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THE CORRELATION BETWEEN 2 HUMAN RESOURCE INDICATORS, THEIR RATIO AND ESTIMATED LIFE EXPECTANCY IN 49 EUROPEAN AND CENTRAL ASIAN COUNTRIES

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Abstract

The purpose of this paper is check if there is a linear correlation between 2 human resource indicators, their ratio and estimated life expectancy. The paper studies if there is any linear correlation between physicians / 100000 population, pharmacists / 100000 population, the ratio physicians / 100000 population / pharmacists / 100000 population and estimated life expectancy. WHO data from 2013 was used for the following European and Central Asian countries: Albania, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia & Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, France, Finland, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Luxembourg, FYR Macedonia, Malta, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovenia, Spain, Sweden, Switzerland, Tajikistan, Turkey, Turkmenistan, Ukraine, United Kingdom and Uzbekistan. Pearson linear correlation coefficient was calculated for all paired indicators and subsequent scatter diagrams were drawn. The r correlation coefficient was compared with critical values of $\acute{\alpha} = 0.05$ and $\acute{\alpha} = 0.01$. It was found that there is a strong linear correlation $\acute{\alpha} = 0.05 < r < \acute{\alpha} = 0.01$ between estimated life expectancy and physicians / 100000 population, between estimated life expectancy and pharmacists / 100000 population, as well estimated life expectancy and the ratio physicians / 100000 population / pharmacists / 100000 population. In addition r2 was calculated in order to understand the proportion to which the variation of estimated life expectancy is explained by linear association between the respective human resource indicator and estimated life expectancy. The research shows which of those human resource indicators have a linear correlation whith estimated life expectancy and to what degree. It yields interesting inferences about health care delivery patterns, and can provide policymakers a hint to increase resource allocation efficiency, and improve access to care.

Keywords:

Estimated life expectancy, human resource indicators, linear correlation

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Introduction

The estimated life expectancy is a statistical indicator defined by the number of years that will a new born live, considering the mortality in the year of birth. It depends on several factors which span from genetics, gender, diet, lifestyle and vices, stress, to environment, economical status, accidents, and diseases. Since the overwhelming majority of people die from disease it is very important the health system the individual lives within. The health system develops two kinds of activities to combat disease: prevention and curative medicine. If prevention is very effective in tackling transmittable diseases, it is less effective against chronic diseases. However, at this moment the other function of the health system, curative medicine is rather successful in fighting diseases lengthening the lives of individuals. This function is performed either by treating ill patients and restoring their health or by keeping the chronic diseases under control. The core resource used in this endeavor is the human resource, mainly doctors who diagnose diseases and prescribe pharmaceuticals or perform surgical treatments and pharmacists whose jobs are dispensing drugs. This is the common knowledge about this issue.

Purpose

The purpose of this paper is to analyze whether there is a linear correlation between estimated life expectancy and few human resource indicators in the health care system, namely number of doctors, number of pharmacists and the ratio between them in European and Central Asian countries. Based on the existence or non-existence of linear correlations as well as their strengths, the paper wants to draw the attention about the importance of these resources in order to improve access to care as well as allocational efficiency. Another purpose is to allow comparison between countries providing policy-makers an insight regarding various policies in specific clusters of countries.

Method

It was studied if there is any linear correlation between estimated life expectancy and the following human resource indicators of the health system: physicians / 100000 population, pharmacists / 100000 population, and the ratio physicians / 100000 population / pharmacists / 100000 population.

Research design

Data used comes from 2013 Health for All Data Base of WHO (1) on which the indicators were constructed. Estimated life expectancy was paired with physicians / 100000 population, pharmacists / 100000 population, and the ratio physicians / 100000 population / pharmacists / 100000 population, for each country.

Thus, Pearson linear correlation coefficient was calculated for all paired indicators and subsequent scatter diagrams were drawn. The calculated (r) correlation coefficient (2) was compared with critical values of $\alpha = 0.05$ and $\alpha = 0.01$ (3), and depending on the value of r we came out with 2 categories: strong correlation and very strong correlation. When calculated (r) for certain pairs was between +/1 and +/- $\alpha = 0.01$ respectively, it was considered a strong correlation between estimated life expectancy and the respective indicators. In other words (r) exceeding the critical value for $\alpha = 0.01$ means that there is a 99% chance there is a linear correlation. When calculated r was almost double the value of $\alpha = 0.01$ it was considered a very strong correlation.

Because in real life the estimated life expectancy is the result of many factors, for the paired indicators which showed a linear correlation, (r^2) was calculated in order to show to which proportion the variation of a variable is attributable to the other variable. The value of (r^2) was translated as % of influence of that factor on the estimated life expectancy (4).

Universe and sampling

We used data from WHO Health-for-All-Data Base, from the year 2013.

The countries included on this study are: Albania, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia & Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, France, Finland, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Luxembourg, FYR Macedonia, Malta, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovenia, Spain, Sweden, Switzerland, Tajikistan, Turkey, Turkmenistan, Ukraine, United Kingdom and Uzbekistan.

Unfortunately we did not find data for all countries and all indicators. This is why the number of pairs ranges from 44 for pharmacists / 100000 population 49 for physicians / 100000 population respectively. There are also variations regarding both indicators, variations explained by the way the health system of that country is designed. This specific organizational design is reflected in the data reported. However, this variation of data is offset by the calculation method; the correlation coefficient varies with the number of pairs, and in order to assess the linear correlation a table with the critical values of the linear correlation coefficient was used, as stated above.

Data analysis

For the pairs between estimated life expectancy and the human resources indicators, the findings of this study are the following:

It was found a strong linear correlation ($-\alpha = 0.05 < r < \alpha = 0.05$) between estimated life expectancy and physicians / 100000 population,

It was found a very strong linear correlation ($-\alpha = 0.01 < r < \alpha = -0.05$ or $\alpha = 0.05 > r > \alpha = 0.01$) between the estimated life expectancy and pharmacists / 100000 population and between estimated life expectancy and the ratio physicians / 100000 population / pharmacists / 100000 population.

The above is illustrated in Table 1 below:

Table 1. Correlation Between Estimated Life Expectancy and Physician Number

VARIABLES PAIRED WITH ESTIMATED LIFE EXPECTANCY	n (pairs)	r value	α = 0.05	α = 0.01	interpretation	r square
Physicians / 100000 population	49	0.378	0.294	0.378	strong correlation	0.14
Pharmacists / 1000000 population	44	0.636	0.312	0.402	very strong correlation	0.40
Physicians / 100000 population / Pharmacists / 100000 population	44	-0.517	0.312	0.402	very strong correlation	0.27

Here is the description of the findings for each pair of indicators: estimated life expectancy and resource indicator:

For the variables estimated life expectancy and physicians / 100000 population, there were 49 pairs, corresponding to 49 countries. The r value found was 0.378 and for this number of pairs the correlation coefficient for $\alpha = 0.05$ was 0.294 and the correlation coefficient for $\alpha = 0.01$ was 0.378. Hence, a strong Pearson linear correlation was found. This is illustrated in Figure 1 below:

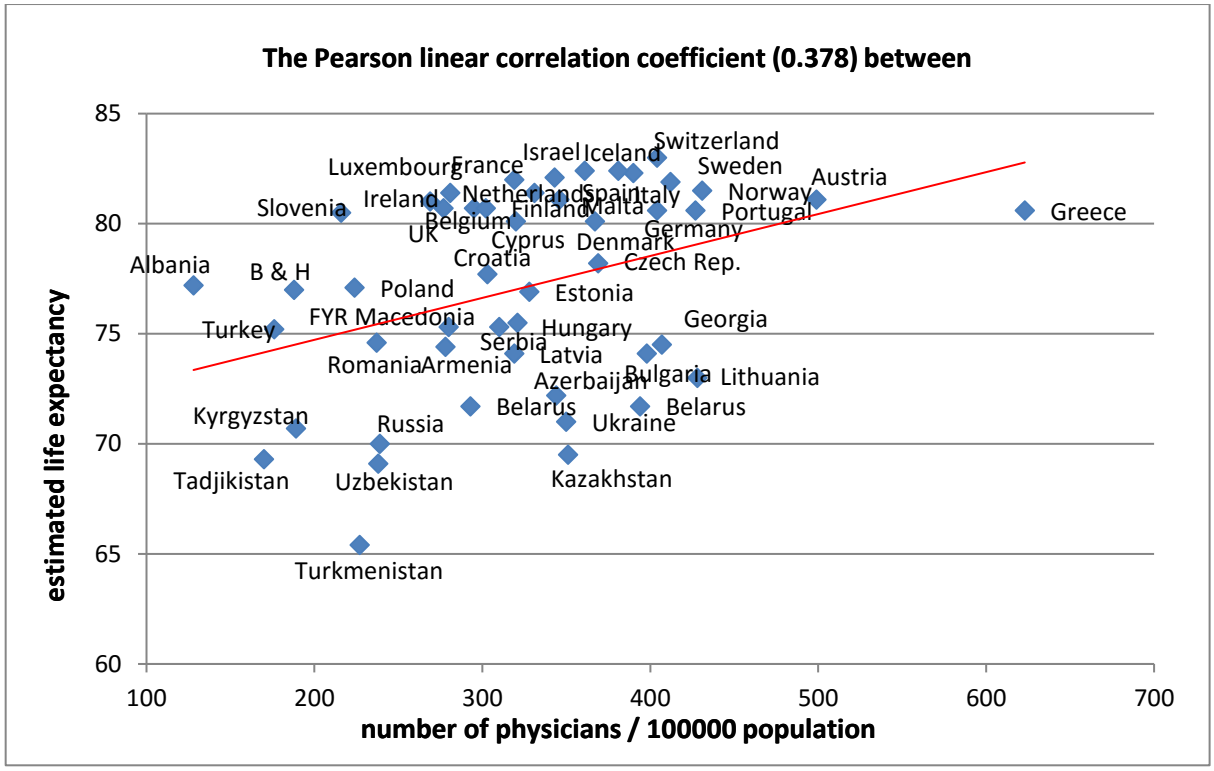

Figure 1. Correlation Between Estimated Life Expectancy and Number of Physiciansin 100.000 Population

The data shows that the more physicians / 100000 population, the higher the estimated life expectancy. Indeed countries like Tajikistan and Greece which are far away on the graph illustrate this. However countries like Turkmenistan and Slovenia have roughly the same number of physicians / 100000 population but the estimated life expectancy is more in Slovenia than in Turkmenistan. This might be explained by social factors or by differences in the organization of the health system which result in lower access to care in Tajikistan. As intriguingly is the similarity between Austria and Ireland, which have roughly the same estimated life expectancy but Ireland has half the number of physicians than Austria.

The r^2 was 0.14, showing that the number of physicians / 100000 population is a factor with little influence on the estimated life expectancy.

For the variables estimated life expectancy and pharmacists / 100000 population, there were 44 pairs, corresponding to 44 countries. The r value found was 0.636 and for this number of pairs the correlation coefficient for or $\alpha = 0.05$ was 0.312 and the correlation coefficient for or $\alpha = 0.01$ was 0.402. This corresponds to a very strong Pearson linear correlation. This is illustrated in Figure 2 below:

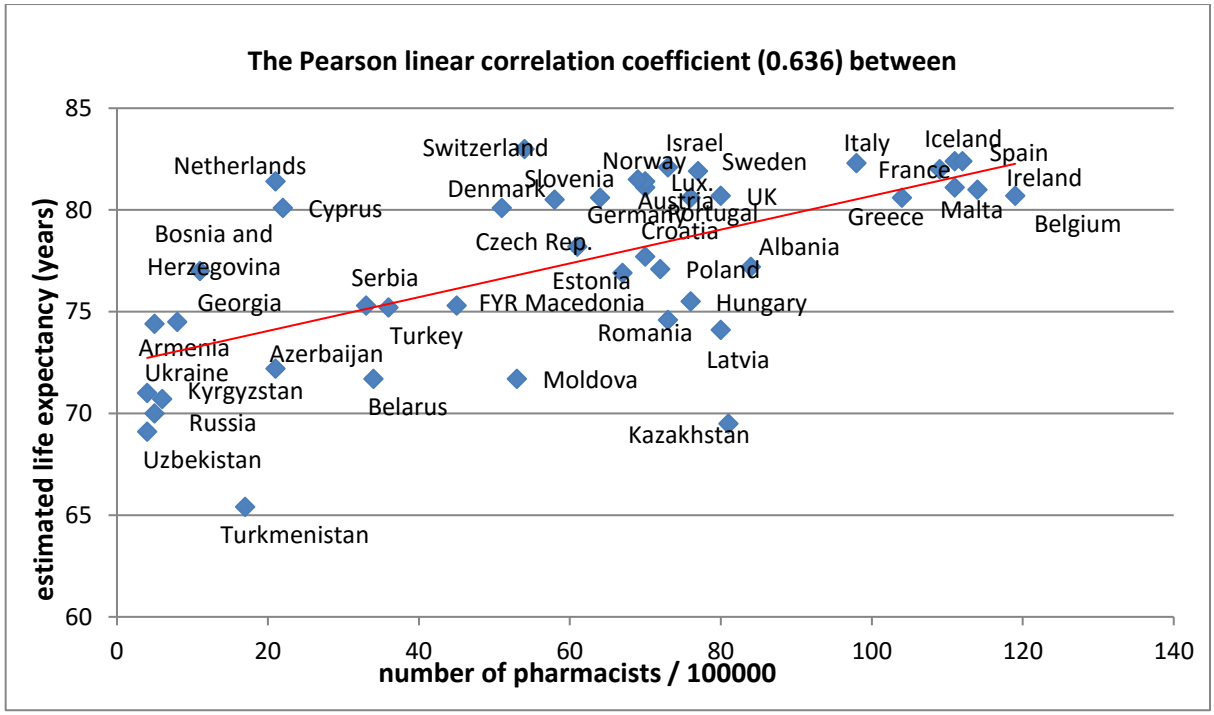

Figure 2. Correlation Between Estimated Life Expectancy and Number of Pharmacist in 100.000 Population

The data is very compelling in showing that the more pharmacists / 100000 population, the higher the estimated life expectancy. Indeed countries like Uzbekistan and Spain which are far away on the graph illustrate this. However countries like Turkmenistan and Netherlands have roughly the same number of pharmacists / 100000 population but the estimated life expectancy is more in the Netherlands than in Turkmenistan. This might be explained by social factors or by differences in the organization of the health system which result in lower access to care in Tajikistan. As intriguingly is the similarity between Netherlands and Belgium, two neighbor countries, which have roughly the same estimated life expectancy but the Netherlands has 6 times less pharmacists than Belgium. This might be caused by the regulation of the retail pharmaceutical sector.

The r^2 was 0.40 showing that the number of pharmacists / 100000 population is an important factor in influencing the estimated life expectancy.

For the variables estimated life expectancy and the ratio number of physicians / 100000 population / number of pharmacists / 100000 population, there were 44 pairs, corresponding to 44 countries. The r value found was -0.517 and for this number of pairs the correlation coefficient for $\alpha = 0.05$ was 0.312 and the correlation coefficient for or $\alpha = 0.01$ was 0.402. This shows also a very strong negative Pearson linear correlation between the estimated life expectancy and the ratio physicians / 100000 population / pharmacists / 100000 population, in other words a low ratio is correlated with high estimated life expectancy and a high ratio with low estimated life expectancy. This is illustrated in Figure 3 below:

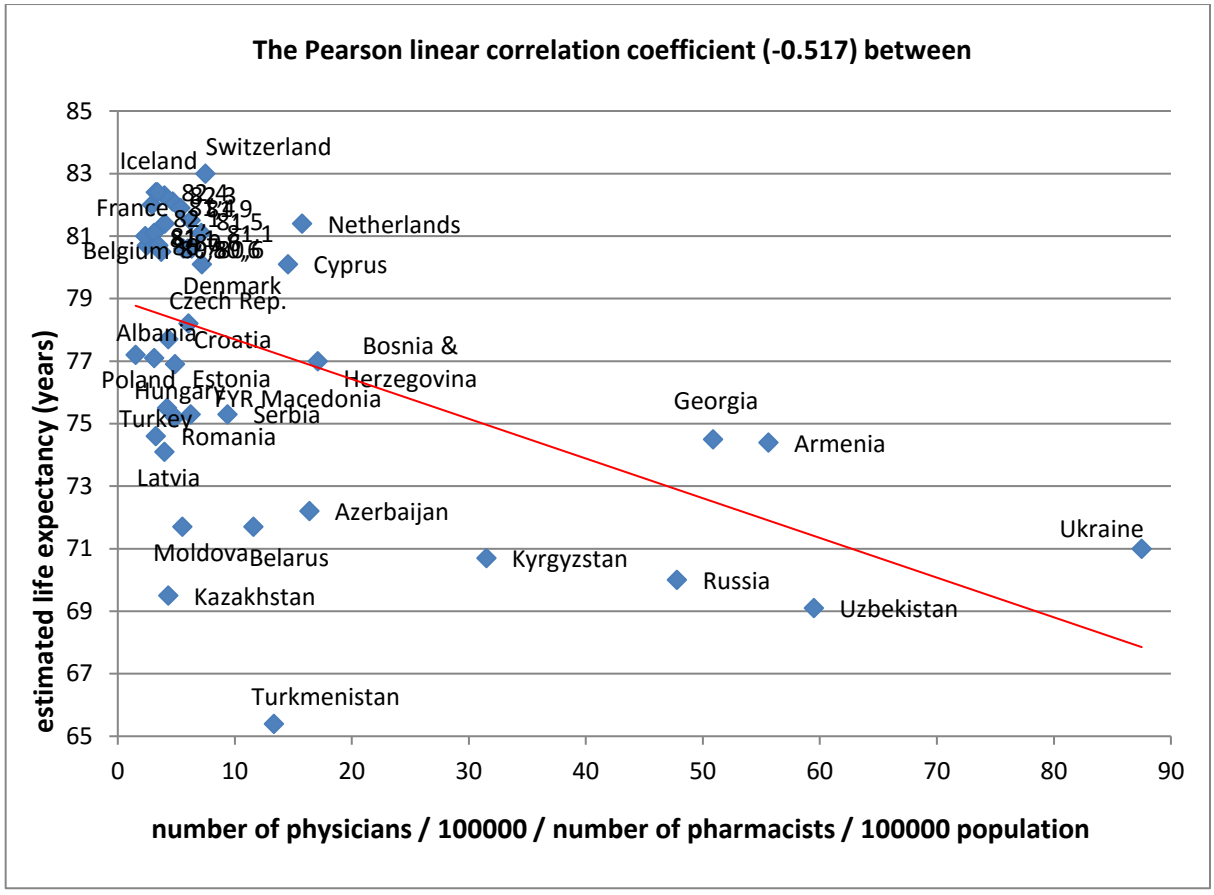

Figure 3. Correlation Between Estimated Life Expectancy and Number of Physiciansin and Pharmacist

The estimated life expectancy is negatively correlated with the ratio number of physicians / 100000 population / number of pharmacists / 100000 population. This suggests that the more pharmacists there are (the lower the ratio) the higher estimated life expectancy. The graph shows a cluster of western countries where the ratio physicians / pharmacists is low and the estimated life expectancy is high. Hence another cluster of Eastern European Countries where the ratio is also low, but the estimated life expectancy is not so high, and finally several former soviet countries, all with low estimated life expectancy but with the ratio physician / pharmacists ranging from 4.3 in Kazakhstan to 87.1 in Ukraine for approximately the an estimated life expectancy of 69.5 and 71 years respectively.

The r^2 was 0.27 showing that the ratio number of physicians / 100000 population / number of pharmacists / 1000000 is an important factor in influencing the estimated life expectancy, but not as important as number of pharmacists / 1000000 population.

Conclusion

The study shows strong and very strong linear correlations between key human resources of the health system (physicians and pharmacists) and estimated life expectancy. This linear correlation is very strong in regard to the number of pharmacists / 100000 population. It suggests that the key activity of the health system is the treatment, all others being subordinated to it. From a wider perspective access to pharmaceuticals seems to be a key factor for increased life expectancy. The study also suggests that there is a proper ratio physicians / pharmacists which should be low. This study is useful for policy makers allowing for comparisons between countries with different health systems.

Bibliography

Triola, M.M, & Triola M.F. (2006). Correlation and Regression, in Pearson Education, Inc., Biostatistics for the Biological and Health Sciences, p. 431,436,640.

WHO. European Health for All Data Base, available at http://data.euro.who.int/hfadb/. (Accessed Date: 2/20/ 2018)