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The nursing workforce crisis in Bulgaria: Workforce imbalance , educational capacity, and urgent health policy reform

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Abstract

Bulgaria faces a structural nursing workforce crisis that threatens the accessibility, safety, and continuity of health and social care. This review analyzes the scale and age structure of the nursing shortage, the imbalance between nurses and physicians, the educational pipeline, and policy options for rapid and sustainable workforce recovery. A structured narrative review and secondary analysis of official data from the Organisation for Economic Co-operation and Development (OECD), Bulgarian National Statistical Institute, Ministry of Health, Sofia Municipality, European Union legislation, professional organizations, and peer-reviewed workforce studies were conducted, using information available through 24 September 2026. In 2025, Bulgaria had 28,357 practicing nurses and 30,409 physicians under a main employment contract, corresponding to only 0.93 nurses per physician. More than 76% of nurses were aged 45 years or older and 18.4% were aged 65 years or older. OECD data show 4.4 nurses per 1,000 population in Bulgaria versus 9.1 on average across OECD countries, while the nursing graduate rate was 7.6 per 100,000 population versus 45.7 across the OECD. Increasing university admission alone cannot correct the shortage within the necessary time horizon. Bulgaria requires an integrated policy combining workforce forecasting, educational reform, student support, safe staffing, retention, skill-mix redesign, expanded nursing roles, regional incentives, and continuous outcome monitoring. A three-year educational pathway should be evaluated only as a regulated policy option that preserves European minimum training hours and competencies, not as a stand-alone solution.

Keywords: nursing workforce; nurse shortage; health policy; nursing education; workforce planning

1. INTRODUCTION

Health systems can only function when sufficiently trained health workers are available, appropriately distributed, and supported to remain in practice. The World Health Organization (WHO) identifies nurses as the largest occupational group in the global health workforce and an indispensable component of universal health coverage, service continuity, and equitable access. [1] In this context, nursing capacity is not simply one staffing variable among many; it is a core component of health-system infrastructure.

Bulgaria presents an unusually pronounced workforce imbalance. The 2026 OECD review of the Bulgarian health system found a comparatively high physician density but one of the lowest nurse densities among OECD countries. In 2023, Bulgaria had 4.6 physicians per 1,000 population, above the OECD average of 3.9, while the country had only 4.4 nurses per 1,000 population compared with an OECD average of 9.1. [2] This produces a workforce structure in which physician supply and nursing supply have developed in markedly different directions.

The problem is also broader than hospital nursing. Bulgarian health-care professionals traditionally grouped under the administrative term “middle medical personnel” include nurses, midwives, physician assistants, medical and radiology laboratory professionals, rehabilitation professionals, and other regulated occupations. Contemporary terminology should instead refer to nursing and allied health professionals or, in the Bulgarian statutory context, “health-care professionals and other medical specialists.” The present review focuses primarily on registered nurses because they are the largest group and because their shortage has become a limiting factor for hospitals, blood services, child-care facilities, school health services, long-term care, and community-based services. [2–4]

The objective of this article is to assess the nursing workforce crisis in Bulgaria as a public health and health policy problem, with particular attention to five questions: (1) the magnitude of the nurse-to-physician imbalance; (2) the demographic sustainability of the existing nursing workforce; (3) whether the current educational pipeline can replace expected workforce losses; (4) the implications of the four-year Bulgarian nursing degree relative to the European minimum framework; and (5) the combination of short-, medium-, and long-term policy measures required to restore nursing capacity without compromising patient safety.

2. MATERIALS AND METHODS

A structured narrative review and policy analysis were conducted using information available through 24 September 2026. Priority was given to primary official sources and high-level evidence. National workforce data were obtained from the Bulgarian National Statistical Institute (NSI), while internationally comparable workforce indicators were obtained from the OECD Reviews of Health Systems: Bulgaria 2026 and OECD Health Statistics cited therein [2,3]. Current policy measures and admission data were obtained

from the Bulgarian Ministry of Health. [4] Positions of the Bulgarian Association of Health Professionals in Nursing (BAHPN) were used to document professional-sector warnings and were treated as stakeholder estimates rather than official population statistics. [5]

For the clinical and organizational relevance of nurse staffing, evidence was drawn from a major European multi-country observational study, a systematic review of longitudinal staffing studies, and recent WHO/European Observatory policy syntheses [6–9]. For the education comparison, the analysis used Article 31 of Directive 2005/36/EC, the Bulgarian regulation on uniform state requirements for the nursing bachelor's degree, and an example of a 180-credit nursing program at Karolinska Institute in Sweden. [12–14]

Derived indicators were calculated from published aggregate data. The nurse-to-physician ratio for 2025 was calculated as 28,357/30,409. The share of nurses aged 45 years or older and 65 years or older was calculated from NSI age-group counts. The ratio of medical to nursing graduates was calculated from OECD standardized graduate rates per 100,000 population. Because OECD and NSI use different operational definitions, their workforce counts and rates were analyzed in parallel rather than treated as methodologically interchangeable. Likewise, estimates of the absolute "shortage" were not treated as directly observed quantities because they depend on the benchmark used to define need.

3. RESULTS AND DISCUSSION

3.1. Scale of the workforce imbalance

The central finding is not merely that Bulgaria has "too few nurses," but that the country has developed a structurally unbalanced health workforce. OECD data for 2023 show 4.6 physicians and 4.4 nurses per 1,000 population [2]. Using the same source and year, this corresponds to approximately 0.96 nurses per physician, compared with approximately 2.33 nurses per physician when the OECD average densities (9.1 nurses and 3.9 physicians per 1,000) are used as a common benchmark. The comparison should not be interpreted as a normative staffing target, but it illustrates the magnitude of the Bulgarian imbalance.

National data for 2025 reinforce the same conclusion. The NSI reported 30,409 practicing physicians and 28,357 practicing nurses working under a main employment contract in health establishments [3]. The resulting ratio is approximately 0.93 nurses per physician. Thus, in simple headcount terms, Bulgaria now records fewer nurses than physicians in the health-establishment workforce captured by this national dataset.

Table 1. Selected health-workforce indicators for Bulgaria and OECD comparators

Indicator	Bulgaria	OECD average	Interpretation
Physicians, 2023 (per 1,000 population)	4.6	3.9	Above OECD average
Nurses, 2023 (per 1,000 population)	4.4	9.1	Approximately half OECD average
Nurse-to-physician ratio,	0.96	2.33	Marked skill-mix

2023a			imbalance
Medical graduates, 2023 (per 100,000)	31.0	14.0	Very high graduate output
Nursing graduates, 2023 (per 100,000)	7.6	45.7	Very low graduate output
Physicians, NSI 2025 (number)	30,409	—	National headcount
Nurses, NSI 2025 (number)	28,357	—	National headcount
Nurse-to-physician ratio, NSI 2025a	0.93	—	Fewer nurses than physicians

a Calculated from published workforce densities or headcounts. OECD and NSI data use different operational definitions and should not be considered identical datasets. Sources: OECD [2]; NSI [3].

The imbalance is especially important because the educational pipeline is moving in the same direction. In 2023, Bulgaria produced 31 medical graduates per 100,000 population, compared with an OECD average of 14, while nursing graduate output was only 7.6 per 100,000 compared with an OECD average of 45.7 [2]. On these standardized indicators, Bulgaria produced approximately 4.1 medical graduates for every nursing graduate. The OECD notes that a substantial share of Bulgarian medical graduates are international students, meaning the medical graduate indicator cannot be interpreted as equivalent to future physician retention in Bulgaria. Nevertheless, the contrast with the nursing graduate rate remains large enough to signal a structural educational imbalance.

Professional organizations have repeatedly raised the alarm. In 2024, the BAHPN publicly estimated that more than 30,000 nurses were needed to overcome the shortage and called for a political response focused on pay, career development, professional respect, and recruitment. [5] This figure should not be treated as a directly comparable official statistic because it reflects the organization's assessment of system need. Its importance is instead that it demonstrates long-standing convergence between official international assessments and the professional community regarding the severity of the problem.

3.2. An ageing workforce and the replacement gap

The age profile of the workforce makes the shortage more urgent. At the end of 2025, only 11.7% of nurses were younger than 35 years and another 12.0% were aged 35–44 years. In contrast, 30.8% were aged 45–54 years, 27.2% were aged 55–64 years, and 18.4% were already aged 65 years or older. [3] In aggregate, 76.3% of practicing nurses were aged 45 years or older. This creates a replacement problem that is qualitatively different from a temporary vacancy rate: a large share of the current stock may leave the workforce within a relatively short period because of retirement or declining capacity for demanding shift work.

Table 2. Age distribution of practicing nurses in Bulgaria, 2025

Age group	Number	Share
<35 years	3,327	11.7%
35–44 years	3,389	12.0%
45–54 years	8,722	30.8%
55–64 years	7,706	27.2%
65–74 years	4,786	16.9%
≥75 years	427	1.5%

Total	28,357	100.0%

Source: Bulgarian National Statistical Institute [3].

The Ministry of Health has characterized the trend as persistent and negative. According to its September 2026 parliamentary response, the number of nurses fell from 53,810 in 1990 to 28,357 in 2025, a decline of approximately 47.3%. The Ministry identified low remuneration, excessive workload, assignment of low-skilled tasks to qualified nurses, and insufficient professional recognition among the factors limiting entry and retention. [4]

These data imply that the policy objective cannot be limited to filling currently advertised vacancies. Bulgaria must replace a substantial number of older nurses while simultaneously increasing the overall stock. If policy succeeds only in replacing retirees one-for-one, the country may stabilize a workforce level that is already inadequate. The required graduate and retention effort therefore needs to exceed the rate of attrition for a sustained period.

3.3. Why nursing capacity is a patient-safety variable

The description of nurses as the “backbone” of the health system is supported by evidence when translated into measurable functions: continuous observation, medication administration, detection of deterioration, infection prevention, coordination, patient education, discharge preparation, and the execution and evaluation of care plans. Nursing availability therefore affects both how much service a facility can provide and how safely it can provide it.

In the European RN4CAST study, which included 422,730 surgical patients in 300 hospitals across nine European countries, each additional patient added to a nurse’s workload was associated with a 7% increase in the odds of death within 30 days of admission, while a 10-percentage-point increase in the proportion of nurses with bachelor-level education was associated with a 7% decrease in the odds of death [6]. Although observational data cannot by themselves establish a universal staffing threshold, they demonstrate that staffing and educational composition are clinically consequential.

A systematic review of 27 longitudinal studies similarly found that higher registered-nurse staffing was consistently associated with lower mortality, while evidence for substituting other staff groups for registered nurses was less clear. [7] WHO Europe’s 2026 technical brief on safe nurse staffing consequently frames adequate staffing as both a patient-safety and workforce-retention intervention. [8}

These findings are important for Bulgarian reform: skill-mix redesign is necessary, but it should release nurses from tasks that do not require nursing competence rather than replace registered nurses in functions requiring clinical assessment and accountability.

3.4. The shortage is already reducing service capacity

The practical effect of workforce scarcity can be seen when infrastructure exists but services cannot operate at intended capacity. A documented example is the National Center for Transfusion Hematology in Sofia. Bulgarian National Television reported in January 2025 that the blood-donation department had operated with reduced hours for almost a year, remained closed on Sundays, and worked only until 14:00 on other days because of mass departures and the inability to form two full nursing shifts. [11] This is an illustrative case rather than a national estimate, but it demonstrates how a nursing shortage can directly reduce access even when the service and physical infrastructure remain in place.

The same mechanism is visible outside hospitals. In February 2026, Sofia Municipality reported that approximately 230 additional nurses were required for normal operation of the municipal nursery system. Of around 550 nurses working in that system, half were older than 62 years and 104 were older than 70 years. The Municipality estimated that departure of those over 70 could place 124 nursery groups at real risk of closure; 34 nursery groups had already been converted to kindergarten groups in 2025 because of staff shortages [10]. A newly opened nursery with capacity for six groups was operating only two groups because medical staff could not be recruited. [10]

This example has wider public-health and economic implications. When nursing shortages constrain nursery capacity, the consequence is not restricted to health-care delivery: access to early-childhood services falls, parents may delay return to employment, and municipalities may be unable to use newly built infrastructure. The nursing workforce therefore functions as an intersectoral resource linking health care, child development, education, social policy, and labor-market participation.

3.5. Educational capacity: admission is necessary but not sufficient

The Ministry of Health has taken several measures to expand the educational pipeline. For the 2026/2027 academic year, 1,310 places were planned for nursing, the highest number reported by the Ministry to date. Nursing was designated a protected specialty in 2025, and students in state-funded places were exempted from tuition fees. The Ministry also reported 771 state-funded places under a mechanism in which the state finances students who have contracts with employers and who commit to work for that employer for at least five years after graduation. [4] These figures describe separate policy instruments and should not be mechanically added without a detailed administrative breakdown of overlap.

The Ministry explicitly acknowledges the central timing problem: the effect of increased admission will become visible only after four to five years. [4] This delay is particularly important given the current age distribution. The policy challenge can therefore be represented as a workforce pipeline rather than a simple admission target: admission capacity → enrolled students → students retained in training → graduates →

professionally registered nurses → entrants into the Bulgarian workforce → nurses retained at 1, 3, and 5 years. A policy that increases only the first component may produce little net workforce gain if places remain unfilled, attrition is high, or graduates leave the profession or country.

OECD graduate indicators reinforce this concern. Bulgaria's nursing graduate rate of 7.6 per 100,000 population in 2023 was only about one-sixth of the OECD average of 45.7. [2] By contrast, the medical graduate rate was more than twice the OECD average. The problem is therefore not simply an insufficient total number of health-professions students; it is also the distribution of educational capacity across professional categories and the attractiveness of nursing relative to other career options.

3.6. Should nursing education be shortened from four years to three?

The duration of nursing education has become a particularly important policy debate. Bulgarian regulation requires the bachelor's program in nursing to be full-time and to last at least four academic years (eight semesters), with 4,630 hours and at least 240 European Credit Transfer and Accumulation System credits. [13] In contrast, Article 31 of Directive 2005/36/EC establishes a European minimum of at least three years of study and at least 4,600 hours of theoretical and clinical training, with theoretical training representing at least one third and clinical training at least one half of the minimum duration. [12] Thus, European law does not require a four-year calendar structure as the only permissible route.

A concrete European example is the Study Programme in Nursing at Karolinska Institutet in Sweden, which is a 180-credit program leading to a Bachelor of Science in Nursing and a professional nursing qualification. [14] At the standard European study load of 60 ECTS credits per full-time academic year, 180 credits correspond to three academic years. This demonstrates that shorter calendar structures can coexist with recognized professional nursing qualifications within the European framework.

However, shortening Bulgarian education should not be presented as a proven solution to the workforce crisis. Bulgarian professional organizations have opposed a mechanical reduction from four to three years, emphasizing that the fourth year contains substantial clinical internship and that shortening training would not by itself create more applicants. [15] Their concern is consistent with the international evidence linking adequate registered-nurse education to patient outcomes. [6–8]

From a workforce-flow perspective, a three-year program has two distinct potential effects. First, it can bring a new cohort into the labor market approximately one year earlier, which may have value during an acute shortage. Second, it may reduce the time and opportunity cost of entering the profession and thereby improve recruitment. Yet, if annual admission remains unchanged, shortening the program produces mainly a transitional acceleration; it does not automatically increase the long-run annual number

of graduates. Sustainable growth still requires more entrants, lower educational attrition, and higher post-graduation retention.

The appropriate policy response is therefore an evidence-based impact assessment rather than an automatic calendar reduction. Bulgaria could compare at least two models: (1) retention of the four-year, 240-credit pathway combined with significantly stronger student support and paid clinical training; and (2) a redesigned three-year pathway that fully preserves the minimum 4,600 hours, clinical exposure, competency outcomes, and automatic-recognition requirements under European law. Any pilot should prospectively evaluate applicant numbers, dropout rates, clinical competency, licensing outcomes, employer assessment, early-career retention, and patient-safety indicators.

3.7. Policy reform must combine recruitment with retention

The European Observatory's 2024 review of nurse retention emphasizes that recruitment alone cannot solve nursing shortages because training takes time and high turnover can neutralize increases in graduate supply. Recommended retention measures include safe staffing, manageable workloads, supportive working environments, career progression, competitive remuneration, effective nursing leadership, support for an ageing workforce, and better data on why nurses leave [9]. A systematic review of nurse staffing and work schedules also found that staffing conditions and scheduling are policy-relevant determinants of turnover. [16]

This is especially relevant for Bulgaria, where a very old workforce means that retention has two purposes: preventing avoidable early exits among working-age nurses and enabling older nurses who wish to remain employed to do so under safer conditions. Flexible schedules, reduced night work for older staff, mentorship roles, ergonomic adaptation, and progressive transition to retirement can preserve expertise without assuming that nurses in their late 60s and 70s can indefinitely compensate for system shortages.

Remuneration remains essential but should be linked to a broader professional model. A sustainable nursing career requires transparent salary progression, recognition of specialty competence, payment for night and high-intensity work, continuing professional development, and a credible career ladder from entry-level practice to specialist, advanced-practice, management, education, and research roles. WHO Europe has highlighted advanced nursing roles as a means of improving access, particularly in primary and chronic care, while also expanding professional autonomy [17].

3.8. A proposed integrated policy package for bulgaria

3.8.1. National health-workforce forecasting and a workforce observatory

Bulgaria should establish an integrated National Health Workforce Observatory or equivalent permanent analytical function linking the Ministry of Health, Ministry of Education and Science, NSI, professional organizations, universities, municipalities, and major employer groups. Planning should use full-time-equivalent positions rather than headcounts alone and forecast workforce needs for at least 10–15 years by age, profession, region, setting, specialty, expected retirement, migration, workload, and population need. WHO workforce-planning tools provide methodologies that can support such modeling. [1, 8]

3.8.2. Redesign state-funded education around workforce need

State-funded admission should become an explicit health-workforce policy instrument. Annual places should be informed by forecast shortages rather than primarily by university capacity. Because admission capacity does not equal workforce supply, a national dashboard should follow each cohort through enrollment, completion, professional registration, first employment, geographic placement, and retention. Public reporting of these conversion rates would reveal where the pipeline loses potential nurses.

Tuition-free education is an important incentive but may be insufficient. Additional measures should include targeted monthly scholarships, paid clinical placements, housing and transport support for students in shortage regions, and service-linked scholarships with fair contractual conditions. Employer-linked state funding can be useful, but outcomes should be evaluated by completion and five-year retention rather than by the number of contracts signed.

3.8.3. Build a national retention strategy

A national retention strategy should set measurable targets for turnover, vacancy duration, sickness absence, burnout risk, and early-career attrition. Hospitals and other publicly financed providers should be required to report nursing vacancies and full-time-equivalent staffing in standardized form. Employers with persistently high turnover should be supported—and where appropriate required—to implement organizational interventions addressing workload, leadership, rostering, workplace violence, professional autonomy, and career development.

3.8.4. Reform skill mix without deskilling care

The Ministry of Health has already recognized the need to remove low-skilled duties from registered nurses and has pointed to the possibility of using health assistants and carers for general care activities that do not require nursing qualification. [4] This direction should be expanded through nationally defined scopes of practice and standardized training. The objective is to protect nursing time for assessment,

medication, clinical monitoring, education, coordination, and other functions that require professional nursing judgment—not to replace nurses with lower-qualified staff where registered-nurse competence is required.

3.8.5. Introduce targeted regional and sectoral incentives

National averages conceal local shortages. Rural hospitals, emergency services, psychiatry, long-term care, school health, and municipal nurseries may compete for a limited workforce under very different financial conditions. Targeted supplements, municipal housing, transport support, guaranteed childcare, regional scholarships, and service commitments should therefore be directed to specific shortage locations and services. Incentive programs should be reviewed periodically and discontinued or redesigned if they fail to improve retention.

3.8.6. Create a specific workforce model for nurseries and school health

The Sofia nursery crisis demonstrates the need for a separate workforce model for early-childhood services. A risk-based national standard could distinguish activities that require a registered nurse from developmental, educational, and basic-care activities that can be safely provided by trained early-childhood professionals and assistants. Medical oversight must remain clearly defined, with protocols for chronic conditions, medication, infection control, emergency response, and escalation. Such redesign could preserve scarce nursing capacity while avoiding an unsafe administrative substitution of professional nursing care.

3.8.7. Expand nursing roles in primary and community care

Bulgaria should also use the crisis to modernize the professional role rather than merely reproduce the existing hospital-centered model. Expanded nursing roles in prevention, chronic-disease monitoring, home care, health promotion, vaccination, patient education, and protocol-based follow-up can improve access and make the profession more autonomous and attractive. OECD has specifically noted the potential value of stronger nursing roles in Bulgarian primary care [2], while WHO Europe identifies advanced roles as a workforce strategy for underserved settings. [17]

Table 3. Proposed policy package for recovery of the Bulgarian nursing workforce

Policy domain	Priority action	Primary expected effect
Workforce intelligence	National FTE registry and 10–15-year forecasting	Align education and staffing with projected need
Education	Need-based state admission, scholarships, paid placements	Increase recruitment and completion
Retention	Safe staffing, pay progression, supportive work environment	Reduce avoidable exits and burnout
Ageing workforce	Flexible schedules, mentorship, phased retirement	Retain experience while protecting health
Skill mix	Assistants for non-nursing duties with protected RN scope	Release nursing time without deskilling care
Regional policy	Housing, transport, salary supplements, service scholarships	Improve distribution in shortage areas
Professional development	Specialist and advanced-practice pathways	Improve autonomy, access, and career attractiveness
Nursery/school health	Risk-based multidisciplinary staffing standards	Protect child safety while using scarce nurses efficiently
Monitoring	Annual public workforce dashboard	Measure whether policy produces real retention

FTE, full-time equivalent; RN, registered nurse. Policy synthesis based on Bulgarian official data and international workforce evidence [1–4,8,9,17].

3.9. An integrated policy model: from managing shortage to rebuilding capacity

The policy logic can be summarized as a continuous cycle: Forecast → Educate → Recruit → Retain → Deploy → Develop → Monitor → Adjust. Each stage is necessary. Forecasting without educational reform does not produce staff; education without retention finances workforce for other sectors or countries; recruitment without safe staffing accelerates turnover; and retention without geographic deployment can leave regional shortages unresolved.

The timing of interventions is equally important. Measures can be classified by expected horizon. Retention, workload relief, and skill-mix reform can produce effects within months. Scholarships, employer contracts, and larger admission cohorts operate over several years. Changes in professional image, advanced roles, and the age structure of the workforce require a decade or more. A credible national strategy should therefore publish not only targets but also expected time-to-effect for each intervention.

3.10. Limitations

This analysis has several limitations. First, OECD and NSI indicators are not directly interchangeable because they use different definitions and reporting systems. Second, an absolute nursing “deficit” depends on the benchmark used—international average, staffing norm, vacancy data, population need, or service model—and estimates from professional organizations should therefore be interpreted as stakeholder assessments rather than direct observations. Third, Bulgaria lacks a single public database identifying services that have reduced or stopped activity specifically because of nursing shortages; the operational examples in this review are illustrative rather than epidemiologic. Fourth, admission places do not equal enrolled students, graduates, workforce entrants, or retained nurses, limiting direct conclusions from state-order figures alone. Fifth, cross-country differences in program duration cannot establish that shortening education causes increased recruitment or adequate workforce supply. The education proposal in this paper is therefore framed as an option for prospective evaluation, not as an evidence-proven intervention.

4. CONCLUSION

Bulgaria’s nursing shortage is a systemic public-health risk rather than an isolated labor-market problem. The country combines a physician density above the OECD average with a nurse density approximately half the OECD average. National 2025 data show only 0.93 nurses per physician, and more than three quarters of the nursing workforce is already aged 45 years or older. At the same time, the standardized output of nursing graduates is exceptionally low relative both to OECD countries and to Bulgaria’s own medical graduate output.

The immediate implication is that expanding university admission, although necessary, cannot by itself stabilize services in the short term. The first additional nurses from current expanded cohorts will enter the workforce only after several years, while a substantial share of the existing workforce is already at or beyond conventional retirement age. Bulgaria therefore needs simultaneous action on entry and retention.

A sustainable response should combine national workforce forecasting, need-based education financing, scholarships and paid clinical training, safe staffing, better working conditions and remuneration, modern career pathways, targeted regional incentives, protected nursing scope within a redesigned skill mix, and expanded nursing roles in primary and community care. The possibility of a three-year nursing bachelor's pathway deserves formal evaluation because it is compatible in principle with the European minimum duration framework if the 4,600-hour requirement and competencies are fully preserved. It should not, however, be used as a substitute for investment in the profession or as justification for lowering clinical preparation.

The central policy objective should be to move from reactive management of vacancies to long-term rebuilding of nursing capacity. Without such a shift, shortages will increasingly determine not only the quality of care but whether hospital units, blood services, nurseries, school health services, and community-care structures can operate at all.

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ETHICAL CONSIDERATIONS

This review used only aggregate, publicly available secondary data and published literature. It did not involve human participants, identifiable personal data, patient interventions, or animal experiments; therefore, institutional ethics committee approval and informed consent were not required.

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CONFLICT OF INTEREST

The author declares no conflict of interest relevant to this manuscript.

DATA AVAILABILITY

All data analyzed in this article are publicly available from the sources cited in the reference list.

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