Estimating required general practitioner capacity due to generational change in Czech regions up to 2035

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Abstract

The Czech healthcare system primary care segment, comprising general practitioners and pediatricians, faces persistent challenges due to the unbalanced and aging workforce of physicians. Ensuring adequate generational turnover in this sector is threatened at the national level and will exert an even more significant impact regionally. The changing age structure of the population will also play a crucial role in shaping the future demand for healthcare services. Using data obtained from the largest Czech health insurance company, this article highlights current regional disparities regarding the number, structure and capacity of general practitioners and pediatricians. It estimates the potential decline in the availability of physicians due primarily to advancing age – it has been estimated that almost 40% of general practitioner and 55% of pediatrician capacity will be withdrawn by 2035. Using regional population projections, the study determines the capacity required in each region to maintain the appropriate doctor/patient ratios. The results of the projections serve to raise awareness of the impact of changing age structures on the future supply of, and demand for, healthcare. Although the study does not determine a precise estimate of unfilled capacity, it prompts further discussions on ensuring accessible healthcare in the future.

Keywords: General practice, general pediatrics, regional differences, demographic aging, model projections, Czech Republic

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1. Introduction

The Czech Republic is one of a large number of countries that are being forced to address the impacts of generational change on the supply of healthcare workers due mainly to the unbalanced age structure of this group with its high proportion of doctors in older age groups (e.g. European Commission, 2021; Šídlo et al., 2015, 2021) and the expected increase in demand for health services due to the aging Czech population.

Thus, the double impact of the aging of recipients and service providers must be considered. Regional challenges concerning the provision of selected health services are already evident. Although the preparation of regular analyses and model projections at the national (let alone the regional) level has not yet been institutionally consolidated, the results of partial analyses conducted to date point to potential major problems in terms of the future provision of basic health services (e.g. Šídlo, 2011; Burcin & Šídlo, 2017).

One of the most intensely discussed sectors in terms of its pivotal position in the general healthcare system concerns primary healthcare (WHO, 1978), particularly the general practical medicine segment, which in the Czech Republic consists of two fields: general practice (hereinafter referred to as GP) and general pediatrics (PED). A range of interested institutions, e.g. the Ministry of Health, health insurance companies, professional societies, etc., have been attempting for several years with varying degrees of

success to find a recipe for managing the generational turnover of general practitioners, due primarily to the high proportion of pre-senior and senior doctors in the Czech healthcare system.

This study attempts to provide a picture of both current regional differences in terms of capacity and the age structure of the two groups of general practitioners, and to highlight the effects of ageing of general practitioners that may lead to reduced capacity and thus threaten the future availability of these health services. From these objectives, the main research question arises: What decline in the capacities of general practitioners can be expected up to 2035 due to aging of physicians, both in the regions and in the Czech Republic as a whole?

Administration Districts of Municipalities with Extended Powers (AD MEP) of the Czech Republic (including the capital city of Prague, i.e. 206 regions) were chosen as the considered regional unit; this unit is considered to be a suitable level for analysis with concern to the so-called geography of services, including primary healthcare sector services. 2035 was chosen as the horizon for our estimates for purely practical reasons, i.e. taking into account the education and training of "new" doctors from general to specialized postgraduate education, which takes an average of 10–12 years. Thus, at the time of the writing of this article (2023), it is already clear that we cannot expect significant changes due to e.g. the entry of a higher number of students in

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the relevant medical fields followed by the entry of more newly-graduated doctors to the system than is currently the case. This renders the challenge ahead of us as a society all the greater.

2. Theoretical background

Almost all developed countries, including the Czech Republic, are facing a shortage of healthcare workers, whether they be specialists, general practitioners or nurses. As a result of the aging population, which is associated with an increase in the number of chronically ill and multimorbidity patients (Marengoni et al., 2011), the demand for healthcare services is increasing (Prince et al., 2014) while the supply of these services is declining due to the aging of healthcare workers (Kurashvili et al., 2023).

In 2019, more than one-third of doctors in OECD countries were over 55 years old; the Czech Republic was only slightly below this average (OECD, 2021a). In 13 of the 44 member countries, 40% of doctors were over 55 years old, whereas in Italy this proportion was as high as 56% (WHO, 2022). Moreover, the aging of the healthcare workforce and increased shortages are particularly evident in the rural areas of these countries (Kroezen et al., 2018).

Gender inequality comprises a further important factor in terms of the capacity of the healthcare sector, with women making up almost 80% of the healthcare and social services workforces (Kluge & Azzopardi-Muscat, 2023). The OECD reported that the proportion of women of physicians increased from 40% to 49% between 2000 and 2019. Moreover, the Czech Republic has one of the highest proportions of female physicians in the healthcare sector, i.e. 56% of GP and 85% of pediatricians in 2019 (OECD, 2021a). This is likely to further negatively impact access to healthcare going forward due to the taking of temporary maternity and parental leave, a higher proportion of part-time work (Strazdins et al., 2018) and earlier ages at retirement.

In addition to the gender imbalance, the aging of the healthcare workforce and its uneven geographical distribution are particularly acute for general practitioners, who comprise a key element in any effective healthcare system. Research in a number of countries has revealed that a robust primary healthcare system positively influences both the health status and satisfaction of patients and acts to reduce overall health care costs. Thus, the aging of this sector is a major concern for all developed countries (Kringos et al., 2013; Schäfer et al., 2019).

The availability and capacities of general practitioners are difficult to compare and evaluate across countries due to differing category definitions. In the US, for example, internists fulfill the same role as a GP in other countries; however, they are classed as specialists (OECD, 2021a). Pediatric primary care comprises three systems according to the type of specialist (Ehrich et al., 2015). Primary care for children is the responsibility of pediatricians, especially in Central and Eastern European countries. Here, however, the Czech Republic is a global exception since primary care for children is provided by "general practitioners for children and adolescents" (referred to in this article as general pediatricians). Primary care for children is provided in Scandinavian countries and the UK by general practitioners and family doctors, who may or may not have formal training in pediatrics (Newson, 2020). In other countries, the provision of care changes from pediatricians to GP over the course of the child's life. We clearly need to take these differences into account when comparing the situation across countries. Most foreign research to date has tended to analyze all GP together, aimed at eliminating differences between healthcare systems.

Most European countries are experiencing a decline in the number of GP compared to specialists due to the higher average age of primary care physicians. The average age of GP in almost all EU states is around 50 years or more (Kringos et al., 2015). The average

age of primary care physicians in the Czech Republic is among the highest in Europe. The increasing age of GP and the shrinking number of practices has been addressed by a number of experts; for example in Germany (Wangler & Jansky, 2023), Hungary (Papp et al., 2019) and England, where GP are increasingly taking early retirement (Dale et al., 2015; Moberly, 2023); the number of doctors in England who opted for early retirement increased by 9.3% from 2022 to 2023 (Moberly, 2023).

Ensuring generational renewal will be a major challenge for all those countries that have witnessed increases in the number of general practitioners aged over 55 in recent years. France, for example, has sought to address this problem by increasing the number of postgraduate training places in general medicine, which in 2017 accounted for almost 40% of all training places, a much higher proportion than in other countries (OECD, 2021b). In many countries, however, it remains very difficult to attract sufficient numbers of medical graduates into general practice due to the lower prestige and remuneration of this specialization. Other factors have also been identified; for example, it has been noted in the Netherlands that the level of attraction for young doctors to work in primary care is low due to a preference for working in teams (Batenburg et al., 2018).

The main challenges, however, include not only ensuring a sufficient number of new GP but, equally importantly, attracting young doctors to rural areas, which are struggling most with limited GP capacity (Gibis et al., 2012; Barriball et al., 2015). The problem of the uneven geographical distribution of GP is being faced by almost all European countries and constitutes a major challenge for the health systems of around half of all EU countries (EU, 2022). Therefore, experts are increasingly focusing on the differences between the structures of GP in urban and rural areas (Groenewegen et al., 2020; Ozegowski, 2013). The lack of primary healthcare services in rural areas is due to a combination of the increasing number of patients and declining numbers of GP who are interested in working in such areas (WHO, 2018), factors that have been confirmed through research in the Czech Republic (Šídlo et al., 2021).

The Czech Republic faces similar problems to those of most developed European states. Previous studies have confirmed the ever-increasing number of older GP, the high proportion of women of the total capacity of healthcare service providers and the widening gap in terms of the availability of GP between urban and rural regions (e.g. Maláková, 2022; Maláková et al., 2020; Šídlo et al., 2021, Bělobrádek et al., 2021). This evident increase in regional inequality is negatively affecting accessibility to general GP services, especially general pediatricians.

3. Data and methods

3.1 Data

The baseline data on physicians were provided by the General Health Insurance Company of the Czech Republic (GHIC) – the country's largest health insurance company. The GHIC covers the care of approximately 55% of insured persons and has concluded contractual relationships with almost all the country's health service providers, especially in the general practice sector. The data on GHIC contracts includes a detailed breakdown of healthcare professionals by location, with their age, gender and capacity. The contractual terms require that such data is updated regularly by providers; thus, this source of information can be regarded as highly reliable, accurate and relevant for the purposes of processing analysis. No other sources, i.e. not even the two basic national registries that contain potential data sources managed by the Institute of Health Information and Statistics of the Czech Republic, provide such comprehensive data: the National Register of Health Professionals does not cover such a high percentage

of providers with detailed and updated data, and the National Register of Reimbursed Health Services, which is based on data submitted by all the Czech Republic's health insurance companies, did not contain data on the capacity of individual providers at specific locations at the time of data processing.

The GHIC input data (GHIC, 2022), covering both types of general practice physicians (GP and PED), comprised anonymized individual data on the age, sex and capacity of doctors aggregated at the regional AD MEP level for the period 2015–2021 (end states as of December 31 of the given year).

The data thus provided a useful basis for fulfilling the main objective of the study, i.e. the estimation of the proportion of the current capacity of physicians in each AD MEP region that will be terminated by 2035 as a result of their withdrawal from practice. The secondary objective was then to determine how much new capacity will be required for both types of practitioners so as to maintain the current population (expressed in terms of the "age-adjusted population" – AAP) per 1 FTE practitioner/pediatrician.

3.2 Regional context of the study

To better understand the subsequent methodological steps and the analysis itself, it is necessary to present the basic trends in the number and structure of physicians in both observed medical specialties at the level of the entire Czech Republic. This will also allow a better understanding of the specific objectives of this article, which are formulated in the introduction of this article.

The aging demographic structure of both general practitioners and general pediatricians currently comprises one of the most intensely discussed problems in the Czech healthcare system. The representation of the number of doctors aged 60 and over currently stands at 40% for GP and almost 50% for PED (Tab. 1). Once doctors in this age group leave the system, serious problems can be expected with concern to the availability of these essential health services at both the national and, especially, the regional levels.

3.3 Methods

The modelled projection of the departure of physicians from the system, with the threshold comprising the number, structure and capacity of physicians as at December 31, 2021 and a horizon of December 31, 2035, was based on several common initial assumptions:

a. The potential departure of doctors was monitored only for the age category in which increased departures from the system are due mainly to retirement or death. The lower limit of the age category comprised the so-called threshold age, which was determined based on the analysis of the average probability of doctors leaving the system by age, gender and medical specialty for the period 2016–2021. The calculation of this probability employed so-called tabular functions e.g. in the construction of mortality tables, specifically the so-called direct calculation of

a given probability method, modified by the authors for analysis purposes and respecting the available data, i.e. the gender and age structure of doctors as of December 31 of each year;

$$_{t}^{c}q_{x}^{x+1\,g,s} = \frac{_{t}^{c}O_{x}^{x+1\,g,s}}{_{31.12.t-1}^{c}P_{x}^{g,s}}$$

where $_{t}^{c}q_{x}^{x+1\,g,s}$ is the probability of leaving the system during year t between age x and $x+1$, $_{t}^{c}O_{x}^{x+1\,g,s}$ is the number of physicians that leave the system in year t and $_{31.12.t-1}^{c}P_{x}^{g,s}$ represents the number of physicians at the end of the previous year, all for the generation of doctors c, gender g and specialty s. Both the number of outgoing physicians and their number at the end of the year comprised the sum of six years of observation (2016–2021); this was aimed at enhancing the robustness of the calculation since some ages featured very few observations. The probabilities were then smoothed for the purposes of our study via moving averages (the simple arithmetic mean of the five closest values – i.e. the arithmetic mean of values over ages $x-2$, $x-1$, x, $x+1$ and $x+2$).

The investigation of the sex- and age-specific probabilities of leaving the system (see Fig. 1) allowed for the identification of the age at which we can infer that potential departures from the system are already reaching levels that may affect the number of physicians, and which are due predominantly to reaching retirement age or death. Based on the analysis of the resulting values, a threshold age of 59 years was set in order to generalize the process for both the specialties and genders of doctors. Moreover, we set an upper limit, i.e. a probability of 1.0 for the age of 90. The probabilities thus determined for the age units in the 59–90 age group were then invariant throughout the projection period in the model. The minimal attrition of physicians in the 45–58 age category from the system was also important for the modelled projection (see Fig. 1), i.e. those cohorts of physicians that gradually enter the age interval with a lower threshold age of 59 over the projection period with a horizon of 2035. For the sake of completeness, we also assumed, based on a partial analysis of the input data, that the vast majority of physicians will have entered the general medical services system by the age of 45, and that the chances of a significant increase in the number of foreign physicians aged 45–58 is minimal given the specific requirements of this sector (e.g. good language skills). Thus, we assumed that the initial numbers of physicians in the cohorts that progressively enter the model projections with a horizon of 2035 are already known and remained unchanged at the time of the projection.

b. Our calculations aimed to determine the capacities of doctors who will leave the system predominantly as a result of reaching the most frequent retirement age or death, and to determine how much new capacity will be required so as to ensure

Indicator	General practitioners				General pediatricians			
	2015	2017	2019	2021	2015	2017	2019	2021
Number	6,259	6,459	6,607	6,777	2,349	2,330	2,294	2,279
Capacity (sum of FTE)	5,383	5,432	5,368	5,328	2,060	2,046	1,965	1,920
– % of female	62.6	62.9	63.3	63.5	85.8	85.5	85.3	85.6
– % at age under 40	11.6	13.0	14.1	15.4	5.3	6.8	6.8	7.9
– % at age 40–59	50.7	45.4	42.9	42.4	52.5	46.8	44.1	43.0
– % at age 60 and over	37.7	41.6	43.0	42.1	42.3	46.4	49.1	49.1
Weighted mean age	54.7	54.8	54.8	54.7	56.5	57.0	57.5	57.3
Average FTE	0.86	0.84	0.81	0.79	0.88	0.88	0.86	0.84

Tab. 1: Development of the number, capacity and structure of general practitioners and general pediatricians in the Czech Republic between 2015 and 2021 (selected years, as of December 31 of the given year)
Note: Weighted mean age; the weighting comprises the amount of the physician's FTE (full- time equivalent)
Source: authors' calculations based on data from the GHIC (2022)

a certain physician/population ratio under the relevant option. It was not considered a rule that the number of doctors was equal to their total capacity (see Tab. 1). Moreover, the average amount of FTE capacity varies according to the age, gender and duration of service of doctors. Again, we proceeded toward a generalization of this variable, starting from the average values for the end states of 2015–2020, which we then again equalized within the age profile applying the moving averages of five consecutive ages (Fig. 2). We also assumed with respect to the model calculations that the average values by age and gender were constant over the projection period.

c. The GHIC input database revealed instances in which physicians practice in multiple AD MEP regions simultaneously. In such cases, we included the physician in all the regions involved, but adjusted the data to take into account the time worked in each region.

The modelled projection of the departure of physicians was based on the so-called cohort-component method, according to which we shifted individual cohorts of physicians from year t to year $t + 1$, and from age x to age $x + 1$ by applying the respective sex and age-specific probabilities of leaving between the completed age x and x+1 to the number of physicians. We then applied the average FTE according to the age, gender and specialization of the physicians to the newly-determined headcount, rounded to the nearest integer. The calculation employed the following formulas:

$$_{31.12.t+1}^{c}P_{x+1}^{g,s} \doteq {}_{31.12.t}^{c}P_{x}^{g,s} \times {}_{t}^{c}q_{x}^{x+1\,g,s}$$

$$_{31.12.t}^{c}FTE_{x}^{g,s} = {}_{31.12.t}^{c}P_{x}^{g,s} \times c_{x}^{g,s}$$

where $_{31.12.t}^{c}FTE_{x}^{g,s}$ is the sum of the capacities of physicians at age x, $_{31.12.t}^{c}P_{x}^{g,s}$ is the physical number of physicians at age x, $_{t}^{c}q_{x}^{x+1\,g,s}$ is the probability of leaving the system between ages x and $x + 1$ and $c_{x}^{g,s}$ represents the average FTE at age x, all in year t (or $t + 1$), cohort c, gender g and specialty s.

The analysis also included the estimation of how much new capacity is required in each region in order to achieve a model variant that assumes that the ratio of the number of the "age-adjusted population" (AIP) per 1 FTE physician in a given AD MEP from the end of 2021 is maintained (see below). The model aimed to highlight differences in the demand for health services depending on the age of patients (see e.g. van den Bussche et al., 2011; Schulz et al., 2004) and regional differences in the capacity of health service providers in relation to the expected changes in the age structure of the population.

In view of the fact that no officially available population forecasts are published for individual AD MEPs (especially at the age-specific level), we compiled our own, somewhat simplified, estimates. The
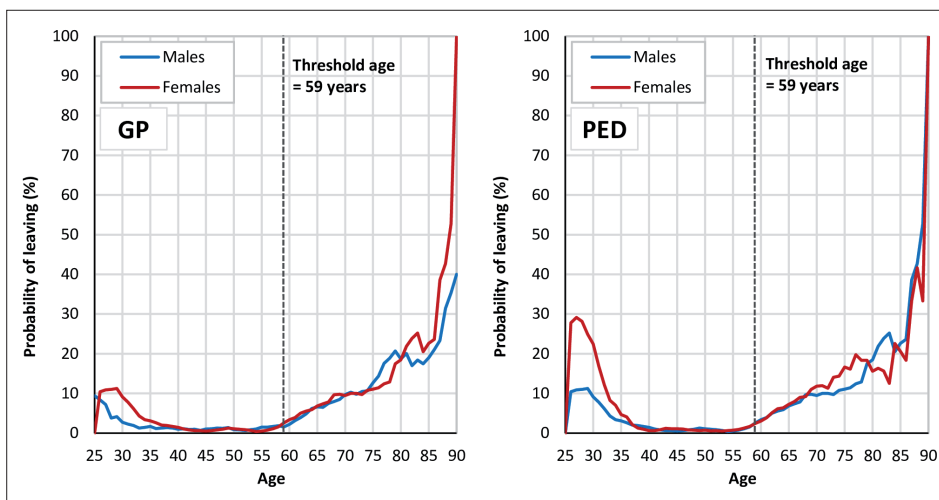

Fig. 1: Probability of leaving the system by the age and gender of general practitioners (GP) and general pediatricians (PED), Czech Republic, average 2016–2021
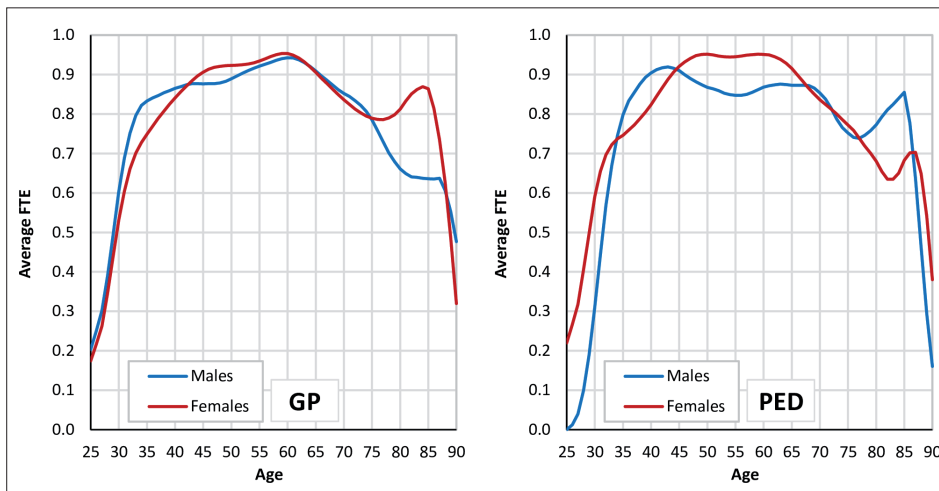*Source: authors' calculations based on data from the GHIC (2022)*

Fig. 2: Average FTE by the age and gender of general practitioners (GP) and general pediatricians (PED), Czech Republic, average 2015–2021
Source: authors' calculations based on data from the GHIC (2022)

population projection for each AD MEP was calculated taking into consideration the baseline population as at December 31, 2020 and based on the following assumptions: a stable age fertility profile (data for the whole of the Czech Republic, average for the period 2017–2021); a stable mortality intensity by age and gender for persons under 30 at the level of 2021 and, for the elderly, a gradual return to pre-COVID-19 pandemic values over the first five years (average of 2019 and 2021) followed by stable mortality rates (2019 values) up to 2035; zero migration.

We are aware of the significant simplification of the projection input parameters, especially considering new developments since the time at which the estimates were compiled, e.g. the influx of Ukrainian refugees with temporary protection status of more than 1 year to the Czech Republic and a significant decline in the birth rate in 2022. However, the intention was to determine indicative population numbers up to 2035 according to five-year age groups (15 and over for GP and up to 19 years for PED – the reason for the overlap of the 15–19 years age group relates to the option to register insured persons in this group with both GP and PED) so as to reflect the potential demand for health services. The comparison of the aggregated results of our projections for the sex-age structures of all the AD MEPs with the latest published official projections for the Czech Republic as a whole (variant without migration) (CZSO, 2018) revealed no significant differences. The most noticeable difference related to the registration of higher ages related to the increase in the mortality rate due to the COVID-19 pandemic, which could not have been expected at the time of the compilation of the national projection.

The afore-mentioned assumption of differences in the demand for health services according to the age of patients is taken into account in the Czech healthcare system. The so-called reimbursement decree, which provides an annual financial evaluation of individual medical procedures (Czechia, 2020), includes so-called indices (sometimes referred to as "capitation indices" due to their use for the calculation of the so-called capitation payment for general practitioners), which express the ratio of the costs of insured persons in given age groups to the costs of insured persons in the 15–19 age group (assigned an index of 1.0). Thus, the analysis included the estimation of the sum of the age-adjusted population (AAP), i.e. the sum of multiples of the estimated population in given regions by age category with the relevant age-specific (capitation) index, valid as at 2021 (see Tab. 2):

$$_{31.12.t}AAP^s = \sum {}_{31.12.t}P_x^s * i_x$$

where $_{31.12.t}AAP^s$ is the number of the age-adjusted population, $_{31.12.t}P_x^s$ is the number of inhabitants as of December 31 of the given year t, and i_x represents the so-called capitation index, all for the given age x and specialty s.

4. Results

Regional differences in the number and age structures of both groups of general practitioners were found to be significant at the AD MEP level. The consideration of the results, which for reasons of comparison were expressed in terms of the sum of the AAP per 1 FTE, revealed regions with values of up to twice as high as regions with the lowest values, with concern to both medical

specializations (Figs. 3A and 3B). These differences may be due to a variety of factors, particularly in areas surrounding large cities (see the Discussion). It is noticeable however that with concern particularly to regions that are generally perceived as peripheral or socio-economically disadvantaged (border areas, inner periphery areas, etc.), the resulting values were above average.

Since the distribution of capacity is difficult to assess without having more detailed information at hand such as the commuting of patients for medical care, it was considered more appropriate to focus on the age composition of doctors. If we assume the ideal situation in the model, i.e. that current capacity in each region is relatively adequate, the age structure of doctors is the main factor that will influence the future availability of health services at the regional level. Figures 3C and 3D illustrate the share of the capacity of general practitioners under 40 years of age of total capacity. The variation in the distribution is clear; while certain regions had a proportion of younger doctors of more than 40% at the end of 2021, certain regions had no contracted physicians aged below 40 – 31 such regions (15%) for GP and as high as 120 for PED, i.e. more than half of all AD MEPs (58%). The low or zero representation of younger doctors does not represent a problem from the future perspective provided that sufficient capacity is ensured by doctors in the intermediate age group, and that the representation of doctors at pre-senior and senior ages does not comprise the majority of practitioners. Figures 3E and 3F suggest that this is not the case, however. Concerning GP, 59 AD MEPs (29%) had a share of doctors aged 60+ of more than 50% at the end of 2021, while regions with a proportion of more than 70% were not exceptional. The situation concerning PED is even more critical in this respect: 45% of AD MEPs (92 regions) had a share of doctors aged 60+ of more than 50% at the end of 2021, with around a quarter of regions with a share of more than 80% of older aged doctors. The comparison of the figures shows that these regions have a correspondingly low or even zero representation of younger physicians. Therefore, more attention should be directed to these regions so as to ensure the availability of general practitioner health care services in the future.

The current age structure will largely determine the future availability of health services in Czech regions. Our research included the modelling of the reduction in the capacities of general practitioners for each region up to 2035 due to their gradual departure from the healthcare system due to reaching retirement age or death. We applied the afore-mentioned conditions, i.e. the application of the age- and gender-specific probabilities of leaving the system (see Fig. 1) and average capacities (see Fig. 2). A summary of the results is provided in Table 3, which illustrates the gradual decrease in capacity in five-year intervals at the national level, and in Figure 4, which shows the potential decrease in capacity up to 2035 at the AD MED level.

The aggregation of the changes at the AD MEP levels revealed that the reaching of retirement age or death will reduce the capacity of GP by 4% and PED by 8% as soon as in 2025. It is expected however that, subsequently, the rate of departures will vary considerably, as driven by the initial age structure of the doctors (Tab. 1). While the current GP capacity will be reduced by a quarter due to doctors leaving the system by 2030 and by nearly 40% by 2035, a decline of 36% in the availability of PED can be expected as early as in 2030 and up to 55% of the current physician capacity by 2035.

Age Group	0–4	5–9	10–14	**15–19**	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85+
Index	4.10	1.90	1.45	**1.00**	0.90	0.95	1.00	1.05	1.05	1.10	1.35	1.45	1.50	1.70	2.00	2.40	2.90	3.40

Tab. 2: Age groups and indices that express the ratio of the costs of an insured person in the given age group to the costs of an insured person in the 15 to 19 years age group, applicable in 2021
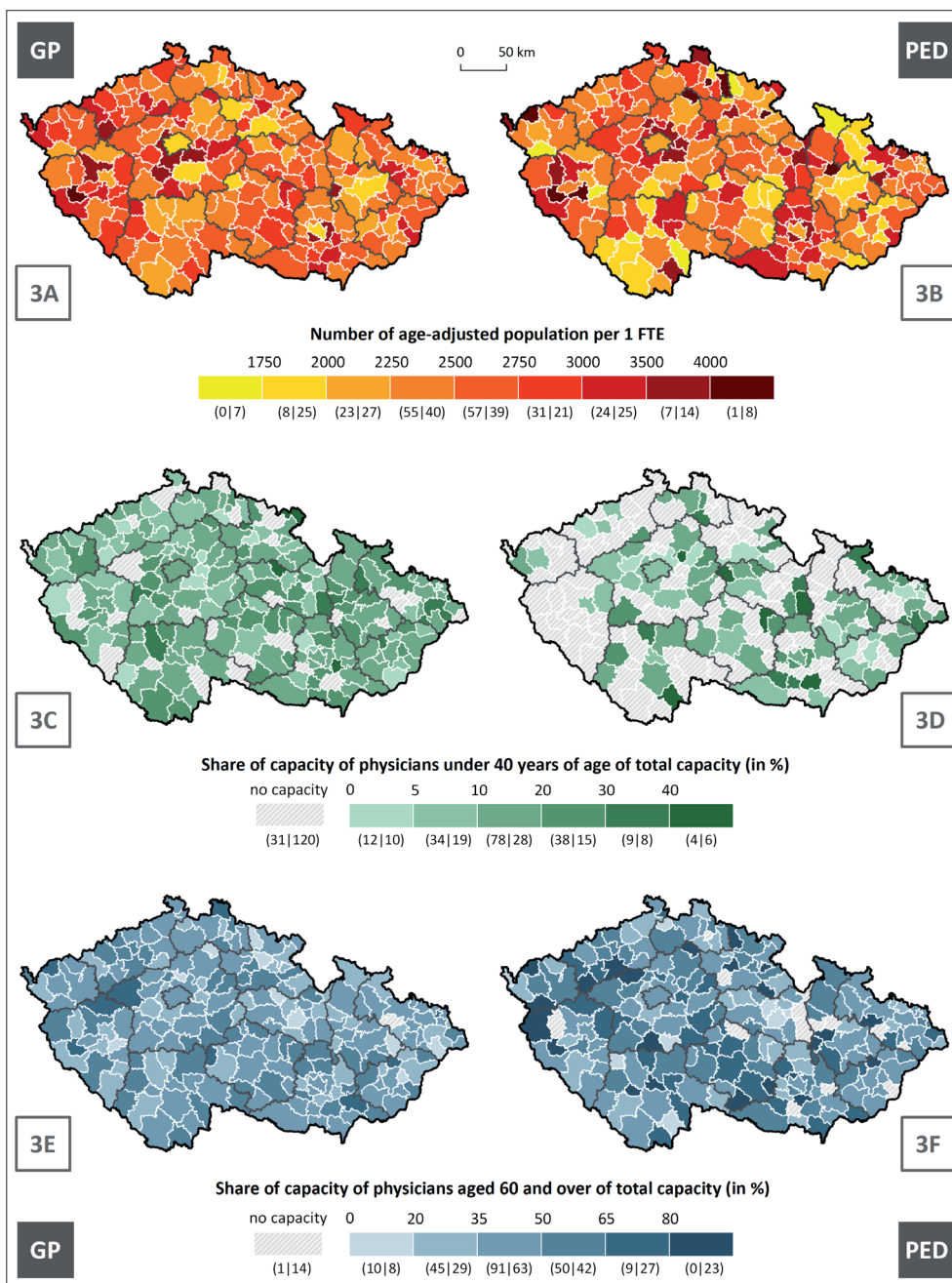*Source: Czechia (2020)*

Fig. 3: Age-adjusted population per 1 FTE (3A, 3B) and the representation of the capacity of younger (3C, 3D) and older (3E, 3F) physicians of the total capacity of both types of general practitioners in AD MEP regions, Czech Republic, as of December 31, 2021
Note: the values in brackets indicate the number of AD MEPs in the given category (GP|PED)
Source: authors' calculations based on data from the GHIC (2022)

	2021	2025	2030	2035
General practitioners	5,328	5,135	4,016	3,252
– absolute change	0	− 193	− 1,312	− 2,076
– relative change	0%	− 4%	− 25%	− 39%
General pediatricians	1,920	1,770	1,233	867
– absolute change	0	− 150	− 687	− 1,053
– relative change	0%	− 8%	− 36%	− 55%

Tab. 3: Modelled estimates of the total FTE of general practitioners and general pediatricians up to 2035 excluding doctors who leave the system due to reaching the age of retirement or death and the change from the base year of 2021 (selected years, as of December 31 of the given year)
Note: This is the so-called bottom-up sum, i.e. the sum of the estimates for all the AD MEPs; these estimates may therefore differ significantly from model projections for higher-level administrative units or for the country as a whole
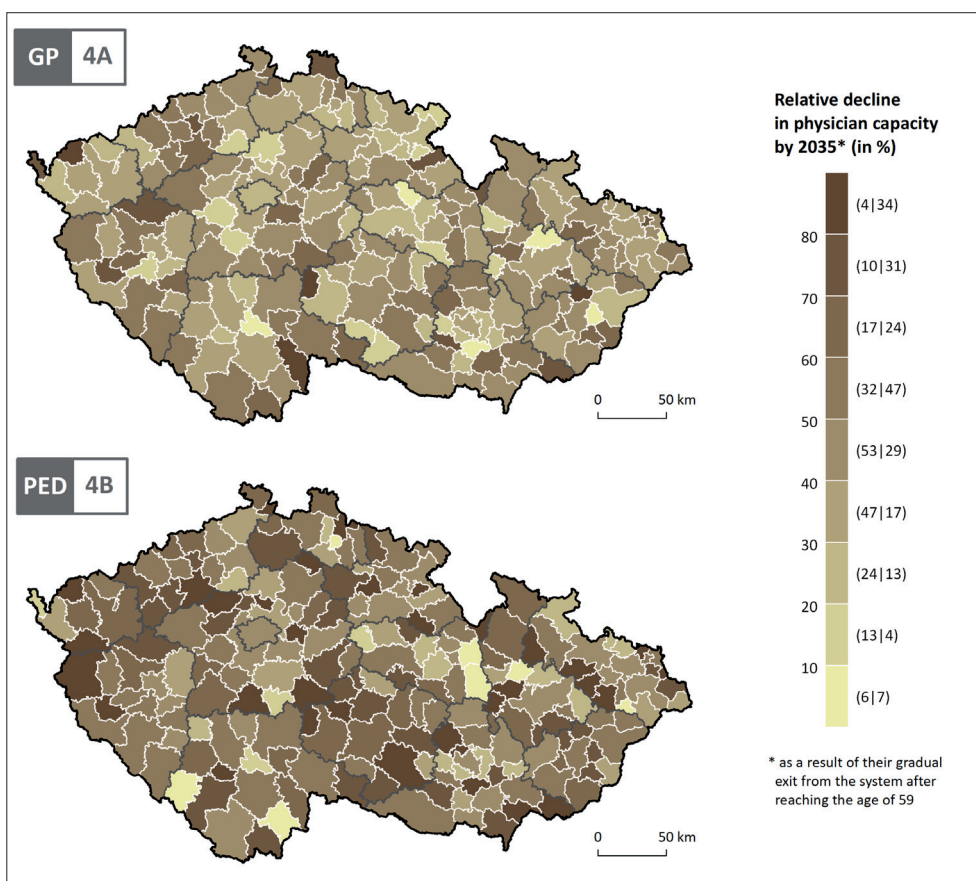*Source: authors' calculations based on data from the GHIC (2022)*

Fig. 4: Relative decrease in the capacity of GP and PED physicians up to 2035 compared to 2021 due to their gradual withdrawal from the system after reaching the "baseline age" of 59 years, AD MEP regions, Czech Republic (as of December 31 of the given year)
Note: the values in brackets indicate the number of AD MEPs in the given category (GP|PED)
Source: authors' calculations based on data from the GHIC (2022)

Clearly these rates of decline are more differentiated at the regional level (Fig. 4). Although many AD MEPs enjoy a good initial position in terms of the age structure of general practitioners and can expect a decline of up to a maximum of just 15%, 4 AD MEPs should plan for a decline of more than 80% of GP capacity and up to 20 AD MEPs can expect a decline of more than 90% of PED capacity, i.e. practically none of the physicians currently in practice will be providing healthcare services in these areas by 2035.

Clearly, the expected changes in the age structure of doctors present a serious challenge going forward. It is also important, however, to consider changes in the age structure of healthcare recipients, i.e. the general population. It is inevitable that the population of the Czech Republic will experience a relatively significant rate of aging, which will be manifested both at the top and at the bottom of the age pyramid. By as soon as 2035, the number of seniors in the population according to the current official national projection (medium variant, see CZSO, 2018) will increase by up to 16% compared to the situation at the end of 2021, while the representation of persons aged under 15 will decrease by approximately 11%. Expressed in terms of the "age-adjusted

population", i.e. applying the so-called capitation indices to the expected age structure, the number of the AAP of GP patient age (15 and over) will increase by 12% by 2035, while the number of AAP of PED patient age (0–19 years) will decrease by 10% by 2035. Thus, the demand for GP services will increase over time, while the demand for PED care is more likely to decline. Hence, the planning of the future capacity of GP and PED care services should take these trends into account.

Figures 3A and 3B show the regional differences in the AAP to 1 FTE ratio. If we assume that the differences largely reflect the current "optimal" state of the current supply-demand conflict, given the estimates of the future size and age structure of the population in each AD MEP, it is possible to model the ideal optimal sum of FTEs in 2035, as well as at previous intermediate time intervals (Tab. 4). The aggregation of the expected numbers of new entrants to the system reveals that capacities of more than 2,200 new GP and almost 800 PED positions will be required by 2035 so as to maintain the appropriate ratio. This is approximately 140 more GP capacity and 280 less PED capacity than the number of expected departures.

Model estimation	General practitioners				General pediatricians			
	2021	2025	2030	2035	2021	2025	2030	2035
The capacity required	5,328	5,416	5,481	5,466	1,920	1,873	1,737	1,643
Capacities of outgoing doctors	–	193	1,312	2,076	–	150	687	1,053
New capacities needed	–	281	1,465	2,214	–	103	504	776

Tab. 4: Modelled estimate of the total and new FTE of both types of general practitioners required by 2035 so as to maintain the 2021 AAP/1FTE ratios in Czech AD MEP (selected years, as of December 31 of the given year)
Note: This is the so-called bottom-up sum, i.e. the sum of the estimates for all the AD MEPs; these estimates may therefore differ significantly from model projections for higher-level administrative units or for the country as a whole
Source: authors' calculations based on data from the GHIC (2022)
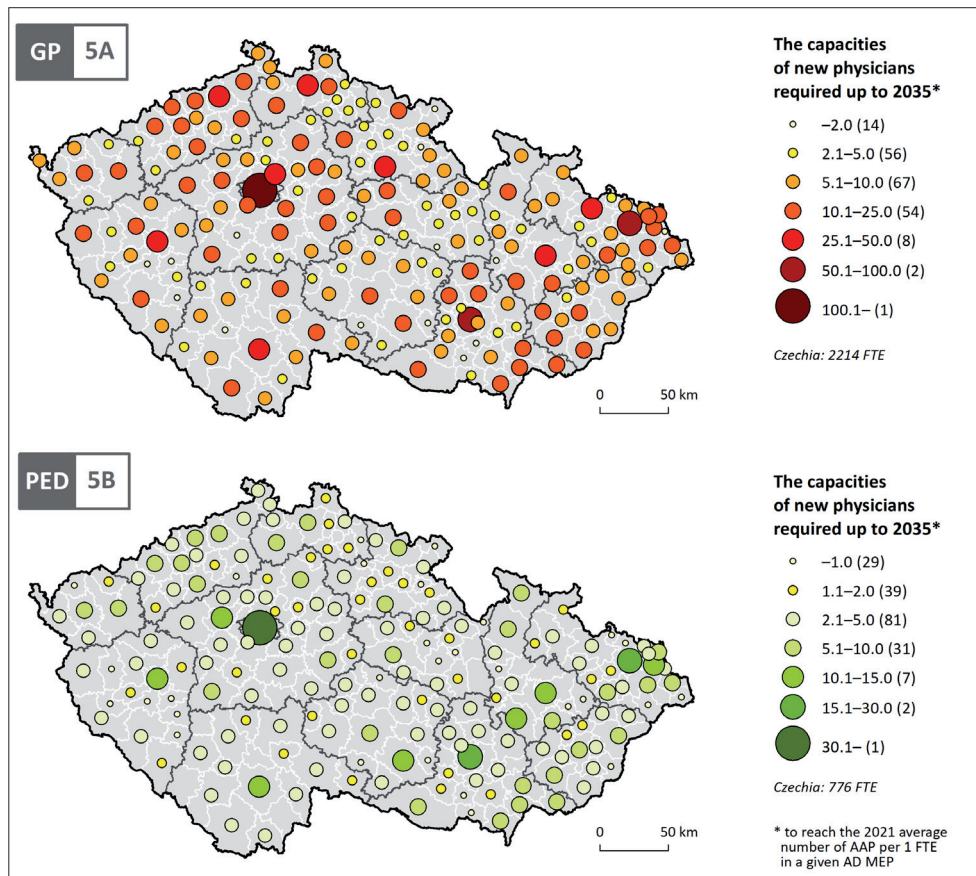
Fig. 5: The capacities of new physicians (GP and PED) required up to 2035 so as to maintain the 2021 AAP/1 FTE ratio, AD MEP regions, Czech Republic (as of December 31 of the given year)
Note: the values in brackets indicate the number of AD MEPs in the given category
Source: authors' calculations based on data from the GHIC (2022)

Figure 5 shows how much new capacity will be needed for each AD MEP by 2035 so as to maintain the same AAP per FTE ratio as in the base year of 2021. While the regional differences largely reflect the population size of the region, it is clear that higher numbers of new practitioners (both GP and PED) should be directed to regions with large (regional) city populations, as well as north-western Bohemia and south-eastern Moravia.

5. Discussion

The representation of physicians in the various regions is clearly uneven (also in per capita terms), as highlighted by the description of the results provided in Figures 3A and 3B. The factors behind these differences primarily reflect the location of the regions. According to previously published studies (e.g. Šídlo & Maláková, 2022), it is clear that in suburban areas many local residents are willing to commute to the local city centre for healthcare treatment since, in many cases, they work or study and spend most of their time in the centre. This, in turn, means that health service providers often concentrate their capacity in city centres so as to meet this increased demand. In many areas, however, commuting for medical care reflects the unavailability of health services in the patients' home regions, a phenomenon known as involuntary commuting. In such cases, health insurance companies should provide assistance to patients either by creating the appropriate conditions for the establishment of new contractual relationships in the respective areas or by ensuring affordable healthcare for their insured clients in other locations within the legally defined travel time limit, i.e. 35 minutes for practical medicine. The question that has yet to be addressed in the Czech Republic concerns the determination of the "optimal" number of the age-adjusted population per 1 FTE doctor. Defining of such a benchmark figure, however, which

should reflect the wider discussion of the provision of affordable healthcare services, requires both detailed analysis based on the benchmarking of individual health service providers and a broader professional and political consensus.

Therefore, when assessing the availability of health services, it is not sufficient to simply consider the ratio of the medical capacity available to the population of the respective region. At present (despite the media coverage of selected local problems), it is reasonable to state that the basic provision of general practice services is sufficient. Thus, going forward it would seem more appropriate to highlight the future capacity shortages that will arise from the current age composition of doctors. Figures 3E and 3F clearly show that regions already exist in which the proportion of care provided by doctors of pre-senior and senior age is in excess of three-quarters of the total capacity provided. These regions are located primarily in areas that are not particularly attractive for young doctors, i.e. in the borderlands or inner peripheries (areas that lie on the borders of the Czech Republic's NUTS 3 regions), as confirmed by Figures 3C and 3D.

Previous studies in the field of GP showed that the rate of aging of GPs in rural municipalities is significantly higher than in urban areas (Šídlo et al., 2021) and that areas with a higher representation of the elderly population also often have a higher proportion of older doctors (Maláková et al., 2020). Nevertheless, concerning the GP sector, it can be assumed that with targetted intervention measures involving the full range of actors in the public health sector and a well-set contractual policy, generational renewal can be achieved even at the regional level.

In contrast, several problems are evident in the area of PED, related mainly to the low number of new doctors entering the system. This is largely linked to changes to, and the unclear concept

of, the setting of postgraduate training in the field of pediatrics. Thus, recent years have seen a significant reduction in the number of newly certified general pediatricians. It is not the case that interest in pediatric medicine is low among young doctors. A number of professional forums have highlighted that while the number of young general "practical" pediatricians is decreasing, their number in hospitals has been increasing over the long term.

This is thought to be due to a number of factors, including the lack of a coherent concept concerning the training of pediatricians and the reluctance of young pediatricians to assume the role of "entrepreneurs" who have to deal with administrative issues, employ a nurse, etc. and cover a much wider range of activities than doctors who are employed by a provider of in-patient services. This is one of the reasons for the emergence of new forms of providing such services in recent years, including the establishment of "practitioners for children and adolescents" (general pediatricians) facilities in hospitals, which eliminate the administrative obligations of small local practices. Nevertheless, such developments are unlikely to solve all the problems inherent in the system. Going forward, the currently low numbers of new PED will be unable to compensate for the departure of older colleagues from the PED system due to age and, in some cases, increasing administrative demands. Despite the reduced demand for PED services due to low birth rates, ensuring an adequate number of PED even at the national level will present a serious challenge (see Tab. 1 and Fig. 5), as confirmed by previously published model projections (e.g. Burcin & Šídlo, 2017). Thus, the various authorities and institutions involved must prioritize the stabilization of the postgraduate training of new pediatricians, as well as create the conditions for evening out the number of hospital-based and general (practical) pediatricians.

The Czech Republic is thus faced with an acute problem in terms of ensuring affordable healthcare services over the long-term and avoiding the exacerbation of regional differences in this respect. This issue has been under discussion in Western European countries for many years. In addition to increasing the number of healthcare professionals, the solutions proposed include the introduction of an electronic healthcare (eHealth) system, which, however, has a number of disadvantages (Valokivi et al., 2021). Hence, most countries are making efforts to increase the attractiveness of working as a general practitioner for young doctors, particularly in rural areas. Most countries have also considered financial incentives; however, non-financial measures such as professional development, access to social services, etc. are also being seen as important (EU, 2022). There are many reasons why young doctors choose to practice in urban rather than rural areas (Weinhold & Gurtner, 2014) or prefer to avoid working in peripheral regions. Rural and peripheral regions are often associated with a higher workload, lower incomes (Steinhaeuser et al., 2011), fewer job opportunities for the partner (Lee & Nichols, 2014) and professional and social isolation (Straume et al., 2010). Moreover, the experience medical students have with rural areas and the attention devoted to rural areas in their postgraduate studies are further important factors in the decision-making process (Lee & Nichols, 2014). In France, the approach to addressing the shortage of general practitioners outside urban areas involves providing support for so-called primary care teams, which include, e.g. dentists, nurses, and administrative staff (Chevillard et al., 2019).

6. Conclusions

The results of the analysis pointed to several important aspects that affect the current and future availability of general practice health services, particularly at the regional level. Firstly, the increasing importance of age structure changes on both the supply side (health service providers – physicians) and the demand side (insured persons, specifically the populations of selected areas).

The generational turnover of physicians is currently one of the most intensively discussed topics in the Czech healthcare system. This factor is impacting most medical specializations, especially in those regions that are not seen as particularly attractive, i.e. where it is difficult to motivate young doctors to practice. In general, however, greater efforts will have to be made by the authorities involved to prevent potential shortages in the future. Admittedly, concerning the potential number of providers in at-risk specializations, including general practice, steps have been taken in recent years to address both overall undercapacity in the healthcare sector and increasing regional inequalities.

With respect to general practical medicine, a working group on primary care reform, which brought together experts from various institutions and disciplines, was established by the Ministry of Health of the Czech Republic in early 2018. The aim was to define the main problem areas and to propose solutions that will ultimately enhance the attractiveness of this field for young doctors and thus ensure the stabilization of staffing requirements going forward. The project output comprised Implementation Plan 1.1 of the Strategic Framework for the Development of Health Care in the Czech Republic up to 2030 (MoH, 2020), one of the proposed and already partially implemented measures of which concerns the provision of incentives for providing primary medical care in less attractive areas. Further examples include the provision of subsidies by the Ministry of Health of the Czech Republic aimed at supporting the availability of general practitioner health services in 2020–2021 and health insurance company subsidy programs aimed at increasing the availability of health services (e.g. the VZP Plus program provided by the GHIC). Measures are also being introduced at the local government level that provide financial and non-financial incentives for the recruitment of new medical capacities in individual municipalities and even in entire regions.

The awareness of the problems associated with the generational turnover of general practitioners, as well as their disproportionate capacity and age composition, has increased significantly in recent years, which has been reflected in an increase in research on identifying current needs and potential solutions. The number of support measures at both the national and regional levels has also increased (see above). It is generally acknowledged however that current measures will not be sufficient to address future problems with the availability of (particularly PED) general practitioner services. Thus, to determine long-term sustainable solutions, it is essential that experts work with the relevant data and identify the potential risks aimed at finding systemic solutions that provide for the stabilization of the situation (WHO, 2008). Enhanced targetted cooperation between public health authorities and the other institutions involved will become increasingly important, and real efforts should be made to ensure that there is the political will to translate proposed solutions into practice. It is already evident that the Czech Republic is facing a difficult period in terms of the provision of GP and PED services and that many challenges lie ahead in terms of effectively addressing this issue.

Abbreviations

AAP = Age-Adjusted Population

AD MEP = Administrative Districts of Municipalities with Extended Powers

FTE = Full-Time Equivalent

GHIC = General Health Insurance Company of the Czech Republic

GP = General Practice

PED = General Pediatrics

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