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EFFECT OF HEALTHCARE EXPENDITURE ON THE CORRELATION BETWEEN THE NUMBER OF NURSES AND DOCTORS EMPLOYED

Abdulkadir ATALAN*,

* Assistant Professor, Gaziantep Islam Science and Technology University , Turkey
abdulkadiratalan@gmail.com
ORCID Number: 0000-0003-0924-3685

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Abstract

Aim: The aim of this study is to analyze the correlation between the numbers of doctors and nurses, as well as the effect of health expenditure (HE) on the employment of doctors and nurses.

Methods: The study data belong to the Turkish health system and cover the years 1975-2018. The amount of HE data was handled as the ratio of Turkey to national income (GDP). Pearson correlation test and linear regression model methods were used in this study. The doctor-nurse ratio was examined in order to see the interaction levels of the relationship between the doctor and the nurse apart from the correlation.

Findings: There is a strong correlation between nurse and doctor employment, and the correlation value was calculated as 0.973 (p-value=0.001, n=44 samples). Correlation coefficients between dependent variables and independent (HE) variables were analyzed as 0.715 (p-value=0.001) for nurse employment and 0.840 (p-value=0.001) for physician employment, respectively.

Conclusion: The amount of HE was very effective on both the number of physicians and the nurses based on the regression analysis.

Keywords: The number of physicians, The number of nurses, Healthcare expenditure, Pearson correlation, Linear regression model

Introduction

Healthcare systems generally develop according to the economic structures of countries (Pellegrini et al., 2014). Countries make investments in healthcare systems by allocating a certain amount of budget in gross domestic product (Atalan, 2020; Eriksen & Wiese, 2019). Spending for healthcare systems is defined in the literature as healthcare expenditure. HE amounts are usually shown as a ratio to GDP (Nghiem & Connelly, 2017). The resources of healthcare, technological systems required for treatment/examination, medicines, and physical structures are included in the amount of HE in countries (Craven et al., 2009). It varies depending on factors such as population, disease, and pandemic in determining this budget amount. In this study, only the effect of the amount of HE on the employment of doctors and nurses was examined.

There are two types of definitions in healthcare systems: healthcare resources and healthcare components (Atalan & Donmez, 2020; Siciliani et al., 2009). The description of healthcare resources is divided into two parts: human structure and physical structure. The human factors such as a doctor, nurse, technician, technician, officer, secretary, etc., are included in the structures created by human professionals. The locations such as beds, treatment rooms, triage units, etc., are defined physical structures. In this study, although it does not include physical structures, human factors are included. Hospitals, insurance organizations, pharmacy structures, and the states defined as rule makers are defined as components of the healthcare system (Mihaylova et al., 2011). The patient factor is at the center of both healthcare components and resources.

Statistical analysis methods are at the forefront of studies for healthcare systems (Briggs & Gray, 1999; Malehi et al., 2015; Rachmani et al., 2019). The relationships between healthcare status, HE, and healthcare resources, which have an impact on healthcare inequalities in the healthcare systems of some European countries, were analyzed using multidimensional statistical methods (Pacáková et al., 2019). Regression statistical analyses were preferred, especially healthcare economics and resources (Folland et al., 2013; Gerdtham et al., 1992; Jaba et al., 2014;

Yang, 2019). Kurtzman and Barnow selected multivariate regression analysis to compare the healthcare service quality and practice models provided by general practitioner nurses and practitioner physicians, and physician assistants in community health centers (Kurtzman & Barnow, 2017).

Researchers have used simple regressions, analysis of variance tests, and chi-square tests to determine the importance of employing nurse practitioners in both rural and non-rural primary care practices (Barnes et al., 2018). The logistic regression model was used to determine the barriers encountered during the treatment between the medical emergency team and the doctors and nurses employed in the wards (Radeschi et al., 2015). Abedi et al. used the regression method to analyze healthcare and economic inequalities in the United Kingdom during the Covid-19 pandemic (Abedi et al., 2021).

Doctors and nurses have an important place in the healthcare system as much as the patient (Svensson, 1996). The number of employments in these two professions depends on many factors. In a study, the effect of population data on healthcare resource employment was statistically measured. In another study, the impact of healthcare resources on per capita health expenditure (HEpc) and the amount of general HE was analyzed with multi-objective statistical optimization models (Atalan, 2018). In this study, unlike other studies, the effect of HE on healthcare resources was analyzed statistically. In addition, the correlation effect of nurse employment depending on doctor employment was analyzed.

This study consists of four parts. The literature review on healthcare systems and the methods used for healthcare systems analysis was discussed in the first section. Theoretical and mathematical information about the data and methods used in this study were given in the second part. The third section includes the numerical and statistical results obtained from the methods used. The last part of the study involves the conclusion part of the study.

1. Research Methodology

The data of the Turkish healthcare system were taken into account in this study. Data on doctors, nurses, and HE were used for 44 years, between 1975 and 2018. These data were obtained from the Turkish Statistical Institute (TUIK, 2021). Ethics committee approval is not required as

the data used is publicly available and references the data used for this study. The distribution of the number of doctors and nurses employed by years was shown in Figure 1 and Figure 2.

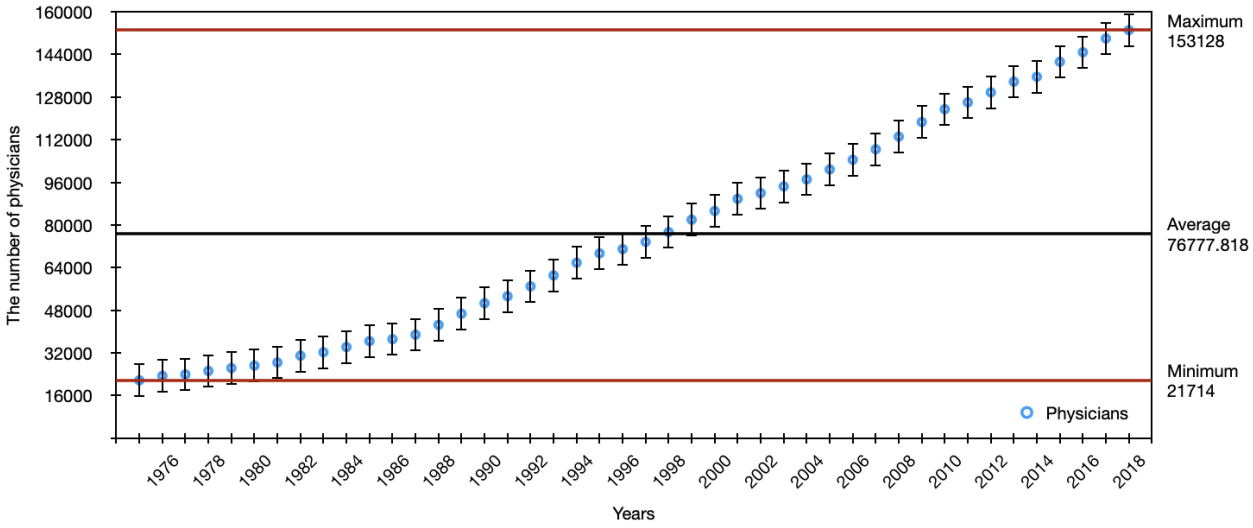

Figure 1. The number of physicians employed between 1975-2018

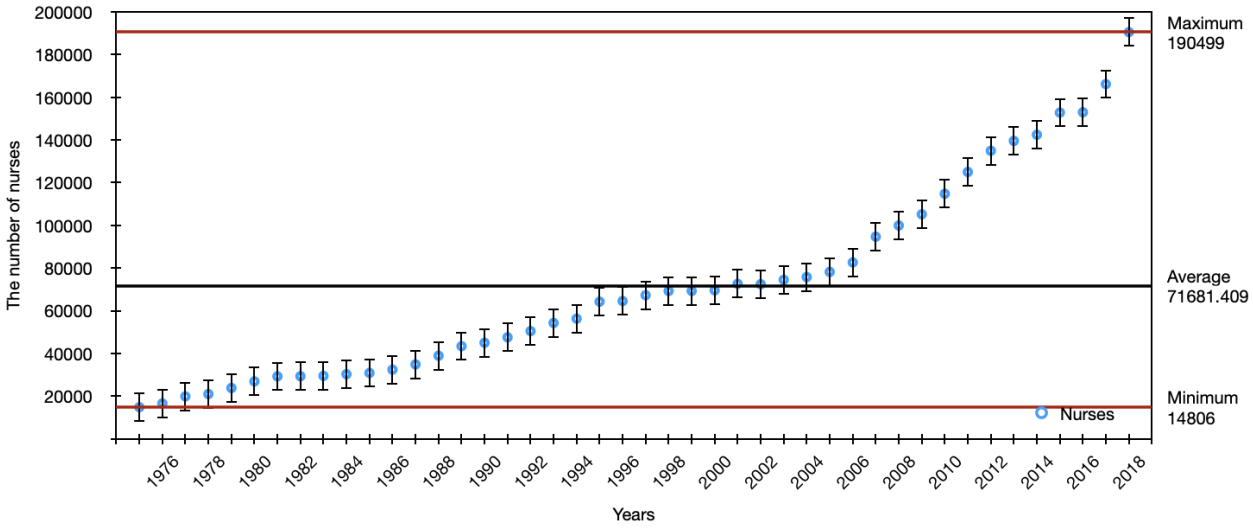

Figure 1. The number of nurses employed between 1975-2018

According to 43 years of data, an average of 77 thousand doctors are employed in the employment of doctors, and it is understood that this rate is equal to the rate in 1998. At the maximum level, 153128 doctors were employed in Turkey. The average nurse employment is at the level of 72 thousand. However, at the top level, it has been observed that with the employment of 190 thousand nurses, it is more than the number of most employed doctors. Descriptive statistics of dependent and independent variable data were given in **Table 1.**

Table 1. The descriptive statistics for the dependent and independent variables

Variables/Statistics	HE	Physicians	Nurses
Sample Size	44.0000	44.00000000	44.00000000
Mean of the samples	3.44600	76778.00000	71681.00000
Standard error of the mean	0.19400	6259.000000	6857.000000
Standard deviation	1.28700	41521.00000	45485.00000
Variance	1.65500	1723978729	2068895062
Coefficient of variance	37.3400	54.08000000	63.45000000
Sum of Squares	593.519	3.340000000	3.150000000
Minimum value	1.49000	21714.00000	14806.00000
Q_1 (the first quartile)	2.23800	36606.00000	31239.00000
Median or Q_2 value	2.94700	72303.00000	65896.00000
Q_3 (the third quartile)	4.67200	111964.0000	98598.00000
Maximum value	5.53400	153128.0000	190499.0000
Skewness	0.15000	0.290000000	0.880000000
Kurtosis	-1.63000	-1.230000000	-0.050000000

As a general perception in healthcare management, nurses are perceived as physician assistants. For this reason, it is assumed that the number of nurse employment depends on the number of physician employment. The Pearson correlation method was used to calculate the correlation value between these two healthcare resources. Correlation value for data set of two variables (Minitab, 2021)

$$r = \frac{\sum_{i=1}^{t}(n_i - \bar{n})(m_i - \bar{m})}{(t-1)(s_n s_m)} \quad (1)$$

is calculated with the formula. Where, the Pearson correlation coefficient is denoted by r. The number of observation data in the sample data set is expressed as t. n_i and m_i are the sample data in the n and m data sets, respectively. The mean values of the data in the n and m data sets are shown as $\bar{n}$ and $\bar{m}$. s_n and s_m are the standard deviation values of the n and m data sets. Correlation values range from -1 to 1. As the correlation coefficient value approaches -1 and +1, it is assumed that there is a strong variable among the variables. Two variables were calculated the correlation value limits as $|0.1 \leq r \leq 0.3|$ for a weak correlation, $|0.3 < r \leq 0.5|$ for an/a average/moderate, and $|0.5 < r|$ for a strong (Cohen, 1988).

There is one independent factor and two dependent factors in this study. The effect of the independent factor on the dependent factors was measured using the linear regression analysis

method. If there is only one independent variable in a simple linear regression, the following formula is used (Montgomery et al., 2015):

$$y_r = \beta_0 + \beta_1 x + \in \quad (2)$$

where, the y_r and x variables represent the dependent and independent variables, respectively. β_0 refers to the constant regression coefficient, while β_1 denotes the coefficient of the independent variable. $\in$ is the margin of error of the regression equation. Two different regression equations were obtained in this study since there are two dependent and one independent variables. These equations are formed as follows:

$$y_{physician} = \beta_0 + \beta_1 x_{he} + \in \quad (3)$$

$$y_{nurses} = \beta_0 + \beta_1 x_{he} + \in \quad (4)$$

Minitab 18 statistical program was used for both Pearson correlation and linear regression analysis.

2. Analysis

The correlation value between the two dependent variables, the number of doctors and nurses employed, was calculated as 0.973 (p-value=0.001). Correlation coefficients between dependent variables and independent (HE) variables were analyzed as 0.715 (p-value=0.001) for nurse employment and 0.840 (p-value=0.001) for physician employment, respectively. With these correlation values, it is understood that the number of physician employment has a significant effect on nurse employment. The results of linear regression analysis of dependent and independent variables are given in **Table 2.**

Table 2. Statistical analysis results of dependent and independent variables

Variables/Statistics	The number of Physicians	The number of Nurses	HE
Sum of Squares	52354972629	45519282584	----------
Mean of Squares	52354972629	45519282584	----------
f-values	100.98	44.010	----------
p-value	< 0.0001	< 0.0001	----------
intercept	-16670 (±9913)	-15453 (± 14001)	0.6146-0.6110
95% Confidence Intervals	-36683 to 3343	-43720 to 12814	-0.1520 to 1.143 -0.7122 to 1.356
R-square (%) Goodness of Fit	70.62	51.17	----------

There is a positive interaction between the dependent and independent variables. According to table 2, it was statistically analyzed that the amount of HE was very effective on both the number of doctors and the nurses. In other words, we can assume that the employment of doctors and nurses is effective with HE separately. The regression equations for the defined dependent and independent variables were formed as follows:

$$y_{physician} = -16669.98028 + 27121.69452x_{he} + \in \quad (5)$$

$$y_{nurses} = 15452.62278 + 25289.22707x_{he} + \in \quad (6)$$

The doctor-nurse ratio should be examined in order to see the interaction levels of the relationship between the doctor and the nurse apart from the correlation. To analyze the relationship between nurses, one of the assistant doctors in health systems, the following formula was used:

$$The\ ratio\ of\ the\ healthcare\ resources\ = \frac{nurses_{t_i}}{physicians_{t_i}} \quad (7)$$

where, the year $t_i;\ i = \{1975, 1976, \ldots, 2018\}$ of each data value from the data in the data set was shown. According to this formula, the number of nurses assisting a doctor was calculated. The doctor-nurse ratio is shown in **Figure 2**.

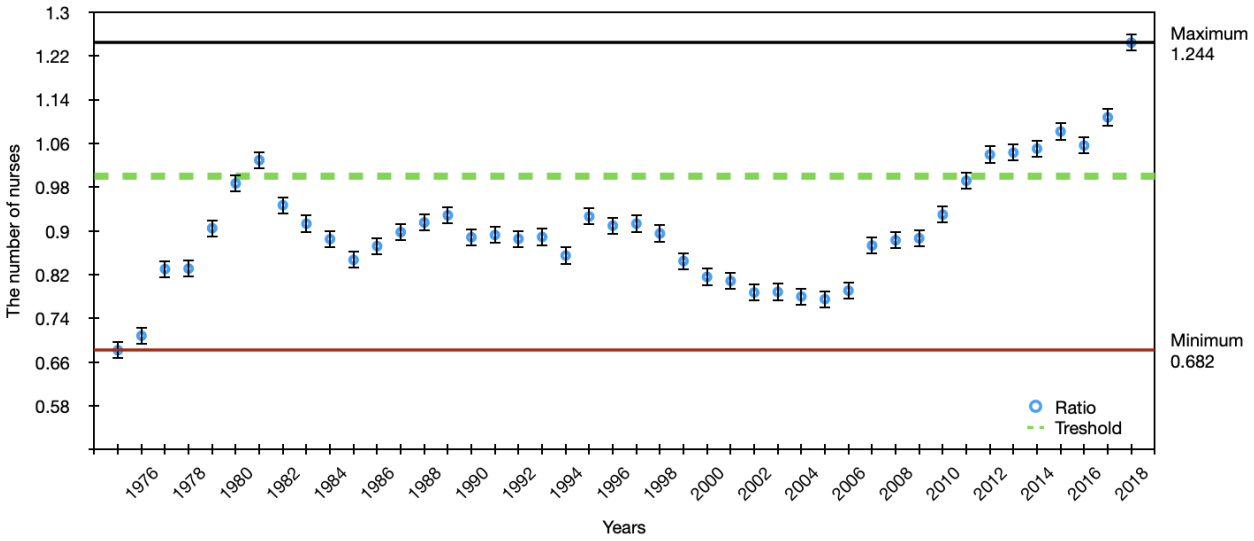

Figure 2. The ratio of the number of nurses to the number of doctors

According to **Figure 3**, the doctor-nurse ratio fluctuates over the years. Based on the correlation analysis, although the relationship between the number of nurse employment and the number of physician employment is strong, there are fluctuations in the 44-year doctor-nurse ratio. We defined the values where the number of doctors equals the number of nurses as a threshold line in these data. We suppose that according to the threshold line, it is possible to work with a doctor and a nurse. According to Turkey data, the threshold line has been exceeded for only eight years (1980, 2012, 2013, 2014, 2015, 2016, 2017, 2018). The doctor-nurse ratio increased continuously after 2011. Based on the calculated doctor-nurse ratio, the number of nurses per doctor in the last eight years has been more than 1.00. However, this does not mean that this ratio is the same in every hospital, regardless of the distribution of nurses and doctors. For this reason, it is necessary to obtain the number of doctors and nurses working in each hospital to determine this rate in the studies to be carried out.

3. Conclusions and Recommendations

This study was created by using the data of the Turkish healthcare system. The dependent and independent data defined for the study cover the years 1975-2018. Two methods were used in the study. By calculating the correlation values between the dependent and independent variables, the number of nurse employment numbers on the number of physician employment was analyzed. In the second method, the regression equations were obtained using the statistical analysis of the

relationship between the dependent variables and the independent variable. As a result, the employment of doctors and nurses from healthcare sources has great effects on the determination of the amount of HE. In future studies, using these data will lead to calculating the estimation data of the healthcare resources to be employed in a country.

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