

Research

Planning the optimal general nurse graduates: methodology and significance

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Received: 27 June 2024 / Accepted: 16 September 2024

Published online: 03 October 2024

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Abstract

Global problems with a shortage of nurses and an increasing demand for nursing care raise questions about whether the education system as the primary source of new nurses is in line with future demands. Despite the shortage, the situation in the Czech Republic is not yet critical, but the analysis of the age structure and the small number of graduates indicates a problem on the horizon of 15 to 20 years. The objective of the article is to present the methodology developed to estimate the demand for the profession of a nurse to maintain a functional health care system according to demographic changes and to propose the optimal number of students enrolled in the nursing study program. Authors created the methodology as part of the project “Competent Nurse for the 21st Century: Analysis and proposal for optimisation of nursing education and professional practice”, supported by the Czech Republic Technological Agency. The methodology was certified by the Czech Republic Ministry of Health at the end of 2022.

Keywords Healthcare workforce · Nursing shortage · Nursing education

JEL I18

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s44250-024-00155-w>.

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Discover Health Systems

(2024) 3:90

| <https://doi.org/10.1007/s44250-024-00155-w>

1 Introduction

1.1 The context of the nursing shortage issue and the purpose of creating the methodology

Along with midwives, general nurses¹ make up the largest professional group in healthcare [1]. In many countries, nurses and midwives make up more than 50% of the national health workforce. According to a report prepared by the World Health Organisation (WHO) in collaboration with the International Council of Nurses (ICN) and the global campaign Nursing Now [2], the total number of nurses (data from 191 countries) is 27.9 million, representing approximately 59% of the entire healthcare workforce. Among them, the number of professional nurses is 19.3 million, almost 70% of the total [3]. Between 2013 and 2018, there was an increase of 4.7 million nurses worldwide, but a shortage persists worldwide along with a growing future demand. The shortage differs in different countries depends on the level of development. The main signal of the shortage is the number of nursing jobs available and the ability to employ new graduate nurses in the health system [1]. The WHO [4], states a global shortage of approximately 6 million nurses and midwives, predicting an increase to 7.6 million by 2030. In the United States, it is estimated that by 2025, there will be a shortage of 260,000 nurses [4]. In the Czech Republic (CR), there is currently a shortage of approximately 3,500 general nurses, and, similar to the global trend, nurses represent the largest professional group in healthcare (42.6%), with 75,059 full-time equivalents [5]. The shortage of nurses in CR is particularly evident in acute care. The high average age of CR nurses (46 years) is a worrying factor (see Fig. 1), indicating a potential further increase in the shortage if older nurses retire without an influx of younger replacements [6]. This unfavourable situation is being addressed by experts, policy makers, professionals, and trade organisations at all levels, seeking causes, correlations, and suitable solutions to stabilise and retain nurses in the profession [7]. A shortage of nurses can have a negative impact on public health and quality of life for individuals, as reported by the WHO [1]. On the other hand, student recruitment alone does not guarantee the quality of care and is not the only solution to the problem of quality of care and patient safety.

Insufficient staff levels create a burden on existing personnel, leading to increased workload, exhaustion, elevated stress, and decreased job satisfaction and can even result in the departure of more nurses from the workplace or the profession. Kretzchmer et al. [9] and Head, Middleton, and Zeigler [10] found that although two-thirds of nurses do not plan to leave the profession in the next year, 48% are considering leaving at some point. Work overload and administrative problems were identified as significant stressors by the nurses surveyed. In terms of CR, the studies by Gurková et al. [11] and Vévoda et al. [12] have previously addressed the issue of nurse shortages and the associated intention to leave the profession. Vévoda et al. [12] reported that 34.7% of general nurses working in Czech hospitals were determined to leave their employer if a good opportunity arose, while only 42.3% were committed to staying and 23% were undecided. Gurková et al. [11] reported that 21.2% of nurses considered leaving their current position, 7.8% considered working abroad, and 13.5% even considered changing professions.

A comprehensive survey of job satisfaction among non-physician healthcare professionals (15,432 respondents, general nurses with more than 10 years of experience being the largest group) conducted by the CR Ministry of Health in 2018 revealed that 60% of healthcare workers did not plan to leave their jobs in the year given. In other words, 40% were considering leaving and 15% planned to leave the healthcare sector altogether. According to the Czech Republic Ministry of Health the number of unsatisfied nurses increased [13].

The shortage of nurses is a strategic and tactical challenge for the management of healthcare systems and hospitals. Therefore, the project "Competent Nurse for the 21st Century: Analysis and Proposal for the Optimization of Nursing Education and Professional Practice of Nurses", supported by the CR Technology Agency, focused on two main objectives: (1) the development of a software application, competence manager, ensuring the management of key nursing competencies, and (2) a certified methodology for estimating the required number of students and graduates in general nurse education programs. A comprehensive survey preceding the creation of these outputs examined the satisfaction of nurses working

¹ In the Czech healthcare system, a nurse has an indispensable position, and the term "nurse" includes general, paediatric, and practical nurses. A practical nurse, formerly known as a healthcare assistant, has lower competencies mainly after completing secondary medical school. General and paediatric nurses possess specialised qualifications acquired through a three-year bachelor's programme in General Nursing or Paediatric Nursing, respectively, or through the Diploma in General Nursing programs at a higher medical school. These educational programs meet the requirements for the qualification of general nurses in accordance with Directive 36/2005/EC of the European Parliament and of the Council and are aligned with the European education curriculum (11 years of general education + at least 3 years of qualification education), as required by the Czech by relevant legislation. This article focusses on a group of nurses referred to as general nurses, including paediatric nurses according to the Nursing concept, whose total number fluctuates around 80,000. These figures, along with the number of midwives, are reported by the Ministry of Health to Eurostat [17]

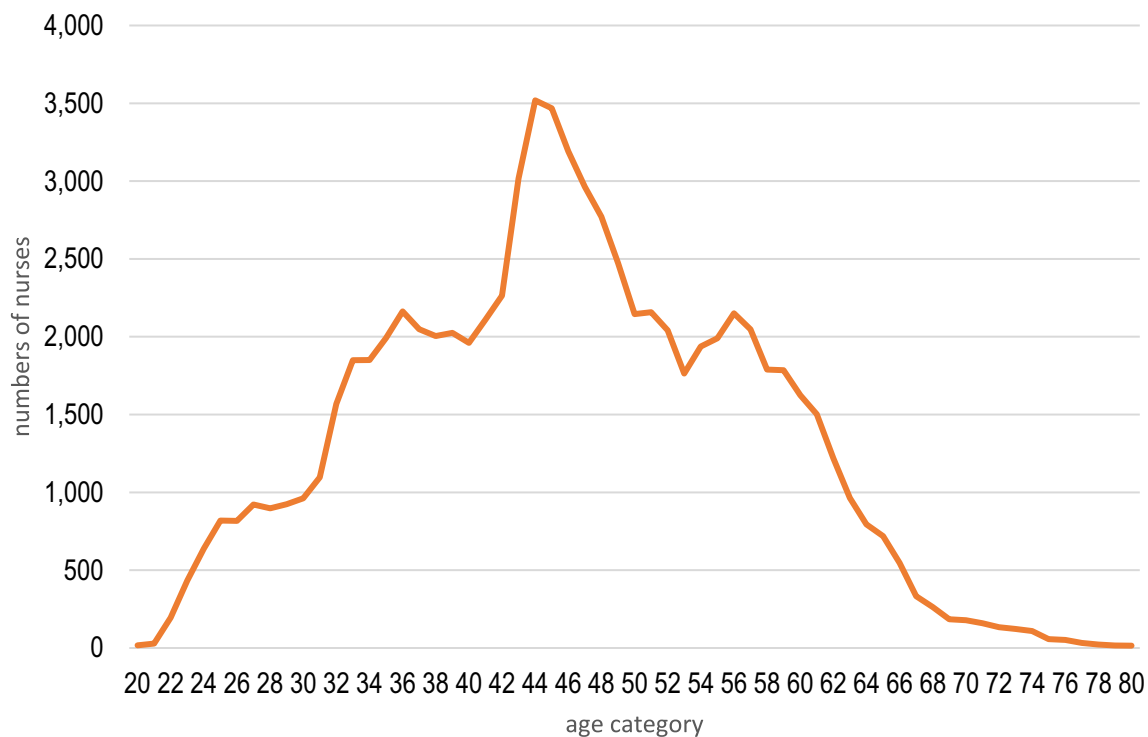


Fig. 1 Age structure of general nurses in czech health system. Source: Institute of Health Information and Statistics of the Czech Republic [8]. Own calculations.

in Czech hospitals. The survey was designed to explore the experiences of general nurses in their profession, their working conditions, and the negative influences and barriers they most commonly encounter. A sample of 2479 general nurses confirmed a correlation between job satisfaction and a shortage of nurses in the workplace [14]. The concept of a certified methodology was supported by the survey results. A shortage of general nurses is not only a barrier to job satisfaction, but also a burden that contributes to more departures from the profession, thus exacerbating the shortage. General nurses play a crucial role in ensuring healthcare care, and given demographic changes in the Czech Republic, it is important to address optimal student intake numbers for the qualification study of general nursing programs in the coming years.

In the Czech Republic, there is currently a shortage of nurses, and the situation may worsen in the future due to the retirement of a large number of nurses. According to information from the Institute of Healthcare Information of the Czech Republic [8], approximately twelve thousand nurses, which is about fourteen percent of the total number, are already over 60 years old. In the coming years, it is expected that, after their retirement, there will be an even greater shortage of healthcare workers. The age structure of nurses in the Czech healthcare system is shown in Fig. 1. It is important to focus attention on this situation because nurses are a key component of the healthcare system, and their shortage can have serious implications for the quality and availability of healthcare.

For the reasons mentioned above, one of the main goals of the project was to create a methodology for optimal planning of the number of graduates of study programs for general nurses as a strategic tool for nursing staffing, and the aim of this article is to present this methodology.

2 Methodology

For the system to be set up correctly to ensure a long-term balance, there must be a balance between the estimated number of nurses needed in the future and, on the one hand, the current situation, which is increased by the increase due to new graduates entering the labor market and reduced by the decrease due to exits from the labor market; on the other hand,

$$S_{t+n}^* \approx S_t + P_{(t;t+n)} - U_{(t;t+n)} \quad (1)$$

where S_{t+n}^* is the estimated number of nurses at the end of period $t+n$, S_t is the number of nurses in year t , $P_{(t;t+n)}$ is the total increase in the number of nurses due to entry into the labor market (more simply, graduates) over the period t to $t+n$ and $U_{(t;t+n)}$ is the overall decrease in the number of general nurses due to exit from the labor market in the period t to $t+n$.

It is appropriate to adjust the left-hand side of the equation for an estimate of the expected increase in demand for health care related, for example, to population aging.

$$S_{t+n}^* = S_t * kp_t \quad (2)$$

where S_{t+n}^* is the estimated number of nurses at the end of period $t+n$, S_t is the number of nurses in year t and kp_t is the coefficient of demand for health care in year t .

The total loss of nurses in the system in the following periods is based on the following relationship.

$$U_{(t;t+n)} = \sum_{x=20}^{70} x S_t - \sum_{x=20}^{70-n} x S_t * {}_x k_n \quad (3)$$

where $U_{(t;t+n)}$ is the overall decrease in the number of general nurses due to attrition from the labor market in the period t to $t+n$, ${}_x S_t$ is the number of nurses in year t in age category x and ${}_x k_n$ is the attrition rate of general nurses in age group x (in year t) in the following n years.

Estimates of the coefficient ${}_x k_n$ must be performed on longitudinal data on nurses; the number of nurses in each age group must go back several years.

The overall increase in the following period is slightly more complex (graduates aged > 20 to 45 are assumed):

$$P_{(t;t+n)} = \sum_{x=20}^{45} \sum_{i=0}^n A_{(t+i,t+i+1)} * {}_x a * {}_x k_{n-i} \quad (4)$$

where $P_{(t;t+n)}$ is the total increase in the number of general nurses due to entry into the labor market over the period t to $t+n$, $A_{(t+i,t+i+1)}$ is the number of graduates in period $t+i$ to $t+i+1$, ${}_x a$ is the proportion of graduates in the age group x years (graduates are in different age groups), and ${}_x k_{n-i}$ is the attrition rate of general nurses in the age group x (in year t) in the next $n-i$ years. It is necessary to specifically estimate ${}_x k_0$, which is the coefficient of the share of graduates entering the labor market in the age group x years.

The final step in estimating the appropriate number of students to admit is to take into account the dropout rate. The number of new admissions (or, better, the capacity of study programs) should be determined according to the following relationship:

$$A_{t+3} = NE_t(1 - DOR) \quad (5)$$

where $A_{(t+3)}$ is the number of graduates in year $t+3$, NE_t is the number of new admissions in year t and DOR is the dropout rate.

3 Results

The basic results of the application of the methodology are demonstrated in the example of the Czech Republic. Like other countries, the Czech Republic is currently under pressure from aging [15]. The evolution of demand for healthcare is simulated on the basis of the indicator "intensity of hospital admissions". The intensity of hospitalization has been decreasing in recent years, and the forecast of total demand until 2050 falls into two scenarios: in the baseline (conservative) variant, the intensity of hospitalization is maintained at the current level of 2016–2018; and in the dynamic variant, the rate of hospitalization will decrease according to the trend of 2006–2018. In the model for estimating the demand for health care, data on hospitalizations by gender and age (in five-year age intervals) were used. For each age group, a specific rate of hospitalization (index) was calculated and its trend over time was evaluated. These rates were then linked to the population forecast (according to age and gender) and the total demand for health care was estimated from these results. Figure 2 presents possible future trends in relative terms. In the dynamic variant, which assumes a decline in the number of hospitalizations in the age groups, there will be

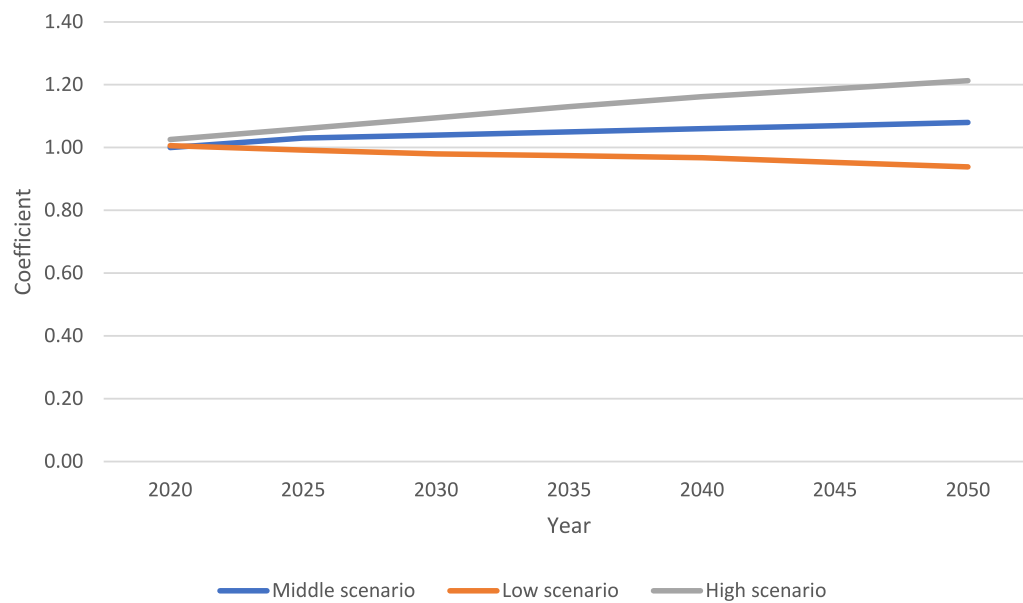


Fig. 2 Estimation of the number of hospital admissions by 2050; comparison of conservative, medium, and dynamic scenarios, 2018 = 100%. Source: Institute of Health Information and Statistics of the Czech Republic [17], own calculations.

an overall decline of 2% in hospitalization in 2030 compared to 2018, 3% in 2040 and 6% in 2050. In contrast, if the current trend of decreasing specific hospitalization rates is stopped, there would be a 10% increase in hospitalization in 2030, 16% increase in 2040 and 21% increase in 2050 compared to 2018 [16]. In addition to the change in the number of hospital admissions, there will be a change in their age structure. To make the forecast of the number and structure of hospital admissions more understandable, a medium variant of the hospital admission forecast is also constructed as an arithmetic average of the dynamic and conservative variants described above.

The baseline scenario for estimating the number of nurses needed is based on the current situation; that is, it assumes that the demand for the system is at the current level (less than 80,000 general nurses; this parameter is optional, and the results of the individual scenarios will, of course, change according to it) and that the annual number of nurse graduates is approximately 1600 [18]. Figure 3 shows the evolution of the number and age structure of general nurses up to 2050. With this number of graduates, there will already be 2.5 thousand fewer general nurses in 2025 than in 2020; the difference will be more than 5 thousand in 2030, almost 20 thousand in 2040 and almost 30 thousand general nurses in 2050 (Fig. 4).

With an increase in the number of graduates to 2600 per year (Fig. 4), the number of general nurses in 2050 will only be approximately 10,000 fewer than it is currently. Increasing the number of graduates to 3,000 per year then leads to a status quo.

Figure 4 is based on the assumption of constant demand for general nurses, that is, without considering the aging population or the increase in the demand for health care. Considering the increase in demand described above, an annual figure of 3450 graduates is necessary to maintain the current number of general nurses (Fig. 5).

To complete the whole estimation, in terms of the number of students admitted (enrolled), it is necessary to use formulae 4 and 5. Then, keeping the dropout rate (the proportion of newly enrolled students who successfully completed their studies) in the field of general nursing at the current level of 33%, the required number of 3450 graduates leads to the required number of newly enrolled students being 5200. Recall that we currently have approximately 1,600 graduates and 2600 newly enrolled students.

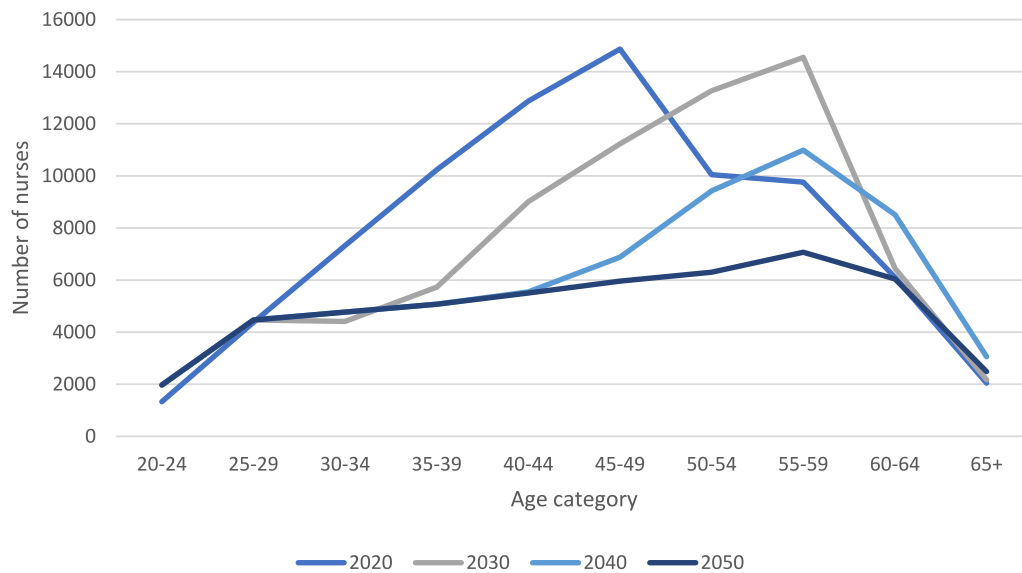


Fig. 3 Evolution of the age distribution under the scenario of 1,600 graduates in 2020, 2030, 2040 and 2050. Source: Own calculations.

4 Discussion

The discussion on ensuring enough nurses must be focused on several key points, the main ones being the stabilisation of the current workforce through employers’ working conditions and timely replenishment with enough graduates. At the same time, the professional company has to go through discussions about ensuring complete care from the entire team in terms of their competences and workload.

The methodology revealed that the current number of graduates will not even ensure basic nursing reproduction in the healthcare sector, and a significant outflow of the nursing workforce is expected in the next 15 to 20 years. If we do not address this problem, it will only worsen.

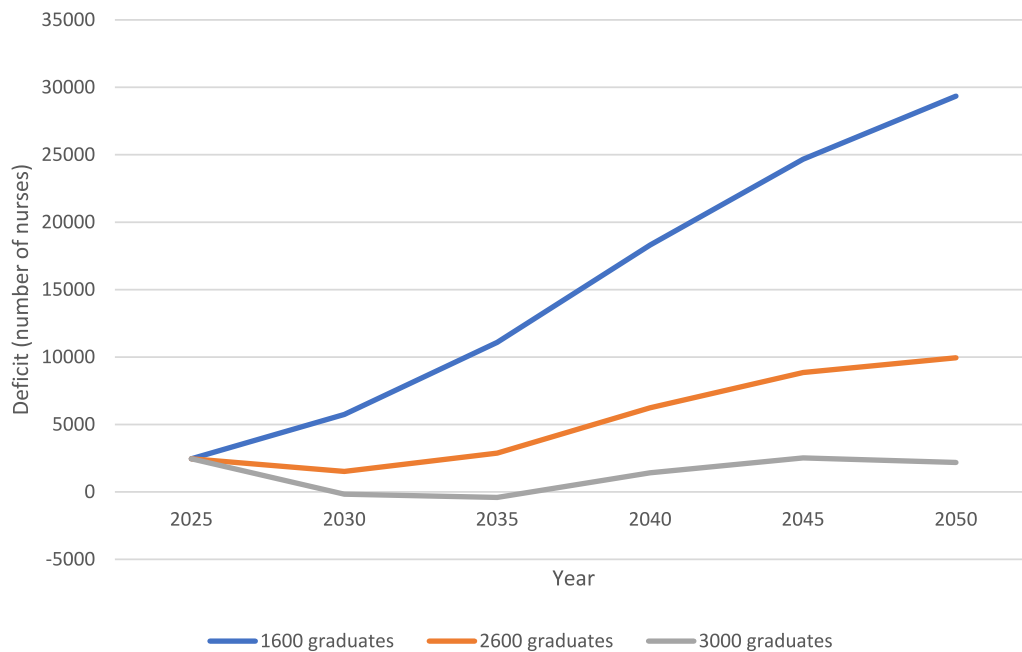


Fig. 4 Comparison of the shortage of general nurses for each forecast option compared to the current situation (80,000 nurses). Source: Own calculations.

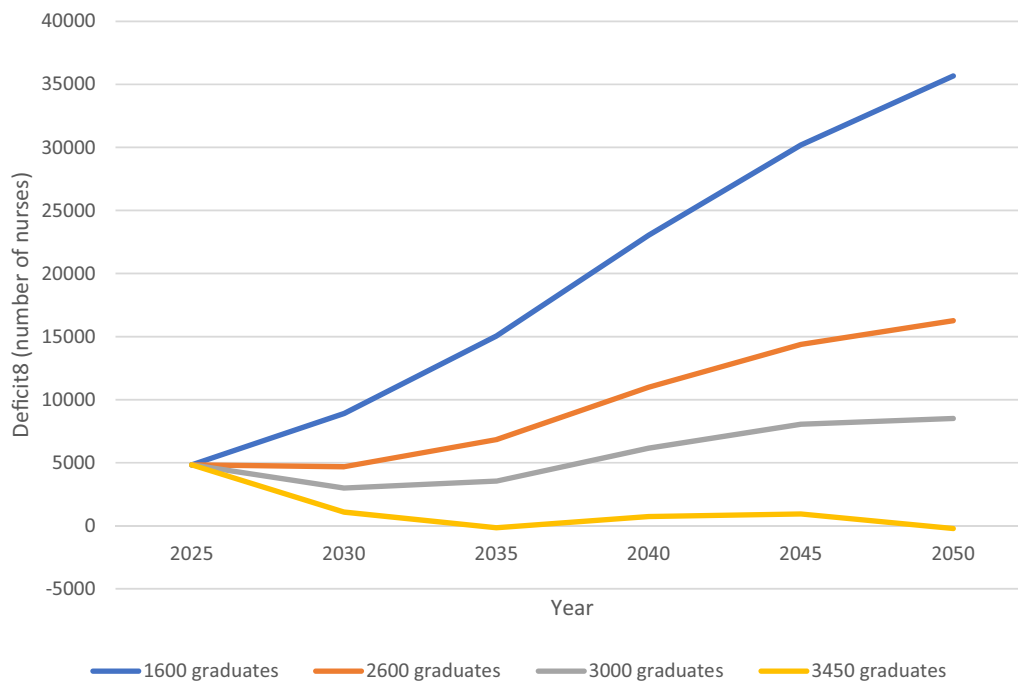


Fig. 5 Comparison of the shortage of nurses for the different forecast options compared to the estimated demand for nurses (due to population aging). Source: Own calculations.

Support for increasing capacity for the education of general nurses is also hampered by arguments that keep appearing in the Czech lay and professional society that the shortage is caused by the lengthy and complicated education. Arguments that nursing education is too complicated and long are completely unfounded. Research such as Aiken et al. [19] demonstrated that a higher level of nursing education reduces the risk of mortality in hospitalized patients. General nurses cannot be replaced or supplemented by staff other than educated general nurses. A shortage of these devices disrupts the stability of existing medical personnel, increases their workload, and creates another shortage. Along with increasing salaries, overworked nurses reduce their working hours and, at the same time, reduce their commitment and interest [10].

In addition to increasing the number of graduates, it is also necessary to stabilize and support all nurses in the system to prevent them from leaving. Nurses are exposed to stress due to the nature of their profession. For example, a study of Lithuanian and Polish nurses [20] shows stress arising from work itself, interpersonal conflicts between nurses and physicians, and mainly death and dying. Increasing the psychological burden on the patient can perpetuate the situation, as overloaded nurses leave the system.

The All-Party Parliamentary Group on Global Health [7] highlights nurses' dissatisfaction with the poor working conditions caused by their shortage, which could be a reason for further departures. Nurses want to work on an acceptable workload, which can be maintained mainly by adequate staffing, as evidenced by studies by [21].

The shortage of nurses and the growing risks associated with this shortage can jeopardise the quality of health-care. The study of nurse staffing and education and hospital mortality in nine European countries: a retrospective observational study conducted on a sample of data from nine countries provided evidence that reducing the number of nurses or increasing the patient-to-nurse ratio increases the risk of death in surgical patients within 30 days after admission. In contrast, a higher level of nursing education (completed by a bachelor's degree program) reduces this risk [22].

A shortage of nurses increases discomfort and the risk of burnout not only among nurses but also among physicians. A sufficient number of nurses are perceived as a working condition established by the management, and physicians prefer nursing staffing solutions over other interventions to strengthen their resilience, as demonstrated in the study by Aiken et al. [21].

A systematic review by Lu et al. [23] found that job satisfaction influences turnover, as well as other factors that influence job satisfaction, such as working hours and management, staffing levels, remuneration, and others identified in a

number of research studies. The job satisfaction of hospital nurses is, among other things, affected by the ratio of patient to nurse.

The labour market has been entered by Generation Z, which is demographically much smaller compared to the previous strong generations X and Y, so generational factors also come into play and can require a larger number of nurses. The emphasis on job satisfaction is more pronounced among Generation Y (born roughly between 1982 and 1995). People who complain more frequently about stress and burnout syndrome report lower loyalty to work and leave work more often than nurses of previous generations [24]. Generation Z (1996–2012) prioritizes work-life balance and personal well-being at work much more than previous generations [25].

Therefore, some countries are helping increase the number of nurses by improving the prestige of this profession and increasing the number of interested students [26]. However, in the Czech Republic the good news is that due to COVID, there has been a significant increase in interest in studying in secondary medical schools. This should be followed by a change being prepared at the Ministry of Health, which would increase the capacity to study capacity general nursing and other nonphysicians healthcare workers at universities [27]. Despite discussions about the shortage of nurses in the Czech Republic over the last 15 years, the system has not systematically addressed the increase in the number of nursing students and graduates, except for a significant increase in salary; between 2017 and 2021, there was a 64% increase in average earnings in acute care [8]. Since 2019, the Czech government has directly financially supported medical studies, leading to an increase in the number of medical students. However, the number of general nursing studies or graduates has not increased, and in the context of the increasing number of medical studies, the ratio of nurses to physicians, according to Health at Glance [28], continues to decrease in the Czech Republic. Compared to that in EU countries, the production of general nurses per 100,000 inhabitants (14) is significantly lower than that in Austria (96), Slovakia, and most European countries, even in comparison within OECD countries.

In its 2020 publication issued for the Year of Nurses and Midwives [29], maintaining and ensuring a qualified nursing workforce is a fundamental premise for the provision of safe care. Aiken et al. [30] defined a safe and good environment for patients and staff and addressed the workload of employees in proportion to their responsibilities. Her studies illustrate that a good environment for care and a good working environment mean the same thing. She also showed that hospitals where nurses are unhappy and often experience burnout have more unhappy patients and poorer clinical outcomes [31].

The report above emphasises that the education and preparation of nurses for professional practice and their life-long learning are strategies to improve the quality of care in any area, from primary care to post-acute care. Ensuring an adequate nursing workforce is an endless challenge, not only for healthcare, but also for society as a whole. In this context, the certified methodology of the Ministry of Health [32] to optimise the number of trained nurses emerged as a significant tool and in January 2024, the Minister of Health announced that he would strongly support the study of nursing.

In the context of a shortage of new general nurses entering the workforce and the need to alleviate the workload burden on current nurses, it may also be necessary to consider redistributing responsibilities across the entire nursing team in the future. The workload also exacerbates the shortage of less qualified nursing staff, which nurses often substitute, as well as the demands of physicians to exceed nursing competencies. In the future, there will need to be a redistribution of responsibilities within the nursing team and in collaboration with the physicians. This can have a crucial impact on determining the number of nurses needed. The aim of the researchers was to create a methodology that, based on the specified requirement of determining how many general nurses are needed for the Czech Healthcare system, would find the optimal numbers of new graduates for this profession. The researchers did not intend in their project to determine how many and what types of nurses are needed; that is the task of the Ministry of Health.

The methodology is constrained by some unavailable data, which prevents refining the calculations, but is certified by the Ministry of Health, which requested it for use. It can be assumed that by supplementing current data, the methodology will always provide calculations of the optimal number of graduates. Similarly, a limitation is that the Ministry of Health currently does not have an exact estimate of the number and types of nurses it will need in the future. Therefore, researchers assume that the current number of general nurses is at least necessary. Another limitation could be the unpredictability of the political situation both domestically and internationally.

5 Conclusion

From 2018 to 2022, the number of nurses employed remained the same. However, the pandemic burdened the healthcare system and caused some nurses to transfer to non-bedside roles [8]. At the same time, it highlighted the importance and security of a job in the healthcare sector, which positively influenced interest in healthcare professions. Despite this

increased interest, there were and are still insufficient educational capacities to accommodate the significant increase in applicants for nursing studies. The authors of this article initiated a call to the Ministry of Health to increase the financial support for nursing education. Even in this context, the methodology created proved to be a significant undertaking.

All of the above indicates that this shortage is a complex and complicated problem that does not have a simple solution, but threatens not only the Czech healthcare system, but the entire society. However, the methodology created is only a small part of addressing this complex problem. It can definitely contribute to its solution within its limitations.

The Ministry of Health has the responsibility to specify the future demand for nurses and nursing staff, as well as the required capacities. At this juncture, the methodology is constrained by the imprecise nature of the demand for these numbers, as it can only rely on the assumption that all general nurses currently registered are necessary. However, the production of new nurses is evidently low to sustain this amount.

In the Czech Republic, there is currently a shortage of more than two thousand general nurses, and many others will gradually retire due to the ageing population. Therefore, the Ministry of Health is preparing changes in the number of students studying general nursing, as well as other professions. The methodology was certified by the Czech Republic Ministry of Health at the end of 2022 and finally this year announced that nursing studies will be financially supported from the academic year 2025/26.

However, it is also important to stabilise current nurses in the system and continuously improve their working conditions. At the same time, it is necessary to restructure the Czech healthcare system, which has an above-average number of acute beds and a below-average number of beds in post-acute care. It is clear that today's healthcare, mainly based on the capacities of generations X and Y, cannot rely on natural turnover; the proportion of healthcare workers must be increased, and every effort must be made to enable all those who wish to study healthcare fields to do so and subsequently work in healthcare.

Acknowledgements The methodology created as part of the project "Competent Nurse for the 21st Century: Analysis and proposal for the optimisation of nursing education and professional practice", supported by the Czech Republic Technological Agency TL01000094 in the years 2018-2021.

Author contributions All authors contributed to the conception and design of this article. The first draught of the manuscript was written by Jana Hola, and all authors commented on other versions of the manuscript. All authors read and approved the final manuscript.

Data availability All data generated or analysed during this study are included in this published article [and its supplementary information files].

Declarations

Competing interests The authors declare no competing interests.

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References

1. World Health Organization States of the World's Nursing. Executive Summary. Investing in education, jobs and leadership. 2020. <https://apps.who.int/iris/bitstream/handle/10665/331673/9789240003293-eng.pdf>. Accessed 5 Jan 2024
2. International Council of Nurses. Nursing Now Report.2021. <https://www.nursingnow.org/wp-content/uploads/2021/05/Nursing-Now-Final-Report-Executive-Summary.pdf>. Accessed 5 Jan 2024
3. World Health Organization. The WHO Global Strategic Directions for Nursing and Midwifery (2021–2025).2021. <https://www.who.int/publications/i/item/9789240033863>. Accessed 5 Jan 2024
4. World Health Organization, Global strategic directions for strengthening nursing and midwifery 2016–2020. 2016. <https://www.nursingnow.org/wp-content/uploads/2021/12/global-strategic-midwifery2016-2020.pdf>. Accessed 5 Jan 2024
5. Monahan JC. A student nurse experience of an intervention that addresses the perioperative nursing shortage. *J Perioper Pract*. 2015. <https://doi.org/10.1177/175045891502501104>.

6. Institute of Health Information and Statistics of the Czech Republic (2018) Healthcare Of The Czech Republic: Personnel Capacity And Compensation <https://www.uzis.cz/res/f/008281/nzis-rep-2019-e04-personalni-kapacity-odmenovani-2018.pdf>. Accessed 5 Jan 2024
7. Maly, L. Since 2010, hospitals have lost two thousand nurses. *Zdravi*. Euro Online. 2019. <https://zdravi.euro.cz/clanky/uzis-od-roku-2010-v-nemocnicich-ubyly-dva-tisice-sester/>. Accessed 5 Jan 2024
8. Glajchová, et al. Job satisfaction of general nurses in standard and intensive care units: “The nurse is a jack-of-all-trades!” *Kontakt*. 2021. <https://doi.org/10.3272/kont.2021.032>.
9. The All-Party Parliamentary Group on Global Health Triple Impact – how developing nursing will improve health, promote gender equality and support economic growth; London 2016. <https://globalhealth.inparliament.uk/news/triple-impact-how-investing-nursing-will-improve-health-improve-gender-equality-and-support> Accessed 5 Jan 2024
10. Kretzschmer S, et al. Nursing empowerment, workplace environment, and job satisfaction in nurses employed in an academic health science center. *J Nurses Prof Dev*. 2017. <https://doi.org/10.1097/NND.0000000000000363>.
11. Head B, Middleton A, Zeigler C. Work satisfaction among hospice and palliative nurses. *J Hosp Palliat Nurs*. 2019. <https://doi.org/10.1097/NJH.0000000000000562>.
12. Gurková M, et al. Job satisfaction and leaving intentions of Slovak and Czech nurses. *Int Nursing Rev Nurs Rev*. 2013. <https://doi.org/10.1111/j.1466-7657.2012.01030>. Accessed Sep 2012.
13. Vévoda J, et al. Datamining techniques-decision tree: new view on nurses’ intention to leave. *Central Eur J Nursing Midwife*. 2016. <https://doi.org/10.1545/CEJNM.2016.07.0024>.
14. Ministry of Health of the Czech Republic (2019). The results of a questionnaire survey. 2019 <https://www.mzcr.cz/tiskove-centrum-mz/hlavni-motivaci-prace-ve-zdravotnictvi-je-pro-nelekare-moznost-pomahat-druhym-vyplynulo-z-dotaznikoveho-setreni-ministerstva/> Accessed Dec 2021
15. Healthcare Of The Czech Republic: Personnel Capacity And Compensation.2023. <https://www.uzis.cz/res/f/008443/nzis-rep-2023-e04-personalni-kapacity-odmenovani-2022.pdf> Accessed Jul 2023
16. Marios G, Bélanger A, Lutz W. Population aging, migration, and productivity in Europe. *Proc Natl Acad Sci*. 2020;117(14):7690–5.
17. Ministry of Health. Nursing Concept 2021. https://mzd.gov.cz/wp-content/uploads/wepub/9584/21397/Koncepce_osevovatelstvi_vestnik_6_2021.pdf Accessed April 2024
18. Ricketts TC, Randolph R, Howard HA, Pathman D, Carey T. Hospitalization rates as indicators of access to primary care. *Health Place*. 2001. [https://doi.org/10.1016/S1353-8292\(00\)00035-6](https://doi.org/10.1016/S1353-8292(00)00035-6).
19. MEYS, 2020. Combined student register information. In: Ministry of Education, Youth and Sport, Czech Republic. 2020. <https://www.msmt.cz/vzdelavani/vysoke-skolstvi/sims-sdruzene-informace-matrik-studentu-1>. Accessed Jun 2021
20. Aiken HL, et al. Physician and nurse well-being and preferred interventions to address burnout in hospital practice factors associated with turnover, outcomes, and patient safety. *JAMA Health Forum*. 2023. <https://doi.org/10.1001/jamahealthforum.2023.1809>.
21. Aiken, et al. Nurse staffing and education and hospital mortality in nine European countries: a retrospective observational study. *Lancet*. 2014. [https://doi.org/10.1016/S0140-6736\(13\)62631-8](https://doi.org/10.1016/S0140-6736(13)62631-8).
22. Kalisch L, Kalisch BJ, Lee KH. Missed nursing care: magnet versus non-magnet hospitals. *Nurs Outlook*. 2012. <https://doi.org/10.1016/j.outlook.2012.04.006>.
23. Kwiecień-Jaguś K, Mędrzycka-Dąbrowska W, Chamienia A, Kielaitė V. Stress factors vs job satisfaction among nursing staff in the Pomeranian Province (Poland) and the Vilnius Region (Lithuania). *Ann Agric Environ Med*. 2018. <https://doi.org/10.2644/aaem/75801>.
24. Lu H, Zhao Y, While A. Job satisfaction among hospital nurses: A literature review. *Int J Nurs Stud*. 2019;94:21–31. <https://doi.org/10.1016/j.ijnurstu.2019.01.011>.
25. O’Hara MA, Burke D, Ditomassi M, Palan Lopez R. Assessment of millennial nurses’ job satisfaction and professional practice environment. *JONA*. 2019. <https://doi.org/10.1097/NNA.0000000000000777>.
26. Kurtovic B, Friganovic A, Cukljek S, Vidmanic S, Stievano A. The development of the nursing profession and nursing education in Croatia. *J Prof Nurs*. 2021;37(3):606–11. <https://doi.org/10.1016/j.profnurs.2021.03.001>.
27. Almeida MH, Orgambides A, Santos CM. The power and perception of global empowerment in linking social support and psychological well-being. *Central Eur J Nursing Midwifery*. 2020. <https://doi.org/10.1545/cejnm.2020.11.0003>.
28. OECD/ Health at a Glance: Europe 2022: State of Health in the EU Cycle, <https://doi.org/10.1787/507433b0-en>
29. World Health Organization Year of the Nurse and the Midwife 2020. 2019. <http://www.who.int/news-room/campaigns/year-of-the-nurse-and-the-midwife-2020> Accessed Jul 2020
30. Aiken LH, et al. Nurses’ and patients’ appraisals shows patient safety in hospitals remains a concern. *Health Aff*. 2018. <https://doi.org/10.1377/hlthaff.2018.0711>.
31. Brooks Carthon J, et al. Association of nurse engagement and nurse staffing on patient safety. *J Nurs Care Qual*. 2019. <https://doi.org/10.1097/NCQ.0000000000000334>.
32. Ministry of Health. Methodology for estimating the required number of students and graduates of focused study programs for the education of general nurses. 2022. <https://www.mzcr.cz/wp-content/uploads/2022/11/Methodika-odhadu-potrebneho-poctu-studentu-a-absolutu-studijnich-programu-zamerenych-na-vzdelavani-vseobecnych-sester.pdf> Accessed May 2022

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