Towards a better approach for physician and nurse requirements planning in Serbia: learning from the past

Abstract

**Background:** The continual rise of health workforce unemployment in the country indicates the need to explore policy and planning of the physician and nurse requirements in Serbia. The study aimed to identify variables that were significantly related to physicians and nurses’ employment in the public healthcare sector of Serbia from 1961 to 2008 and to forecast the physicians and nurse’ requirements for the public healthcare sector by 2015.

**Methods:** The significant interactions among six variables used for planning the physicians and nurses’ employment in public healthcare sector of Serbia have been identified in two periods: 1961-1982 and 1983-2008. The physician and nurse’ requirements for public healthcare sector by 2015 (with corresponding 95% confidence level -CL) have been forecasted with Autoregressive Integrated Moving Average (ARIMA) / Transfer function (TF). The forecasting was based on assumptions that there will be no significant changes in the planning approach of physician and nurses’ requirements, population size and macroeconomic growth rate, production of physicians and healthcare service utilization in Serbia by 2015.

**Results:** The ARIMA/TF modeling yielded correct and significant forecasts of physician’ \( R^2 = 0.983 \) and nurse’ \( R^2 = 0.989 \) employment in public healthcare sector of Serbia by 2015. The predictors for physician employment were the population size and GDP growth rate. The nurse staff was predicted by the number of physician staff. Physicians and nurses rates per
100 000 of population would increase by 25% and by 26%. Seven-year absolute difference between the number of medical graduates and new vacancies in public healthcare sector will be 6328 persons.

**Conclusions:** By 2015, poor coordination between the key stakeholders for HRH development in the country will generate every year about 3.5-fold higher number of graduated medical doctors than the number of physician’ posts. Serbia needs to remodel traditional HRH planning approach toward one more accountable and coherent with targets in health needs and healthcare services. This study may be used as an approach for understanding the health workforce policy making in other settings and to discuss the accountability of HRH governance.

**Key words:** physicians; nurses; medical graduates; workforce; health planning; forecasting; ARIMA/TF models; Serbia.
TOWARDS A BETTER APPROACH FOR PHYSICIAN AND NURSE
REQUIREMENTS PLANNING IN SERBIA: LEARNING FROM THE PAST

Background

Strategic human resources for health (HRH) planning is usual activity within the healthcare reform focused on improvement of health system performance.[1,2] Formulation of a coherent HRH plan for healthcare system encompass identifying interplay among many issues within health sector and beyond, such as social, economy, policy, technology, environment and epidemiology context. It is also a learning process since it includes projections about cross-cutting problems [1] between HRH production, employment and management, such as attractiveness of health professions and migration of health professionals that are not wholly predictable in complex contexts.

In the last sixty years, various planning approaches and tools have been used worldwide to plan how to develop and mobilize sufficient and competent health workforce that will meet the healthcare sector requirements on various term basis.[3-14] However, a country may lack the coherent plan for HRH development because of inaccurate databases, pitfalls in general planning, presence of significant private sector, lack of a responsible body and adequate support system, and due to inadequate attitude of policymakers and other stakeholders.[15] Those reasons also pose difficulties for health planners in assessing shortage or excess HRH and projecting future requirements.

As of the Second World II, public sector has been the major employer and producer of health workforce in the Republic of Serbia.[16] The country had three HRH strategies: first two were long-term strategies created within the health care development plans, by 1990[17] and 2000[18] respectively; and the third was part of planned activities for the reconstruction of health care provider network during 2005-2010.[19] During 1990s the country has faced social
and economic downturn due to army conflicts, international sanctions and NATO bombing. In 2000, soon after fundamental political changes, the shift from socialist and centrally planned economy system toward liberal market-oriented economy was launched. In 2007, the country has reached only 80% of gross domestic product (GDP) in 1990 and its industrial development was lagging 50% behind the stage in the year 1990.[20] During last decade or so, the average monthly salary of a worker in the health sector has been almost equal to the Republic average.[21] Health professionals as state employees have been salaried with regard to qualification degree, job-position and years of work-experience irrespectively of efficiency and quality. To reform healthcare delivery and finance, the Serbian Ministry of Health have collaborated with the World Bank, and had delivered the master plan encompassing reconstruction of the health care provider network, staff rationalization in the public sector and the human resources strategy 2006-2010.[19,22] In 2007, the Government adopted the Regional Development Strategy of the Republic of Serbia 2007-2012, and in 2009 the Health Development Plan for 2010-2015 period.[23] Hence, the national strategy for HRH development has not been created. Instead, the staffing in healthcare institutes continues according to the by-law, which has been slightly updated after its adoption in 2006.[24]

However, from 2000 the unemployment rate has been growing annually by 5.6% of physicians and by 1.5% of nurses.[21] Two-thirds of about 2,000 unemployed physicians were aged less than 30 years, and half of almost 10,000 nurses were under 25 years of age. At professional meetings, local health managers have been concerned with the staffing and operating norms, which were the same for public healthcare providers in districts with urban and rural infrastructure. According to the last available data, districts have differed with regard to health workforce rates per 100,000 population up to 2.74-fold for physicians, 3.52-fold for specialists, 1.98-fold for nurses and 6.62-fold for midwives, highlighting the effects
of staffing and operating norms and to some extent, the drain of population and health workforce from rural to urban areas.\textsuperscript{[21]}

Specific studies about methods for planning health workforce requirements are limited in Serbia.\textsuperscript{[17-19,21,25-28]} This study is the first that explored the suitability of past planning approaches for forecasting physicians and nurses requirements for the public healthcare sector in 2015. It covers the description of variables used for physicians and nurses’ employment in the public healthcare sector of Serbia from 1961 to 2008, identification of predictors of physicians and nurses’ employment in the same period, and has included the forecasting of physicians and nurses’ requirements for the public healthcare sector by 2015. Relevance of the study method and importance of the findings for the policy and practice were discussed.

**Methods**

*Study design and data sources*

Study focused on the total number of physicians (y1: general practitioners and specialists) and nurses (y2: general, paediatric nurses and midwives with secondary and high education) employed in the public healthcare sector of Serbia from 1961 to 2008 and their forecasts by 2015.

Three national plans for HRH development covering 1961-2008 period (the first plan by 1990\textsuperscript{[17]}; the second by 2000\textsuperscript{[18]} and the third from 2006 to 2010\textsuperscript{[19]}) were reviewed in order to identify health policy factors and the method used for workforce planning. As expected, related data have been routinely monitored and reported in national statistics, and hence cited in the by-law about physician and nurse staffing and operation norms.\textsuperscript{[24]} Thus, they were used for analyses in this study. Health policy factors and data were: demography (x1: population size annual data); national economy (x2: GDP at 1994 prices, data per year);
public healthcare sector productivity (x3: annual number of inpatient care discharges and x4: annual number of outpatient care visits); and HRH production policy (x5: annual number of students enrolled at the first year of medical studies at public university based faculties; and x6: annual number of graduated physicians).

Data on physicians, nurses, outpatient care visits and inpatient care discharges were obtained from the Public Health Institute of Serbia.\(^{[29]}\) Data on population size, GDP and production of physicians (enrolled and graduated students) were taken from the Statistical office of the Republic of Serbia and Ministry of Finance.\(^{[30,31]}\) For consistency reasons, all data refer to Republic of Serbia without data of Kosovo and Metohia.

*Statistical analyses*

The longitudinal analysis of interactions among selected variables and employment of physicians and nurses included analyses of all variables time-series (from 1961 to 2008) and their forecasting by 2015 (estimates with corresponding 95% lower confidence level - LCL and upper confidence level - UCL). The separate time-series analysis was conducted for two periods: the first period, from 1961 to 1982, before the first HRH development plan has been designed and during its operation \(^{[17]}\); and the second period, from 1983 to 2008, after the second HRH development plan has passed and during operation of the third HRH development plan.\(^{[18,19]}\)

Predictors of physicians and nurses’ employment have been identified based on interaction among six variable time-series models during 1983-2008 (inputs: x1, x2, x3, x4, x5, and x6), and used for forecasting the numbers of physicians and nurses (key outputs: y1 and y2) employed from 2009 to 2015. Forecasted outputs, absolute numbers of physicians and nurses with corresponding 95% LCL and UCL represent the workforce required for Serbian
public healthcare sector annually assuming that relation among observed input variables (population size and GDP growth rate, production of physicians and healthcare services utilization) will not significantly change by 2015. Forecasted outputs will differ from their concrete annual values by 2015, if identified predictors significantly change or Serbian health policy makers opt for different HRH planning approach in the meantime.

The Autoregressive Integrated Moving Average (ARIMA)/Transfer function (TF) time-series models \[32\] were key statistical analyses and forecasting tools applied in this study. The ARIMA/TF procedure has included an Expert Modeller that identifies and estimates an appropriate model for each output variable series and predicts its values. Model description has integrated identification of outliers i.e. modelled non-standard values. Model correctness, significance and fit have been tested with R-squared and Ljung-Box statistics and explained by mean absolute error (MAE) and maximum absolute error (MaxAE). Kolmogorov-Smirnov Z test has been used to verify normal distribution of residuals in the model. The statistical tool was IBM SPSS Statistics (ver. 20).\[33\]

**Results**

*Physicians and nurses’ deployment in the public healthcare sector of Serbia from 1961 to 2008*

From 1961 to 1982, the number of employed physicians has increased by 174%, the number of nurses by 282%, the population number by 15%, GDP by 200%, the number of inpatient discharges by 132%, the number of outpatient visits 67%, the number of enrolments at the first year medical studies by 206%, and the number of graduated physicians by 114%.

From 1961 to 1982, the employment of physicians has been related only to GDP while nurses have been employed irrespective of changes in input variables. Both physicians and
nurses’ employment models have been statistically correct without outliers and with a normal distribution of residuals (Table 1). The number of inpatient care discharges has been related to the number of employed physicians and GDP \( [x_3 \Rightarrow f(y_1, y_2, x_1, x_2, x_4, x_5, x_6 \Rightarrow f(y_1, x_2)] \), while the number of outpatient care visits has depended only on the number of employed physicians \( [x_4 \Rightarrow f(y_1, y_2, x_1, x_2, x_3, x_5, x_6 \Rightarrow f(y_1)] \).

Table 1

In the second period, from 1983 to 2008, the numbers of employed physicians and nurses have increased by about 43%. The population size has decreased by -6%, GDP by -100% and the number of outpatient visits by -11%. However, the inpatient discharges have increased by 28%. Both numbers of the students enrolled at the first year medical studies and the graduated physicians have decreased by -100%. Physicians have been employed in relation to the population size and GDP, while nurses in relation to the number of employed physicians (Table 1). The physicians’ employment model has been statistically correct, without outliers and with a normal distribution of residuals (Figure 1). The nurses’ employment model has been statistically correct, with two outliers, and with a normal distribution of residuals (Figure 2). The modelled non-standard values in the nurses’ employment model were: additive in 1995 \( (t = -8.216; p = 0.0001) \) and level shift in 2005 \( (t = -3.606; p = 0.003) \). In 1995, the nursing staff has been significantly reduced due to mild general conditions for retirement and disability pension, and in 2005 due to rationalization and early retirement in the public healthcare sector, as planned by the HRH Action plan from 2005 to 2010.[22,25]

From 1983 to 2008, the number of inpatient care discharges has been related to GDP \( [x_3 \Rightarrow f(y_1, y_2, x_1, x_2, x_4, x_5, x_6 \Rightarrow f(x_2)] \), while the number of outpatient care visits has
been related to the number of employed physicians \[x4 \Rightarrow f(y1, y2, x1, x2, x3, x5, x6 \Rightarrow f(y1))\].

However, the population size of Serbia, GDP, the number of inpatient care discharges and outpatient care visits and their changes throughout the whole observed period have not been significantly related to the number of enrolled students at the first year medical studies (x5) and the number of graduated physicians (x6) \[(x5 \Rightarrow f(y1, y2, x1, x2, x3, x4 \Rightarrow f(Ø) and x6 \Rightarrow f(y1, y2, x1, x2, x3, x4, x5 \Rightarrow f(Ø) respectively)\].

**Forecasting the physicians and nurses’ requirements for the public healthcare sector of Serbia by 2015**

In the second period, from 1983 to 2008, ARIMA/TF models of almost all input variables time-series had outliers, with exception of the model of outpatient care visits time-series. The ARIMA \((1, 2, 0)\) model of population size time-series had 4 outliers: level shift in 1991 \((t = -24.999; p = 0.0001)\), additive in 2001 \((t = 32.787; p = 0.0001)\) and in 2002 \((t = -38.184; p = 0.0001)\), and local trend in 2005 \((t = 10.310; p = 0.0001)\). The decrease of population size was registered in census years, most likely because the methodology used for population census in 1991 and 2002 year has differed from techniques for estimating mid-year population in other years of the time-series. Increases of the population size in the year 2001 and in 2005, perhaps have reflected the pull effect of the national politics that changed in 2000, and then the economy reform that have begun in the following year.\(^{20}\)
The ARIMA (0, 2, 0) model of GDP time-series had one local trend outlier in 1994 \( (t = 3.398; p = 0.002) \), as a result of currency reform after cumulative hyperinflations in 1991 and 1993.

The model of inpatient care discharges time-series had additive outlier in 1999 \( (t = -6.142; p = 0.0001) \), maybe because of reduced operations of inpatient care institutes during NATO aggression on Serbia (Figure 3). The model of outpatient care visits time-series had no outliers (Figure 4).

![Figure 3](image1.png)  
![Figure 4](image2.png)

Innovation outlier has been recorded as a decrease in time-series model of enrolled medical students in 1985 \( (t=-8.716; p=0.0001) \), which could have been a sign of the achievements of the second HRH strategy \(^{19}\) (Figure 5). The increased number of graduated physicians in 2008 \( (t=2.835; p=0.009) \) was another innovation outlier, recorded after adoption of the Bologna declaration \(^{34}\) and most likely it has corresponded to the change of medical curricula and longer duration of medical studies (from five to six years) at public universities (Figure 6).

![Figure 5](image3.png)  
![Figure 6](image4.png)

According to forecasts, the number of employed workers will be higher in 2015 than the recorded staff in 2008, by 17% (12-22%) of physicians and by 19% (15-23%) of nurses (Table 2). Therefore, their rates per 100 000 of population would be higher in 2015 than in
2008 by 25- 26% (physicians 272 v 340, and nurses 562 v 707), and the number of inpatient care discharges and outpatient care visits in public healthcare sector will rise by about 15% and 0.6% respectively.

Table 2

With regard to forecasting, for the period from 2009 to 2015, the annual enrolment rate will be higher by about 20% than the graduation rate at public medical faculties (in absolute numbers 1771 v 1415). Thus, it will equal to the public workforce generation ratio \(^{[35-36]}\) of about 6.68 % calculated as the ratio of the number of physician graduates and the total number of physicians in public sector. Furthermore, if annual employment in the public sector continues to grow by the rate from 2.1-2.5% during 2009-2015, there will be new vacancies only for about 506-520 physicians and 925-1084 nurses per year. By 2015, total of 3577 physicians (95% CL: 2538-4616) and 7918 nurses (95% CL: 6209-9627) will find the job post. For 63% of all graduated physicians each year there won’t be vacancy in public healthcare sector or in total 6328 new graduated physicians in the forecasted period.

**Discussion**

This study analyzed the relationship among six different variables used for planning the physicians and nurses’ requirements for the public healthcare of Serbia in last, almost, six decades. Based on those findings the number of physicians and nurses required for public healthcare of Serbia by 2015 were forecasted. From earlier research \(^{[21, 26, 28]}\) has been known that the rise of physicians and nurses’ density in public sector of Serbia was significant, and this study has identified that predictors of physicians and nurses’ staffing for last twenty-five
years (1983-2008) were GDP and population size. The correlation between changes in economy and changes in the demand for physician services was well documented in the literature.\textsuperscript{[10, 37-41]} This study revealed that in Serbia the GDP rate has influenced the number of inpatient care discharges, and that the supply of physicians was an incentive for healthcare service utilization in general.

The constant rise of physician and nurse’ density rates imply that access to healthcare was a social value in the traditional Serbia, alike was the access to education. This study provided evidence that enrolment and graduation rates at public medical studies were self-directed. Precisely, the economic context (assessed by GDP), demographic situation (assessed by population size), and health policy (assessed by rates of physician employment and utilization of inpatient care and outpatient care services) weren’t significant factors for the production of new physicians.

Yet, in economic difficulties present in settings similar to Serbia, addressing population health needs should denote more than creating more health workers.\textsuperscript{[42]} Health experts agree that responsive partnering between medical schools, health system and other health stakeholders is what such country should have.\textsuperscript{[43]} This study has provided evidences of the inadequate inter-sector coordination at the highest HRH authority level in Serbia. For example, the unchanged high education policy will result each year with 3.5 fold higher enrollments at medical studies and about 2.8 fold higher numbers of graduated physicians than the numbers of vacancies in the public healthcare sector. To deal appropriately with HRH development, the “working lifespan” approach has been proposed \textsuperscript{[2]} as it addresses the dynamics of the health workforce at the stage when people enter the workforce, are part of the workforce, and when they make their exit from it.

Since almost 95\% of physicians and nurses in Serbia have permanent employment \textsuperscript{[28]}, new workers might be looking for job outside the public sector, or outside the country. In
relation to that possibility, some authors are warning to a possible lack of doctors and nurses
in middle-income countries due to emigration by 2015.[8] A shortfall of 1 million health
professionals is estimated in the European Union by 2020 if existing workforce problems are
not addressed.[44] A shortage of 159 300 physicians is projected in the United States of
America by 2025 under a variety of scenarios[10] and almost a million nurses by 2020.[11] In
the case of higher intention to emigrate among health workers, the return of investments in
their education and fiscal income should be assessed in advance. The country has spent US$ 9-12 billions (the lower sum corresponded to Serbian public debt in 2009[31]) on educating
and training only medical specialists.[44] The real financial losses would have been much
higher if the calculation has covered the total estimated 10 000 Serbian health professionals
working abroad,[44], lost profits, replacement costs and other indirect losses.

Therefore, Serbia needs to apply best practices from the WHO Global Code of
Practice on the International Recruitment of Health Personnel and to strategically govern the
mobilization and development of national HRH.

Study limitations

This study design had limitations due to a time-series approach. Despite having
consistent and valid time-series models, using historical approach for forecasting ultimately
may yield either pessimistic - forecasted the unfavorable status quo, or too optimistic scenario
– if emigration gain higher relevance. Modeling in the study was a simplification of the reality
since not all important factors could be captured in consistent manner during that period. We
could not say to what extent changes in the health workforce situation (growth of private
practice, private medical schools or health workforce migration) will affect the forecasting.
Since we lack reliable data from private medical schools, private healthcare sector and health
workforce circulation, the study findings refer only to public sector. In that respect, continual monitoring and evaluation of all mentioned HRH issues is needed so planners could modify forecasts in the light of any additional information and provide policy makers with fast response to unforeseen changes and to operate with lower risks once when healthcare labor market enlarges. On contrary, the unrevised staffing plans may require expanding either the number of user groups and/or services in order to maintain efficiency.\[12\]

Time-series models in the study were reasonably similar to current situation, thus it is unlikely that the workforce forecasts would be models artifact. Shifts in macroeconomic contexts were dominant source of forecasting failures in this study. The difference between forecasted and registered number of physicians (-3.1% in 2010), and nurses (-2.6% in 2009 and -4.4% in 2010) in public healthcare sector has mirrored the effects of national economy downsize and global financial crises in 2008. GDP growth rate in Serbia has fallen from 5.5% in 2008 to -3.0% in 2009 and to 1.8% - 2.0% growth in 2010.\[31\] Some authors have calculated the 3.5% of difference between the forecasted and registered number of health workers that was reached only by the changed conditions for retirement.\[13\] In our study, the change in retirement conditions, comprehend as a macroeconomic intervention\[45\], has induced the cut back of nurse staff in 1995.

\begin{quote}
\textit{Study implications for policy and practice}
\end{quote}

This study provided evidences that rising unemployment of physicians and nurses surmount the capacities of ministry of health. Serbia needs to remodel traditional HRH planning approach toward HRH development that is more coherent with population needs. The government should commission a high-level institution to analyze and forecast dynamics of cross-cutting problems between HRH production, employment and performance, and to
harmonize relevant policies of other sectors like labour, education, finance, international affairs and science development with health care programmes, health services development and health workforce planning. To take care about the whole process of health workforce and development in a responsible way, leadership towards better human resources management and development may be especially important.

Conclusions

Based on background planning approach in Serbia, this study provided valid forecasts of physicians and nurses’ requirements for public healthcare sector of Serbia. The inter-sector cooperation on HRH planning was poor. It was insufficient to confront HRH issues like rising unemployment, and if it continues, Serbia should be designated as another one source country of health professionals. This study may be used as an approach to improve understanding of the health workforce policy making in other settings. It may serve for comparison with other research forecasts of physician and nurse requirements in Serbia, as well as to discuss future polices and accountability in the HRH governance.

Conflicts of interest: None to declare.

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Authors’ contributions: MSM, VV and JM conceived and designed the study and have made substantial contributions to analysis and interpretation of data. MSM and VV collected data and drafted the manuscript. All authors have given the final approval.
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Table 1 Modelled physicians and nurses’ requirements in public sector of Serbia in two periods (1961-1982 and 1983-2008)

<table>
<thead>
<tr>
<th>Model Description</th>
<th>Output variables (annual number)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Physicians (y1)</td>
</tr>
</tbody>
</table>

| Input variables in both periods (time-series of annual number) | y1 => f(x1; x2; x3; x4; x5; x6) | y2 => f(y1; x1; x2; x3; x4) |

<table>
<thead>
<tr>
<th>The first period 1961-1982</th>
<th>Model type: ARIMA/TF (0,1,0)</th>
<th>ARIMA/TF (1,2,0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time-series predictor:</td>
<td>y1 =&gt; f(x2)</td>
<td>y2 =&gt; f(Ø)</td>
</tr>
<tr>
<td>Model Fit statistics:</td>
<td>( R^2 = 0.987; )</td>
<td>( R^2 = 0.992; )</td>
</tr>
<tr>
<td></td>
<td>( \text{MAE} = 175.376; )</td>
<td>( \text{MAE} = 466.110 )</td>
</tr>
<tr>
<td></td>
<td>( \text{MaxAE} = 433.206 )</td>
<td>( \text{MaxAE} = 1643.583 )</td>
</tr>
<tr>
<td>Model Correctness:</td>
<td>Ljung-Box Q(18) = 11.503;</td>
<td>Ljung-Box Q(18) = 20.061;</td>
</tr>
<tr>
<td></td>
<td>( \text{DF} = 11; \text{Sig.} = 0.402 )</td>
<td>( \text{DF} = 17; \text{Sig.} = 0.271 )</td>
</tr>
<tr>
<td>Model Noise residual:</td>
<td>Kolmogorov-Smirnov Z = 0.581; ( p = 0.889 )</td>
<td>Kolmogorov-Smirnov Z = 0.816; ( p = 0.518 )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The second period 1983-2008</th>
<th>Model type: ARIMA/TF (0,1,0)</th>
<th>ARIMA/TF (0,1,0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time-series predictor:</td>
<td>y1 =&gt; f(x1, x2)</td>
<td>y2 =&gt; f(y1)</td>
</tr>
<tr>
<td>Model Fit statistics:</td>
<td>( R^2 = 0.983; )</td>
<td>( R^2 = 0.989; )</td>
</tr>
<tr>
<td></td>
<td>( \text{MAE} = 135.955; )</td>
<td>( \text{MAE} = 200.540; )</td>
</tr>
<tr>
<td></td>
<td>( \text{MaxAE} = 349.467; )</td>
<td>( \text{MaxAE} = 761.807; )</td>
</tr>
<tr>
<td>Model Correctness:</td>
<td>Ljung-Box Q(18) = 24.059;</td>
<td>Ljung-Box Q(18) = 15.656;</td>
</tr>
<tr>
<td></td>
<td>( \text{DF} = 18; \text{Sig.} = 0.153 )</td>
<td>( \text{DF} = 18; \text{Sig.} = 0.617 )</td>
</tr>
<tr>
<td>Model Noise residual:</td>
<td>Kolmogorov-Smirnov $Z=0.631; p=0.821$</td>
<td>Kolmogorov-Smirnov $Z=0.530; p=0.942$</td>
</tr>
</tbody>
</table>

*Legend: Number of $y_1$- physicians, $y_2$- nurses, $x_1$- population size, $x_2$- GDP, $x_3$- inpatient care discharges, $x_4$ – outpatient care visits, $x_5$ - students enrolled at the first year of medical studies and $x_6$ - graduated medical doctors (at public faculties).*
Table 2 Forecasts of physicians and nurses’ requirements in public sector of Serbia by the year 2015

<table>
<thead>
<tr>
<th>Annual number</th>
<th>Physicians</th>
<th>Nurses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recorded in 2008</td>
<td>20668</td>
<td>42480</td>
</tr>
<tr>
<td>Forecasted (95% LCL - UCL) in the year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>21188 (20705 - 21581)</td>
<td>43564 (42918 - 44210)</td>
</tr>
<tr>
<td>2010</td>
<td>21705 (21149 - 22260)</td>
<td>44617 (43703 - 45531)</td>
</tr>
<tr>
<td>2011</td>
<td>22216 (22029 - 22413)</td>
<td>46050 (44831 - 47169)</td>
</tr>
<tr>
<td>2012</td>
<td>22725 (21940 - 23510)</td>
<td>47041 (45749 - 48333)</td>
</tr>
<tr>
<td>2013</td>
<td>23232 (22354 - 24110)</td>
<td>48407 (46962 - 49851)</td>
</tr>
<tr>
<td>2014</td>
<td>23739 (22777 - 24701)</td>
<td>49473 (47891 - 51055)</td>
</tr>
<tr>
<td>2015</td>
<td>24245 (23206 - 25284)</td>
<td>50398 (48689 - 52107)</td>
</tr>
</tbody>
</table>
Figure 1. Observed and fitted number (with 95% LCL and UCL) of physicians employed in public healthcare sector of Serbia (1983-2008) and the forecast by the year 2015
Figure 2. Observed and fitted number (with 95% LCL and UCL) of nurses employed in public healthcare sector of Serbia (1983-2008) and the forecast by the year 2015
Figure 3. Observed and fitted number (with 95% LCL and UCL) of inpatient care discharges (000) in public healthcare sector of Serbia (1983-2008) and the forecast by the year 2015.
Figure 4. Observed and fitted number (with 95% LCL and UCL) of outpatient care visits (000) in public healthcare sector of Serbia (1983-2008) and the forecast by the year 2015.
Figure 5. Observed and fitted number (with 95% LCL and UCL) of students enrolled at the first year of medical studies at public faculties in Serbia (1983-2008) and the forecast by the year 2015.
Figure 6. Observed and fitted number (with 95% LCL and UCL) of graduated medical doctors at public faculties in Serbia (1983-2008) and the forecast by the year 2015