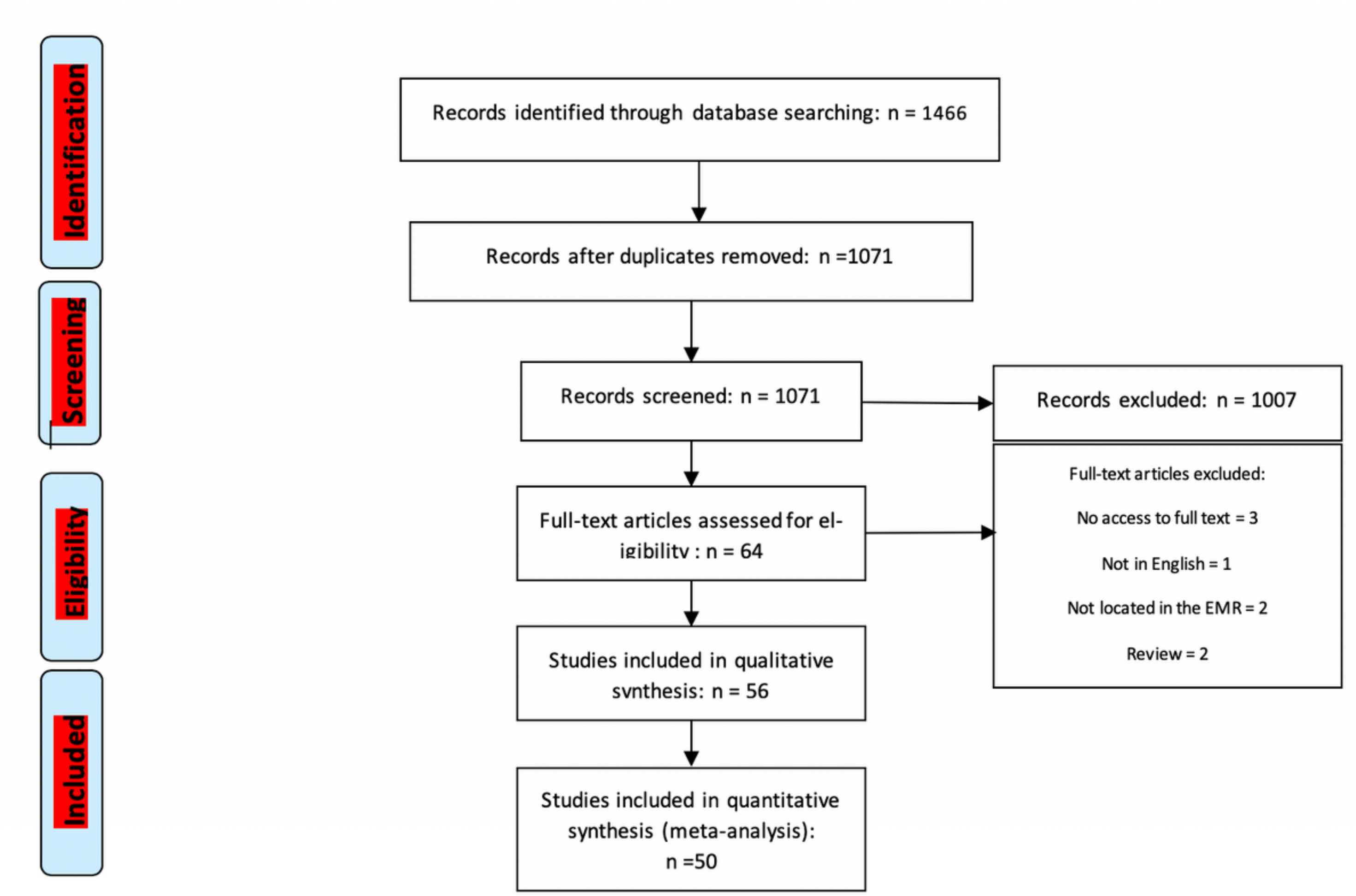

Figure 1

PRISMA flow diagram depicting the study selection process

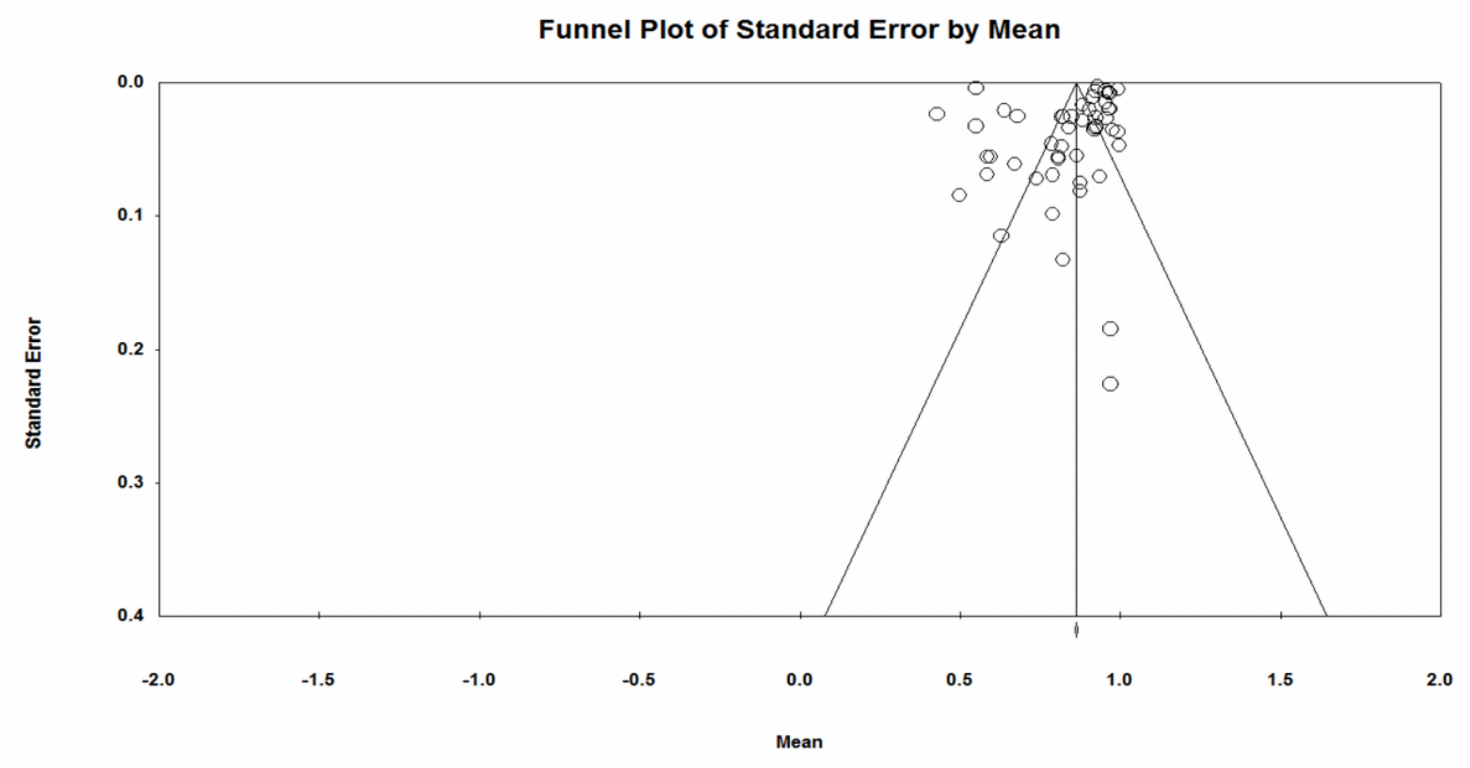

Figure 2

Publication bias in Egger's test

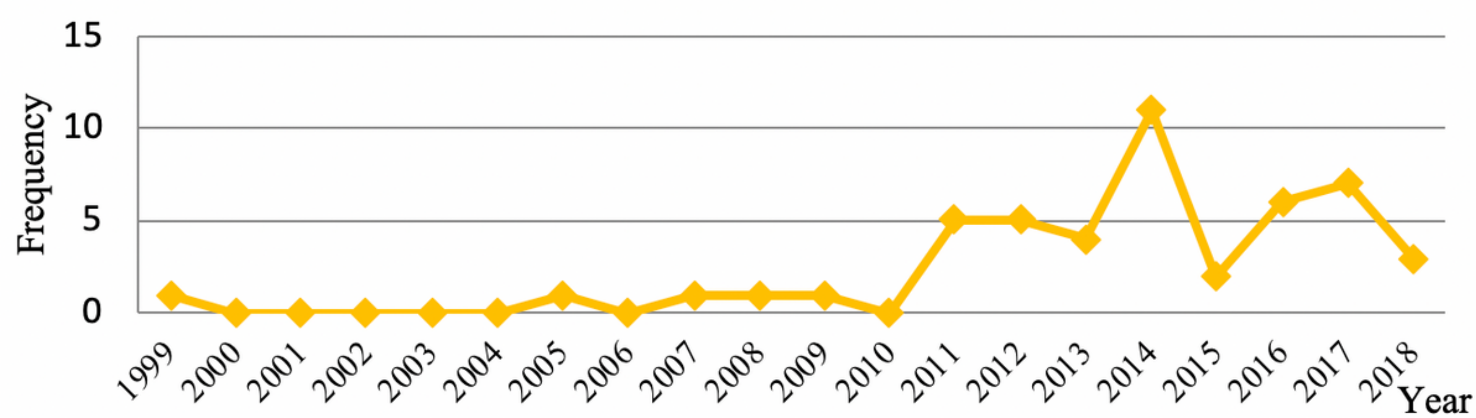

Figure 3

Distribution of hospital efficiency studies by publication year

Study name	Subgroup within study	Mean	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
yusesfzadeh, 2013	Iran	0.584	0.055	0.003	0.475	0.693	10.529	0.000
Torabipour,2014	Iran	0.996	0.047	0.002	0.904	1.088	21.298	0.000
syed aziz rasool, 2014	Pakistan	0.786	0.046	0.002	0.696	0.876	17.180	0.000
younsi, 2014	Tunisia	0.550	0.004	0.000	0.543	0.557	144.938	0.000
shetabi, 2015	Iran	0.876	0.075	0.006	0.729	1.023	11.647	0.000
shahhoseini, 2011	Iran	0.970	0.185	0.034	0.608	1.332	5.250	0.000
ramanathan, 2005	oman	0.926	0.032	0.001	0.862	0.990	28.560	0.000
pourmohammadi, 2014	Iran	0.428	0.024	0.001	0.381	0.475	18.021	0.000
osmani, 2012	Afghanistan	0.883	0.016	0.000	0.851	0.915	53.540	0.000
mehrtak, 2014	Iran	0.807	0.057	0.003	0.695	0.919	14.148	0.000
mahate, 2016	united arab emirates	0.638	0.021	0.000	0.597	0.679	30.794	0.000
lotfi, 2014	Iran	0.924	0.026	0.001	0.873	0.975	35.200	0.000
ketabi, 2011	Iran	0.967	0.019	0.000	0.929	1.005	49.866	0.000
kalhor, 2014	Iran	0.956	0.027	0.001	0.904	1.008	36.026	0.000
kalhor, 2016	Iran	0.819	0.026	0.001	0.769	0.869	32.013	0.000
kakeman, 2016	Iran	0.821	0.026	0.001	0.771	0.871	32.091	0.000
jandaghi, 2010	Iran	0.970	0.226	0.051	0.527	1.413	4.287	0.000
hatam, 2008	Iran	0.966	0.020	0.000	0.928	1.004	49.378	0.000
hatam, 2010	Iran	0.930	0.003	0.000	0.924	0.936	327.830	0.000
hajialiafzali, 2007	Iran	0.904	0.020	0.000	0.865	0.943	45.077	0.000
Goudarzi, 2014	Iran	0.594	0.056	0.003	0.485	0.703	10.662	0.000
Goshtasebi, 2009	Iran	0.876	0.081	0.007	0.717	1.035	10.783	0.000
Gholipourm 2013	Iran	0.821	0.133	0.018	0.560	1.082	6.176	0.000
Farzianpour, 2017	Iran	0.818	0.047	0.002	0.725	0.911	17.225	0.000
sultan, 2017	Jordan	0.839	0.034	0.001	0.773	0.905	24.912	0.000
mousa,2017	Saudi Arabia	0.964	0.007	0.000	0.950	0.978	133.110	0.000
AlyHelal,2017	Saudi Arabia	0.923	0.006	0.000	0.911	0.935	151.664	0.000
Arfa,2017	Tunisia	0.848	0.025	0.001	0.798	0.898	33.421	0.000
AL-Shayea,2011	Saudi Arabia	0.629	0.115	0.013	0.404	0.854	5.485	0.000
al-shammari,1999	Bahrain	0.584	0.069	0.005	0.449	0.719	8.503	0.000
migdadi,2018	Jordan	0.993	0.005	0.000	0.983	1.003	202.414	0.000
askari,2014	Iran	0.955	0.014	0.000	0.927	0.983	66.217	0.000
Kassam,2017	Iraq	0.976	0.035	0.001	0.907	1.045	27.713	0.000
ajlouni,2013	Jordan	0.936	0.070	0.005	0.798	1.074	13.328	0.000
barati,2012	Iran	0.967	0.008	0.000	0.951	0.983	118.912	0.000
Chaabouni,2012	Tunisia	0.924	0.033	0.001	0.859	0.989	27.828	0.000
Sajadi, 2016	Iran	0.680	0.025	0.001	0.631	0.729	27.157	0.000
Hassanain,2016	Saudi Arabia	0.790	0.069	0.005	0.654	0.926	11.403	0.000
nabilo,2016	Iran	0.992	0.037	0.001	0.920	1.064	27.087	0.000
Adham, 2014	Iran	0.914	0.011	0.000	0.893	0.935	85.497	0.000
bahadori,2011	Iran	0.883	0.028	0.001	0.827	0.939	31.138	0.000
Imamgholi,2014	Iran	0.499	0.084	0.007	0.334	0.664	5.920	0.000
moradi,2017	Iran	0.865	0.055	0.003	0.758	0.972	15.850	0.000
rezaee,2018	Iran	0.738	0.072	0.005	0.597	0.879	10.282	0.000
hamidi,2016	palestine	0.550	0.032	0.001	0.486	0.614	16.972	0.000
goudarzi,2014	Iran	0.956	0.006	0.000	0.944	0.968	157.699	0.000
rezaei,2016	Iran	0.670	0.061	0.004	0.550	0.790	10.948	0.000
chaabouni,2015	Tunisia	0.920	0.035	0.001	0.852	0.988	26.448	0.000
sheikhzadeh,2012	Iran	0.790	0.098	0.010	0.597	0.983	8.029	0.000
kiadaliri,2011	Iran	0.807	0.056	0.003	0.698	0.916	14.536	0.000
		0.829	0.026	0.001	0.778	0.880	31.764	0.000

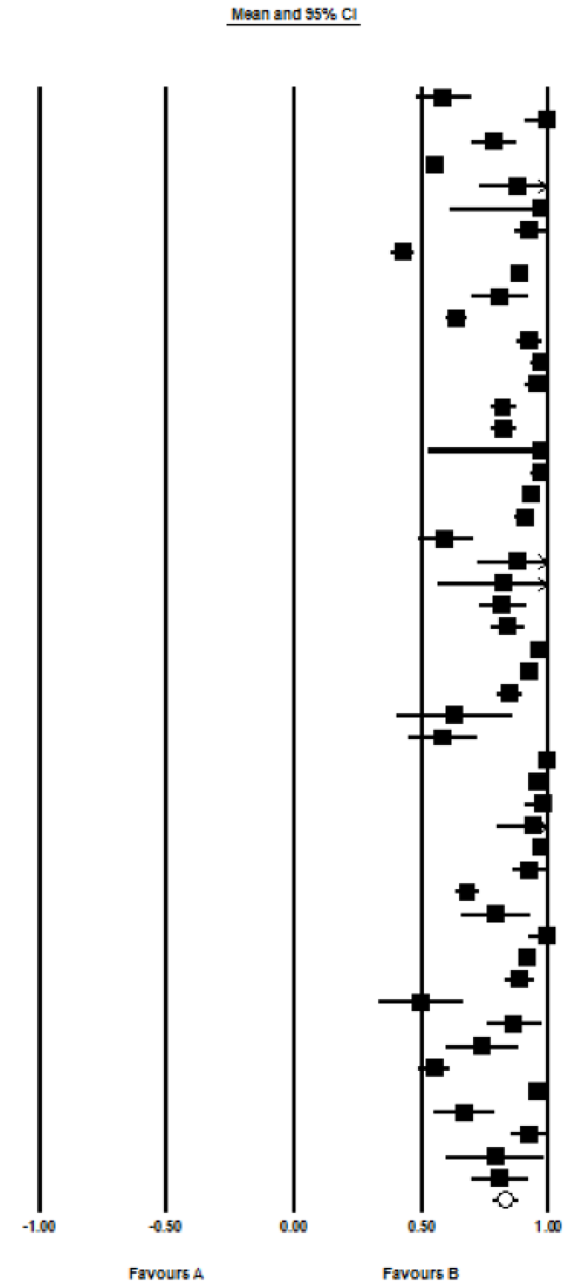

Figure 4

Mean and standard deviation of hospital efficiency in included studies based on the random-effects model.

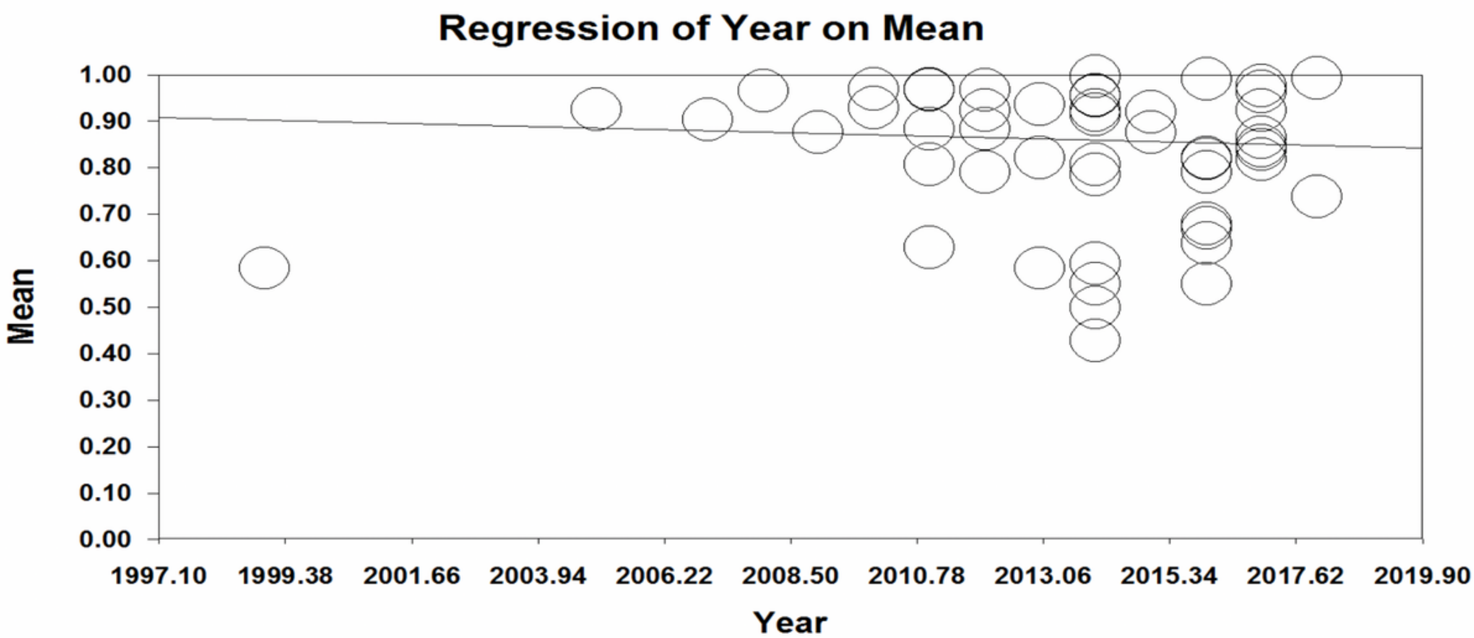

Figure 5

Meta-regression of the mean technical efficiency of Eastern Mediterranean hospitals by year.