



Assessment of efficiency levels of training and research hospitals in Turkey and the factors affecting their efficiencies

Gülnur İlgin*, Murat Konca

R. A. Department of Health Care Management, Faculty of Economics and Administrative Sciences, Hacettepe University, 06800, Ankara, Turkey

ARTICLE INFO

Article history:

Available online 5 September 2019

Keywords:

Training and research hospitals
Efficiency
Data envelopment analysis
Tobit
Turkey

ABSTRACT

Objectives: This study's aim was to compare the efficiency levels of training and research hospitals in Turkey during 2014–2017 and find the factors affecting their efficiency scores.

Methods: To achieve the above objective, input oriented and variable returns to scale (VRS), data envelopment analysis (DEA), and Tobit regression model were used. The number of beds (BD), the number of intensive care beds (IBD), and the number of specialist doctors (SD) were used as the input variables of DEA while the number of polyclinic admissions (PA), number of inpatients (InP), and number of A, B, and C type surgeries as the output variables. The Tobit regression model was created by using some control variables as independent variables and transformed DEA scores as dependent variables. Average length of stay (ALS), bed turnover rate (BTR), bed occupancy rate (BOR), surgery number per specialist doctor (SNSD), polyclinic admission number per specialist doctor (PANS), and metropolitan city status (MCS) were used as control variables.

Results: Statistically significant control variables of BTR ($p < 0.001$), SNSD ($p = 0.001$), and MCS ($p = 0.015$) affect the transformed DEA score while ALS, BOR, and PANS do not ($p > 0.05$).

Conclusions: The research revealed that efficiency increased as BTR and SNSD increased, and that MCS also had a positive effect on efficiency. Policy makers should therefore consider the province's MCS status while allocating resources to relevant educational research hospitals for improving their efficiency. Likewise, policy makers should pay more attention to increasing BTR and SNSD compared to other variables.

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Introduction

The health care services industry encounters new challenges every day and this industry's expenditures comprises a major part of the gross domestic product (GDP) in many countries [1]. Among health expenditures incurred, hospitals have the biggest share [2]. Taking into account countries' health expenditures, there has been a major increase since the 1980s mainly due to an increase in hospital expenditures [3]. For instance, the expenditure on services provided in many hospitals located in European as well as developed countries constitute the biggest share in the total health expenditures [2,4].

As a result of increasing health expenditures and the problems they have caused in countries' budgets, it has begun to be questioned whether health services realize efficiency or not. Performance measurement is the only way to find out if a country's health system realizes efficiency. By taking advantage of not only health systems but also performance measurements, health institutions in health systems can be evaluated. As already men-

tioned, the institutions with the highest rate of resource utilization in health systems are hospitals. Hence, hospitals are important targets in national efforts to improve health system performance [5]. Hospitals' performance should be addressed not only because its expenditures has the biggest share in the health expenditures but also because it is important whether the outputs generated from hospitals meet society's expectations. Additionally, the monitoring of hospitals' performance makes comparison between hospitals possible. While a comparison of hospitals' performances has the benefit of revealing inefficient aspects of hospitals, it can also create several positive outcomes such as contributing to policy makers' decision-making processes.

This study aims to compare the managerial performances of training and research hospitals in Turkey. Although Turkey lags behind developed countries in its share of income devoted to health spending, an examination of its health expenditure per capita revealed an increase in the last ten years. Turkey's annual average growth rate (real term) in per capita health spending was 0.8% during 2009–2013 and 3.2% during 2013–2017 [6]. As in many other countries, in Turkey, too, expenditures for hospital services constitute a significant part of total health expenditures [7]. It is a well-known fact that training and research hospitals use more

* Corresponding author.

E-mail address: gulnurharmanci@hacettepe.edu.tr (G. İlgin).

Table 1
Descriptive statistics of input and output variables (2014–2017).

Variables	2014		2015		2016		2017		Change from 2014 to 2017 (%)
	Mean	Sd.	Mean	Sd.	Mean	Sd.	Mean	Sd.	
Inputs									
Number of beds (BD)	624.4	241.7	633.9	255.2	680.3	277.6	728.9	313.5	0.17
Number of intensive care unit beds ^a (IBD)	70.9	32.2	74.7	31.6	79.4	36.3	91.3	46.5	0.29
Number of specialist doctors (SD)	244.7	95.2	268.7	100.8	282.0	114.6	291.1	117.4	0.19
Outputs									
Number of polyclinic admissions (PA)	1,433,218.1	534,771.4	1,496,428.4	553,856.0	1,652,622.8	666,009.5	1,792,216.6	729,212.9	0.25
Number of inpatients (InP)	39,693.4	16,693.7	39,483.2	16,547.8	40,799.1	19,229.7	41,205.4	17,540.7	0.04
Number of A type surgeries (A)	1792.7	1143.1	2116.3	1235.5	2343.0	1375.5	2486.4	1415.6	0.39
Number of B type surgeries (B)	6520.4	2884.0	5862.1	2563.2	5913.5	2597.0	6323.5	2563.1	-0.03
Number of C type surgeries (C)	8671.4	4236.2	8445.2	3748.9	8711.0	3649.6	9182.0	3922.8	0.06
Control Variables									
Average length of stay (ALS)	4.8	0.9	4.8	0.9	4.8	0.9	4.9	1.0	0.02
Bed turnover rate (BTR)	65.0	16.3	63.0	15.3	60.6	14.3	58.4	13.1	-0.11
Bed occupancy rate (BOR)	80.3	11.1	79.4	9.3	78.2	9.8	75.7	9.8	-0.06
Surgery number per specialist doctor (SNSD)	70.8	21.0	62.2	19.1	61.3	15.4	63.8	157.7	0.18
Polyclinic admissions number per specialist doctor (PANSD)	6156.4	1736.9	5787.4	1469.8	6129.3	1871.0	8426.9	15,704.5	0.37
Metropolitan city status (MCS)	number	%	number	%	number	%	number	%	-
	36	77	36	77	36	77	36	77	-

^a Including number of the beds in adult, child, and new born intensive care units.

resources than other hospitals because they carry out training and research tasks in addition to providing health care. Since it was important to reveal the managerial performance of hospitals that use more resources compared to other hospitals, only the training and research hospitals were included in this study's scope.

This study adopted the DEA and Tobit regression model methods. DEA was used to determine the efficiency levels of training and research hospitals, and thereafter the Tobit regression model was used to identify the factors affecting the efficiency as a second stage analysis. The DEA was input oriented since planning and control of outputs are difficult in service fields like hospitals, where administrators have more control on inputs leading to adoption of more input oriented models [1,8,9]. Pursuant to the scale, the reason for using the VRS model was to evaluate pure technical efficiencies. We used the VRS model that shows pure technical efficiency since we wanted to find out hospitals' managerial performance. Also, the use of VRS models in the health care sector is recommended to reveal the managerial performances of the decision making units [10]. In the analysis, only training and research hospitals were included because these hospitals use more resources than other types of hospitals. Although several studies have measured the performance of training and research hospitals in Turkey, through this study the factors that affect training and research hospitals' efficiency levels were revealed for the first time in Turkey.

Method

Sample

This study's population comprised the training and research hospitals located in 81 provinces of Turkey under the Ministry of Health. It did not undertake any sampling but covered all general training and research hospitals under the Ministry of Health that had performed training and research tasks during 2014 to 2017. The data were generated from Public Hospitals Statistics Yearbook 2014–2017 data set [11–14]. This study excludes special branch training and research hospitals affiliated to the Ministry of Health as well as Ministry of Health's training and research hospitals affiliated to a university. Hence, the study constituted 47 training and research hospitals.

Research variables

Table 1 indicates the input and output variables used in measuring the efficiencies of training and research hospitals under the Ministry of Health. Within the scope of this study, BD, IBD, and number of SDs were used as input variables of DEA while PA and, InP numbers, along with number of A, B, and C type surgeries, as output variables.

Among the input variables identified in this study: BD and SD were used in the studies of Kavuncubası and Ersoy [15], Ersoy et al. [16], Güles et al. [17] and Bayraktutan and Pehlivanoglu [18]; while IBD was used in the studies by Valdmanis et al. [19] and Dexter et al. [20]. Among the output variables identified: PA was used in the studies of Kavuncubası and Ersoy [15] and Güles et al. [17]; InP in the studies of Keskin and Orhaner [21] and Güles et al. [17]; and the number of A, B, and C type surgeries in the study of Kavuncubası and Ersoy [15].

In the Tobit Model, ALS, BTR, BOR, SNSD, PANSD, and MCS were used as control variables.

Data analysis

Two main methods were determined within the framework of this study. Firstly, the efficiencies of 47 training and research hospitals were compared with DEA between 2014 and 2017, and then a Tobit model was developed considering the transformed DEA scores as the dependent variable and ALS, BTR, BOR, SNSD, PANSD, and MCS as independent variables.

DEA

It is a linear programming based, non-parametric method, that is used in the performance comparison of organizations with more than one input and output to measure the relative efficiency where both inputs and outputs are not combined in an efficiency index objectively [15]. DEA was first inspired by Ferrall's [22] work. Then, constant return to scale (CRS) DEA model was introduced and furthermore, Banker et al. [23] developed the VRS DEA model. The following formula shows the input oriented VRS model [23]:

$$\text{Max } \frac{\sum_{r=1}^s u_r y_{rk} + u_0}{\sum_{i=1}^m v_i x_{ik}}$$

Constraints: $\frac{\sum_{r=1}^s u_{rk} y_{rj} + u_0}{\sum_{i=1}^m v_{ik} x_{ij}} \leq 1 \quad (j = 1, 2, 3, \dots, n)$

$v_{rk}, v_{ik} \geq \varepsilon > 0, (r = 1, 2, \dots, s), (i = 1, 2, \dots, m), u_0 \in R$

Since DEA is not a parametric method, it is widely used in performance measurements. While in parametric methods, the independent variables are associated with dependent variables, and they introduce certain restrictions such as imposing specific functional patterns such as production function, and normality assumption; in non-parametric methods, there is no restriction on researchers with regard to the variables [24].

Before using DEA as a method, a decision must first be taken if the study would be input or output based, and after that, if it would adopt VRS or CRS. Input oriented models reflect the most suitable input composition to generate certain output compositions in the most effective way; whereas the output oriented models state the maximum number of output compositions that it is possible to generate with certain input compositions [25]. Hence, input and output oriented models are designed to ensure minimization and maximization, respectively [1].

Tobit model

It is a regression model developed by Tobin [26] and used as an extension of the Probit model, to explain the effect of independent variables on dependent variables in models where dependent variables can have a value in an interval (in DEA between 0 and 1) [27]. The Tobit censored regression's eliminating the problem of data normalization is considered as its superiority to other modes of regression analysis [1]. This model that is considered as the alternative to the least squares regression [28], is used in circumstances where in return for the known values of independent variables, some of the dependent variable values cannot be observed, unlike linear regression models [29]. Hence, the Tobit model can be defined as the regression model used when the values of complete observations in dependent variables are not fully generated, or their complete values are generated, yet defined in certain intervals [30]. The following formula shows the standard Tobit model [26]:

$y_i^* = x_i' \beta + u_i (i = 1, \dots, n)$

$y_i = \begin{cases} y_i^*, & \text{if } y_i^* > 0 \\ 0, & \text{if } y_i^* \leq 0 \end{cases}$
 $u_i \sim \text{IIN}(0, \sigma^{-2})$

In the formula, y_i^* is a latent random variable that is observed as y_i , if it is positive, and is otherwise observed as equal to zero and the parameter vector $\beta \in R^k$. The error, u_i is independent normal with mean zero and precision $\sigma^2 > 0$.

Pursuant to the Tobit model's assumption, DEA scores must be censored at point 0 at left [1,31]. Therefore, in this study, DEA scores used as dependent variable in Tobit model are transformed with $[(1 / \text{DEA Score}) - 1]$ formula and censored at point 0 at left. The coefficients generated as a result of using such transformed scores as dependent variables in this model show the effect on inefficiency.

Taking into consideration activities of the Tobit Model wherein the activities of the hospital are compared with DEA, and then DEA or transformed DEA scores are considered as dependent variables, this study is similar to studies by Puig-Junoy [32], Zere et al. [33], Hu and Huang [34], Lee et al. [35], Keskin and Orhaner [21].

Results

When the input variables in Table 1 were examined, it was found that from 2014 to 2017; BD increased by 17%, IBD by 29% and SD by 19%. Similarly, variables other than the number of type B surgeries had also increased over the years. Accordingly, the highest increase (39%) was observed in the type A operations and the second highest (25%) increase in PA. Finally, when the percentage change in the control variables was examined, it was found that ALS increased by 2%, SNSD by 18% and PANSD by 37%. It was determined that BTR and BOR variables had decreased by years.

Table 2 shows the correlation values for the input and output variables used in DEA. Accordingly, for 2014, the lowest correlation value ($r=0.30$) was found between A and PA and the highest correlation value ($r=0.80$) was found between InP and PA and BD and PA. For 2015, the lowest correlation value ($r=0.43$) was found between A and PA and the highest correlation value ($r=0.80$) was found between IBD and BD. For 2016, the lowest correlation value ($r=0.36$) was found between A and IBD and the highest correlation value ($r=0.80$) was found between IBD and BD. Finally, for 2017, the lowest correlation value ($r=0.36$) was found between

Table 2
Correlation coefficients of variables (2014–2017).

Year 2014									Year 2015								
	BD	IBD	SD	PA	InP	A	B	C		BD	IBD	SD	PA	InP	A	B	C
BD	1								BD	1							
IBD	0.78**	1							IBD	0.80**	1						
SD	0.76**	0.57**	1						SD	0.71**	0.58**	1					
PA	0.62**	0.42**	0.74**	1					PA	0.61**	0.46**	0.76**	1				
InP	0.80**	0.71**	0.70**	0.80**	1				InP	0.72**	0.78**	0.65**	0.71**	1			
A	0.45**	0.33*	0.68**	0.30*	0.37**	1			A	0.53**	0.51**	0.78**	0.43**	0.50**	1		
B	0.61**	0.36*	0.75**	0.58**	0.58**	0.77**	1		B	0.57**	0.49**	0.72**	0.56**	0.55**	0.76**	1	
C	0.69**	0.52**	0.62**	0.69**	0.69**	0.41**	0.74**	1	C	0.57**	0.50**	0.58**	0.58**	0.64**	0.54**	0.74**	1
Year 2016									Year 2017								
	BD	IBD	SD	PA	InP	A	B	C		BD	IBD	SD	PA	InP	A	B	C
BD	1								BD	1							
IBD	0.80**	1							IBD	0.80**	1						
SD	0.68**	0.50**	1						SD	0.65**	0.36*	1					
PA	0.64**	0.51**	0.76**	1					PA	0.64**	0.44**	0.70**	1				
InP	0.80**	0.78**	0.54**	0.62**	1				InP	0.77**	0.76**	0.60**	0.67**	1			
A	0.50**	0.36*	0.76**	0.48**	0.39**	1			A	0.53**	0.38**	0.74**	0.43**	0.45**	1		
B	0.57**	0.43**	0.79**	0.62**	0.48**	0.76**	1		B	0.64**	0.45**	0.74**	0.64**	0.59**	0.76**	1	
C	0.65**	0.48**	0.76**	0.66**	0.59**	0.59**	0.76**	1	C	0.69**	0.45**	0.68**	0.66**	0.67**	0.56**	0.76**	1

* $p < 0.05$.
 ** $p < 0.01$.

Table 3
Technical efficiency scores of hospitals ($n = 47$; 2014–2017).

Hospitals	VRS Efficiency Score			
	2014	2015	2016	2017
Adana Numune Training and Research Hospital	1.00	1.00	1.00	0.78
Adıyaman Training and Research Hospital	1.00	0.80	1.00	1.00
Amasya Sabuncuoğlu Şerefeddin Training and Research Hospital	1.00	1.00	1.00	1.00
Ankara Numune Training and Research Hospital	1.00	1.00	1.00	1.00
Ankara Türkiye Yüksek İhtisas Training and Research Hospital	1.00	1.00	1.00	1.00
Ankara Training and Research Hospital	1.00	1.00	1.00	1.00
Ankara Dışkapı Yıldırım Beyazıt Training and Research Hospital	0.80	1.00	1.00	1.00
Ankara Keçiören Training and Research Hospital	0.99	1.00	1.00	1.00
Ankara Atatürk Training and Research Hospital	1.00	1.00	1.00	1.00
Ankara Yenimahalle Training and Research Hospital	1.00	1.00	1.00	1.00
Antalya Training and Research Hospital	1.00	1.00	1.00	1.00
Bolu İzzet Training and Research Hospital	0.56	1.00	1.00	1.00
Çorum Training and Research Hospital	0.94	0.81	0.74	0.69
Diyarbakır Gazi Yaşargil Training and Research Hospital	0.70	0.77	1.00	1.00
Elazığ Training and Research Hospital	0.74	0.81	0.70	0.73
Erzincan Mengücek Gazi Training and Research Hospital	1.00	1.00	1.00	1.00
Erzurum Training and Research Hospital	1.00	1.00	0.98	0.85
İstanbul Kartal Dr.Lütfi Kırdar Training and Research Hospital	1.00	1.00	1.00	1.00
İstanbul Marmara University Pendik Training and Research Hospital	0.86	0.93	1.00	1.00
İstanbul Ümraniye Training and Research Hospital	1.00	1.00	0.93	1.00
İstanbul Haydarpaşa Numune Training and Research Hospital	1.00	1.00	1.00	1.00
Göztepe Training and Research Hospital	0.68	0.73	0.80	0.70
İstanbul Fatih Sultan Mehmet Training and Research Hospital	1.00	1.00	1.00	0.93
İstanbul Dr. Sadi Konuk Training and Research Hospital	0.82	0.99	1.00	1.00
İstanbul Bağcılar Training and Research Hospital	1.00	1.00	1.00	1.00
İstanbul Okmeydanı Training and Research Hospital	1.00	1.00	0.92	0.78
İstanbul Şişli Hamidiye Etfal Training and Research Hospital	0.89	0.85	0.85	0.81
İstanbul Gaziosmanpaşa Taksim Training and Research Hospital	1.00	0.96	0.87	0.64
İstanbul Kanuni Sultan Süleyman Training and Research Hospital	1.00	1.00	1.00	1.00
İstanbul Haseki Training and Research Hospital	1.00	0.89	0.86	0.89
İstanbul Training and Research Hospital	0.77	0.92	0.92	0.92
İzmir Katip Çelebi University Atatürk Training and Research Hospital	0.80	1.00	0.84	1.00
İzmir Bozyaka Training and Research Hospital	0.79	0.92	0.90	0.81
İzmir Tepecik Training and Research Hospital	0.91	1.00	1.00	1.00
Karabük Training and Research Hospital	0.95	0.96	1.00	0.91
Kayseri Training and Research Hospital	1.00	1.00	1.00	1.00
Kırşehir Training and Research Hospital	1.00	1.00	1.00	1.00
Kocaeli Derince Training and Research Hospital	0.90	0.78	0.92	0.81
Konya Training and Research Hospital	0.86	0.71	0.77	0.80
Kütahya Evliya Çelebi Training and Research Hospital	0.74	0.74	0.76	0.85
Muğla Training and Research Hospital	0.92	1.00	1.00	0.88
Ordu Training and Research Hospital	1.00	1.00	1.00	1.00
Rize Training and Research Hospital	0.98	0.99	1.00	1.00
Sakarya Training and Research Hospital	1.00	1.00	1.00	1.00
Samsun Training and Research Hospital	1.00	1.00	1.00	1.00
Şanlıurfa Mehmet Akif İnan Training and Research Hospital	1.00	1.00	0.68	1.00
Trabzon Kanuni Training and Research Hospital	0.67	0.72	0.85	0.79
Avegare Efficiency Score	0.92	0.94	0.94	0.93
Avegare Inefficiency Score	0.82	0.85	0.84	0.81
Number of Efficient Hospitals	26	29	30	29

Table 4
Tobit regression model on efficiency scores during 2014–2017.

Independent variables	Coefficient Std. error		Z	p	Confidence intervals 95%	
					Min.	Max.
Constant	1.289	0.316	4.079	0.000	0.665	1.912
ALS	−0.049	0.047	−1.039	0.299	−0.141	0.044
BTR	−0.015	0.004	−4.018	0.000	−0.022	−0.008
BOR	0.003	0.003	0.763	0.445	−0.004	0.009
SNSD	−0.005	0.002	−3.301	0.001	−0.008	−0.002
PANSD	−0.005	0.001	−0.031	0.975	−0.001	0.002
MCS	−0.131	0.054	−2.439	0.015	−0.237	−0.025
			Log. likelihood= −50.078			
			Left censored obs 114		Right censored obs 0	
			Uncensored obs 74		Total obs 188	

SD and IBD and the highest correlation value ($r=0.80$) was found between IBD and BD. It can, therefore, be said that the relationship coefficients between all variables are within acceptable limits for DEA.

Table 3 depicts the efficiency scores of training and research hospitals related to health care services calculated in accordance with VRS methods from 2014 to 2017, and the efficient hospitals are shown in bold. Pursuant to the efficiency analysis, 26 hospitals were found as efficient in 2014, 29 in 2015, 30 in 2016 and finally 29 in 2017. Additionally, 17 hospitals were found efficient and 10 hospitals were found inefficient in the years covered by the study.

According to the DEA results, the average efficiency score of all training and research hospitals was 0.92 in 2014, 0.94 in 2015, 0.94 in 2016 and finally 0.93 in 2017. In addition, when the hospitals' inefficiency scores were examined year wise, the inefficiency averages for 2014, 2015, 2016 and 2017 were found to be 0.82, 0.85, 0.84, and 0.81, respectively.

Table 4 shows the results from the Tobit analysis that was conducted on the effect of variables used as control variables (ALS, BTR, BOR, SNSD, PANSD, and MCS) on the efficiency scores during 2014–2017. The model is generally significant (Log. Likelihood = −50.078). According to the Tobit model, BTR, SNSD, and MCS have a significant effect on the efficiency score ($p \leq 0.05$), while ALS, BOR, and PANSD do not have any significant effect on the efficiency score ($p > 0.05$). Considering the coefficients, MCS (−0.131) had a higher effect on the efficiency of hospitals. When the effect of independent variables found as significant in the model were evaluated in detail, the efficiency score increased with the increase in BTR, SNSD, and MCS.

Discussion and conclusion

Hospital services are majorly responsible for meeting the health care needs at individual and community levels. Hence, health care planners, policy makers, and service providers should make sure that the resources allocated for hospitals are provided in an efficient and effective way. As there are a number of different approaches for controlling the use of resources, one of the possible methods can be reflecting the extent of reaching the desired outputs with the existing resources. From this perspective, this study aims at evaluating the efficiency of training and research hospitals in Turkey during 2014 to 2017, and identifying the factors that affect the generated efficiency scores.

DEA for the total number of 47 hospitals showed that 55% were efficient in 2014, 62% in 2015, 64% in 2016, and finally 62% in 2017. In general, the average efficiency scores among all hospitals were: 0.92 in 2014, 0.94 in 2015, 0.94 in 2016, and finally 0.93 in 2017. The technical efficiency average of inefficient hospitals ranged between 0.81 to 0.85 from 2014 to 2017. From this, it can be said that there has been an increase in the percentage of efficient hospitals during 2014 to 2016, and a decrease of 2% in 2017 compared to

the previous year. This decline in 2017 can be explained with the transfer of military hospitals affiliated to the Ministry of Defence to the Ministry of Health in mid-2016, which caused the share of hospitals affiliated to the Ministry of Health to decrease relatively. An examination of literature reveals that several studies have been conducted for measuring training and research hospitals' performance. The study by Bal and Bilge [36] conducted on 35 training and research hospitals by using three-year average values of variables noted that the average efficiency score of hospitals was 0.88. Additionally, Torabipour et al. [37] in their study performed in Iran argued that the average technical efficiency change score of training and research hospitals was 0.996 between 2007 and 2010. Pursuant to Cınaroğlu's [38] study performed in 48 training and research hospitals, the average efficiency score was 0.88 for the year 2014. A study by Amole et al. [39] in training hospitals in Nigeria, showed that the average efficiency score of hospitals was 0.715 for the 5 year period (2010–2014). Moreover, the study by Goudarzi et al. [40] conducted in Iran reflected that the average efficiency score of training hospitals was 0.59 between 1999 and 2011.

In the second stage of this study, a Tobit regression model was established in which some control variables determined by the researchers were independent variables and the transformed DEA score was a dependent variable. According to the model, it was determined that BTR, SNSD, and MCS variables had a statistically significant effect on the efficiency score, but ALS, BOR, and PANSD variables had no statistically significant effect on the efficiency score. According to the Tobit Model results; the efficiency score increases as BTR and SNSD increase. This situation is consistent with the hospitals' basic objectives, that is to say, if both variables are high, then it shows that hospitals perform well. The positive effect of MCS on the efficiency score can be explained by the fact that hospitals are preferred by more patients due to the high population of the province they serve. In the study by Ali et al. [41] that was similar to this study, the coefficient of BOR was not statistically significant. In the study by Zere et al. [33], also similar to this study, the ALS coefficient was not statistically significant but contrary to this study, the BOR coefficient was statistically significant. Contrary to this study, the study by Samsudin et al. [42] conducted in Malaysia indicated that there is a statistical effect of outpatient number per doctor on efficiency. Similarly, the study by Keskin and Orhaner [21] BOR and ALS have statistical significance.

Hospitals found inefficient in this study must increase their BTR and SNSD to become efficient. MCS has a significantly positive effect on efficiency scores. For example, despite being in metropolitan provinces some hospitals in Istanbul, Izmir, and Kocaeli provinces were not efficient in four years. To increase their efficiency scores, such hospitals should try to increase their BTR and SNSD using the advantage of providing services in metropolitan cities.

The generalization of outcomes should be considered in a prudent manner since this study did not cover non-training and

research hospitals, university hospitals, and private hospitals. Additionally, the analysis results have been limited with the simple measurement of training and research hospitals since physical activity criteria such as PA, InP, and number of surgeries (A, B, and C) were used as output variables in this study, and it does not include the outcome criteria analyzing the changes in the health levels of treated individuals (case mix index, the success rate of surgeries, etc.). Hence, future studies, that would consider the health care services of private, public, university, and training and research hospitals and health results specific to health care services should be conducted accordingly.

Regardless of such limitations, this study provides crucial tips to hospital administrators and policy makers in the planning of health care services since there are no studies that identify both the efficiency and factors affecting the efficiency (two stage DEA analysis) at training and research hospitals in Turkey concurrently.

Acknowledgments

We would like to thank Hacettepe University Teknokent Teknoloji Transfer Merkezi for its contribution regarding editing.

Author statements

Funding: None.

Competing interests: None declared.

Ethical approval: Not required.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.hlpt.2019.08.008.

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