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Measuring the Efficiency of Public Hospitals in Kuwait: A Two-Stage Data Envelopment Analysis and a Qualitative Survey Study

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Abstract

The recent drop in oil prices has challenged public sector financing in Kuwait. Technical and scale efficiency scores for fifteen public hospitals in Kuwait from 2010 to 2014 were estimated using a two-stage data envelopment analysis (DEA). Technical efficiency scores were regressed against institutional characteristics using Tobit regression to investigate the determinants of efficiency differences in hospitals. Semi-structured interviews were also carried out with fourteen public and private hospital managers to qualitatively explore their perceptions and experience about about factors affecting hospital efficiency.

The mean technical efficiency score for all hospitals was 85.8%, an improvement of 2% since 2010. The mean pure technical efficiency score was 79.6%, improving from 75% in 2010 to 81.2% in 2014. The mean scale efficiency score was 91.8%, improving from 87.6% in 2010 to 94.2% in 2014. Only three hospitals were constantly technically and scale efficient. Tobit regression showed that hospital efficiency was significantly associated with the average length of patient stay. Hospitals with more than 400 beds were potentially more technically and scale efficient. The qualitative study revealed that external factors affecting efficiency commonly included implemention of legislative changes and decreasing bureaucracy, while internal factors included increasing bed capacity and improving qualifications and training of human resources.

Most public hospitals in Kuwait were not technically and scale efficient, but improvements were observed. Potential factors that affected the efficiency of hospitals in Kuwait were identified. These findings are useful to decision-makers in Kuwait for developing strategies to improve public hospital efficiency.

Keywords: technical efficiency, scale efficiency, data envelopment analysis, public hospitals, Kuwait

1. Introduction

In 1962, the Constitution of the State of Kuwait was implemented, which included Articles 11 and 15 ensuring health provision (Sabah, 1962). In accordance with the above-mentioned articles, a 'Health for All' policy was adopted by the government to provide access to comprehensive and high-level quality health services by all (Ministry of Health [MOH], 2016).

Currently, the country's economy is experiencing a decline caused by a drop in oil export returns (Fund, 2016), the main source of healthcare financing. In addition, a rapid increase in health expenditure in the country, due to increased demand for services, has made the situation more challenging (MOH, 2016). The increase in healthcare demand has been attributed to multiple factors, including an increase in the total population in the country from about 1.6 million in 1995 to 4.1 million in 2017, as well as an increase in the total life expectancy at birth from 72.7 to 74.8 for the same years (Databank, 2019). Additionally, the increase in demand for advanced services is believed to be the result of the growing health awareness in the population (MOH, 2016).

In response to these challenges, the government of Kuwait issued a six-point economic reform policy document in March 2016 that included 'boosting the public sector's efficiency' and 'launching administrative and institutional reforms by means of upgrading the efficiency of general and financial administration' (Kuwait News Agency [KUNA], 2016).

Providing sustainable health care financing is a challenge for many countries facing increasing demand for healthcare services and cost inflation of these services (Osmani, 2012). Since hospitals consume a large portion of the health care budget and are large health-production facilities that have diverse resource inputs, such as buildings, health and administrative personnel, drugs, and equipment, the focus of health decision-makers is often drawn to the efficiency of these facilities to rationally distribute human and capital resources (Chisholm & Evans, 2010; Osmani, 2012; Oxley & MacFarlan, 1994; Sefiddashti et al., 2016; Zhou, Xu, Antwi, & Wang, 2017). Many researchers have evaluated the technical efficiency of hospitals in Europe (Hollingsworth & Parkin, 1995; Kounetas & Papathanassopoulos, 2013; Lindlbauer, Schreyögg, & Winter, 2016; Magnussen, 1996; Pérez-Romero, Ortega-Díaz, Ocaña-Riola, & Martín-Martín, 2019; Siciliani, 2006; Staat, 2006; Tynkkynen & Vrangbæk , 2018; Xenos, Nektarios, Constantopuolos, & Yfantopuolos, 2016), North America (Brown III & Pagán, 2006; Giménez, Keith, & Prior, 2019; Harrison, Coppola, & Wakefield, 2004; Johnson, & C.Y. Lee, 2016), Asia (Ahmad Kiadaliri, Zarei, & Haghparast-Bidgoli, 2011; Ahmed et al., 2019a; Ahmed et al., 2019b; Chai, Zhang, Zhou, Liu, Kinfu, 2019; Cheng et al., 2015; Cheng et al., 2016; Guven-Uslu & Linh, 2008; Hu, Qi, & Yang, 2012; W.F. Lee & Wang, 2004; Mahate, Hamidi, & Akinci, 2016; Osmani, 2012; Cheng et al., 2015; Guven-Uslu & Linh, 2008; Hu, Qi, & Yang, 2012; W. F. Lee & Wang, 2004; Mahate, Hamidi, & Akinci, 2016; Osmani, 2012), and Africa (Kirigia, Emrouznejad, Sambo, Munguti, & Liambila, 2004; Kirigia et al., 2010; Masiye, 2007; Mujasi, Asbu, & Puig-Junoy, 2016; Top, Konca, & Sapaz, 2019; Zere et al., 2006). A meta-analysis of hospital efficiencies is available for the gulf region (Alatawi, A., Ahmed, S., Niessen, L., & Khan. J., 2019), but relatively few studies are available that specifically measure the efficiency of public health care and the cost associated with its inefficiencies of Kuwait (Burney et al., 1999;).

This study aims to measure the technical and scale efficiencies of secondary and tertiary public hospitals in Kuwait for the period 2010 to 2014, using a data envelopment analysis (DEA) approach. This study also aims to identify the factors affecting the efficiency of hospitals. It is believed that this study will provide decision makers in the Kuwaiti health sector with useful information to develop strategies for improving public hospital efficiency.

2. Methods

2.1 Study Setting

In Kuwait, the share of total health expenditure from gross domestic product (GDP) has increased from 2.5% in 2000 to 3.9% in 2016 and public health expenditure as percentage of total government expenditure increased from 5.2% in 2000 to 6.2% in 2016 (Databank, 2019). But a substantial change was apparent in the increase in the per capita health expenditure, which increased from $462.6 per capita in 2000 to $1,068.3 per capita in 2016. In the fiscal year 2011-2012, total health expenditure was around 1.8 billion Kuwaiti Dinars (KD) (around USD$5.9 billion). In that period, government expenditure on health made up 82% of the total health expenditure, while out-of-pocket was 16% of the total health expenditure in the country (MOH, 2016). More recently, public health expenditure made up 83.9% of total health expenditure in 2016, making the State the biggest healthcare provider in the country (Databank, 2019).

Health services provided by the Ministry of Health (MOH) are divided into three main levels: primary, secondary and tertiary care. In addition to these, the MOH also provides other services such as dental health, occupational medicine, preventative medicine, treatment abroad and services during the Hajj season (MOH, 2016). Figure 1 shows describes MoH spending.

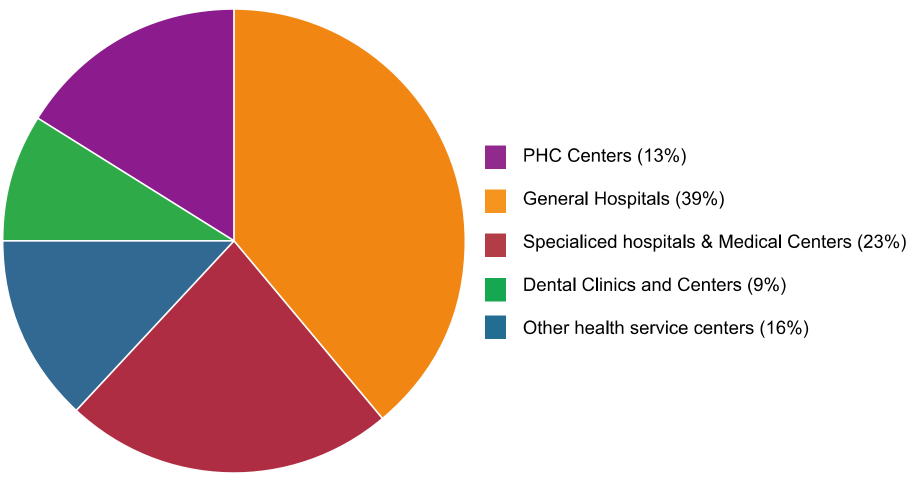

Figure 1. Share of MOH expenditure based on the service provider for the fiscal year 2011-2012 (MOH, 2016)

As shown in Figure 1, more than 60% of MoH resources are consumed by secondary and tertiary healthcare providers. Secondary healthcare providers consist of six general hospitals with outpatient, inpatient and emergency departments. Each of these hospitals provides medical services to the people living in the governorate that these facilities serve.

2.2 Efficiency Concepts

Palmer & Torgerson (1999) explain that efficiency in a health system is associated with the connection between system inputs (proxies of cost such as capital, labour or equipment) and either intermediate outputs (numbers of treated individuals, waiting time, etc.) or final health outcomes (quality adjusted life years (QALYs) or life years gained). In the health system literature, two main types of efficiency are widely mentioned: technical and allocative efficiency. Technical efficiency aims at either maintaining the same level of outputs with less inputs, or more output with the same level of inputs (Bevan, Helderman, & Wilsford, 2010). Whereas allocative efficiency is believed to be achieved by directing health funds towards interventions that would optimize health gains (Kruk & Freedman, 2008).

Farrell (1957) explains that a hospital is technically efficient if it was producing a certain level of outputs with the least inputs, or if it was producing the maximum level of outputs with a certain level of inputs, and this efficiency concept is the base of the current study. Mangusson (1996) argued that evaluating the technical efficiency of hospitals allows the comparison of their real use of inputs and outputs rather than costs and 'profits'. It is believed that hospitals' outputs must be clearly identified in order to measure their efficiency. Potential outputs can be number of outpatient visits, number of surgical interventions, number of patient-days, bed turnover and bed occupancy, among others (Moshiri, Aljunid, & Amin, 2010).

2.3 Data Envelope Analysis (DEA)

DEA is the most frequently used technique for measuring the efficiency of a health system as a whole, or of smaller units within a health system such as hospitals (Gok & Sezen, 2013, O'Neill, Rauner, Heidenberger, & Kraus, 2008, Pelone et al., 2014). It is a non-parametric approach that uses a linear programming technique for analysing the relative efficiencies of individual Decision-Making Units (DMUs) with respect to multiple inputs and outputs (Roh, Jae Moon, & Jung, 2013).

DEA has several benefits, including its capacity to measure technical efficiency (Jacobs, 2001). It is also characterised by its ability to deal with multiple outputs and multiple inputs easily (Hollingsworth, Dawson, & Maniadakis, 1999; Li & Dong, 2015; O'Neill et al., 2008; Rosko, 2001; Wranik, 2012), even if they were heterogeneous (Osmani, 2012). Additionally, it has the advantage of the simplicity underlying this approach in terms of not having prior or complicated standard assumptions as is the case with statistical regression analysis (Alexander, Busch, & Stringer, 2003, Hollingsworth et al., 1999, Osmani, 2012). Additionally, it can provide useful information for developing strategies to eliminate areas of inefficiency (Rosko, 2001).

DEA does also have disadvantages. It cannot take into account socioeconomic and environmental factors when measuring technical efficiency of DMUs (S. Hadad, Y. Hadad, & Simon-Tuval, 2013; Smith & Street, 2005), and can only analyse the efficiency of homogeneous units (Rosko, 2001). Additionally, it is desirable to have a large sample when applying this method because it is sensitive to sample size (Hadad et al., 2013; Masiye, 2007). The inability to differentiate true inefficiency from random variation is another disadvantage of DEA (Hollingsworth & Wildman, 2002; Rosko, 2001; Wranik, 2012). This approach also has sensitivity to high-performing outliers, so the efficiency frontier may change if such outliers were not detected (Allin, Grignon, & Wang., 2015).

Using the CCR model (Charnes, Cooper, & Rhodes, 1978), multiple output and input variables are incorporated to measure technical efficiency of a DMU in relation to other DMUs (Kirigia, Emrouznejad, & Sambo, 2002). The calculated relative hospital efficiency scores fall between 0, completely inefficient, and 1, being completely efficient. There are two programming models to calculate technical efficiency, under the assumption of constant returns to scale (CRS in model 1) and variable returns to scale (VRS in model 2) (Kirigia et al., 2002).

The model used in this study is an input-oriented model, which was developed by Banker and colleagues (Banker, Charnes, & Cooper, 1984), where an inefficient unit is made efficient through the proportional reduction of its inputs while its output proportions are held constant. It is possible, by using this model, to assess whether a hospital is producing on an optimal scale, which is known as scale efficiency (Ahmadkiadaliri, Zarei, & Haghparast-Bidgoli, 2011; Kirigia et al., 2002). This model allows for the division of total technical efficiency (CRS) to pure technical efficiency (VRS) and scale efficiency (Ahmadkiadaliri et al., 2011). According to Coelli (1996) the scale efficiency score is equal to the CRS technical efficiency (TE) score divided by the VRS technical efficiency (TE) score. The degree to which a hospital is producing at an optimal scale is, on the other hand, known as scale efficiency (Ahmadkiadaliri et al., 2011). Technical efficiency that is not attributable to departures from optimal scale and is related to operation is known as pure technical efficiency or managerial efficiency (Ahmadkiadaliri et al., 2011). It is believed that hospital managers have more control in altering the level of inputs rather than outputs, and this is one of the justifications for choosing the input-oriented model (Ahmadkiadaliri et al., 2011; Ketabi, 2011).

Model 1. DEA weights model, input-oriented, CRS	**Model 2.** DEA weights model, input-oriented, VRS
$\text{Eff} = \underset{u_r, v_i}{\text{Max}} \sum_r u_r y_{r j_0}$ *s.t.* $\sum_r u_r y_{rj} - \sum_i v_i x_{ij} \leq 0; \quad \forall j$ $\sum_i v_i x_{i j_0} = 1$ $u_r, v_i \geq 0; \quad \forall r, \forall i.$	$\text{Eff} = \underset{u_r, v_i}{\text{Max}} \sum_r u_r y_{r j_0} + u_0$ *s.t.* $\sum_r u_r y_{rj} - \sum_i v_i x_{ij} + u_0 \leq 0; \quad \forall j$ $\sum_i v_i x_{i j_0} = 1$ $u_r, v_i \geq 0; \quad \forall r, \forall i.$

Where (Kirigia et al., 2002)

Yrj = the amount of output *r* produced by hospital *j*,

xij = the amount of input *i* used by hospital *j*,

ur = the weight given to output *r*, (*r* = 1 ,..., *t* and *t* is the number of outputs)

v_i = the weight given to output *i*, (*i* = 1 ,..., *m* and *m* is the number of outputs)

n = the number of hospitals,

j0 = the hospital under assessment

2.4 Two-stage DEA Analysis

In order to identify the potential factors affecting the technical efficiency of the hospitals, a second stage was added to this study. In this second stage, a regression analysis was performed, in which hospital efficiency scores from the first stage were used as dependent variables and a number of institutional factors were used as independent variables. Independent variables were selected on the basis of literature review, the context of the study and availability of data. The efficiency scores calculated in the first stage were regressed against these variables using Tobit regression analysis. This analysis model, known as censor regression, is widely used in two-stage DEA since the scores have only a positive probability of attaining one of the two corner values (between 0 and 1), and is believed to be sufficient in regressing efficiency cores against exogenous variables (Hoff, 2007). Both stages of the DEA analyses were conducted using Stata version 14 (StataCorp, College Station, Texas 77845 USA).

2.5 Data and Variables

The data for this study was obtained from the 'Health, Kuwait' annual report published by the MOH's Department of Statistics. The analysis will include data from 2010 to 2014 relating to a total of fifteen hospitals; six general hospitals at the secondary level and nine specialized hospitals at the tertiary level. The Center for Palliative Care and the Urology Center were not included in the analysis due to a lack of data for the study period. Additionally, some specialized centers were excluded from the sample because they only provide outpatient services and were therefore not comparable DMUs.

Based on the use of similar variables in other studies (Akazili, Adjuik, Jehu-Appiah, & Zere, 2008; Guven-Uslu & Linh, 2008; W.F. Lee & Wang, 2004; O'Neill et al., 2008; Worthington, 2004; Zere et al., 2006) and the availability of local data, four input- and two output-variables were selected for the first stage DEA. Input variables included the number of beds (which is usually used as a proxy for capital inputs in hospital efficiency studies (Kounetas & Papathanassopoulos, 2013; Worthington, 2004)) and three human resources inputs including total number of doctors, nurses, and non- medical workers. Output variables were total outpatient visits and total number of discharges (a proxy for admissions).

Hospital size (i.e. total number of beds), bed occupancy rate, average length of stay and hospital type (general or specialised) were the independent variables used in the second stage of the analysis. The institutional variables were chosen based on the data availability and the evidence from the previous studies (Cheng et al., 2015; Kounetas & Papathanassopoulos, 2013; K.S. Lee, Chun, & J.S. Lee, 2008; W.F. Lee & Wang, 2004; Osmani, 2012).

2.6 Semi-Structured Interviews

To better understand potential factors affecting hospital efficiency in Kuwait, qualitative semi- structured interviews were conducted with 14 hospital managers from the public and private sectors. Participants received information sheets that explained the objectives of the study, and provided written informed consent to participate. They were asked open-ended questions about the meaning of hospital efficiency; factors they believe would affect hospital efficiency; and the steps they would take to improve the efficiency of their hospitals. The data were analysed using thematic analysis to identify overall themes and patterns.

3. Results

3.1 Descriptive Results

Table 1 provides a summary statistics of input and output variables of secondary and tertiary level hospitals in Kuwait for the years 2010 to 2014. On average, number of beds, doctors, nurses, non- medical workers, outpatient clinics visits, and number of discharges for the whole period of the study and for all hospitals were 444, 307, 853, 603, 182,057, and 14,534 respectively.

Table 1. Descriptive statistics of inputs and outputs of secondary and tertiary public hospitals in Kuwait, 2010-2014

		Beds	Doctors	Nurses	Non-medical workers	Outpatient visits	Number of discharges
	Median	416	196	656	484	168944	12144
2010	Mean	423	268	800	579	152992	14361
	STDEV	257	205	511	295	99026	12715
	Median	418	205	718	501	165387	12118
2011	Mean	447	281	834	590	162185	14444
	STDEV	271	219	522	299	105728	12664
	Median	409	219	715	505	160287	12087
2012	Mean	448	297	845	603	166341	14405
	STDEV	270	236	538	310	115437	12946
	Median	408	231	729	509	181270	12267
2013	Mean	450	330	852	620	215564	14735
	STDEV	277	274	551	317	158991	13399
	Median	418	263	765	503	164904	12073
2014	Mean	453	359	933	622	213202	14727
	STDEV	281	289	605	326	163647	13243
	Median	**414**	**223**	**717**	**500**	**168158**	**12138**
Average	**Mean**	**444**	**307**	**853**	**603**	**182057**	**14534**
	STDEV	**271**	**245**	**545**	**309**	**128566**	**12993**

Table 2. Technical and scale efficiency scores for the Kuwait public hospitals, 2010–2014

Hospital name	2010			2011			2012			2013			2014		
	CRS	VRS	Scale	CRS	VRS	Scale	CRS	VRS	Scale	CRS	VRS	Scale	CRS	VRS	Scale
Sabah	0.795	0.832	0.956	0.813	0.845	0.962	0.755	0.788	0.959	0.783	0.795	0.985	0.781	0.860	0.908
Amiri	0.767	0.832	0.922	0.901	0.926	0.973	0.898	0.903	0.994	0.873	0.894	0.977	0.829	0.871	0.952
Mubarak Alkabeer	0.754	0.832	0.906	0.864	0.892	0.968	0.841	0.909	0.925	0.810	0.850	0.953	0.772	0.804	0.961
Farwaniya	0.994	1.000	0.994	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Adan	0.912	0.960	0.950	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Jahra	1.000	1.000	1.000	1.000	1.000	1.000	0.991	1.000	0.991	1.000	1.000	1.000	0.929	1.000	0.929
Al-Razi	0.657	0.677	0.970	0.628	0.683	0.920	0.654	0.727	0.900	0.543	0.543	1.000	0.543	0.555	0.979
Physical Medicine and Rehabilitation	0.321	0.696	0.461	0.269	0.686	0.392	0.364	0.854	0.427	1.000	1.000	1.000	1.000	1.000	1.000
Maternity	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Chest Diseases	0.615	0.726	0.847	0.635	0.705	0.900	0.583	0.664	0.878	0.581	0.628	0.926	0.668	0.674	0.992
Infectious Diseases	0.659	1.000	0.659	0.994	1.000	0.994	0.683	1.000	0.683	0.864	1.000	0.864	0.626	1.000	0.626
Psychological Medicine	0.411	0.552	0.745	0.518	0.598	0.866	0.541	0.669	0.808	0.532	0.630	0.845	0.601	0.625	0.961
Ibn Sina	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Kuwait Cancer Control Center	0.367	0.504	0.728	0.415	0.498	0.833	0.443	0.501	0.884	0.482	0.640	0.754	0.430	0.524	0.820
Kuwait Allergy Center	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Mean	***0.750***	***0.841***	***0.876***	***0.802***	***0.856***	***0.920***	***0.784***	***0.868***	***0.897***	***0.831***	***0.865***	***0.953***	***0.812***	***0.861***	***0.942***
Median	***0.767***	***0.832***	***0.950***	***0.901***	***0.926***	***0.973***	***0.841***	***0.909***	***0.959***	***0.873***	***1.000***	***1.000***	***0.829***	***1.000***	***0.979***
Standard deviation	***0.24***	***0.17***	***0.16***	***0.25***	***0.17***	***0.16***	***0.23***	***0.16***	***0.16***	***0.2***	***0.17***	***0.08***	***0.2***	***0.18***	***0.1***
Coefficient of variation, %	***32.2***	***20.7***	***18.3***	***30.9***	***20.4***	***16.9***	***28.8***	***18.7***	***17.7***	***24.1***	***20***	***7.89***	***24.3***	***21***	***10.7***

Note. CRS=constant returns to scale technical efficiency (overall technical efficiency); VRS=variable returns to scale technical efficiency (pure technical efficiency); Scale=scale efficiency.

3.2 First Stage DEA: Efficiency Results

Table 2 presents the DEA results. Three hospitals (20%) were constantly technical and scale efficient for the whole period. The mean technical efficiency score was 86% over the study period, and it improved by 2% since 2010. The mean pure technical efficiency score was around 80%, which improved from 75% in 2010 to 81% in 2014. Figure 2. Changes in efficiency scores over the 2010-2014 study period shows the changes of efficiency scores during the period 2010-2014.

In 2010, 2011, 2012, 2013 and 2014, out of the 15 hospitals, approximately six (40%), seven (47%), seven (47%), eight (53%) and eight (53%) hospitals respectively had a technical efficiency score of 1 (fully efficient). The average pure or managerial technical efficiency (VRS) scores were 84%, 86%, 87%, 87% and 86% respectively during the five years under consideration. This finding implies that if the hospitals were operating efficiently, they could have produced 16%, 14%, 13%, 13% and 14% more output using their current levels of input, or could produce their current levels of output with 16%, 14%, 13%, 13% and 14% reductions in their existing inputs.

The mean scale efficiency score was 92%, which improved from 88% in 2010 to 94% in 2014. Based on the analysis of scale efficiency, it can be illustrated that in period of 2010-1014: four (27%), six (40%), five (33%), eight (53%) and six (40%) hospitals displayed constant returns to scale, which means that they were operating at their most productive scale sizes. The average scale efficiency score in the sample was 86% in 2010, 92% in 2011, 90% in 2012, 95% in 2013 and 94% in 2014.

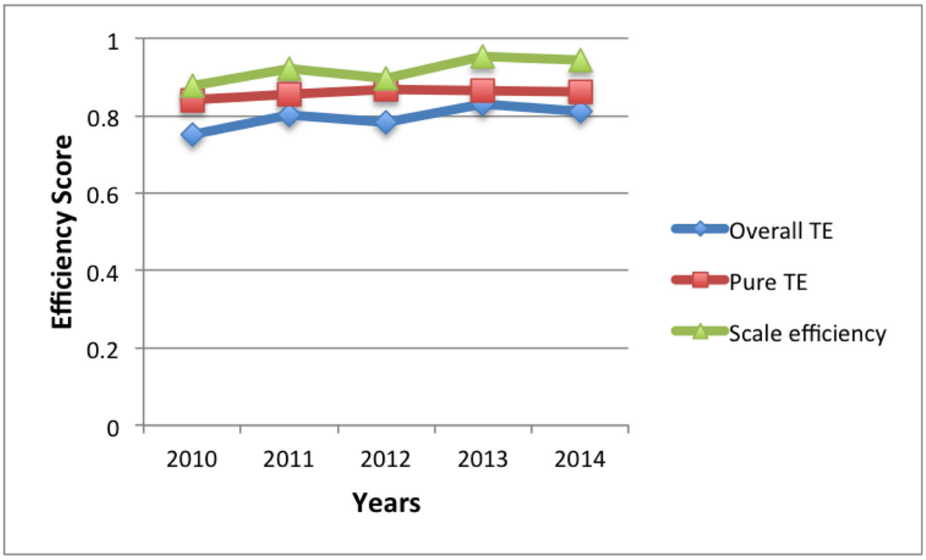

Figure 2. Changes in efficiency scores over the 2010-2014 study period

Hospitals in Kuwait are already operating at a high and increasing level of efficiency but the opportunity for further efficiency gains exists in this context. Table 3 illustrates the total amount of input reductions and/or output increases needed to make less efficient hospitals fully efficient for the years 2010-2014. In 2010, the less efficient hospitals combined had 765 (19.1%) more doctors than needed to be efficient, which was the largest percentage among all variables in the study. For the same year, hospitals could be more technically efficient if they were able to decrease their input levels by 7.9% fewer beds, 9.2% fewer nurses and 5.3% fewer non-medical workers, while holding their level of outputs constant. Alternatively, an increase of 12.5% in outpatient visits and 0.3% in discharges - while keeping inputs constant - would improve efficiency for the same year. In 2014 on the other hand, a reduction of 8.9% in the number of beds, 9.7% in the number of doctors, 8.2% in the number of nurses and 7.1% in the number of non-medical staff would be required to reach full technically efficiency - while keeping the level of outputs constant. Alternatively, for the same year, the level of output increase required to make hospitals efficient would be 6.2% in outpatient visits, while utilizing the same level of inputs.

3.3 Second Stage DEA: Results of Tobit Regression Analysis

At the second stage of the DEA, technical efficiency scores estimated at the first stage were regressed against a group of hospital level variables, including type of hospital (general or specialized), number of beds, bed occupancy rate and average length of stay, in order to determine the factors affected the technical efficiency of the hospitals. Table 4 shows the results of the regression analysis. The results show that the average length of stay is a significant determinant of hospital technical efficiency; indicating that the higher the average length of stay, the lower overall (CRS) technical efficiency ($p<0.05$) and lower scale efficiency ($p<0.001$). A higher number of beds was also found to be associated with higher scale efficiency ($p<0.05$).

Table 3. Total input reductions and/or output increases needed to make inefficient hospitals efficient, 2010-2014

		Beds	Doctors	Nurses	Non-medical workers	Outpatient visits	Number of discharges
2010	Total actual values	6338	4014	11995	8680	2294882	215417
	Shortfall/excess	498	765	1102	461	287086	656
	% of total actual values	7.9%	19.1%	9.2%	5.3%	12.5%	0.3%
2011	Total actual values	6703	4219	12504	8850	2432773	216658
	Shortfall/excess	631	517	1047	892	214941	243
	% of total actual values	9.4%	12.3%	8.4%	10.1%	8.8%	0.1%
2012	Total actual values	6714	4462	12676	9051	2495121	216073
	Shortfall/excess	654	572	1124	957	239975	1921
	% of total actual values	9.7%	12.8%	8.9%	10.6%	9.6%	0.9%
2013	Total actual values	6756	4947	12786	9296	3233456	221032
	Shortfall/excess	606	520	957	615	237967	0
	% of total actual values	9.0%	10.5%	7.5%	6.6%	7.4%	0.0%
2014	Total actual values	6793	5378	14000	9327	3198023	220901
	Shortfall/excess	602	524	1151	658	199824	35
	% of total actual values	8.9%	9.7%	8.2%	7.1%	6.2%	0.0%

Moreover, we explored the relationship between efficiency scores and hospital size, in terms of the number of beds (Figure 3). The results show that larger hospitals (with more than 400 beds) are generally more technically and scale efficient.

2.4 Qualitative Interviews

To better understand the potential factors affecting efficiency of the hospital in the context of Kuwait, qualitative semi-structured interviews were conducted with 14 hospital managers from public, private and military sectors. Twenty managers from the public and private sector hospitals in Kuwait were approached to take part in an interview. Six declined and 14 participated. Among the 14 participants, 2 (14%) were female, ten had Kuwaiti nationality (71%), eight (57%) were from public hospitals, nine (64%) had a postgraduate qualification in health management and nine (64%) had management experience of 10 years or more. A detailed description of the participants' characteristics is presented in Appendix 1.

Table 4. Result of Tobit regression analysis

	(1) CRS TE	(2) VRS TE	(3) Scale
Tertiary	-0.0654	-0.126	0.0638
	(0.0989)	(0.0927)	(0.0543)
Number of beds	0.000212	0.000152	0.000207**
	(0.000180)	(0.000172)	(0.0000970)
Bed occupancy rate, %	-0.00161	-0.00768**	0.00168
	(0.00258)	(0.00291)	(0.00141)
Average length of stay, days	-0.00480**	-0.000727	-0.00509***
	(0.00208)	(0.00196)	(0.00114)
Constant	0.971***	1.421***	0.807***
	(0.174)	(0.193)	(0.0949)
N	75	75	75
Pseudo R^2	0.221	0.227	0.474
χ^2	16.23	15.21	27.23
p-value	0.003	0.004	0.000

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

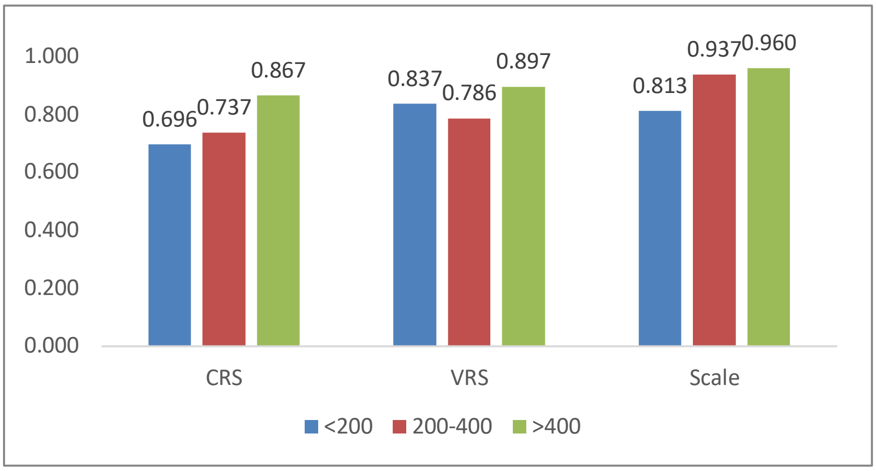

Figure 3. Relationship between efficiency scores and the number of hospital beds

Participants expressed their perception of factors affecting the efficiency of their hospitals as well as factors that would help in improving hospital efficiency. The factors reported by participants can be grouped into two broad categories: External and internal factors. External factors include the presence of a national strategic health plan, legislative changes, bureaucracy in the system, provider payment mechanisms (mainly salary), and communications between hospitals. Managers stated that bureaucracy lead to a slow and centralised process of decision making. This is believed to be due to the rigid structure of the public healthcare sector, the lack of autonomy for hospital managers, and that decision makers at high levels in the ministry are overwhelmed. Internal factors include bed capacity, qualifications and training of human resources, procurement and utilisation of equipment, the use health information system (HIS), as well as the accountability of staff and users.

4. Discussion

The literature suggests that a common cause of technical inefficiency is the sub-optimal or unnecessary use of certain resources such as excessive hospitalization (Chisholm & Evans, 2010). Other causes of technical inefficiency include overstaffing and weak purchasing or distribution systems (Mills, 1995; Tandon, Lauer, Evans, & Murray, 2003). Another example of inefficiencies found in hospitals is the under-utilisation of services (e.g. low utilisation of beds), which may be observed when hospitals show diseconomies of scale when they depart from their optimal level of efficiency by deciding to enlarge (Chisholm & Evans, 2010).

This study measured the technical efficiency of secondary and tertiary public hospitals in Kuwait. It was found that three hospitals (20%) were constantly technical and scale efficient, and therefore 80% of hospitals could have made efficiency gains during the study period. The percentage of less efficient hospitals in this study is high when compared to a study of the efficiency of general hospitals in South of Iran, which found that 53% of hospitals were technically inefficient (Kiadaliri et al., 2011). Mahate and colleagues (2016) found that one third of hospitals in the United Arab Emirates were technically efficient. Studies conducted in two settings in Sub-Saharan Africa showed that 74% of hospitals in Kenya (Kirigia et al., 2002), and 40% of hospitals in Zambia were technically efficient (Masiye, 2007).

The results from this study are comparable with earlier work (Burney, Mohammad, & Al-Ramadhan, 1999), which assessed the cost of inefficiencies in the public health care system in Kuwait. These authors concluded that there were relative inefficiencies in the production of health services in the country at that time. They believed that an over supply of beds and nurses caused an excess of 18% in total health expenditure in Kuwait.

As explained in other studies, in order to decrease the inefficiencies in hospitals, there should be close evaluation of the excess in medical and non-medical manpower (Osmani, 2012). The results of this study showed that a hospital's size has an effect on its efficiency, which was supported by other studies (W.F. Lee & Wang, 2004; Masiye, 2007; Worthington, 2004). It was found that the larger hospitals were potentially more technically and scale efficient. This is in line with the findings of studies conducted in the South of Iran (Kiadaliri, Zarei, & Haghparast-Bidgoli, 2011) and in Thailand (Watcharasriroj & Tang, 2004).

The results of the Tobit regression revealed that the average length of stay was significantly associated with overall technical efficiency of the hospitals. Previous studies (Cheng et al., 2015; Herr, 2008) have found similar results where there was a negative association between the average length of stay and technical efficiency. There was no statistically significant association between technical efficiency with other institutional factors such as bed occupancy rate and level of specialisation. This was not the case in previous studies. For example, K.S. Lee and colleagues (2008) found that hospitals that were more specialised, were also more efficient. Moreover, Kounetas and Papathanassopoulos (2013) described that the hospital type (Regional, Prefectural, or University) affected the technical efficiency of hospitals in Greece.

Other factors that were believed to affect hospital efficiency were explored through semi-structured interviews with hospital managers in the country. Managers believed that there were external factors, such as changes in regulations, financing/provider payment mechanisms, and centralization (i.e. less autonomy for hospitals), which affected efficiency of the hospitals. Dalmau-Atarrodona and Puig-Junoy (1998) showed that healthcare regulations as well as the presence of competitors would affect hospital efficiency scores. Alternatively, Tiemann and Schreyögg (2012) argued that resources were used more efficiently after converting hospitals to a private for-profit status in Germany, for example. Hu and colleagues (2012) have concluded that there was a negative relationship between government subsidy and hospital's efficiency when they evaluated the effect of a health insurance reform in China. Another study from Norway has shown that the introduction of activity-based financing has improved the technical efficiency of hospitals (Biørn, Hagen, Iversen, & Magnussen, 2003). Most participants described increasing their autonomy would increase the efficiency of their hospitals, which was supported by studies from other settings (Guven-Uslu & Linh, 2008). The use of health information systems, on the other hand, was believed to increase the efficiency of a hospital by several participants. This was supported by a study in Thailand, which showed that there was a positive relation between the use of IT and the efficiency of public hospitals (Watcharasriroj & Tang, 2004). Additionally, the use of technology was found to decrease scale inefficiencies in Greek hospitals (Kounetas & Papathanassopoulos, 2013).

This study has provided evidence that could be useful to managers and policy makers in formulating reforms to improve the efficiency of public hospitals. The government of Kuwait aims to improve the efficiency of public services in the country, including health services, due to the current economic situation. The technical efficiency as well as factors influencing the efficiency could help health policy makers to make informed decisions to improve the technical efficiency of the main health-producing units in the country. Most hospitals were found to be technically inefficient suggesting that there is room for improvement in this domain. Additionally, any health reform that aims to improve the performance of local health services should take into consideration the factors that were found to influence the technical efficiency of hospitals. Similar studies have emphasised on the importance of studying other dimensions of performance, such as quality and equity in addition to efficiency, in order to have a comprehensive picture of the performance of hospitals (Dalmau-Atarrodona & Puig-Junoy, 1998; Guven-Uslu & Linh, 2008).

5. Limitations

It is important to note that in order to improve future research in this field, the limitations that faced this study should be taken into consideration. Firstly, there were some limitations related to the method that was used in the second stage of this study. Simar and Wilson (2011) argue that tobit regression in the second stage of DEA constitutes a mis-specification. They explain that tobit estimation in the second stage produces biased and inconsistent estimates when compared to their truncated model (Simar & Wilson, 2011). Secondly, this study was unable to determine to what extent the inefficiency might be caused by quality of care variations due to the lack of data about variables reflecting severity of diseases and quality of care provided in hospitals. Just as other researchers recommended, in order to improve quality of future studies measuring hospital efficiency, more efforts need to be made in developing appropriate indicators reflecting quality of care in hospitals (Kiadaliri et al., 2011). Thirdly, when applying DEA, it is desirable to have a large sample size. The sample size for the current study is 15 hospitals, which is the total number of public hospitals that provided inpatient and outpatient services in Kuwait during 2010-2014. Fourthly, the data used in this study is outdated but it was used because of uniformity reasons. Alsabah hospital, which is a secondary level hospital, was divided to two administratively independent hospitals, Alsabah (secondary) hospital and Zain (tertiary) ENT hospital in 2015. This division resulted in a disparity in the variables that were used in the two stages on the analysis. Additionally, the allergy center, which was one of the efficient hospitals throughout the study period, stopped providing inpatient services starting in the year 2015. So for this hospital, one of the variables that were used in the analysis would be lost. Fifthly, it is desirable to have a homogeneous sample when applying DEA. However, in the current study, six hospitals provided general services whereas nine hospitals provided mainly specialized services in addition to some general services.

6. Conclusion

This study has quantified the technical and scale efficiency of 15 public hospitals in Kuwait, and identified the input reductions and/or output increases needed to make inefficient hospitals efficient. The results show that the majority of the public hospitals are not operating at technically efficient levels, indicating room to improve the performance of these hospitals. This study also provided an insight into the factors affecting the efficiency of hospitals. Health policy makers in Kuwait can extract useful information from this study to develop concrete strategies to improve hospital efficiency. Replicating the analyses performed in this study on a routine basis for public healthcare facilities would help in identifying ways of best practice, but this would not be easy to achieve unless timely and accurate data is available.

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Competing Interests Statement

The authors declare that there are no competing or potential conflicts of interest.

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