ANALYSIS AND FORECAST OF THE EMPLOYEES IN THE PUBLIC AND PRIVATE HEALTH SYSTEMS IN ROMANIA

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Abstract:
In this paper, a statistical analysis is made of the health personnel in Romania in the public and private systems using data from the period 1990-2022, provided by the National Institute of Statistics. Using the least squares method, analytical functions are found that model the trend and forecasts are made for the years 2023 and 2024. The confidence intervals for the predictions are also found, at a significance threshold of 5%, and the correlations between certain indicators are analysed. It was found that in the public sector there was a downward trend, in general, for all categories of medical personnel in the period 1990-2017, followed by an increasing evolution after 2018, due to salary increases in the system. However, there is still a shortage of physicians in the public sector, even if their number has steadily increased in the last years. There is no correlation between the number of physicians and the number of beds in public hospitals, although this should be positive and high. On the other hand, in the private sector the trend is obviously increasing throughout the studied period, the correlations are very strong between the analysed indicators, a situation explained by the fact that in this system the goal is to minimize expenses and increase profit and less access of all citizens to health services.

Keywords: health system, statistical analysis, forecasts, correlations, health management.

1. Introduction

Health is one of the most important areas in a society, having an impact on economic and social results, because it is closely linked to productivity, human capital and the availability of resources, thus contributing to economic growth and the sustainable development of society. We can say that an effective health system is essential for any country to be able to achieve its social and economic goals, to ensure that citizens have the opportunity to lead a healthy and productive life. A

country's health system can also have an impact on its reputation and competitiveness on a global scale. But as the global population grows, the demand for more employees in the medical sector increases simultaneously.

The migration of health personnel is also a phenomenon watched with increased attention worldwide. In Europe, the creation of a borderless labor market and the enlargement of the EU after the 2000s made it possible for healthcare personnel to move to another EU member state. For Romanian physicians, the EU-level recognition of the diploma created new opportunities, while inadequate working conditions and relatively low salaries until 2017, led many of them to emigrate (Apostu et al., 2022, Balan and Dumitru, 2017). On the other hand, patients' awareness and satisfaction increase in correlation with technological processes and therapeutic procedures (Radu et al., 2021). Therefore, public hospitals in Romania should offer patients quality and ensure the efficiency and professionalism of the medical staff, as well as a high level of patient satisfaction and safety. But these objectives cannot be achieved without a sufficient number of employees in the medical field and a financing that is adequate to the real needs of the system.

The medical system in Romania after 1990 went through a series of transformations and challenges, reflecting the social, economic and political changes of the post-communist period. After 1990, Romania began to implement reforms in the health sector, including the decentralization of the medical system. This change involved the transfer of responsibilities to local authorities, which led to significant differences in the quality and accessibility of medical services in different regions (Asandului et al., 2013; Breazu et al., 2023). Also, the Romanian medical system has been affected by chronic underfunding and limited resources. The budget allocated for health was often insufficient to cover the real needs of the population, which led to shortages in equipment, medicines and medical personnel. As I mentioned before, a significant problem in the Romanian medical system after 1990 was the massive emigration of medical personnel in search of better working conditions and higher salaries abroad. This migration has had a negative impact on the system's ability to provide quality healthcare (Apostu and Vasile, 2020).

In contrast, there has been an increase in the private sector in health. Private clinics, hospitals and private health insurance began to become more and more present, providing additional options for those who could pay for medical services. On the other hand, many hospitals and public health units in Romania have encountered difficulties in maintaining and modernizing the infrastructure. This has led to poor working conditions, outdated equipment and a lack of specialized medical services in many places. Despite the problems, Romania has implemented a compulsory health insurance system to ensure the financing of medical services. However, the effectiveness of the collection and distribution of funds was often challenged, and access to certain treatments or procedures was limited. Over the years, there have been efforts to reform the health system to improve the efficiency and quality of medical services. However, the reforms have had varying degrees of success and have been met with varying levels of resistance. It is important to note that these characteristics reflect a general picture and the specific situation may vary depending on the region and local context. The healthcare system in Romania was and remains a complex field, with multiple challenges and needs for improvement. According to Eurostat statistics for the year 2021, among the EU member states, Greece had 6.29 physicians per 1000 inhabitants, being the best ratio, followed by Portugal with 5.62 and Austria with 5.4 physicians in activity per 1000 inhabitants. At

the bottom of the ranking were France (3.18), Belgium (3.24) and Hungary (3.29), which recorded the lowest rates, being below the threshold of 3.5 per 1000 inhabitants. Romania remains at the threshold level, having a ratio of just over 3.5 physicians per 1000 inhabitants and registering the eighth lowest value among the EU member states. Moreover, according to a report published by the European Commission at the end of 2021, (https://health.ec.europa.eu/system/files/2022-01/2021_chp_romania_romanian.pdf) Romania registers the lowest life expectancy for new-born, some of the highest mortality rates from causes that could be avoided through adequate prevention and high mortality rates from treatable causes. There is also a relatively high percentage of people whose medical problems are not fully resolved, mainly for those with low incomes. Thus, it can be concluded that although the human resource is essential in the health sector, these problems are not exclusively related to the lack of personnel in the system, but there are also other factors that must be taken into account, such as insufficient funding, lack of investment or the fact that only 89% of the population benefits from social health insurance.

The current work aims to make a statistical analysis of the medical staff in Romania, both in the public and private sectors. The trends, the evolution over time will be analyzed and an attempt will be made to identify the causes of the fluctuations of medical personnel in the last 25-30 years. Also, forecasts will be made on the number of employees for the different staff categories and the confidence interval for the prediction will be found, at a significance threshold of 5%. Finally, we will analyze the correlation coefficients between the number of physicians, the number of medical personnel, the number of beds in hospitals and the number of hospitals in the public and private sectors and we will interpret the results.

Forecasting the number of employees in the health system is essential in resource management and effective staff planning in the health sector. By correctly estimating staffing needs, facilities can ensure they have the right number of physicians, nurses and support staff to meet patient needs. Anticipating the number of employees allows healthcare organizations to allocate their financial resources efficiently, taking into account staff salaries and benefits. This contributes to better budget management and avoiding unplanned expenses. Forecasts can also take into account demographic changes, such as population growth, aging or migration, to anticipate increasing health service needs and adjust staffing levels accordingly. Moreover, in emergency situations, such as the Covid pandemic, forecasting the number of employees is crucial and allows health institutions to quickly adapt their staff to cope with the sudden increase in demand for medical services. Also, the anticipated knowledge of personnel needs contributes to the optimization of organizational performance. It can help identify weaknesses and develop strategies to improve efficiency in health care delivery.

In terms of determining forecast confidence intervals, this provides a measure of the possible variability around the central forecast. Confidence intervals are useful for quantifying the uncertainty associated with predictions and help decision makers account for variability in decision making. These ranges reflect the fact that although we make estimates, there is always some uncertainty associated with future forecasts. In general, the forecast of the number of employees in the health system and the determination of confidence intervals contribute to more efficient planning and administration, ensuring the optimal provision of medical services in accordance with the needs of the population.

The present paper is structured as follows. In the second section, an analysis of the specialized literature in the field is made, with emphasis on the case of the countries of the European Union and especially Romania. The third section is dedicated to the research methodology, briefly presenting the main scientific research methods and statistical tests used to validate the results. The fourth section presents the results of the statistical research of medical personnel from the public and private sector. We will use descriptive statistics, including the mean, the standard deviation and the coefficient of variation in the analysis of the data series, but also certain statistical indicators specific to the chronological series such as the absolute mean change, the mean index growth, the mean rate of growth and the absolute mean value of a percentage of growth rate. The aim is to evaluate the changes, developments and trends in the number of employees in the health sector corresponding to the period 1990-2022 for the public sector and 1997-2022 for the private sector. We will use the method of least squares to be able to find the analytical functions that model the trend and with the help of which we will be able to make predictions. We will test whether the model errors follow a normal distribution and determine the confidence intervals of these predictions at a 5% significance level. Finally, an analysis will be made of the correlations between the number of physicians, the number of medical assistants, the number of beds available in hospitals and the number of hospitals in Romania and we will interpret the results, with the aim of determining the links between these indicators.

2. Literature Review

Several research papers have analyzed and studied the health system in Romania and the European Union from a comprehensive perspective. In the study carried out by Apostu, Vasile, Marin and Bunduchi (2022), it is shown that after Romania's accession to the EU, the migration phenomenon of physicians intensified, contributing significantly to the shortage of physicians in Romania. In this sense, the factors that influence the decision of physicians to migrate from Romania were identified, using a panel regression analysis, resulting in the fact that the migration of physicians is influenced by several factors, such as: the number of beds in hospitals, the number of emigrants, unemployment rate and income. It was also analyzed to what extent public policies in the field of medical staff salaries influenced the migration decision of practicing physicians, already employed or recently graduated. The results obtained in the paper confirmed the fact that public policies can be a tool for redistributing labor allocation in the health sector. Moreover, the results also highlight the fact that specific measures do not solve the crises in the system faced by the health sector, as deeper, multidimensional changes are needed, adapted to the needs of medical services that are specific to the geographical area and appropriate to the health status of the population.

The work of Bălan and Dumitru (2017) shows that migration from the health field is influenced by several factors. In Romania, the migration of health workers was and is a predominant topic of concern, along with the quality of medical services, their availability, but also the number of physicians in both the public and private sectors. The migration process seems to go beyond the well-known and documented factors of migration, as the decision to migrate seems to contain considerations that go beyond the traditional individual goals in the literature. Consequently, economic and social analyzes are of increased interest, but also a permanent concern. The

paper makes a brief analysis of the size and structure of migration flows of health personnel in Romania in the complex context of the European crisis and post-crisis, but also a short-term forecast, the results being obtained before the salary increases of 2017 in the health field. Since there is uncertainty regarding the extent of the exodus of Romanian physicians, the work of Suciu et al. (2017) conducted a survey to assess the migration intention of future Romanian physicians. The study was carried out during three consecutive years 2013-2015 at the University of Medicine and Pharmacy "Iuliu Hatieganu" Cluj-Napoca, Romania. The questionnaire included 19 questions regarding the migration intentions of students, on a sample of 957 undergraduate students. Thus, 84.7% of students wanted to look for a job abroad after graduation. A large number of students had already started preparing for emigration, 21.7% of those who wanted to migrate had at least one Erasmus mobility in the chosen country, 44.5% followed a language course, and 42.7% had looked for jobs in the health field on the Internet. The findings of this study are worrying and may have an impact on both health policy making and future research. Structural reforms in healthcare are needed to drive retention of healthcare workers. Recently, intensively studied topics include healthcare workers and the impact of the Covid pandemic on the healthcare system. The work of Breazu, Olariu, Popa and Popa (2023) analyzed the level of resources and the quality of the health system in the 42 counties of Romania. In this sense, national statistical data were collected and several indicators were investigated in relation to the allocated resources, such as the average number of physicians and hospitals, but also the quality of the health system, where values such as the average birth rate, mortality and others. The conclusions of the study led to the division of the country into four groups, depending on the availability of medical resources per thousand inhabitants, where medical resources are limited and where resources are high. Moreover, it was determined that there is a statistically significant difference between medical resources and mortality rate.

In the study by Iacobută, Asandului, Gavrilovici and Oprea (2013), several inequalities in the health system in Romania are analyzed at the regional level. The similarities and differences are also highlighted, taking into account the socio-economic development, the health status of the population and the material and human resources allocated to the medical system for eight regions in Romania using data collected from Eurostat (2009 - 2010). The results showed large discrepancies between Romania's regions for most of the studied variables. Thus, it resulted that the regions of Bucharest, North-West and West are characterized by a higher level of allocation of resources in the field of medical assistance, these geographical areas also having a higher level of education and a lower rate of poverty, towards unlike the North-East, South-West and South regions, which present a situation totally opposite to the previous one.

In the work of Vlădescu et al. (2016) an analysis of the health system in Romania is made regarding the organization, financing, provision of medical assistance, health reforms and the performance of the health system. The Romanian health system is a social health insurance system that has remained quite centralized, offering a package of benefits to the 85% of the population that is insured, with the remaining population having access to a minimum package of benefits. Differences in access to health care exist in many regions, such as rural versus urban, and health outcomes also differ between these regions. Romania's population has seen a slight increase in life expectancy and a decrease in the death

rate, but both remain among the worst in the European Union. In 2014, Romania had the lowest health expenditure as a share of gross domestic product (GDP) among EU member states.

The work of Petre et al. (2023) analyzed the health system in Romania, assessing the strengths, weaknesses and impact on the population's access to health services, including insufficient funding, shortage of medical personnel and inefficiency in the provision of services. The study presents three hypotheses. The first hypothesis states that insufficient funding has a negative impact on the availability and standard of health facilities in Romania. The second hypothesis assumes that insufficient medical personnel play a considerable role in regional inequalities and in the access and provision of medical assistance. Finally, the existence of inadvertences in the provision of services hinders the timely and efficient provision of medical assistance. It examines medical infrastructure and financing mechanisms to service delivery and health outcomes, both in public and private providers. This research highlights the criticality of the significant changes implemented in the Romanian health system to address the problems arising from insufficient funding, shortage of medical staff and deficiencies in service delivery.

The quality of medical services offered in public hospitals is an important health indicator. The study by Radu et al. (2021) evaluated patient satisfaction measures used in the Romanian healthcare system. Thus, between January and February 2019, they conducted a study with data collected through face-to-face interviews based on a questionnaire, for patients who used the health system the previous year. The analyzed results led to the conclusion that only 39.71% of the patients were satisfied with the quality of medical services, and 61.29% of the respondents were disappointed with the health system. Being free, the public sector is currently the only option available to a large mass of patients. The findings suggest that traditional measures of patient satisfaction are no longer relevant and that new modalities need to be considered. Regarding the employment rates of physicians and nurses in the public healthcare sector in Serbia from 1961-2008, the study by Santric-Milicevic, Vasic and Marinkovic (2013) analyzed the indicators that shape the supply of physicians and nurses in the public sector of this country. These indicators included: the total annual population, the gross domestic product in prices comparable to 1994, the number of discharges, outpatient care visits, students enrolled in the first year of medical studies at public universities and the annual number of graduating physicians. Thus, two periods (1961-1982) and (1983-2008) were identified and the relationships between the six variables used to plan the employment of physicians and nurses in the public health care sector in Serbia. The most significant indicators for physician employment were population and GDP. The supply of medical personnel was correlated with the number of physicians, and the rates of physicians and nurses per 100,000 inhabitants increased by 13%.

The purpose of the study carried out by Stepovic et al. (2023) was to compare and predict certain indicators that refer to the number of medical personnel and medical technologies in selected countries of Eastern Europe and the Balkans during the period studied. The paper analyzed the reported data of selected health indicators from the European Health for All database, such as: the number of physicians, pharmacists, general practitioners and dentists per 100,000 people. In order to identify the changes in these indicators and the evolution over the years, linear trends, regression analysis and forecasting until the year 2025 were used. The regression analysis showed that in most of the studied countries there was an

increase in the number of general practitioners, pharmacists, dentists, healthcare personnel, as well as in the number of computed tomography scanners and the number of magnetic resonance units, estimated until 2025. Determining trends in medical indicators can help governments and health sector decision makers in making the best decisions to investments for each country depending on their level of development.

3. Research methodology

In the analysis of time series, with the values noted y_1, y_2,...,y_n, there are certain indicators used to evaluate changes and developments over time. In the paper we use the mean indicators:

- the absolute mean change, which is useful in identifying the overall trend level over time, with the formula

$$\bar{\Delta}=\frac{y_n-y_1}{n-1}.$$

- the mean growth index, used to evaluate general trends of growth or decline in the time series, with the formula

$$\bar{I}=\sqrt[n-1]{\frac{y_n}{y_1}}.$$

- the mean rate of growth, which provides a measure of the average rate of increase or decrease of the time series and is obtained from the average index. This can be useful for understanding the speed at which changes occur in chronological data by having the formula

$$\bar{R}=(\bar{I}-1)\cdot 100.$$

- the absolute mean value of a percentage of the growth rate allows the average evaluation of changes that are proportional to a certain percentage value. It can be useful in identifying the relative impact of changes, having the formula

$$\bar{A}=\frac{\bar{\Delta}}{\bar{R}}.$$

These indicators provide information on the evolution of the time series and can help make future decisions. The use of these indicators provides a more comprehensive picture of the evolution of the time series and allows the identification of periods of volatility or stability in the time series data, the evaluation of general trends of growth, decrease or stabilization, the quantification of the mean rate of change in the chronological data, but also the relative impact of changes that are proportional to a certain percentage value.

The least squares method is a widely used technique in statistics and data forecasting, being a common method used in determining the trend function in time series analysis. Instead of looking for an exact function that passes through all the points, we try to find a function that minimizes the sum of the squares of the differences between the estimated and observed values. It is used to find a mathematical model that describes and predicts the evolution of a time series as a function of time. By fitting a linear or nonlinear model, estimates can be made for future points in the series. It is worth noting that the least squares method provides an estimate of the trend function based on the available data, but cannot anticipate unpredictable changes or external influences. That is why it is useful to find, in addition to the point value of the prediction, a confidence interval of the prediction, in which we can say that the value of the prediction will be found with a certain probability.

In the case of a linear prediction of the form $\tilde{y}_i = a + bx_i$, the value of the prediction at point x_0 is given by $\tilde{y}_0 = a + bx_0$, and the confidence interval for the prediction is (see, for example, Georgescu, 2005)

$$\left[\tilde{y}_0 - t_{\alpha,n-2} \cdot s_{\tilde{y}},\ \tilde{y}_0 + t_{\alpha,n-2} \cdot s_{\tilde{y}}\right],$$

where the standard error of the prediction has the expression

$$s_{\tilde{y}} = \sqrt{s^2\left(1 + \frac{1}{n} + \frac{(x_0 - \bar{x})^2}{\sum_{i=1}^{n}(x_i - \bar{x})^2}\right)},$$

and the error dispersion estimate is given by the formula

$$s^2 = \frac{\sum_{i=1}^{n}(y_i - \tilde{y}_i)^2}{n-2},$$

and $t_{\alpha,n-2}$ represents the score corresponding to the confidence level α in the t-Student distribution, adjusted accordingly according to the sample size.

For the case of prediction with a polynomial function of degree *k*, we consider the following form

$$\tilde{y}_i = a_0 + a_1 x_i + \cdots + a_k x_i^k,$$

We initially denote $x_{1i} = x_i,\ x_{2i} = x_i^2, \ldots, x_{ki} = x_i^k$, and obtain the matrix notation $\tilde{y} = X \cdot A$. We consider $\tilde{x} = (1, \tilde{x}_1, \ldots, \tilde{x}_k)^t$ the corresponding vector in which we calculate the point prediction and the prediction value is given by $\tilde{y} = a_0 + a_1\tilde{x}_1 + \cdots + a_k\tilde{x}_k$. The confidence interval for the prediction is (see, for example, Georgescu, 2005)

$$\left[\tilde{y} - t_{\alpha,n-k-1} \cdot s_{\tilde{y}},\ \tilde{y} + t_{\alpha,n-k-1} \cdot s_{\tilde{y}}\right],$$

where the standard error of the prediction has the expression

$$s_{\tilde{y}} = \sqrt{s^2(1 + \tilde{x}^t(X^tX)^{-1}\tilde{x})},$$

and estimating the dispersion of errors

$$s^2 = \frac{\sum_{i=1}^{n}(y_i - \tilde{y}_i)^2}{n-k-1},$$

and $t_{\alpha,n-k-1}$ represents the score corresponding to the confidence level α in the t-Student distribution, adjusted accordingly for sample size.

It should be emphasized that these formulas are applied in the case of the normal distribution of the prediction model errors. The verification of the global significance of the model is done with the help of the *F* test (Fisher) at the significance threshold of 5%. The null hypothesis H_0 (all coefficients are not significantly different from zero) is checked against the alternative hypothesis H_1 (at least one coefficient is significantly different from zero). If the probability attached to the *F* test is less than 0.05, then the alternative hypothesis H_1 is accepted and the model is significant. To check whether the model errors follow a normal distribution or not, we will use several tests: Kolmogorov-Smirnov, Shapiro-Wilk and Jarque-Bera. (for more details, see Georgescu 2005, Maddala 2001, Wooldridge 1999).

The Kolmogorov-Smirnov and Jarque-Bera tests are mainly used to test large data sets while the Shapiro-Wilk test is more meaningful for a smaller sample of 50 observations or less. If the probability attached to the test, for any of the three tests, is above 0.05, then the data are normally distributed, at a significance threshold of 5%.

The correlation coefficient between time series is a statistical measure used to assess the degree of association or relationship between two sets of data that vary over time. This coefficient provides information about how values in one time series

change in accordance with changes in the other series. There are several types of correlation coefficients used in time series analysis, but in this paper we will use the Pearson correlation coefficient, which is a measure of linear correlation between two data series. Its values vary between -1 and 1, where a value close to 1 indicates a strong positive correlation, a value close to -1 indicates a high negative correlation, and a value around 0 indicates no linear correlation. The formula is

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})^2 \sum(y_i - \bar{y})^2}},$$

where x_i and y_i, $i = 1, \dots, n$ represent the values of the two series, and $\bar{x}, \bar{y}$ are the means of the values from the two series. It is important to note that correlation does not necessarily imply causation, that is, a cause-and-effect relationship between the two series. The correlation coefficient only provides information about the degree of association or relationship between them.

4. Results and discussion

4.1 Analysis of health personnel in the public sector

4.1.1 Physicians (excluding dentists)

The descriptive statistical analysis shows a mean of 40.964 people in the period 1990-2022 with a standard deviation of 2.365. The minimum value of 34.965 employees was recorded in 2015 and the maximum value of 46.921 physicians is obtained in 2022. The coefficient of variation has the value of 5,77%, which leads to the conclusion of a representative mean, the data series being homogeneous with values that located around the mean. Regarding the evolution over time, it can be seen that between 1990-2014, a relatively constant number of physicians in the public sector was kept, the value being around the mean, with small annual fluctuations. In the period 2009-2015, there was a tendency to decrease staff in the public health system, due to the facilitation of emigration through the recent accession to the European Union and the austerity measures imposed as a reaction to the economic crisis since then. In 2015, there was a massive decrease, with over 4.000 physicians employed in the public sector, compared to 2014, i.e. a decrease of 14%, followed in the period 2017-2022 by an increasing trend, mainly due to the increase in salaries in the field through the law 153/2017. An absolute mean change $\bar{\Delta}$=247 employees per year was calculated, and the mean growth index is $\bar{I}$=1,005. The mean growth rate was $\bar{R}$=0,5% annually, while the absolute mean value of a percentage of the growth rate is $\bar{A}$=427 employees. For the forecast we use a polynomial function of the fourth degree, (R^2=0,74) and by the method of least squares we obtain (Figure 1)

$$f(x)=0,2408x^4 - 14,164x^3 + 247,38x^2 - 1208,3x + 41138 \quad (1)$$

The model is significant at a level of 5%, according to the *F* test with a value of 20,75 and zero probability attached. For the year 2023, a number of physicians employed in the public health system calculated by f(34) ≅51.115 is expected. The standard error of the prediction has the value 1.270 and the residuals of the model follow a normal distribution at a significance level of 5%, according to the Shapiro-Wilk (prob.=0,8), Kolmogorov-Smirnov (prob.=0,8) and Jarque-Bera (prob.=0,6) tests (Table 1). The confidence interval for the prediction is given by [48.515; 53.715], the t-Student value is $t_{0,05;n-5}$=2,048 (n=33), this means that we can say with

a 95% probability that the number of physicians in 2023 will be in the respective range. For the year 2024, the forecast is f(35)≅ 53.957 employees.

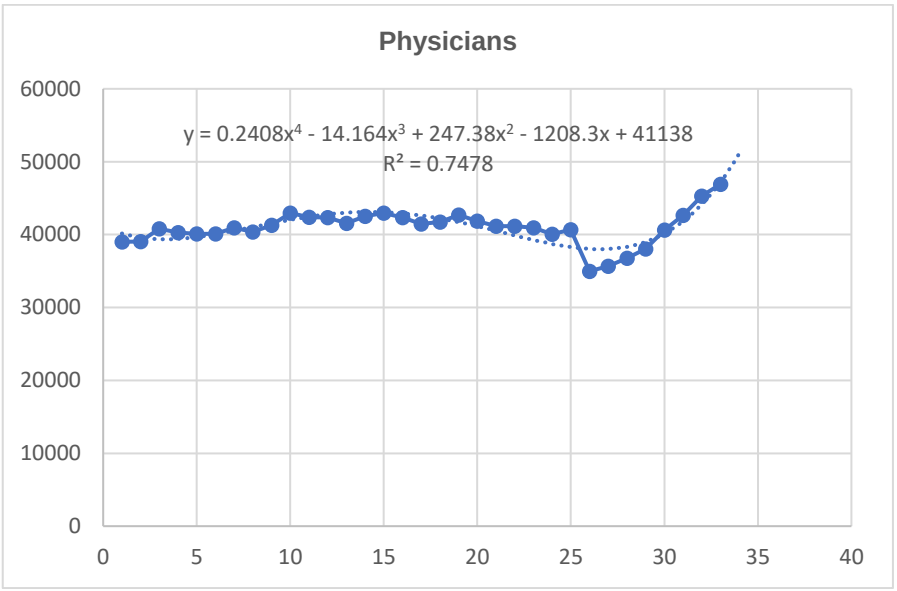

Figure 1. Physicians (except dentists) in the public sector

Table 1. Tests of normality of model errors for physicians in the public sector

	Kolmogorov-Smirnov			Shapiro-Wilk			Jarque-Bera		
	Statistic	df	Sig.	Statistic	df	Sig.	Statistic	df	Sig.
	0,086	33	0,20	0,980	33	0,800	1,017	33	0,601

Source: Made by the authors with SPSS and Eviews softwares

4.1.2 Dentists

For the analyzed period, a mean of 4.229 dentists was calculated, with a standard deviation of 1.509, with a maximum number of 6.326 employees in 1993, but also a minimum of 1.603 registered in 2018. The coefficient of variation has the value of 35,68%, suggesting that the data have a significant variation from the mean, which is not significant. A downward trend can be observed in the period 1993-2018, with a sharp decrease in 2015 of 46% compared to 2014. Starting with 2018, the situation changes and we see a sharp increase in employment in the public system, mainly due to substantial salary increases since 2017. The absolute mean change was thus calculated $\bar{\Delta}$= -45 physicians annually and the mean decrease index has the value of $\bar{I}$= 0,9916. The mean rate of decrease is $\bar{R}$= -0,83% and the absolute mean value of a percentage of the rate of decrease is $\bar{A}$=54 employees. For the prediction, a polynomial function of the fourth degree was chosen (R^2=0,94) and by the least squares method the expression resulted has the form (Figure 2)

$$f(x) = 0,07x^4 - 4,0514x^3 + 71,093x^2 - 531,88x + 7028,1 \quad (2)$$

The validity of the model is given by the *F* test with a value of 115,37 and zero probability attached. The forecasted value for the year 2023 is obtained from f(34) ≅5.435 dentists. The standard error of the prediction is 386 employees, the model errors being normally distributed according to the Shapiro-Wilk (prob.=0,403), Kolmogorov-Smirnov (prob.=0,2) and Jarque-Bera (prob.=0,535) tests (Table 2). The confidence interval for the prediction is [4.645; 6.225], at a significance threshold of 5% with the tabular value for t-Student $t_{0,05;\ n-5}$=2,048 (n=33). For the year 2024, the forecast is f(35)≅ 6.842 employees.

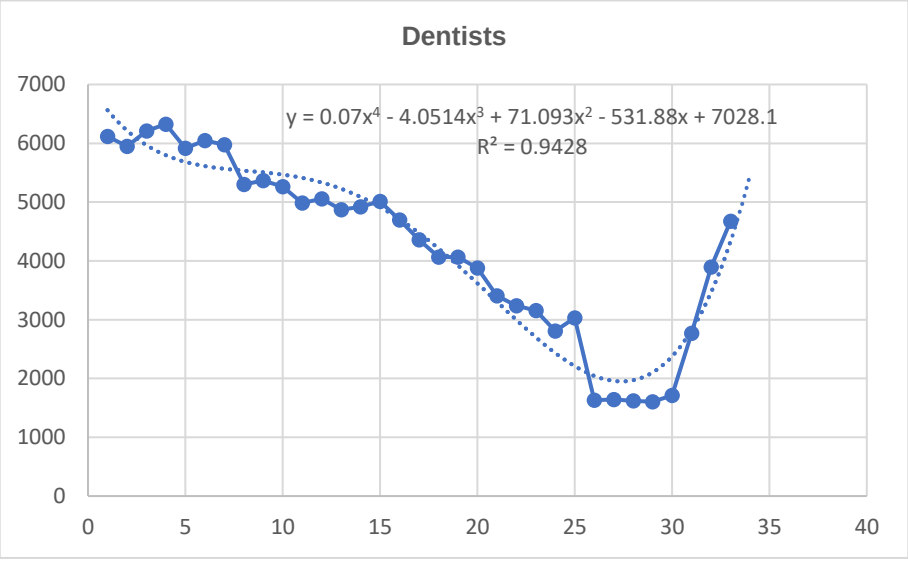

Figure 2. Dentists in the public sector

Table 2. Tests of normality of model errors for dentists in the public sector

	Kolmogorov-Smirnov			Shapiro-Wilk			Jarque-Bera		
	Statistic	df	Sig.	Statistic	df	Sig.	Statistic	df	Sig.
	0,112	33	0,20	0,967	33	0,403	1,249	33	0,535

Source: Made by the authors with SPSS and Eviews softwares

4.1.3 Pharmacists

In the analyzed period, there was a mean of 1.902 pharmacists, with a high standard deviation of 1.364 employees. The maximum number was recorded in 1990 of 6.068 pharmacists in the public sector and a minimum value of only 808 recorded in 2008. The coefficient of variation has a value of 71,69% suggesting that the data have a large variation, the mean being unrepresentative. There is an accelerated decrease in the period 1990-1996, followed by a more moderate decrease until 2012. Starting with 2012, a slight increase can be seen, which is accentuated after 2017, due to the salary increases of physicians in the public sector, reaching the value was 4.764 in 2022. An absolute mean change of $\bar{\Delta}$= -41 physicians was calculated annually with a mean index of decrease with a value $\bar{I}$= 0,9924. The mean

rate of decrease is $\bar{R}$= - 0,75%, while the absolute mean value of a percentage of the rate of decrease has the value $\bar{A}$= 54. For forecasting we also use a fourth degree polynomial function (R^2=0,95) and the expression results (Figure 3)

$$f(x)= 0{,}0808x^4 - 5{,}3814x^3 + 129{,}47x^2 - 1394{,}3x + 7127{,}2 \quad (3)$$

with the value f(34)≅5.854 dentists predicted for the year 2023. The model is significant at a threshold of 5%, according to the *F* test with a value of 144,91 and zero probability. The standard error of the prediction is 313, the errors following a normal distribution according to the Shapiro-Wilk (prob.=0.362), Kolmogorov-Smirnov (prob.=0,2) and Jarque-Bera (prob.=0,573) tests (Table 3). The confidence interval for the prediction resulted is [5.213; 6.495], at a significance threshold of 5% with the tabular value for t-Student $t_{0,05;\ n-5}$=2,048 (n=33). For the year 2024, the forecast is f(35)≅ 7.450 employees.

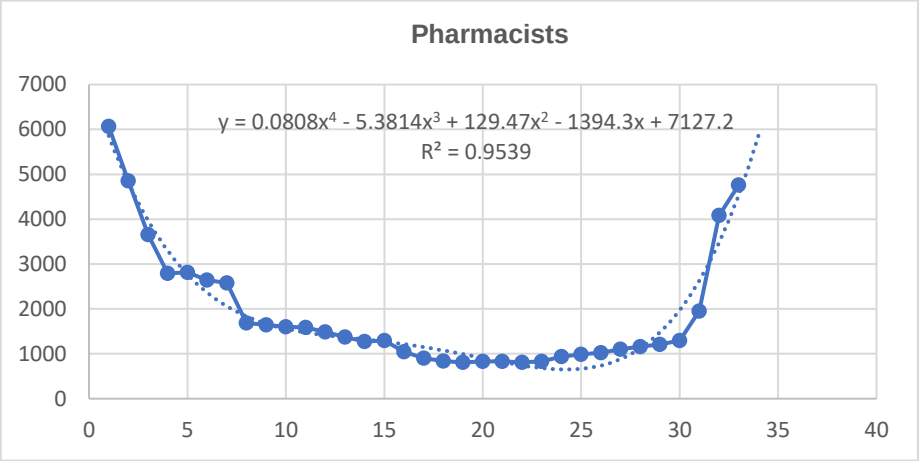

Figure 3. Pharmacists in the public sector

Table 3. Tests of normality of model errors for pharmacists in the public sector

	Kolmogorov-Smirnov			Shapiro-Wilk			Jarque-Bera		
	Statistic	df	Sig.	Statistic	df	Sig.	Statistic	df	Sig.
	0,113	33	0,20	0,965	33	0,362	1,111	33	0,573

Source: Made by the authors with SPSS and Eviews softwares

4.1.4 Medical assistants

For the period 1990-2022, a mean of 108.440 medical assistants employed in the public sector was calculated, with a standard deviation of 12.059, with a maximum value of 130.093 employees recorded in 1994 and a minimum of 87.771 in 2015. The coefficient of variation has the value of 11,12%, resulting in the data series being sufficiently homogeneous with relatively small annual fluctuations, the mean being significant. A decreasing trend is observed, in general, between 1994-2015, followed by an increasing trend from 2016. The absolute mean change is given by $\bar{\Delta}$= - 794 employees annually, while the mean decrease index has a value of $\bar{I}$=

0,9929. The mean rate of decline is $\bar{R}$= -0,7% annually, and the absolute mean value of a percentage of the rate of decline is $\bar{A}$= 1127. We make the forecast with a polynomial function of the third degree (R^2=0,85), resulting the expression (Figure 4)

$$f(x)= 4{,}1684x^3 - 198{,}36x^2 + 1341{,}3x + 121197 \quad (4)$$

and for the year 2023 we forecast a value f(34) ≅101.332 employees. The model is valid according to the *F* test, which has a value of 58 and a zero probability. The standard error of the prediction is 4.788 employees, the model errors being normally distributed according to the Shapiro-Wilk (prob.=0,093) and Jarque-Bera (prob.=0,102) tests (Table 4). A confidence interval for the prediction resulted is [91.541; 111.123], at a significance threshold of 5% with the tabular value for t-Student $t_{0,05;\ n-4}$=2,045 (n=33). For the year 2024, the forecast is f(35)≅ 103.872 employees.

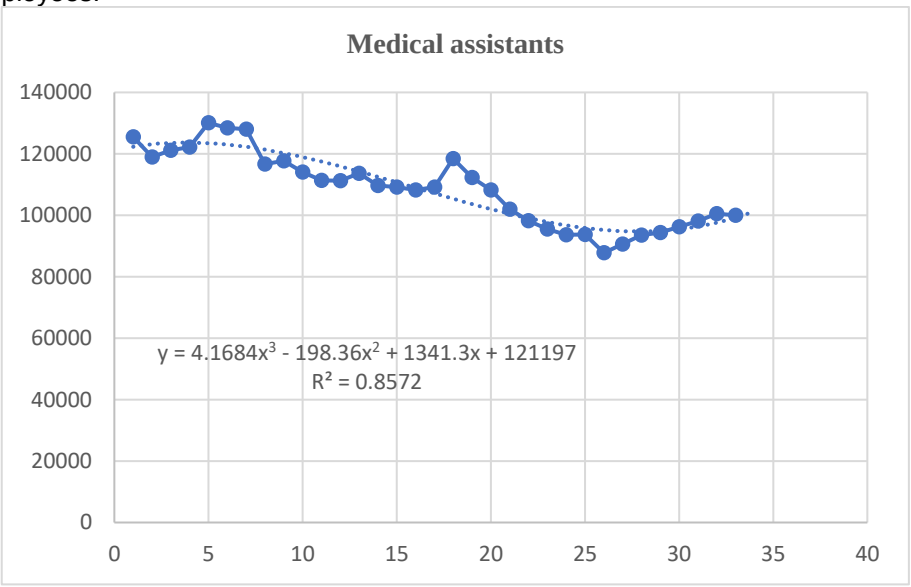

Figure 4. Medical assistants in the public sector

Table 4. Tests of normality of model errors for medical assistants in the public sector

	Kolmogorov-Smirnov			Shapiro-Wilk			Jarque-Bera		
	Statistic	df	Sig.	Statistic	df	Sig.	Statistic	df	Sig.
	0,157	33	0,03	0,945	33	0,093	4,549	33	0,102

Source: Made by the authors with SPSS and Eviews softwares

4.1.5 Auxiliary health personnel

For the period 1990-2022, the result was a mean of 61.404 people, with a standard deviation of 4.256, with a maximum number of 68.689 employees registered in 1993, but also a minimum of 55.071 registered in 2013. The coefficient of variation has the value of 6,93%, suggesting that the data have a small variation from the mean, which is significant. It is noted that in the period 1990-2013 there

were periods of successive increases and decreases, with a sharp decrease in 1997 of 13% compared to the previous year. Starting with 2013, the situation changes and we see a constant increase in the employment of auxiliary health personnel in the public system. The absolute mean change was calculated $\bar{\Delta}$= -11 employees annually and the mean decrease index has the value of $\bar{I}$= 0,9998. The mean rate of decrease is $\bar{R}$= -0,01% annually and the absolute mean value of a percentage of the rate of decrease is $\bar{A}$=659 employees. For the prediction, a polynomial function of the second degree was chosen (R^2=0,55) and by the method of least squares the expression resulted is (Figure 5)

$$f(x)= 35{,}806x^2 - 1341{,}1x + 70608 \quad (5)$$

The validity of the model is given by the *F* test with a value of 18,9 and zero probability attached. The value of the forecast for the year 2023 is obtained from f(34)≅66.402 auxiliary health personnel. The standard error of the prediction is calculated for 2.923 employees, the errors following a normal distribution according to the Shapiro-Wilk (prob.=0,166), Kolmogorov-Smirnov (prob.=0,2) and Jarque-Bera (prob.=0,448) tests (Table 5). The result was a confidence interval for the prediction given by [60.432; 72.373], at a significance threshold of 5% with the tabular value for t-Student $t_{0,05;\ n-3}$=2,042 (n=33). For the year 2024, the forecast is f(35)≅ 67.532 employees.

Table 5. Tests of normality of model errors for auxiliary health personnel

	Kolmogorov-Smirnov			Shapiro-Wilk			Jarque-Bera		
	Statistic	df	Sig.	Statistic	df	Sig.	Statistic	df	Sig.
	0,105	33	0,20	0,953	33	0,166	1,604	33	0,448

Source: Made by the authors with SPSS and Eviews softwares

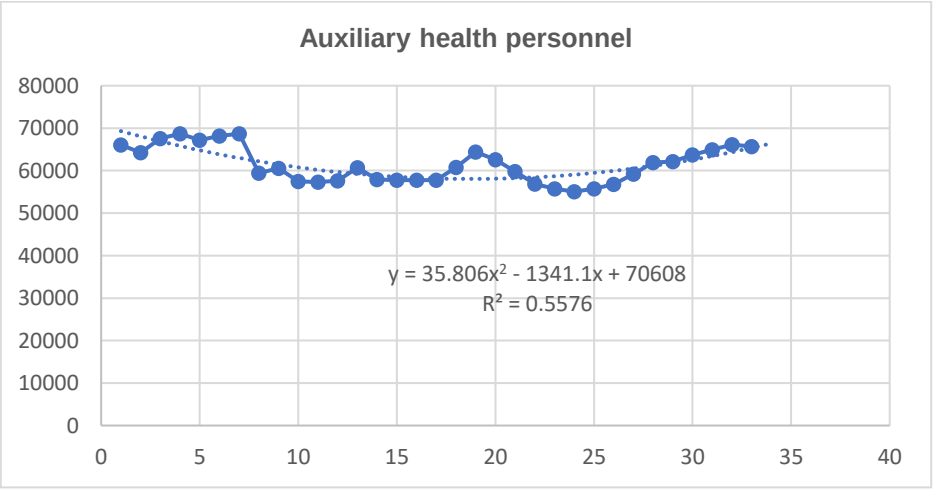

Figure 5. Auxiliary health personnel in the public sector

4.1.6 Correlation coefficients in the public health system

From the analysis of the correlation matrix (Table 6), it is found that in the period 1990-2022, between the number of physicians in public hospitals (excluding dentists) and the number of beds in hospitals, we have a very small correlation coefficient, even negative, of only -0,057, which leads to the conclusion of the lack correlation, there being an imbalance, in the sense of a shortage of physicians, compared to the number of beds in hospitals. Also, between the number of physicians and the number of hospitals we have a relatively small correlation coefficient of 0,247 which leads to the same conclusion as above. On the other hand, the correlation coefficient between the medical assistants and the number of beds in public hospitals is 0,850, a value that suggests a strong link between the two data series, so we can say that with an increase in the number of beds in hospitals, increase the number of medical assistants employed. The same conclusion results from the analysis of the correlation coefficient between the number of hospitals and the number of medical assistants, a value of 0.770 indicating a high correlation. Moreover, the linear correlation coefficient between the number of physicians and the number of medical assistants is quite small, with a value of 0.190, which means that we can draw the conclusion of a disproportionate increase between the two categories, in the sense of a shortage of physicians in the public system.

Table 6. Correlation coefficients in the public health system

	Number of beds in hospitals	Physicians (except dentists)	Medical assistants	Number of hospitals
Number of beds in hospitals	1			
Physicians (except dentists)	-0,057	1		
Medical assistants	0,850	0,190	1	
Number of hospitals	0,694	0,247	0,770	1

Source: Made by the authors

4.2 Analysis of health personnel in the private sector

4.2.1 Physicians (excluding dentists)

The analysis is made for the period 1997-2022. A mean of 11.700 people was calculated, with a standard deviation with a high value of 8.189. The minimum value of only 923 physicians employed in the private sector was recorded in 1997, and the maximum value of 24.372 physicians is obtained in 2022. The coefficient of variation has the value of 69,99%, which leads to the conclusion of an unrepresentative mean, the data series being heterogeneous, with an obvious upward trend throughout the analyzed period. As regards the evolution over time, it is increasing every year, with a significant jump in 2015 when a massive increase is noted, with over 6.800 physicians employed in the private sector, which compared to 2014, means an increase of 48%. This increase in the private sector in 2015 is correlated with the decrease in the public sector, physicians migrating during this period from the public to the private sector, due to the low salaries of that period in the public sector. An absolute mean change $\bar{\Delta}$=938 employees per year was calculated, and the mean growth index $\bar{I}$=1,139. The mean growth rate was $\bar{R}$=13,9% annually, while the absolute mean value of a percentage of the growth rate is $\bar{A}$=67 employees. For the

forecast we use a linear function, (R^2=0,94) and by the method of least squares we obtain (Figure 6):

f(x)= 1038,8x – 2323 *(61)*

The model is significant at a level of 5%, according to the *F* test with a value of 384.3 and zero probability attached. For the year 2023, f(27)≅ 25.725 provides the value of the forecast for the number of physicians in the private sector. The standard error of the prediction is calculated for 2.185 employees, the residuals following a normal distribution according to the Shapiro-Wilk (prob.=0,114), Kolmogorov-Smirnov (prob.=0,2) and Jarque-Bera (prob.=0,405) tests (Table 7). The result was a confidence interval for the prediction given by [21.214; 30.235], at a significance threshold of 5% with the tabular value for t-Student $t_{0,05;\ n-2}$=2,064 (n=26). For the year 2024, the forecast is given by f(28)≅ 26.763 employees.

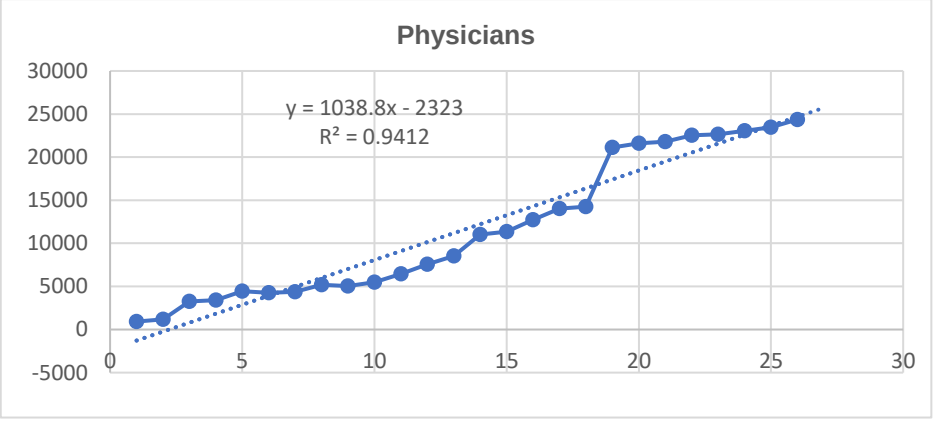

Figure 6. Physicians (except dentists) in the private sector

Table 7. Tests of normality of model errors for physicians in the private sector

	Kolmogorov-Smirnov			Shapiro-Wilk			Jarque-Bera		
	Statistic	df	Sig.	Statistic	df	Sig.	Statistic	df	Sig.
	0,111	26	0,20	0,937	26	0,114	1.806	26	0,405

Source: Made by the authors with SPSS and Eviews softwares

4.2.2 Dentists

For the period 1997-2022, a mean of 9.104 dentists was obtained, with a large standard deviation, at a level of 5.034, with a minimum number of 1.263 employees registered in 1997, but also a maximum of 16.753 registered in 2022, with a trend obviously breeder. The coefficient of variation has the value of 55,2%, suggesting that the data have a large variation compared to the mean, which is not significant. It can be seen that in 2015 the number of employees increased by 17,3% compared to the previous year, a situation also encountered in 2016. Subsequently, the increases stabilize around 3% annually. The absolute mean change was calculated $\bar{\Delta}$= 620 employees annually and the mean growth index is $\bar{I}$= 1,1089. The mean

growth rate is $\bar{R}$= 10,89% annually and the absolute mean value of a percentage of the growth rate is $\bar{A}$= 57 employees. For the prediction, a polynomial function of the first degree was chosen (R^2=0,99) and by the least squares method the expression resulted (Figure 7)

f(x) = 655,07x + 260,83 *(7)*

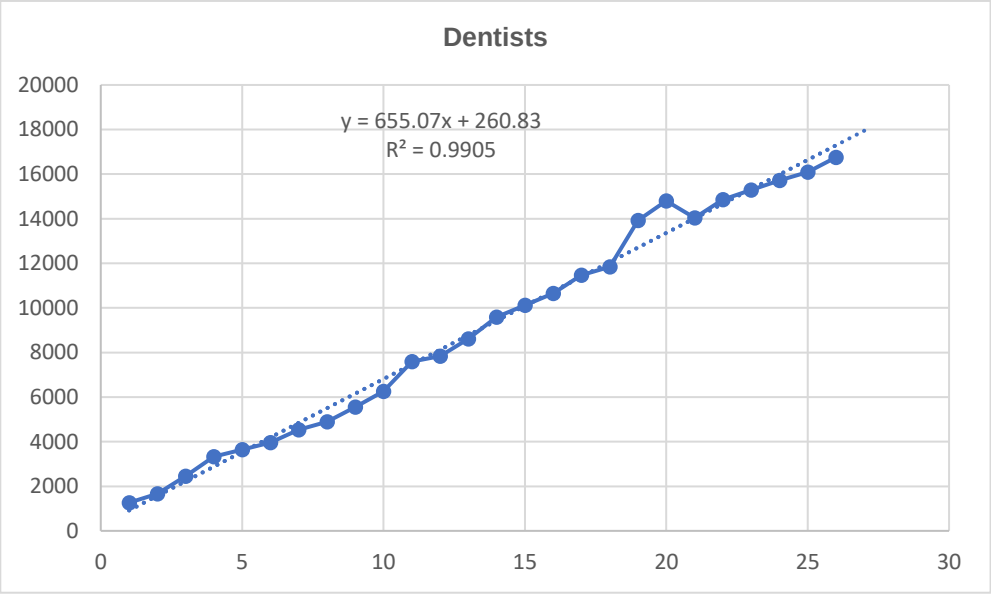

Figure 7. Dentists in the private sector

The model is valid according to the *F* test, which has a value of 2501,3 and zero probability attached. The forecasted value for the year 2023 is obtained from f(27) ≅17.948 dentists. The standard error of the prediction is 540 employees, but the model errors do not follow a normal distribution according to the Shapiro-Wilk (prob.=0,003), Kolmogorov-Smirnov (prob.=0,04) and Jarque-Bera (prob.=0,001) tests (Table 8), so we cannot calculate the confidence interval using the t-Student distribution. Regarding the year 2024, the prediction is given by f(28) ≅18.603 employees.

Tabel 8. Tests of normality of model errors for dentists in the private sector

	Kolmogorov-Smirnov			Shapiro-Wilk			Jarque-Bera		
	Statistic	df	Sig.	Statistic	df	Sig.	Statistic	df	Sig.
	0,172	26	0,04	0,865	26	0,003	12,494	26	0,001

Source: Made by the authors with SPSS and Eviews softwares

4.2.3 Pharmacists

In the period 1997-2022, there was a mean of 11.627 pharmacists, with a standard deviation at a high level of 4.838 employees. The minimum number was registered in 1997 of 4.265 pharmacists in the private sector and a maximum value of 17.897 registered in 2022, the trend being obviously increasing. The coefficient of

variation has a value of 41,6%, resulting in the fact that the analyzed data have a large annual variation, the mean being unrepresentative. There is an increasing trend throughout the period, but moderate since 2017, when there were salary increases for physicians in the public sector, where more jobs were made. An absolute mean change of $\bar{\Delta}$= 545 pharmacists annually was calculated with a mean growth index with a value of $\bar{I}$= 1,059. The mean growth rate is $\bar{R}$= 5,9%, while the absolute mean value of a percentage of the growth rate has the value $\bar{A}$= 92. For forecasting we use the second order degree polynomial function (R^2=0.97) resulting the expression (Figure 8)

$$f(x)= -8,8185x^2 + 859,74x + 2123,4 \quad (8)$$

The model is significant at a 5% level, according to the *F* test with a value of 436,6 and zero probability attached. The value of the forecast for the year 2023 is obtained by calculating f(27)≅ 18.908 pharmacists. The standard error of the prediction is calculated for 808 employees, the errors following a normal distribution according to the Shapiro-Wilk (prob.=0,191), Kolmogorov-Smirnov (prob.=0,2) and Jarque-Bera (prob.=0,42) tests (Table 9). The result was a confidence interval for the prediction given by [17.236; 20.580], at a significance threshold of 5% with the tabular value for t-Student given by $t_{0,05;\ n-3}$=2,069 (n=26). For the year 2024, the prediction is given by f(28) ≅19.282 employees.

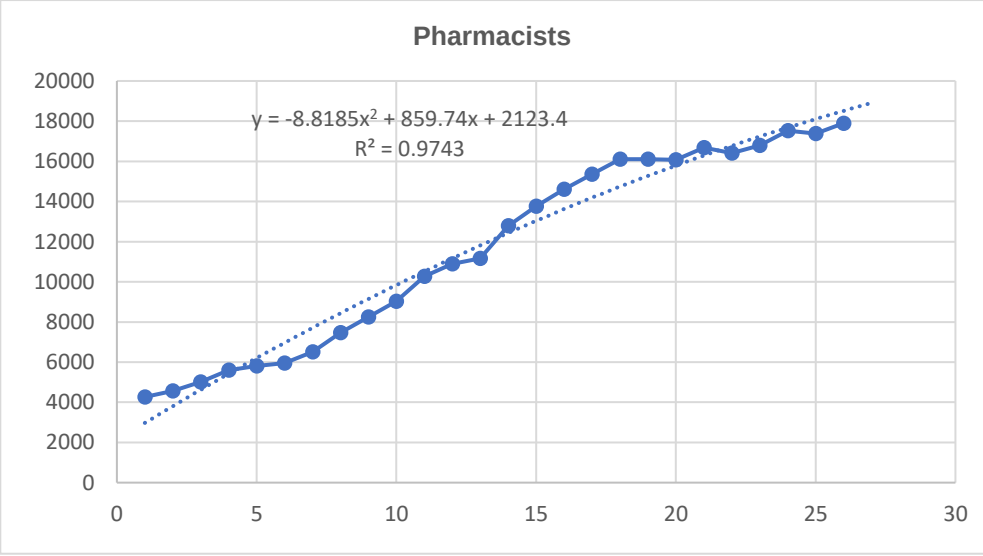

Figure 8. Pharmacists in the private sector

Table 9. Tests of normality of model errors for pharmacists in the private sector

	Kolmogorov-Smirnov			Shapiro-Wilk			Jarque-Bera		
	Statistic	df	Sig.	Statistic	df	Sig.	Statistic	df	Sig.
	0,124	26	0,20	0,946	26	0,191	1,731	26	0,42

Source: Made by the authors with SPSS and Eviews softwares

4.2.4. Medical assistants

For the period 1997-2022, a mean of 27.725 medical assistants employed in the private sector was calculated, with a large standard deviation of 18.190 employees, with a minimum value of 5.103 recorded in 1997 and a maximum of 56.636 in 2022 with a trend obvious increasing. The coefficient of variation has a value of 65,6%, resulting in the data series having large annual fluctuations, the mean being insignificant. An upward trend is observed, with a higher increase of 29% in 2015, compared to 2014. The absolute mean change is given by $\bar{\Delta}$= 2061 employees annually, while the mean growth index has a value $\bar{I}$= 1,101. The mean rate of growth is $\bar{R}$=10,1% annually, and the absolute mean value of a percentage of the growth rate $\bar{A}$= 204. We make the forecast with a linear function (R^2=0,96), resulting the expression (Figure 9)

$$f(x)= 2335,7x - 3807,3 \quad (9)$$

The validity of the model is given by the *F* test with a value of 653.4 and zero probability attached. For the year 2023, the forecast is obtained from f(27)≅ 59.257 for the medical assistants in the private sector. The standard error of the prediction is calculated for 3.769 employees, the residuals of the model following a normal distribution according to the Shapiro-Wilk (prob.=0,142), Kolmogorov-Smirnov (prob.=0,2) and Jarque-Bera (prob.=0,393) tests (Table 10). The result was a confidence interval for the prediction given by [51.479; 67.035], at a significance threshold of 5% with the tabular value for t-Student $t_{0,05;\ n-2}$=2,064 (n=26). Regarding the year 2024, the prediction is f(28) ≅61.593 employees.

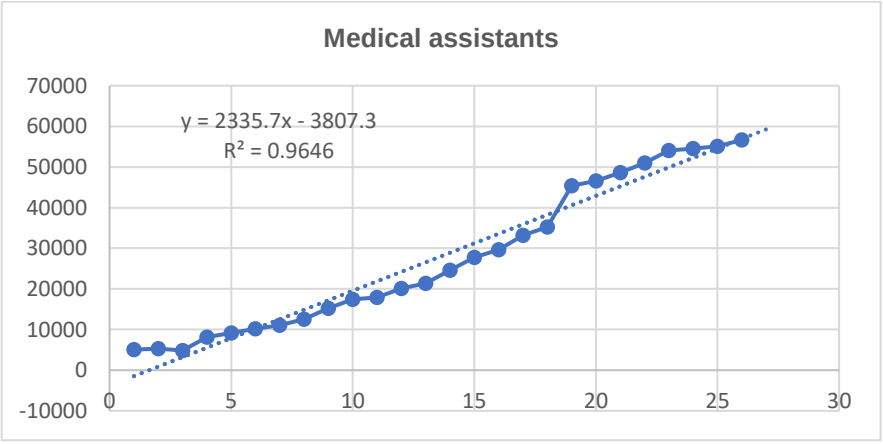

Figure 9. Medical assistants in the private sector

Table 10. Tests of normality of model errors for medical assistants in the private sector

	Kolmogorov-Smirnov			Shapiro-Wilk			Jarque-Bera		
	Statistic	df	Sig.	Statistic	df	Sig.	Statistic	df	Sig.
	0,140	26	0,20	0,941	26	0,142	1,865	26	0,393

Source: Made by the authors with SPSS and Eviews softwares

4.2.5. Auxiliary health personnel

For the analyzed period from 1997 to 2022, a mean of 3.807 people resulted, with a high standard deviation of 3.476, with a minimum number of 84 employees registered in 2002, but also a maximum of 10.882 registered in 2022. The coefficient of variation has the value of 91,3%, suggesting that the data have a large variation from the mean, which is insignificant. It can be seen that in the period 1997-2002 the tendency was to decrease, followed by a sharp increase starting with the year 2003 as the activity in the private health environment became more complex. The absolute mean change was calculated $\bar{\Delta}$= 399 employees annually and the mean growth index has the value of $\bar{I}$= 1,104. The mean growth rate is $\bar{R}$= 10,4% annually and the absolute mean value of a percentage of the decrease rate is $\bar{A}$= 38 employees. For the prediction, a polynomial function of the second degree was chosen (R^2=0,99) and by the least squares method the expression is obtained (Figure 10)

$$f(x)= 19{,}415x^2 - 90{,}571x + 399{,}24 \quad (10)$$

The model is significant at a 5% level, according to the *F* test with a value of 1454,7 and zero probability. The value of the forecast for the year 2023 is obtained from f(27)≅12.107 auxiliary health personnel. The standard error of the prediction is calculated for 321 employees, the model errors following a normal distribution according to the Shapiro-Wilk (prob.=0,297), Kolmogorov-Smirnov (prob.=0,2) and Jarque-Bera (prob.=0,45) tests (Table 11). It resulted in a confidence interval for the prediction given by [11.443 ;12.771], at a significance threshold of 5% with the tabular value for t-Student $t_{0,05;\ n-3}$=2,069 (n=26). For the year 2024, the prediction is f(28) ≅13.085 employees.

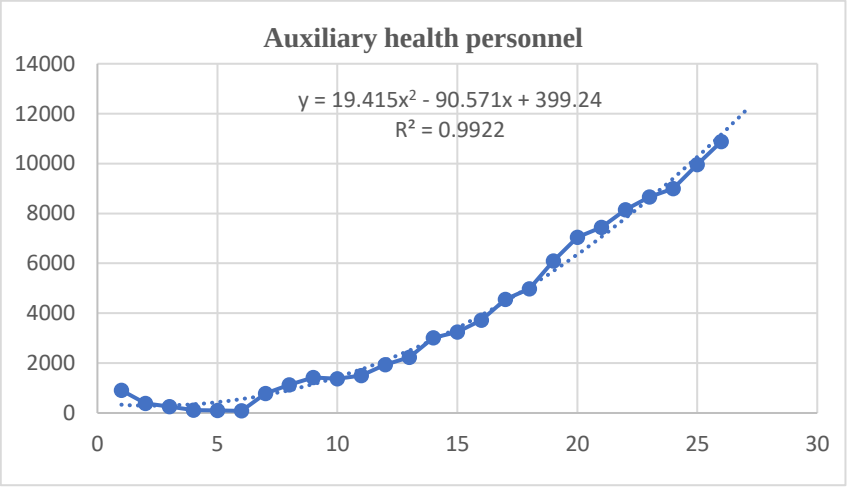

Figure 10. Auxiliary health personnel in the private sector

Table 11. Tests of normality of model errors for auxiliary health personnel in the private sector

	Kolmogorov-Smirnov			Shapiro-Wilk			Jarque-Bera		
	Statistic	df	Sig.	Statistic	df	Sig.	Statistic	df	Sig.
	0,125	26	0,20	0,955	26	0,297	1,594	26	0,45

Source: Made by the authors with SPSS and Eviews softwares

4.2.6 Correlation coefficients in the private health system

From the analysis of the correlation matrix (Table 12), it is found that in the period 1997-2022, between the number of physicians in private hospitals and the number of beds in private hospitals, we have a very high correlation coefficient, of 0,982, which leads to the conclusion of a balance, in the sense of the existence of strong links between the two indicators, the number of physicians increasing proportionally to the number of hospital beds. Also, between the number of physicians and the number of hospitals we have a very high correlation coefficient of 0,956 which leads to the same conclusion as above. Moreover, the correlation coefficient between the medical assistants and the number of beds in private hospitals is also very high, of 0,986, a value that suggests a strong link between the two data series, so we can say that with an increase in the number of beds in hospitals and the medical assistants employed. The same conclusion results from the analysis of the correlation coefficient between the number of hospitals and the number of medical assistants, a value of 0,945 indicating a high correlation. Finally, the linear correlation coefficient between the number of physicians and the number of medical assistants is close to 1, with a value of 0,994, which means that we can draw the conclusion of an almost perfect positive correlation between the two categories of personnel.

Table 12. Correlation coefficients in the private health system

	Number of beds in hospitals	Physicians (except dentists)	Medical assistants	Number of hospitals
Number of beds in hospitals	1			
Physicians (except dentists)	0,982	1		
Medical assistants	0,986	0,994	1	
Number of hospitals	0,937	0,956	0,945	1

Source: Made by the authors

5. Conclusions

Comparing the available data (Annexes 1-2), we observe several major differences between the public and private systems. Thus, auxiliary health personnel have a rather small share in the private sector, of only 8,5% compared to the public sector, where the percentage is 29,5%, compared to the year 2022. This can be explained, mainly, by the absence of private emergency services, but also the fact that the treatment of serious cases, which require hospitalization for a longer period of time, is mostly carried out in the public sector. This fact also became evident during the Covid pandemic, where serious cases were treated in the public system.

On the other hand, dentists and pharmacists have a very small presence in the public sector, these activities being practically privatized to a very large extent. It is found that the two categories of personnel taken together represent 27,4% of the health personnel in the private sector, compared to only 4,2% in the public sector. Thus, the question arises whether the development of health services in the private sector is correlated with the goal of the public sector to ensure health services accessible to the majority of citizens. This fact seems not to be achievable, because the activity in the private environment is aimed at increasing profit and less the citizens' access to health services. Finally, there is a slightly lower share of physicians in the private sector, 19,2% compared to 21,2% in the public system, compared to the year 2022, while the share of medical assistants is approximately the same, of 44,7%, respectively 45% in the public sector. This difference can be explained by the fact that in the private system physicians are not always employed with an employment contract for an indefinite period, usually having a collaboration contract and some of them having an employment contract in the public system.

Regarding the evolution over time of the number of physicians (except dentists) in the public sector, it can be noted that in the period 1990-2009, a relatively constant number of physicians in the public sector was kept. In the period 2009-2015, there was a tendency to decrease staff, due to the facilitation of emigration through the recent accession to the European Union and the austerity measures imposed as a reaction to the economic crisis, with a massive decrease in 2015, with over 4.000 physicians, compared to the year 2014, i.e. a decrease of 14%, followed in the period 2017-2022 by an increasing trend, mainly due to the increase in salaries in the field. Analyzing the evolution in the private sector, it can be seen that it is increasing every year, with a significant jump in 2015 when a massive increase is noted, with over 6.800 physicians employed in the private sector, which compared to 2014, means an increase of 48%. This increase in the private sector in 2015 is correlated with the decrease in the public sector, physicians migrating during this period from the public to the private sector, due to the low salaries of that period in the public sector.

For dentists in the public sector, there is a downward trend between 1993-2018, with a sharp decrease in 2015 of 46% compared to 2014. Starting with 2018, the situation changes and we see a sharp increase in employment in the public system, mainly due to the consistent wage increases from 2017. In the private sector, an obvious upward trend is registered. It is noted that in 2015 the number of employees increased by 17,3% compared to the previous year, a situation also encountered in 2016. Later increases stabilize around 3% annually.

Pharmacists in the public sector recorded an accelerated decrease in the period 1990-1996, followed by a more moderate decrease until 2012. Starting with 2012, a slight increase can be seen, which is accentuated after 2017, due to the salary increases of physicians from public sector, reaching the maximum value in 2022. In the private sector, the trend is obviously increasing. There is an increasing trend throughout the period, but more moderate since 2017, when there were salary increases for physicians in the public sector, where more jobs were made. For medical assistants in the public sector, a decreasing trend is observed, in general, between 1994-2015, followed by an increasing trend from 2016. In the private sector, an increasing trend is recorded throughout the analyzed period, with an increase of more than 29% in 2015, compared to 2014.

In the case of auxiliary health personnel, it can be seen that in the period 1990-2013 there were periods of successive increases and decreases, with an

accentuated decrease in 1997 of 13% compared to the previous year. Starting with 2013, the situation changes and we see a constant increase in the employment of auxiliary health personnel in the public system. In the private sector, there is a sharp increase starting with 2003 as the activity became more complex.

Forecasts for 2023 and 2024 were made for all these categories of personnel in the health field. Obviously, these forecasts can be influenced by the policies in the health field, such as, for example, the blocking of positions in the public sector, or employment more consistent in 2024.

From the analysis of the correlation coefficients, it is found that in the analyzed period, between the number of physicians in public hospitals (excluding dentists) and the number of beds in hospitals, we have a negative and very small correlation coefficient, of only -0.057 which leads to the conclusion of the lack of correlation, there is an imbalance, in the sense of a shortage of physicians, compared to the number of beds in hospitals. Normally, we should have a high positive correlation between the two indicators. Also, between the number of physicians and the number of hospitals we have a relatively small correlation coefficient of 0,247 which leads to the same conclusion as above. Instead, the correlation coefficient between the medical assistants and the number of beds in public hospitals is high, with a value of 0,850, which suggests a strong connection between the two data series, so we can say that an increase in the number of beds in hospitals, the number of medical assistants employed also increases. The same conclusion results from the analysis of the correlation coefficient between the number of hospitals and the number of medical assistants, a value of 0,770 indicating a high correlation. Finally, analyzing the coefficient of linear correlation between the number of physicians and the number of medical assistants, it is found that it is very small, with a value of 0,190, that is, we can draw the conclusion of a disproportionate increase between the two categories, in the sense of a shortage of physicians in the public system.

Analyzing the correlation matrix between certain indicators in the private sector, it is found that in the period 1997-2022 between the number of physicians and the number of beds in private hospitals we have a very high correlation coefficient, of 0,982 which leads to the conclusion of a balance, in the sense of the existence very strong links between the two indicators, the number of physicians increasing proportionally to the number of beds in hospitals. Also, between the number of physicians and the number of hospitals we have a very high correlation coefficient of 0,956 which leads to the same conclusion as above. Moreover, the correlation coefficient between the medical assistants and the number of beds in private hospitals is also very high, of 0,986, a value that suggests a strong link between the two data series, the number of medical assistants increasing proportionally to the number of beds from hospitals. The same conclusion results from the analysis of the correlation coefficient between the number of hospitals and the number of medical assistants, a value of 0,945 indicating a high correlation. Finally, the linear correlation coefficient between the number of physicians and the number of medical assistants is close to 1, with a value of 0,994, which means that we can draw the conclusion of an almost perfect positive correlation between the two categories of personnel.

Thus, the shortage of physicians is maintained in the public system, even if after 2017 their number increased constantly, due to salary increases. There is no correlation between the number of physicians and the number of beds in public hospitals, although this should be positive and high. On the other hand, in the private sector the correlations are very strong between the analyzed indicators, a situation

that can be explained by the fact that in this system the minimization of expenses and the increase of profit are essential.

Thus, the novelty of our study results from the statistical analysis carried out, as well as from the forecasts made, but also from the correlations found between the indicators studied in the public and private health sectors. These results can help managers and government institutions in making informed decisions, based on valid statistical analyses.

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Annex 1. Public health sector

Years	Physicians (except dentists)	Dentists	Pharmacists	Medical assistants	Auxiliary health personnel	Number of beds in hospitals	Number of hospitals
1990	38997	6116	6068	125484	66063	207001	423
1991	39041	5948	4855	118958	64220	206869	427
1992	40829	6208	3658	121172	67548	179169	430
1993	40265	6326	2790	122166	68689	179082	433
1994	40114	5914	2814	130093	67224	174900	415
1995	40112	6045	2646	128460	68164	173311	412
1996	40919	5974	2578	128038	68672	170954	413
1997	40378	5299	1690	116712	59441	166411	416
1998	41310	5367	1642	117719	60584	164526	414
1999	42975	5261	1598	114027	57493	164156	425
2000	42371	4983	1588	111326	57344	166817	439
2001	42339	5057	1490	111263	57608	167888	442
2002	41547	4873	1371	113620	60673	162588	442
2003	42538	4919	1275	109668	57884	142676	422
2004	42960	5013	1295	109131	57773	142029	416
2005	42333	4694	1042	108202	57772	142377	422
2006	41455	4360	901	109153	57752	141225	419
2007	41736	4064	840	118424	60794	137065	425
2008	42699	4067	808	112321	64405	137061	428
2009	41861	3881	832	108286	62564	137534	431
2010	41176	3408	833	102026	59822	129247	428
2011	41171	3236	811	98212	56884	124937	367
2012	40956	3157	831	95484	55717	125456	364
2013	40058	2809	939	93679	55071	125627	365
2014	40658	3032	991	93702	55738	125192	366
2015	34976	1631	1025	87771	56767	125482	367
2016	35680	1643	1103	90669	59215	125294	366
2017	36788	1619	1161	93512	61909	125265	367
2018	38064	1603	1208	94355	62112	125034	368
2019	40647	1711	1297	96204	63694	125144	368
2020	42675	2771	1950	98146	64933	125165	368
2021	45281	3894	4087	100488	66103	125210	367
2022	46921	4677	4764	100052	65701	125673	374

Source: National Institute of Statistics, http://statistici.insse.ro:8077/tempo-online/

Annex 2. Private health sector

Years	Physicians (except dentists)	Dentists	Pharmacists	Medical assistants	Auxiliary health personnel	Number of beds in hospitals	Number of hospitals
1997	923	1263	4265	5103	913	63	2
1998	1188	1666	4567	5324	386	39	2
1999	3263	2447	5012	4848	260	59	3
2000	3415	3324	5601	8120	115	41	3
2001	4434	3637	5808	9170	100	55	4
2002	4258	3957	5957	10216	84	87	5
2003	4381	4528	6518	11072	786	63	5
2004	5190	4894	7468	12552	1131	544	9
2005	5055	5555	8241	15253	1427	650	11
2006	5481	6260	9031	17460	1372	809	17
2007	6463	7587	10268	17929	1498	960	22
2008	7568	7834	10896	20143	1934	1123	30
2009	8525	8616	11164	21387	2237	1381	43
2010	11028	9582	12791	24630	3016	2757	75
2011	11370	10119	13764	27780	3246	3564	97
2012	12725	10657	14604	29657	3723	4186	109
2013	14028	11473	15362	33181	4555	5081	134
2014	14271	11847	16108	35197	4982	5771	161
2015	21134	13925	16110	45402	6090	6667	187
2016	21624	14799	16077	46577	7041	6983	201
2017	21795	14034	16672	48591	7444	7215	209
2018	22521	14854	16412	50962	8145	8147	147
2019	22656	15292	16796	54047	8663	9063	155
2020	23065	15720	17520	54540	8998	9518	159
2021	23479	16088	17383	55070	9957	9875	168
2022	24372	16753	17897	56636	10882	10244	170

Source: National Institute of Statistics, http://statistici.insse.ro:8077/tempo-online/