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Original article

WORKLOAD DYNAMICS OF MEDICAL PROFESSIONALS IN BULGARIAN HEALTHCARE SYSTEM: EVIDENCES FROM AGGREGATE DATA

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ABSTRACT

Purpose. This study aims to analyze the tendencies of the workload of medical professionals in Bulgaria after the liberal reforms in the national healthcare system.

Material/Methods. Basic econometric methods, such as tests for structural breaks and dynamic rows modeling based on "macro-" or aggregate data, are implemented. The period covered is 1980-2023, twenty years before and twenty-four years after introducing market elements in national healthcare. Variables such as the number of patients discharged, consultations, doctors, and nurses are used to assess the workload level. Workload estimates are derived from a linear regression model of hospital output as the dependent variable with the number of doctors and nurses in the health system as factors. The model is tested for the stability of the regression coefficients (structural breaks) dated 2000.

Results. A structural break was found in 2000 in all three dynamic rows of doctors, nurses, and discharges. There was a well-defined increasing trend in the number of patients passing through the hospitals after the liberalization of the national healthcare system. In this condition, the number of medical professionals follows its own dynamics – a slight reduction for the group of doctors and a sharp decline for the nurses in the after-reforms sub-period. These facts indicate the presence of an increasing trend in the workload and intensity of medical labour. The dependence is well established, especially in the case of nurses.

Conclusions. This study confirms the hypothesis that the liberalization of the Bulgarian healthcare system, together with open-ended payment systems, caused an intensive growth of inpatient system output and workload. The expansion, especially for hospital facilities, which is not supported by a relevant number of medical professionals, threatens workplace performance and the quality of medical services.

Keywords. workload, medical staff, structural breaks, hospital discharges.

INTRODUCTION

Over the last two decades, we have witnessed some processes and phenomena in the Bulgarian healthcare system that have aroused scientific interest, at least from the perspective of the use and efficiency of the resources invested, and accessibility to medical services.

A key component of resource availability, central to the system's ability to respond adequately to any demand for medical services, is the quantity and quality of the labour factor. It is known that there are very high expectations for the quality of knowledge and skills of medical specialists, and the formation of professional qualities takes a long period. This, in turn, causes high educational costs for the creation of future medical personnel.

As a specific set of highly skilled knowledge strictly regulated by the state, the supply of medical labour is characterized by relatively low-price elasticity. Its wage level does not ensure that a surplus or deficit in the demand and supply volumes can be quickly overcome.

The workload of the healthcare workforce has been discussed in a wide range of literature. Most of these focus on nurses for understandable reasons - recent decades have witnessed a substantial reduction in the numbers of this professional group, particularly in countries with lower living standards. In general, research in this thematic area is aimed at identifying and formulating relationships between workload levels on the one hand and on the other hand:

- the factors that determine it
- employee performance, including workplace performance
- the quality of medical services provided
- the levels of burnout to which employees are exposed.

In theoretical and conceptual terms, the perception of workload is mostly related to the level of labour resources available to healthcare organisations. In this regard, Fournier PF, et al. (2011) propose a detailed workload model within which they present the following range of predictors: "The model also takes into account different factors having an impact on the workload: the workers' resources, the consequences of the work activity and the organizational processes." (p. 45) [1].

Most workload surveys are of cross-sectional design; in some cases, they use panel analysis based on observational data on specific treatment facilities. The possibilities of estimating workloads starting from higher level or, to some extent, aggregate data remain unexplored. Our research is based on "macro-" data, representing processes and phenomena over time at a health system level rather than an individual facility or group of facilities. It is conducted on time series analysis, considering specific socioeconomic phenomena in the country's healthcare system before and after the transition from a command-administrative to a liberal system.

The conceptual framework of this study includes the following main elements:

• scientific question - whether in the period after the reform of the national health system, there have been significant changes in the workload of the two professional groups - doctors and nurses

• the study is based on econometric analysis and time series modelling using three series - the number of discharges, the number of doctors and the number of nurses

• within the modelling, discharges function as the dependent variable and the two professional groups as independent variables

The level of the regression coefficient in front of the independent variables in the multivariate linear model of discharges is adopted to estimate the workload.

The study aims to analyze the tendencies of the workload of medical professionals in Bulgaria, considering the liberal reforms. The objective is achieved using data for the main groups of medical professionals, hospital care discharges, and contacts to the outpatient system analyzed with econometric methods. From the point of view of the set objective, the following tasks are solved:

• to present a brief description of the evolution of the Bulgarian healthcare system as a specific environment in which the processes of workload and intensity of work are undergoing changes

• to select empirical data that can be used to assess the workload of medical work

• to construct a time series over a sufficiently long period to serve as a basis for analyzing changes in the workload of physicians and nurses in hospital and outpatient care

• to choose methods and provide an analysis of the data collected.

MATERIALS AND METHODS

Three sets of variables are used to assess the employment and intensity of workload of medical specialists:

• for inpatient system output (volume of activity) – the total number of patients discharges from inpatient facilities

• for outpatient system output (volume of activity) – the total number of contacts

• for the number of medical staff - the number of doctors and nurses, as the two main groups of professionals directly involved in the creation of medical services.

The level of the regression coefficient in the hospital system activity volume models (discharge models) with the number of physicians and nurses as independent variables from 1980 to 2023 is used to estimate the workload. In the middle of this period, the system underwent liberal changes. Thus, outcomes in two roughly equal sub-periods can be compared before and after the reforms. In particular, using classical regression analysis on time series with the ordinary least squares method, the estimates of the regression coefficients (slope coefficients) are determined for the independent variables 'number of doctors' and 'number of nurses' for the whole period from 1980 to 2023 in both sub-periods 1980-1999 and 2000-2023. After a regression analysis of the workload model incorporating observations for the entire period, a Wald test for structural breaks is used with an ex-ante known break date 2000. The choice of this year is because the first National Framework Contract dates from then.

The three hospital product models were subjected to post-hoc diagnostics by conducting tests for serial autocorrelation (Durbin-Watson test), for heteroscedasticity (Breusch-Pagan test), and for multicollinearity (Variance inflation factor), which are important for the reliability of results in time series regression analysis.

The product of the outpatient system is represented using the indicator "consultations per capita" (consultation of a medical doctor per inhabitant). It is necessary to consider that health statistics do not provide sufficiently long and continuous observations over time on this indicator, which seriously limits the possibilities of analysing the workload of medical professionals in the outpatient sector in particular in unity with the approach described above. The National Centre of Public Health and Analyses publications do not disclose product and activity data for our nation's outpatient system. Two databases, WHO and Eurostat, are used to construct the time series of outpatient sector contacts. Thus, a time series of consultation length from 1980 to 2022 was eventually constructed, but with 14 missing observations for the years 2000 to 2013.

The data for conducting the empirical analysis are collected from three sources - the European Health for All database (HFA-DB), Eurostat (healthcare statistics), and "Healthcare: A Brief Statistical Guide" yearly publication of the National Centre for Public Health and Analyses. The outpatient system's output was calculated using data from the Eurostat population database and the HFA-DB outpatient contacts per person per year. All statistical analyses were performed using StataNow 18.5 at a significance level 0.05.

The working hypothesis is that over the last two decades, due to the liberal reforms, there has been a process of increasing workload in the main categories of medical staff, especially in the inpatient system.

RESULTS

The construction of the national health system in Bulgaria is a long process, which dates back to the first and second decades of the 20th century. The first law to regulate public relations regarding forming a public insurance fund and covering damages resulting from the adverse effects of health risks in Bulgaria dates back to 1918. For

the first time, compulsory insurance for "accident", "sickness" and "maternity" risks was introduced for all workers and employees in state, public and private enterprises. In 1924, the Public Insurance Act was passed, which covered all categories of wage workers and all types of public insurance. With this law, Bulgaria was the first in the Balkans to establish comprehensive public insurance [2]. It is important to note that medical care was at the expense of the Public Insurance Fund. In this period, 2/3 of the amount in the fund was raised at the expense of employers and the state and 1/3 at the expense of workers. An interesting fact is that the Social Insurance Fund was given the right to grant loans for the construction of health and social facilities, and patients had the right to freely choose a doctor [3]. From a contemporary perspective, we could interpret this fact as an intention on the part of the state to supplementing the credit market of banking institutions to stimulate capital formation and facilitate accessibility to the consumption of medical services. One widely accepted view nowadays is that one of the defects of the market mechanism is the potential incompleteness of some financial markets, including credit markets [4].

At this relatively early stage of the development of a national health system, there was a drive for the gradual introduction of compulsory health insurance to cover all categories of employees. This fact is due to another one, that historically social insurance was the first to emerge and establish itself as a method of financing health costs. This occurred in Germany in the late 19th and gradually spread to many European countries. The UK example of funding entirely from the state budget to build a more integrated and centralized healthcare system dates back to the period after the end of World War II [5, 6].

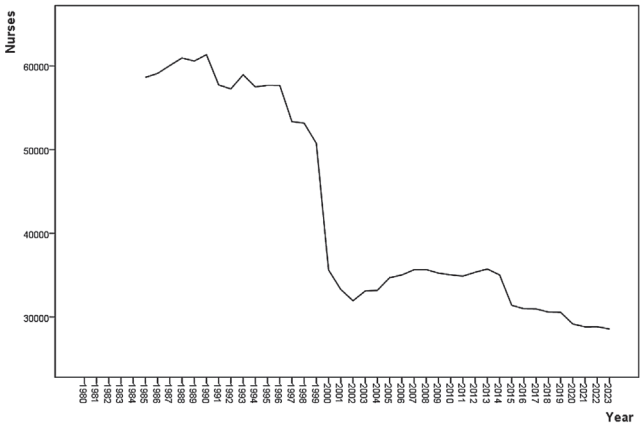
The imposition of a command-administrative economy puts an end to the natural development of the public-insurance model and its inherent market relations on the occasion of the creation and consumption of health goods. Well, after the beginning of the transition to a market economy, it was only after 2000 that social insurance financing of the system was restored. If in the initial year of liberal reforms (2000), the expenditure of the public insurer accounted for 1.5% of GDP, in the year 2023, it is now a significant 6.3%. In the new liberalized system, a process of increase in the number of healthcare providers and the associated growth in investment, technological level and volume indicators in the sector is underway. However, in these conditions, the volume of labour resources or medical professionals employed in the sector follows its own course of development, which affects the workload and intensity of work in the sector in a specific way.

Dynamics of Number of Physicians and Nurses

Taking into account the whole period - about twenty years before and twenty years after the reform of the healthcare system, we encounter two diametrically opposite trends in the development of the numbers of the two groups of medical personnel - an upward trend in doctors and a sharp decline in nurses. Applying a test for structural breaks [7,8], we find statistically significant differences in the intercepts and slope coefficients of the trend regression models with time as an independent variable of the two time-series before and after 2000 (Wald test p-value < 0.05). Figures 1 and 2 illustrate the trends in the number of doctors and nurses.

Fig. 1. Total number of physicians in the period 1980-2023.

Fig. 2. Total number of nurses in the period 1980-2023.



In general, by the year 2000, the number of physicians increased significantly. This process was particularly pronounced in the 1980s. After the year 2000, we now observe a much less pronounced form of moderate growth in the physician time series, and this is in the face of significant annual fluctuations. In the case of nurses, however, we see the opposite trend of a sharp and significant decline in their numbers. This decline appears to be dramatic and is most pronounced in the late 1990s when their numbers were cut by around 45% in seven years. After 2002, for a period of 10 years, the number of nurses fluctuates, but after 2013, we witness another decline that continues invariably until the last observed year, 2023. The dynamics in the number of physicians and nurses determines the rather low ratio of nurses per physician, which, if the EU average is about 3 nurses per physician, is one of the worst for Bulgaria - 1 nurse per physician [9,10].

For the group of nurses, there has been a substantial reduction in the estimates of annual average numbers in

the period since 2000. The reduction is significantly great, from 57 649 to 32 886 (Mean Difference = - 24 763, p-value < 0.05). For physicians, there was an increasing trend in the mean annual number – from 26 690 for the first sub-period to 28 623 for the post-reform period, respectively (Mean Difference = 1 933, p-value < 0.05). For both groups, the marginal changes in the means in the two sub-periods are statistically significant.

Dynamics of discharges

Discharges since 2000 have brought about a marked change not only in the way labour resources developed but also in the volume of activity. The process of development of patients discharged is illustrated in Figure 3.

Fig. 3. Total number of discharges in the period 1980-2023.

The number of patients admitted to hospital treatment facilities follows a specific logic of development, which is characterized by a prolonged period of continuous decline from the late 1980s to 2001, followed by expansive growth. The rapid increase in the number of patients transferred since 2000 is diametrically opposed to the decline in the number of nurses and the small and fluctuating increase in the time series of doctors. Also, in the volume of activity in inpatient facilities, represented by discharges, there is evidence of a structural break following the liberal reforms (Wald test p-value < 0.05). It should be noted that during the COVID pandemic period, we had a two-year break in the upward trend in hospital admissions and in the number of patients discharged – an effect attributable to the normative limitation of planned admissions to hospitals and, more generally, in reduction of contacts to the health system. Based on the fact that there are no significant changes in the environment surrounding the health system, we could assume that the volume of patients admitted and discharged will very quickly reach its pre-pandemic levels.

Modeling discharges with labour resources and workload estimates

The number of treated patients, as a measure of the volume of activity, can be seen as a function of labour, which is a major element of productive resources. On the other hand, the workforce, with its quantity and quality is connected with the level of workload. This is why, in terms of the stated research objective, a model of the number of patients discharged with the number of medical professionals can be debated as a characteristic of workload. With its help, it can be ascertained how many units of activity volume are accounted for per unit change in the number of medical staff. This way, the workload changes can be assessed by comparing discharge function estimates for the two sub-periods. We propose a model with the number of patients discharged as a dependent variable, and two predictors – the number of doctors and the number of nurses. The data are fitted in the model as follows:

1/ Pooled model - $\text{Discharges}_{80\text{-}23} = \beta_0 + \beta_1 . \text{Physicians}_{80\text{-}23} + \beta_2 . \text{Nurses}_{80\text{-}23} + u$

2/ Pre-reforms - $\text{Discharges}_{80\text{-}99} = \beta_0 + \beta'_1 . \text{Physicians}_{80\text{-}99} + \beta'_2 . \text{Nurses}_{80\text{-}99} + u'$

3/ After reforms - $\text{Discharges}_{00\text{-}23} = \beta_0 + \beta''_1 . \text{Physicians}_{00\text{-}23} + \beta''_2 . \text{Nurses}_{00\text{-}23} + u''$

The coefficient estimates of the pooled model are unstable. It is confirmed that 2000 is a break date in the same model (Wald test p-value < 0.05). By comparing the estimates of the slope coefficients for the two subperiods, inferences can be made about workload and work intensity. Using the Ordinary Least Squares method, we obtain the following estimates of the discharges model (table 1).

Table 1. Estimates of slope, determination coefficients, mean sum of squares, Durbin-Watson statistic and variance inflation factor of discharges model for the whole period and in two subperiods.

Model	$\beta_{Physicians}$ (p-value)	β_{Nurses} (p-value)	R^2 (p-value)	MSS	DW statistic	VIF
Pooled	116.48 (0.034)	-6.77 (0.128)	0.267 (0.004)	8,91E+10	0,197	1,26
Pre-reforms	-69.77 (0.001)	50.07 (0.000)	0.923 (0.000)	3,33E+09	1,012	1,06
After reforms	493.53 (0.000)	92.27 (0.001)	0.757 (0.000)	3,53E+10	1,647	2,27

We found insignificant estimates of slope coefficients for nurses for the whole period; thus, the pooled model has a small explanatory power. In the pre-reform period, the slope coefficient is negative and the number of patients discharged per doctor decreased by 69.77 units. This fact is due to the inversely proportional relationship in the development of the two time-series. Finally, it is evident from the data in the table that slope coefficients increased significantly after 2000, which is an estimate of the growing workload and labour intensity of doctors and nurses employed.

The two models, before and after the reforms, have higher explanatory power than the model covering all observations after 1980 (pooled model) We observe higher determination coefficients in the subperiods at relatively lower mean residuals sum of squares. In addition to the above, the full (pooled) model is characterized by very high levels of positive serial autocorrelation (positive serial autocorrelation), which puts the reliability of its estimates at serious risk. In the pre-reform model, the Durbin-Watson test is inconclusive - it does not conclusively show the presence or absence of serial autocorrelation. However, the model, including post-reform observations, is not exposed to serial autocorrelation, it has a high determination coefficient (R2 = 0.757), and it appears to have relatively the greatest explanatory power in this case. All three models have a constant variance of residuals (Breusch-Pagan test p-value > 0.05). This fact favours the explanatory power of the model, i.e. it allows us to trust the estimates of the workload of the occupational groups of doctors and nurses in the models before and after the reforms.

The workload model is exposed to low levels of multicollinearity. In all three of its performance variants, the VIF ranges between 1 and 5 (table 1). With data for the whole period and before the reform, multicollinearity is almost absent, it is relatively higher after the reform but remains well below 5. This result allows us to have confidence in the estimates of the regression coefficients and in the robustness of the model.

Finally, splitting the pooled model into two with pre- and post-reform data leads to more robust estimates of physician and nursing workload. The model with post-2000 data has relatively the highest explanatory power because it exhibits a high coefficient of determination in the setting of lowest mean sum of squares of residuals, no serial autocorrelation, and not much multicollinearity.

Assessing of Workload with Mean Estimates' Ratios

As another piece of evidence that confirms the working hypothesis, the ratio (W) of the estimated means of the number of treated patients to the number of doctors and nurses for the two sub-periods can be used to estimate the workload.

Table 2. Assessments of workload using means estimation.

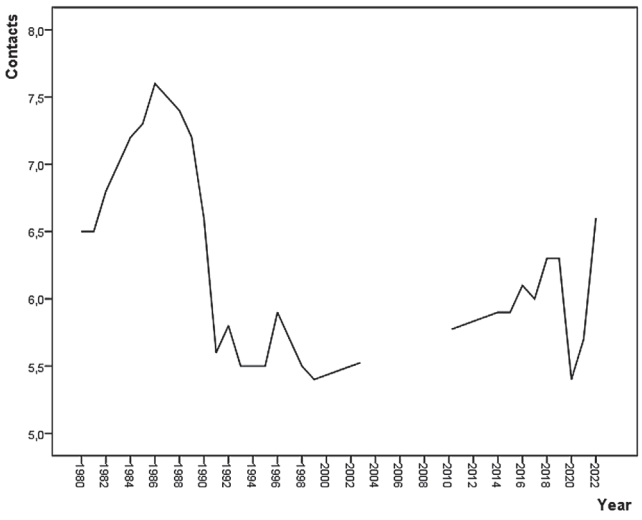
Subperiod	$Mean_{discharges}$	$Mean_{physicians}$	$Mean_{nurses}$	$W_{physicians}$	W_{nurses}
1980-1999	1 600 556	26 690	57 649	60	28
2000-2023	1 888 842	28 622	32 886	66	57

In the first sub-period, the average annual number of patients per physician was 60, and in the second one, it rose to 66 (table 2). We have a much more marked effect for nurses, from 28 to 57 treated patients.

Contacts to the outpatient system

The number of patient visits for consultations, etc., with doctors from the outpatient system after 1980 noticeably decreased. This decrease is primarily due to the negative change in the number of the population. The opposite effect, however, is the aging trend. After all, in 2019, if the country's population decreased by 20.8% compared to 1980, the drop in the total number of visits to the outpatient system was 23.3%. The latest available data on the number of contacts per inhabitant for Bulgaria in the European HFA-DB covers the 1980-2022 period but with a large break between 2000 and 2013. As expected, like the product of the hospital system, contacts to the outpatient system fall significantly in the pandemic years 2020-2021, exceeding pre-pandemic levels in 2022. The number of contacts to the outpatient system per inhabitant dynamic row is presented in Figure 4.

Fig. 4. Outpatient contacts per person per year.



In this dynamic row, we observe two essential changes. The first occurred within a few years, from 1987 to 1991, and the second covered the pandemic years 2020 and 2021. After transitioning to a liberal healthcare system, a smooth trend of increasing the number of visits and contacts to the outpatient system was formed.

The available data on patient contacts to the outpatient system, and even more so on the number of human resources in it, are fragmented and inconsistent over time

and do not allow for a thorough quantitative analysis of the employment and workload of medical specialists before and after the reforms in national healthcare.

DISCUSSION

The present results regarding the established knowledge about some criteria and indicators used to evaluate healthcare systems can be discussed. The affordability analysis, for example, is based on quantitative indicators for labour and material resources, normalized per 100,000 inhabitants. On the other hand, to assess the relevance, the absolute number of hospitalizations or discharges is considered [11]. Our research shows a rapid increase in hospitalizations over the past 20 years in the context of a sharp reduction in the number of nurses and an unbalanced increase in the number of doctors. It has its explanation with the legally ensured freedoms for entrepreneurship and competition in the industry, which, along with the open-ended payment system, led to the rapid increase in the number of hospital service providers. If we assume that the numbers of hospitalizations and discharges assess the system's relevance, Bulgarian hospital healthcare probably does not perform at the desired level in this aspect.

Another fact that can be discussed from the point of view of the workload of medical professionals is the growth rate of the material base in the industry. According to data from the National Center for Public Health and Analysis, if hospital beds per 10,000 inhabitants in 2000 were 74.3, then at the end of 2023, they reached 83. At the same time, the average length of stay was shortened by more than two times – treated patients from 11.5 in 2000 to 4.7 days in 2023 [12, 13]. The shortening of the average hospital stays, on the one hand, and the increase in hospital capacity, on the other hand, has a double effect on hospitalizations and discharges. Through the increased number of diagnoses and active treatment activities, we evaluate the impact on the workload of the medical workforce.

These processes are also reflected in the level of payment of medical care providers, i.e., leading to an increase in their incomes and, 'ceteris paribus', an increase in the level of wages. Under the conditions of the applied clinical pathway payment system without significant restrictions and limits, insurance payments for hospital care for the last 10 years have grown by about 139%, from BGN 1,169 million in 2012 to BGN 2,792 million in 2022 [14, 15]. The increasing workload of the medical staff over the years has been rewarded, in nominal terms, by higher pay.

Certain parallels can also be drawn between the results of the present studies and the papers that explore the influence of workload and caseload on the performance of workplace, quantity, and burnout syndrome. In this direction, Cordero-Guevara JA, et al. (2022) came to the conclusion that the number of diagnoses, along with some other factors such as age and physical status, have the most significant influence on the high workload of doctors and nurses [16]. The relationship between workload and workplace performance is debatable. A recent study by Asamani J, et al. (2015) concluded that about 75% of the respondents believed that average workload levels would provide conditions for better performance in their workplace. The same study showed that nurses and midwives were rated with the highest workload, followed by paramedics, support staff, and doctors [17]. There is an opinion that a shortage of a sufficient number of medical staff, associated with a higher workload, has a negative effect on the quality of health service. However, Kovacs & Lagarde's (2022) study demonstrated a different picture regarding the relationship between workload and quality. Their study was conducted in primary care in a low- and middle-income per capita country. Despite staff shortages, the workload level remained low, with medical facilities found to be operating below their production capacity regardless of the potential to serve larger numbers of patients. Overall, however, Kovacs & Lagarde draw the conclusion that even at times of higher workload, no evidence of deterioration in the quality of medical service was found [18]. In the same direction are the conclusions of Petel SH, et al. (2019), according to which one of the main predictors of errors in diagnosis, following the example of radiology, is the number of cases or caseload [19]. The relationship between workload and stress, and hence the risk of burnout syndrome for medical staff, is relevant to the management of work processes in medical institutions. In a study by Portoghese I, et al. (2014) covering healthcare workers from public hospitals, a moderately high correlation was found between workload ratings and occupational burnout. The authors measured the interdependencies within a complex model including four components - workload, job control, exhaustion, and cynicism, emphasizing hospital management's importance in applying control over production processes to reduce the risk of burnout [20].

Linking the results of the present study with previous ones, we could suggest that the main effects of the trend of increasing workload of the main categories of medical staff are reflected in improved health outcomes on the one hand, but on the other hand, exposure to the risk of exhaustion and even occupational burnout. Prevention of these risks needs to be approached by medical institutions with attention to medical staffing levels and work process control. On the other hand, health authorities need to plan more precisely the number of medical students admitted for training, given the increasing volume of patients passing through the hospital system, and at the same time make greater efforts to improve the pre-hospital system so as to prevent a proportion of hospital admissions.

CONCLUSIONS

The performed quantitative analysis confirms the hypothesis that with the introduction of market elements due to the liberal reform in national healthcare, there is an increase in the workload, which is strongly pronounced for the inpatient system. The expansion of the hospital's output should be expected to have a corresponding positive effect on the national health status indicators. But on the other hand, unbalanced changes in the number of practicing doctors and nurses against the background of a rapid increase in hospital discharges pose risks of deterioration in workplace performance, the quality of medical services, errors, and burnout syndrome.

In this study, the focus is on discovering and modelling trends and dependencies between specific outcome and resources as one proposal for workload assessment. Of course, to get a more complete picture of the processes of workload dynamics, the potential effects of rapid growth in hospital output need to be more fully appreciated. These effects are associated with the assumption of certain risks and, in turn, challenges for hospital management at the micro-level and, on the other hand, in the need to stimulate the outpatient system, mainly along the lines of strengthening prevention and prophylaxis, in which the health authorities play a leading role.

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