

# THE IMPACT OF THE NUMBER OF DOCTORS ON HEALTH INDICATORS AND THE SUSTAINABILITY OF THE HEALTHCARE SYSTEM

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This research was funded by the Slovak Ministry of Education's Scientific grant agency VEGA: VEGA 1/0691/22 Economic aspects of emigration of university graduates in health care departments in the context of the sustainability of staffing of health care facilities in the Slovak Republic.

**Abstract:** Health workforce shortages, particularly in the profession doctor, affect the availability and quality of health care, which has a direct impact on population health indicators. The main aim of the study is to determine the impact of workforce in the profession of doctor in the healthcare sector on selected indicators of the health of the population. At the same time, evaluate the state and structure of human resources in the healthcare sector. By collecting secondary data from the OECD and NCZI statistical databases on the number and structure of doctors, followed by mathematical and statistical processing and interpretation of the results, the aim is to propose a model of the relationship between the availability of doctors and indicators such as preventable and avoidable mortality, life expectancy, healthy life years, years of life lost, number of consultations with a doctor, capacity of health care beds, and health expenditure as a share of GDP. We then evaluate the state and structure of human resources in the healthcare sector in Slovakia, Czech Republic, Austria, Germany, the UK and Norway. The results of the study show that the number of doctors strongly influences health indicators such as healthy life years or health expenditure, and is closely linked to migration and the number of graduates. The study provides evidence for policies aimed at retaining doctors in the country, improving working conditions and systematic human resource planning in the healthcare sector.

**Keywords:** Doctors, Health Indicator, Healthcare Capacity, Human Resource in Healthcare, Migration of Doctors, Systematic Human Resource Planning

## 1 Introduction

The global shortage of health workers is one of the major challenges facing health systems worldwide (Oda et al. 2018; Scheffler et al. 2019; Jin & Chen, 2023; Giraldo-Santiago et al. 2024; Ulupinar et al. 2024). The solution to this crisis lies in finding new sources of workforce, while two main sources are education and training of graduates of health professions and migration of already prepared workers from abroad. Health workforce planning is a key task, complicated by the increasing demand for health services (Oda et al. 2018; Stokes et al. 2021) in the context of demographic changes, rising living standards or migration flows dynamics (Calenda et al. 2019; Kamau et al. 2023).

Within the European Union, the free movement of labour is regulated by Directive 2005/36/EC, which guarantees the recognition of professional qualifications between Member States (Domagała et al., 2022). However, this mechanism creates a paradoxical tension between Eastern and Western European countries, as migration flows of health professionals are mainly directed from countries with lower per capita income in the East to countries with higher income in the West. As a result, inequalities increase. Inadequate numbers of health workers needed to ensure the provision of quality health care lead to a reduction in the quality of health services provided, reduced accessibility and increased costs of health services, which has a negative impact on the overall health of the population (Chikanda, 2024). At the same time, countries of origin face a significant loss of financial resources invested in the education and training of potential health workers (Quamruzzaman, 2020). If they decide to migrate to work abroad after completing their training, the investment becomes a loss (Poku et al., 2023; Bezuidenhout et al., 2009). At first glance, it may seem that host countries only benefit from the acquisition of skilled personnel without incurring the costs of their education, but their successful integration and adaptation to a new professional and cultural environment requires additional investments (Popescu et al., 2024), which are considerably lower.

Despite these challenges, there has been a dramatic increase in the recruitment of health professionals from Eastern European countries to Western European countries, suggesting the need to develop comprehensive strategies to mitigate the negative

consequences of migration. The exploration of this issue has attracted the attention of the professional community for more than three decades (Brommels & Jaaskelainen, 1984; Dubois et al., 2006; Ono et al., 2013; Malgieri et al., 2015).

This study focuses on the analysis of the consequences of the migration of health workers in the medical profession, who represent key human resources in terms of performance in the context of health care delivery. After defining the research problem and its background, the article describes a general model of the consequences of understaffing in health care facilities, paying attention to the objective and the methods used to achieve the stated goal. The final section presents the results, discussion, some limitations and possibilities for further research into the problem.

## 2 Literature review

The health workforce can be considered central to the performance of the health care system (Dussault & Dubois, 2003) and thus to the overall health of the population, as the available range and quality of health services depends to a large extent on the number, skills, knowledge, competencies and attitudes of the workforce (Domagała & Klich, 2018; EC, 2019; Rój, 2020). According to the World Health Organization, one of the essential functions of health care is to invest systematically and strategically in the creation of human resources (WHO, 2000). Human resources in healthcare can be defined as the clinical workforce. Their education and training are key investment tools to create human resources in the right numbers and structure, with emphasis on the required knowledge and skills, according to current needs, but also within the range of future needs. This is the responsibility of public policy makers because, in the short term, the health sector can only use the human resources that have been created in the past. And because investments in education are long-term, they must be carefully planned and systematically implemented (Rój, 2020).

The determinants of the healthcare workforce are divided into external: ageing population, changing healthcare needs, migration patterns, technological innovation, and internal: ageing workforce, recruitment and retention, regional redistribution and underdeveloped skills (EC, 2019). The workforce, and in particular the clinical part of human resources, is central to the performance of the health system. The number and structure of its knowledge, skills, abilities and competences determine the availability and quality of healthcare provided, which overlaps with the overall health of the population (Domagała & Klich, 2018; Folland et al., 1993). Almost all countries in the European Union are facing a shortage of health workers (Crisp, 2017; Kroezen et al., 2015). The shortage of health workers is cumulative with the problem of inadequate competencies in the face of changing population health needs (Sarkis & Mwanri, 2013), as demonstrated by the Covid-19 pandemic. Both the World Health Organization and the Organisation for Economic Co-operation and Development provide evidence that improved access to high-quality, efficiently delivered health services that meet the needs of the population can lead to improved health indicators and sustainable economic development (WHO, 2014; OECD, 2016).

Health workforce planning is therefore a key element in addressing the problem. Migration of workers from abroad is one source of labour, as evidenced by the global increase in recruitment of health workers from abroad (Eaton et al., 2002). The outflow of health workers has far-reaching consequences for the country of origin, in the form of worsening population health indicators, reduced sustainability of the workforce, increased migration of health graduates, or loss of funds invested in education and training for the profession. Research has been mapping the consequences of health worker brain drain for several decades (Beine et al., 2008; Mills et al., 2008;

Bezuidenhout et al., 2009; Malgieri et al., 2015; Quamruzzaman, 2020; Poku et al., 2023). Countries of origin should focus on retaining workers and building resources through graduates.

### 3 Materials and Methods

The main aim of the study is to determine the impact of workforce in the profession of doctor in the health sector on selected indicators of the health of the population. At the same time, evaluate the state and structure of human resources in the healthcare sector.

Based on the analysis of relevant scientific studies registered in the Web of Science and Scopus databases to identify the research problem and the current state of issue. Collect secondary data from the OECD and NCZI statistical databases on the number and structure of doctors and then process them using mathematical and statistical methods, interpret the results and propose a model of the impact of doctors workforce on selected population health indicators (preventable mortality, avoidable mortality, life expectancy at birth, healthy life years, years of life lost, consultations with a doctors per capita per year, number of beds in health facilities, health expenditure as a percentage of GDP).

Descriptive statistical methods were used in the study, and correlation analysis, regression analysis and multi-criteria logistic regression were used to examine the relationships identified. In the next step, the potential resources of the workforce in the profession of doctor are analyzed with the calculation of losses on state expenditures for education and training for the profession of doctors in the Slovak Republic.

### 4 Results

Based on the results of the analysis of the current state of the issue, it was found that the inadequate workforce of the health sector has an impact on the quality of health services provided and thus the overall health of the population. In particular, clinical human resources, especially in the profession doctor and other health professions, have a direct impact on the performance of health services. According to the system of professions, the role of a doctor is health promotion, prevention, early and rapid diagnosis, differential diagnosis, comprehensive treatment, dispensary care and other care (National System of Professions of the Slovak Republic).

The study identifies doctors as the clinical human resources with the most significant impact on health service delivery in the context of population health. It can then be reasoned that the number and structure of doctors employed in health facilities in a country has an impact on performance as measured through health indicators: Avoidable and preventable mortality, years of life lost (the number of years that a person would have been active if their health or death had not been impaired), life expectancy at birth and number of years lived in health (perception of the health of people aged 65 and over), number of consultations with a doctor per year per capita, number of beds in institutional health facilities, and the health system: health expenditure measured in purchasing power parity in Euros per year as a share of gross domestic product. In the case of human resources, the potential workforce is also considered, which can be included in the workforce planning for the health sector, which is measured not only by the number of doctors practicing their profession, but also by the number of graduates and migrated doctors who can return to their country of origin. We also include in this category doctors employed in medical facilities whose country of origin is different.

In the first step, a correlation and regression analysis of human resources - doctors and graduates - was carried out, with the dependent variable being the number of doctors employed in health care institutions in Slovakia and the independent variables being the number of doctors who left for work abroad and the number of graduates of general medicine. As a deeper analysis of the number of graduates revealed that the year-on-year

increase was driven by the number of graduates of foreign nationality, this variable was supplemented by the number of graduates with Slovak citizenship. After conducting a normality test using the Shapiro-Wilk test, it was found that the data in all categories had a normal distribution. Table 1 shows the results of the correlation analysis carried out on the basis of Pearson's coefficient.

Table 1 Correlation analysis (Pearson's coefficient) for the period 2004-2022

Variable	Number of doctors		Statement
	Correlation coefficient - r	P - value	
Number of doctors, who left - migrants	0,925	< 0.001	strong positive correlation
Number of general medical graduates	0,820	< 0.001	strong positive correlation
Number of general medical graduates with Slovak citizenship	0,582	0,009	moderately strong positive correlation

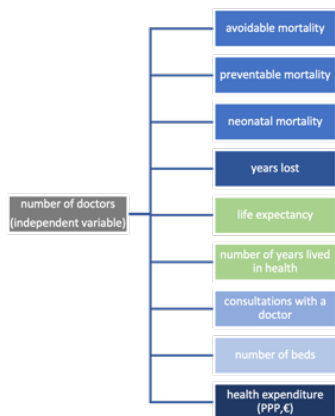
Source: authors' own processing based on OECD and NCZI data

85.6% of the variability in doctor migration is explained by the number of doctors, with a p-value of less than 0.001, showing that the greater the number of doctors in the health system, the more migration increases. The above is confirmed by the results of the research on migration of Slovak doctors to work abroad carried out within the APVV 19-0579 project Setting... (Tupá, 2024). The causes reveal doctors' job dissatisfaction with material and technical equipment, with the management and performance of personnel activities, but also with the situation in the country or the prestige of the doctor's profession.

The variability of general medical graduates shows an explainability level of 67.2%, with a p-value of less than 0.001. Although there should be an almost perfect correlation between general medical graduates and the number of doctors, the results suggest that this is not the case. This is consistent with the results of a survey of medical universities, which suggest that the propensity for graduates to migrate is greatest among medical graduates. Indeed, they say that one in ten graduates go abroad for work after completing their education and training. Based on NCZI data from 2004 to 2022, the latest year available, the number of graduates with Slovak citizenship is declining very rapidly. In 2004, one out of ten graduates was a foreigner, while in 2022 it was already four out of ten. For this indicator, the variability of explainability is only 33.8% at a p-level of 0.009. The relationship is statistically significant, but with only a moderately strong correlation, suggesting a significant role of graduates in migration, but other factors such as legislation, the setup of the education system or the demand for education in foreign universities are also important.

In the next step, the impact of the number of doctors (clinical human resources) on selected indicators of health and the healthcare system was investigated.

Figure 1 Impact of clinical human resources (number of doctors) on performance through selected health and healthcare system indicators



Source: authors' own processing

Multicriteria logistic regression was used to examine the impact of clinical human resources on selected health and healthcare system indicators. The number and structure of dependent variables were adjusted. Avoidable mortality, preventable mortality and neonatal mortality, these indicators are highly correlated with the indicator of years lost, which is based on them. Similarly, the perception of the number of years lived in health is reflected in life expectancy. The life expectancy variable enters the model because employees working in the health sector do not feel healthy but continue to work. The other variables remained unchanged and showed no multicollinearity. After adjusting for the composition of the variables, the VIF values ranged from 1 to 9. Subsequently, the normality of the data distribution was verified through histograms, which indicated that the residuals were normally distributed. Another test was used to examine the variance of the residuals, verification was done using the Breusch-Pagan test for homoskedasticity. The results say that the residuals are homoskedastic, which means that the error variance is constant and the assumption of homoskedasticity is satisfied. After verifying the conditions for using multicriteria linear regression, we subjected the data to the actual analysis.

Table 2 Results of multicriteria logistic regression of the impact of clinical human resources on selected performance indicators for the period 2004 to 2022

	Coefficient	Intercept	R-squared	Statement
The lost years	-0.413303	14876.599485	0.330	moderately strong relationship
Average life expectancy	0.007040	63.049590	0.429	moderately strong relationship
Consultation with a doctor	-0.000080	12.612209	0.063	weak relationship
Number of beds	-0.000330	12.186028	0.699	strong relationship
Health expenditure	0.000143	4.517351	0.148	weak relationship

Source: authors' own processing based on OECD and NCZI data

The results presented in Table 2 show that the number of doctors has the strongest effect on the number of beds in health facilities ( $R^2 = 0.699$ ), implying that the greater the number of doctors working in a country's health system, the fewer the number of beds that will be operated by health facilities. We can assume that a higher number of doctors will result in better access to health services, which will positively affect the health status of patients, and therefore there will not be a need for as much inpatient health care as is currently the case.

There is a moderate positive effect of the number of doctors in relation to life expectancy at birth ( $R^2 = 0.429$ ), which implies

that a larger number of doctors will translate into an increasing life expectancy at birth. The number of doctors is also moderately but negatively related to the years lost ( $R^2 = 0.330$ ) due to deteriorating health status and increased mortality (preventable, avoidable and neonatal), i.e., that if the number of doctors increases, the number of years of potential economic activity lost will decrease. Weakly related to the number of doctors are the indicators of consultations with a doctor ( $R^2 = 0.063$ ) and government spending on health measured in purchasing power parity in Euros ( $R^2 = 0.148$ ).

Multicriteria linear regression equation:

$$\text{Number of doctors} = -29130 + 0.007 \times \text{Life expectancy} - 0.4133 \times \text{Years lost} - 0.00033 \times \text{Number of beds} + 0.00014 \times \text{Health expenditure}$$

The equation states that:

- for life expectancy at birth to increase by one year, the number of doctors needs to increase by **0.007 units**,
- if the number of years lost increases by 1 unit, the number of doctors is expected to decrease by about **0.4133 units**,
- if the number of beds increases by 1 unit, the number of doctors is expected to decrease by about **0.00033 units**,
- if health expenditure increases by 1 unit, the number of doctors is expected to increase by **0.00014 units**.

The third step was to recalculate the lost training costs of doctors who migrate abroad for work after graduation. We rely on the available OECD data presented in Table 3. The expenditures are reported not only for Slovakia, but also for the destination countries of the outgoing doctors and general medical graduates. The aim is to show the differences in the cost of study and thus the differences in the loss of public resources invested in the education of medical students, but also the benefits of the destination countries.

Table 3 Annual expenditure per student from primary to tertiary education in Euros, converted in purchasing power parity to GDP

	Pre-primary pupil/year	Primary pupil/year	Secondary pupil/year	Tertiary pupil/year
Slovakia	7 348,42	9 251,58	8 647,06	15 567,42
Czech Republic	8 378,28	7 998,19	12 814,48	16 320,36
Austria	11 676,02	13 950,23	17 238,91	22 419
Germany	12 991,86	11 609,95	15 454,3	19 904,98
United Kingdom	8 265,16	12 485,97	13 270,59	30 608,14
Norway	18 103,17	16 323,08	17 946,61	23 920,36

Source: OECD Education at Glate

Education in Slovakia lasts three years as part of pre-primary education, four years of primary education itself, five years of secondary education at the 2nd level of primary school and two years of secondary education at high school. Completion of secondary school is a prerequisite for university studies in the field of general medicine, which takes at least 6 years in Slovakia. Table 4 shows the recalculation of state expenditures on education at individual levels.

Table 4 Recalculation of state expenditure on medical education at each level

Education	Pre-primary	Primarily	Secondary	Tertiary		
				B. Sc. (in Slovakia Bc.)	M. Sc. (in Slovakia Mgr.)	M. D. (in Slovakia MUDr.)
Slovakia	22 045,25	83 264,25	43 235,29	46 702,26	77 837,1	93 404,52

Source: authors' own processing

It costs the country 267 354 € to educate a doctor with a doctorate degree, which represents a direct loss. Assuming a graduate age of 24-26 years, with a retirement age of 64-66 years, each graduate will work for a minimum of 40 years and add value. The gross value added created in the health sector in 2023 was 4252.2 million € for 118,363 persons working in the health sector. The average value added created in the health sector per person per year was 35 925 €. Then, the return on funds spent on education from the state is 7.44 years of work of

a doctor after completing education and training for the profession.

## 5 Discussion

The findings of the study show that inadequate workforce of the health sector has a significant impact on the quality of services provided and the overall health of the population. The correlation between the number of doctors and selected indicators of health and the health care system suggests that a greater number of doctors leads to improvements in key health parameters such as life expectancy, healthy years of life and a reduction in years of life lost with spillovers to preventable, avoidable and neonatal mortality. This trend is consistent with previous research, which suggests that the presence of more doctors in the health care system has a positive impact on the health of the population (Rój, 2020; Dussault & Dubois, 2003). The findings are consistent with work that identifies medical personnel as a key factor in achieving higher quality health care. According to WHO (2000) and OECD (2016), systematic planning of human resources is a key tool for improving health care systems, because the effective use of these resources contributes to improving the availability and quality of health care services. On the contrary, the shortage of medical personnel has led to limited availability of services, reduced quality of care and increased costs of the health care sector (Chikanda, 2024).

This study also confirmed the strong impact of doctor migration on the availability of medical staff. The positive correlation between the number of doctors employed in Slovakia and the number of doctors who left Slovakia to work abroad indicates that countries with more doctors face a higher outflow of these specialists abroad. The finding is supported by works that point to factors such as low salaries, job dissatisfaction, poor working conditions and the prestige of the medical profession as the main drivers of migration (Beine et al., 2008; Malgieri et al., 2015). This trend is consistent with previous research on the migration of healthcare workers from lower-income countries to higher-wage countries, leading to widening inequalities between Eastern and Western Europe (Domagała et al., 2022).

On the other hand, the analysis shows that even if a higher number of doctors improves some indicators, not all independent variables show a strong correlation with the number of doctors. For example, indicators such as doctor's consultations and health care expenditures show a weaker relationship with the independent variable under investigation. The above indicates that these indicators are influenced by other factors, such as political decisions, technological development or the quality of public policies (Kamau et al., 2023; Stokes & Iskander, 2021; Tupá, 2024).

The influence of the number of doctors on health indicators is closely linked to other factors, such as the number of beds in medical facilities and health care expenditures. The strong negative correlation between the number of doctors and the number of beds suggests that an increased number of doctors can improve the efficiency of the system, thereby reducing the need for more hospital beds. Here, it is possible to observe the agreement with previous findings on the efficiency of the use of health resources (Folland et al., 1993).

## 6 Conclusion

The results of the study suggest that the number of doctors has a significant impact on various indicators of population health and health system. An increase in the number of doctors is associated with an increase in healthy life years and health expenditures, while an increase in the number of beds and years lost lead to a decrease in the number of doctors. This model provides valuable tools for analyzing the factors influencing doctors numbers in different regions and time periods, showing how the availability of doctors capacity directly affects effective health care. The analysis of the number of doctors in the context of migration and general medical graduates has shown a close correlation, with the identified relationships providing important evidence for the

development of strategies to improve conditions in the Slovak health sector and reduce the outflow of professionals abroad. Based on the findings, policies can be designed to improve working conditions for doctors, to increase incentives for retention, and also to systematically plan human resources in the health sector with an emphasis on maintaining a long-term balance between supply and demand for health professionals.

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