




EANM nuclear medicine workforce survey: Sentiments, gaps, and strategic priorities in Europe

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ABSTRACT

Background: This study aimed to characterise the European nuclear medicine workforce, determine open vacancy rates, assess career satisfaction and challenges, identify factors influencing career choices, and evaluate training patterns to support evidence-based workforce development strategies.

Methods: A cross-sectional online survey was conducted by the European Association of Nuclear Medicine (EANM) among the nuclear medicine workforce in Europe between April and June 2024. The survey consisted of three sections: professional background and work environment, basic training, and advanced nuclear medicine specialisation. Statistical analyses included descriptive statistics and exploratory tests for associations between variables, with effect sizes calculated using Cramér's V.

Results: Among 239 respondents from 31 countries ($\pm 3\%$ response rate), physicians comprised 58.2% of participants, followed by physicists/engineers (13.0%) and technologists/radiographers (10.9%). Gender distribution was balanced (49% male, 49% female, 2% undisclosed), with a median age of 46 years. Training in nuclear medicine typically begins between ages 25-30 and lasts 3-5 years, with notable variation across professions reflecting diverse educational backgrounds and entry pathways. While most professionals (71.8%) chose nuclear medicine during early adulthood, 29.6% transitioned from other careers. Work-life compatibility was high (89.4%). Age-related differences emerged in motivational patterns, with early career entrants more influenced by innovation and multidisciplinary, while those entering during mature adulthood prioritised career environment

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and conditions ($P = 0.024$). Career satisfaction was high, with 85.2% willing to choose nuclear medicine again. Critical findings included substantial vacancy rates with 80.2% of departments reporting open positions, particularly for technologists/radiographers (61.6%) and physicians (57.1%). Significant gender disparities existed in leadership roles (male 60.0% vs female 41.3%, $P = 0.017$, Cramér's $V = 0.19$). Findings should be interpreted as exploratory and hypothesis-generating.

Conclusions: The European nuclear medicine workforce demonstrates high career satisfaction and optimism for future growth, yet faces significant challenges, including persistent vacancies and professional disparities in career advancement and leadership. Strategic interventions, including educational outreach, career pathway resources, and professional development initiatives, are essential for sustaining workforce development.

1. Introduction

Nuclear medicine represents a highly specialised medical field that combines diagnostic imaging and therapeutic applications of radioactive substances, serving an expanding patient population across Europe through both diagnostic and therapeutic interventions, often as part of the theranostic approach. Demographic aging, the rising incidence of cancer, cardiovascular and other diseases, and sustained innovation in radiopharmaceuticals have driven an estimated 10 million procedures annually across the European Union (EU), figures projected to increase further over the next decade, especially concerning therapeutic applications [1,2].

This growing demand occurs against the backdrop of an emerging healthcare workforce crisis [3]. Between 2018 and 2030, the EU-27 (representing all current member states of the European Union) is expected to require 11 million newly trained or imported healthcare workers to meet the rising demand in these sectors [4]. Nevertheless, despite the increasing number of physicians and nurses per inhabitant in most countries over the last 20 years, an estimated shortage of 1.2 million doctors, nurses, and midwives was already reported in 2022 [5]. This deficit is projected to increase to 4.1 million in the EU-27 by 2030 (0.6 million physicians, 2.3 million nurses and 1.3 million other healthcare professionals) [6]. In nuclear medicine, this challenge is even more acute given the rapid expansion of procedures, with radiopharmaceutical therapies projected to increase substantially over the coming decade.

Attracting and retaining qualified professionals in nuclear medicine is therefore paramount [7]. An EANM-led survey of European junior doctors identified intellectual challenges, research opportunities, and the field's inherently multidisciplinary nature as key attractions, but, also highlighted perceived barriers such as the limited visibility of nuclear medicine during undergraduate training and uncertainty about long-term career prospects [8].

Maintaining a well trained, multidisciplinary nuclear medicine workforce is essential for health system resilience and aligns with the objectives outlined in Europe's Beating Cancer Plan [9]. However, recent evidence suggests a widening gap between service needs and workforce capacity. The EU-funded European Union Radiation, Education, Staffing & Training (EU-REST) study recently concluded that reliable, comparable data on staffing levels, vacancy rates, and role definitions are still lacking for most nuclear medicine professions, thereby hampering workforce planning at both national and European levels [10]. Moreover, significant variation in training duration, hybrid imaging credentials, and academic opportunities persists despite initiatives to harmonise training [11,12].

Given the absence of comprehensive, pan-European workforce data encompassing all professional categories in nuclear medicine, this survey sought to characterise the current workforce through an EANM-sponsored cross-sectional survey. We assessed professional demographics, career trajectories, factors influencing career choice, training pathways, job satisfaction levels, and perspectives on future workforce needs. These findings provide an evidence base to inform targeted strategies to address nuclear medicine workforce challenges and guide EANM's strategic response to evolving service demands.

2. Methods

2.1. Study design

A cross-sectional online survey was conducted among the European nuclear medicine workforce between April 4 and June 15, 2024. The survey targeted nuclear medicine professionals across Europe, including physicians, physicists/engineers, technologists/radiographers, (radio) pharmacists, scientists/chemists, and other related professionals working in clinical practice, research, or education. It should be noted that the professional categories used in this study were intended to group roles by function rather than by specific job titles, recognising that professional nomenclature varies significantly across European healthcare systems. For example, 'technologists/radiographers' may be termed differently in certain countries (e.g., clinical scientists, medical technical officer, etc.). This pragmatic approach does not imply a preference for particular terminology or disregard for alternative professional designations used for similar roles in different countries.

2.2. Survey instrument

The survey instrument (see Supplementary Materials) comprised three main sections: professional background and work environment, basic training before speciality training in nuclear medicine, and advanced nuclear medicine specialisation/training. The first section included questions on country of practice, age, gender, professional role, work environment, educational background, leadership positions, departmental vacancy patterns, life stage at career entry, factors influencing career choice in nuclear medicine, and retrospective career satisfaction. Next, section 2 of the questionnaire explored educational pathways and training experiences, including the role of basic education in generating interest in nuclear medicine, factors influencing university selection, prerequisite study requirements, and English language proficiency requirements for nuclear medicine programmes. Finally, section 3 of the survey examined career trajectories and professional experiences, including training timelines, career alignment with initial aspirations, work-life compatibility, patterns of professional advancement patterns, employer loyalty, career transition pathways, advice for new professionals, and perspectives on the field's future opportunities and challenges. Questions used multiple-choice formats and open-ended responses to capture quantitative and qualitative data. All data were self-reported.

2.3. Data collection

The survey was programmed using QuestionPro Survey Software (QuestionPro Europe GmbH, Germany), and distribution occurred via EANM's communication channels (i.e., newsletter and social media channels [i.e., Facebook and LinkedIn]). Participants completed the survey voluntarily. Multiple reminders were sent during the collection period to maximise response rates. No personally identifiable information was collected.

2.4. Analysis framework

Three analytical datasets were defined to report the results: 1) All data set (ADS): all available data for variables completed by all respondents ($n = 239$), 2) non-missing set (NMS): all available non-missing data per variable regardless of questionnaire completion ($n = \text{variable}$), and 3) section completed set (SCS): data from respondents who completed specific questionnaire sections ($n = \text{variable}$). For analysis sets with variable denominators, the total size used to calculate percentages is reported for each outcome.

2.5. Statistical analysis

Descriptive statistics characterised demographic and professional variables. Chi-square (χ^2) tests were used to assess associations between categorical variables, while Jonckheere-Terpstra tests were employed for ordered categorical variables. For significant categorical associations, Cramér's V was calculated to assess effect size, with values interpreted as small ($V \geq 0.10$), medium ($V \geq 0.30$), and large ($V \geq 0.50$) effects. Distribution of variables is reported using medians and quartiles. For key proportions, exact 95% confidence intervals (CIs) were calculated using the binomial distribution. Statistical significance was set at $P = 0.05$, without adjustment for multiple testing. Analyses were exploratory and hypothesis-generating, with emphasis on possible association rather than causation. All analyses were performed using Stata/BE 18.0 (College Station, TX, USA).

3. Results

3.1. Demographics and professional characteristics

The survey collected responses from 239 nuclear medicine professionals across 31 European countries, with 172 (72%) completing the full questionnaire (Table 1). All percentages are calculated relative to $n = 239$ (ADS), unless otherwise specified. The geographic distribution showed concentration in Western Europe (42.3%), followed by Southern Europe (23.8%) and Eastern Europe (23.4%). The Czech Republic led participation with 13.8% of respondents, followed by Italy (12.1%), Germany (9.6%), and Belgium (9.2%). The majority of respondents (94.1%) were high-income countries, as defined by the World Bank.

The gender distribution was balanced, with males comprising 49.4% and females 48.9% of respondents (1.7% not disclosed). The median age was 46 years (Q1: 38; Q3: 54), with the largest age group being 45 to <50 years (17.1%). Professional roles showed physicians as the predominant group (58.2%), followed by physicists/engineers (13.0%), technologists/radiographers (10.9%), and pharmacists (8.4%). No significant gender imbalances were observed in professional roles (χ^2 , $P = 0.746$). The survey respondents (total $n = 227$, NMS) had a high level of advanced degrees: Ph.D. held by 82 (36.1%) and M.D. degree reported by 78 (34.4%).

3.2. Career patterns and leadership

Career timing patterns revealed that 71.8% (148/206; 95% CI 65.2-77.9%) of professionals chose nuclear medicine during early adulthood (18-25 years), and 29.6% (53/179; 95% CI 23.0-36.9%) transitioned from other careers. Physicians showed significantly lower transition rates (20.4%; 95% CI 13.3-29.2%) compared to other professions (43.7%; 95% CI 31.9-55.9%) (χ^2 $P = 0.001$). Among all professions, physicists/engineers (47.6%) and technologists/radiographers (47.1%) reported the highest transition rates. A diverse set of prior disciplines was observed, with the most frequent being radiology (20.7%), internal medicine (17.0%), and physics/engineering, which included positions outside nuclear medicine (13.2%) (Fig. 1).

Leadership roles were reported by 50.7% of respondents (total $n = 227$, NMS), with significant gender disparities observed. Males were

Table 1

Main demographic characteristics and professional background of survey respondents. All percentages are calculated relative to $n = 239$, unless otherwise specified.

Variable	Frequency (%) / Median (Q1 – Q3)
Fully completed questionnaires	172 (72.0%)
Geographical origin	
Eastern Europe	56 (23.4%)
Non-Europe	13 (5.4%)
Northern Europe	12 (5.0%)
Southern Europe	57 (23.5%)
Western Europe	101 (42.3%)
Top 10 participating countries	
Czech Republic	33 (13.8%)
Italy	29 (12.1%)
Germany	23 (9.6%)
Belgium	22 (9.2%)
United Kingdom	20 (8.4%)
Spain	14 (5.9%)
France	12 (5.0%)
The Netherlands	11 (4.6%)
Portugal	8 (3.3%)
Croatia	6 (2.5%)
Gender	
Male	118 (49.4%)
Female	117 (49.0%)
Not disclosed	4 (1.6%)
Age	46 (38 – 54)
Professional role	
Physician	139 (58.2%)
Technologist/Radiographer	26 (10.9%)
Pharmacist	20 (8.4%)
Physicist/Engineer	31 (13.0%)
Scientist/Chemist	11 (4.6%)
Other	12 (5.0%)
Working environment	
Academic hospital/institution	103 (43.1%)
Public hospital/institution	123 (51.5%)
Private hospital/institution	37 (15.5%)
Commercial organisation	10 (4.2%)
Other	7 (2.9%)
Highest degree (n=227)	
High school diploma or equivalent	7 (3.1%)
Short cycle higher education/Higher national diploma	4 (1.8%)
Bachelor of Science (B.Sc.)	11 (4.8%)
Master of Science (M.Sc.)	26 (11.4%)
Medical Doctor/Doctor of Medicine (M.D.)	78 (34.4%)
Doctor (Pharm.D., Ph.D.)	86 (37.9%)
Other	15 (6.6%)

more likely to hold leadership positions (60.0%; 95% CI 50.4-69.0%) compared to females (41.3%; 95% CI 31.9-51.1%) (χ^2 $P = 0.017$; Cramér's $V = 0.19$). As expected, age demonstrated a strong association with leadership roles, with 28.9% (95% CI 19.1-40.5%) of professionals under 40 years reporting leadership positions compared to 61.6% (95% CI 53.3-69.4%) of those 40 years and older (Jonckheere-Terpstra $P = 0.0001$).

3.3. Workforce vacancies

Vacancy data revealed substantial gaps across nuclear medicine professions (Fig. 2). Overall, 80.2% (95% CI 74.3-85.1%) of respondents (total $n = 227$, SCS) reported at least one open vacancy in their departments, with 57.7% (131/227; 95% CI 51.0-64.2%) of positions remaining unfilled for six months or longer. Technologists/radiographers faced the highest vacancy rates (61.6%), with 45.7% of positions open for extended periods. Physicians experienced similar challenges with 57.1% vacancy rates and 42.4% long-term openings.

Other professions showed notable but lower vacancy rates: physicists/engineers (36.9% with 23.8% long-term), pharmacists (32.8% with 18.7% long-term), nurses (31.1% with 24.1% long-term), and

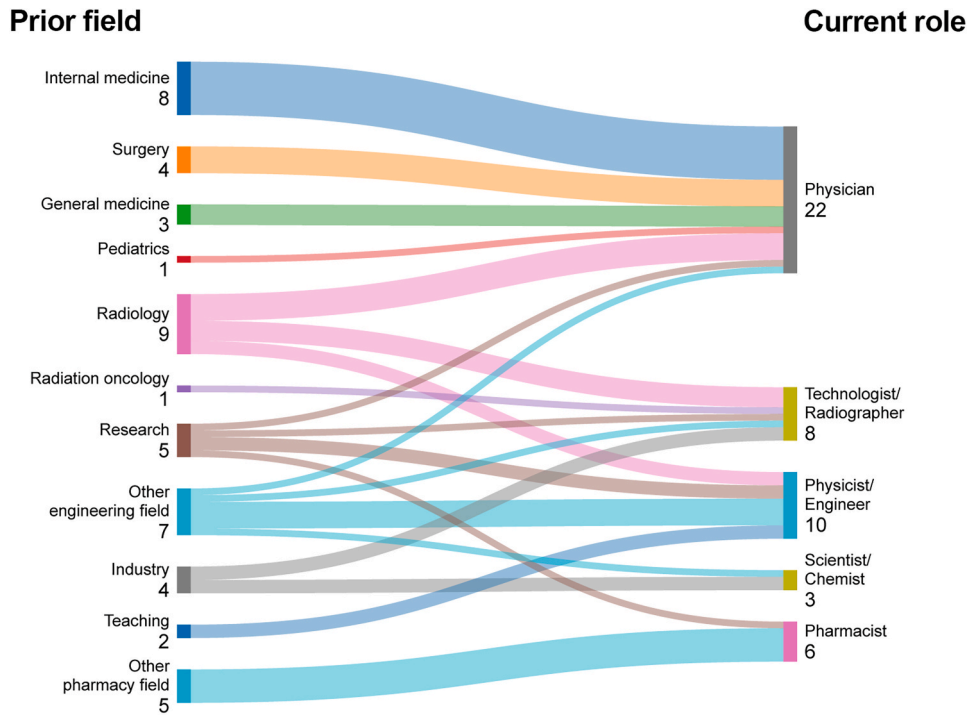


Fig. 1. Career transition pathways showing prior fields of employment and current nuclear medicine roles among participants who changed careers (n = 53).

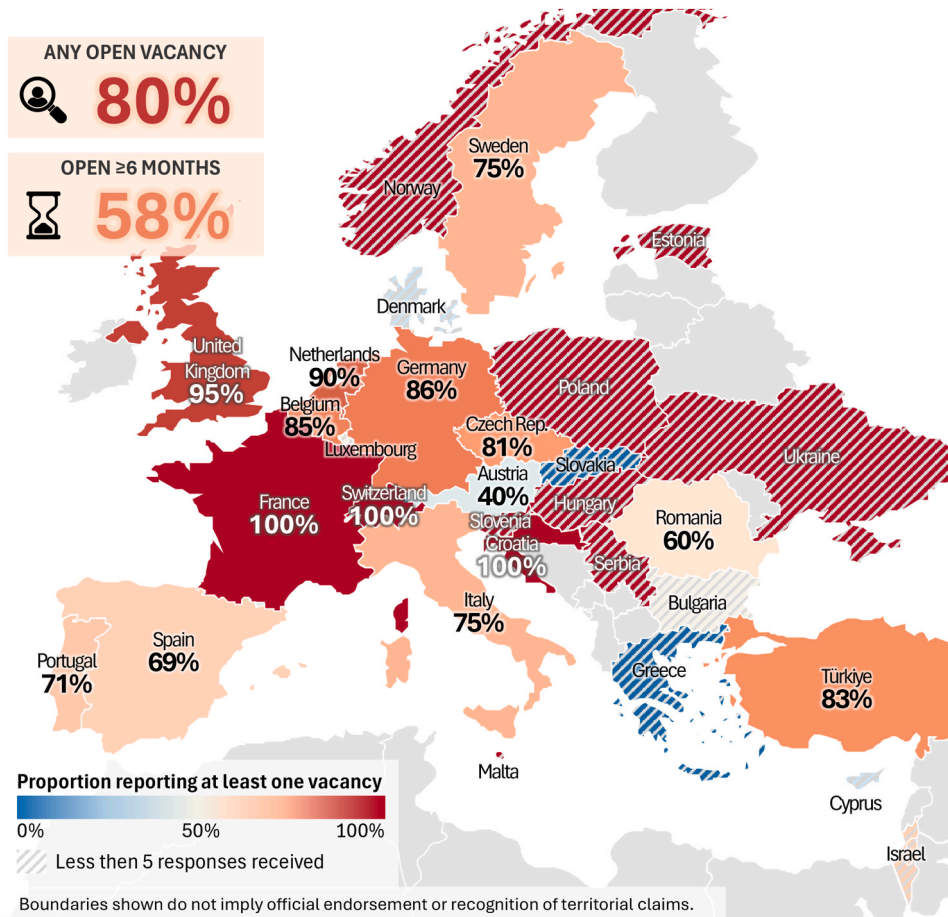


Fig. 2. Proportion of respondents reporting at least one open vacancy for any role in their department. Countries receiving fewer than five responses are marked with diagonal stripes and excluded from numerical reporting due to insufficient sample size for reliable estimates.

scientists/chemists (21.5% with 11.6% long-term). Multiple technologist/radiographer vacancies were reported by 18.5% (42/227; 95% CI 13.7-24.2%) of respondents, the highest rate among all professions.

3.4. Career motivations and satisfaction

Analysis of career-motivating factors revealed that multidisciplinary opportunities (52.5%) and innovation potential (40.2%) were the primary influences for choosing nuclear medicine (multiple selections possible per participant, total n = 204, NMS) (Fig. 3). Role models (28.9%) and personal experiences (27.0%) also played a role. Age-related differences emerged in motivational patterns, with early career entrants (18-25 years) across roles more influenced by innovation (49.3%) and multidisciplinary (52.1%), while those entering during mature adulthood (45-65 years) prioritised career environment and conditions (43.8% vs 19.9% for early entrants, $\chi^2 P = 0.024$, Cramér's V = 0.22). No relevant difference existed between genders.

Career satisfaction levels were high, with 85.2% (95% CI 79.4-89.9%) of respondents (total n = 196, NMS) indicating they would choose nuclear medicine again (49.5% definitely, 35.7% probably) (Fig. 4). A similar satisfaction rate was observed among those transitioning into nuclear medicine later (86.8%). No significant differences in satisfaction were observed by gender, age, country, or region. However, numerical differences suggested lower satisfaction among technologists/radiographers (68.4%; 95% CI 43.4-87.4%) compared to other professions (physicians 84.5%, pharmacists 82.4%, physicists 92.3%, scientists/chemists 100%), but with a considerable overlap ($\chi^2 P = 0.142$). A large majority of respondents (82.7%) indicated they were very or highly likely to continue working for their current employer until retirement.

Work-life compatibility was rated as moderate/high by 89.4% (95% CI 84.0-93.5%) of respondents (total n = 178, NMS) (Fig. 4). While this percentage was high across professional groups, variations existed: technologists/radiographers (81.2%; 95% CI 54.3-95.5%), pharmacists (76.5%; 95% CI 50.1-93.2%), and scientists/chemists (77.8%; 95% CI 40.0-97.2%) reported lower moderate/high compatibility rates compared to physicians (92.6%; 95% CI 85.9-96.7%) and physicists/engineers (100%; 95% CI 83.9-100%) ($\chi^2 P = 0.012$; Cramér's V = 0.27). No significant association existed with gender, age, or region.

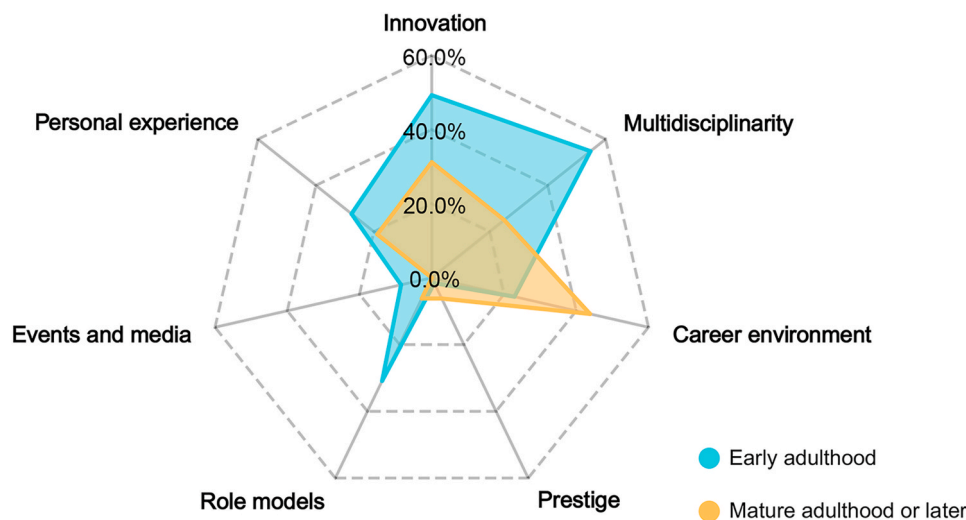


Fig. 3. Career motivating factors by age at entry into nuclear medicine. Radar chart comparing the relative importance of different motivational factors between professionals who entered nuclear medicine during early adulthood (18-25 years) versus mature adulthood (45-65 years) or later. Career environment and conditions were shown to be significantly more important for mature adult entrants ($\chi^2 P = 0.024$), while innovation and multidisciplinary aspects were more prominent motivators for early-career entrants.

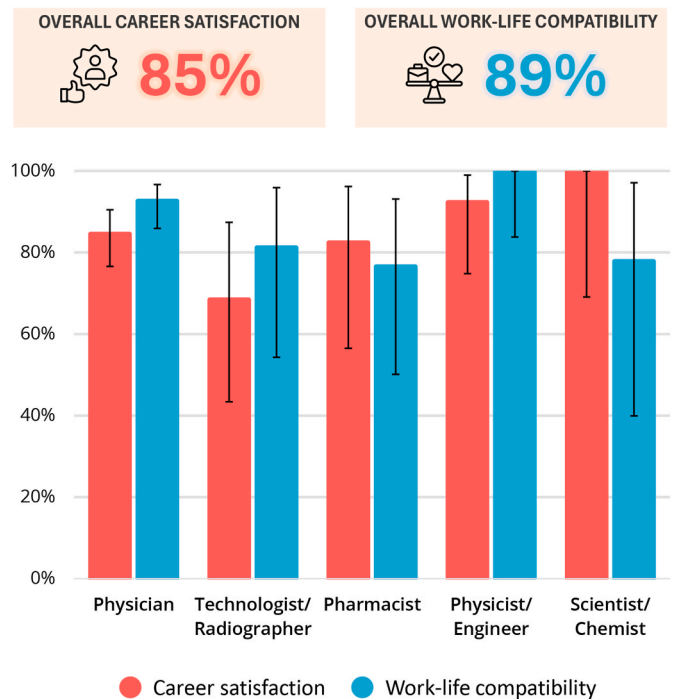


Fig. 4. Career satisfaction and work-life compatibility by professional category. Proportion of respondents who would probably/definitely choose nuclear medicine again (career satisfaction) and rating moderate/high work-life compatibility. Error bars represent 95% confidence intervals.

3.5. Nuclear medicine training

Training initiation patterns showed that 51.7% of respondents (total n = 180, NMS) began specialisation in nuclear medicine between the ages of 25 and 30, with 26.1% starting between 20 and 25 years. Professional variations were evident: physicians predominantly started between the ages of 25 and 30 (62.4%) after completing a medical degree, while technologists/radiographers often began earlier, at 20 to 25 years (58.8%). Pharmacists had varied ages of training initiation, with 52.9% starting at 25-30 years and 23.5% at 20-25 years. Physicists/engineers and scientists demonstrated even broader distributions across

age categories.

The training duration varied significantly across respondents (total $n = 204$; NMS) and professions (Fig. 5). The majority completed training in 4-5 years (31.7%) or 3-4 years (29.4%). Physicians typically required 4-5 years (42.2%), while technologists/radiographers completed training in 1-3 years. Training duration variability within professions is particularly pronounced among pharmacists (ranging from 1 to 2 years to over 6 years), physicists/engineers, and scientists/chemists, reflecting diverse educational backgrounds and entry pathways into nuclear medicine, or further subspecialisation.

While basic education provided foundational knowledge for 51.5% of respondents (total $n = 196$; NMS), only 23.5% reported that it sparked their interest in nuclear medicine, and 17.9% gained practical exposure through educational activities. Moreover, 27.0% indicated that basic education had little influence on their career choice.

3.6. Career evolution and future perspectives

Most respondents (83.8%; 95% CI 77.5-88.9%) (total $n = 179$, NMS) reported some or significant career advancement since completing their training. Career progression varied significantly by profession, with technologists/radiographers showing lower advancement rates (64.7%; 95% CI 38.3-85.8%) compared to physicians (88.9%; 95% CI 81.4-94.1%), physicists (80.9%; 95% CI 58.1-94.5%), pharmacists (82.3%; 95% CI 56.6-96.2%), and scientists (88.9%; 95% CI 51.7-99.7%) ($\chi^2 P = 0.025$; Cramér's $V = 0.17$). No differences existed between genders or regions.

Advice to new professionals (total $n = 179$; NMS) emphasised continuous learning (68.2%), mentorship and networking (49.2%), and openness to diverse roles (48.0%). Work-life balance prioritisation was recommended by 25.1% of respondents.

The professional outlook remained optimistic, with 65.9% (95% CI 58.5-72.8%) of respondents (total $n = 179$, NMS) perceiving future growth in nuclear medicine. However, 17.9% (95% CI 12.6-24.3%)

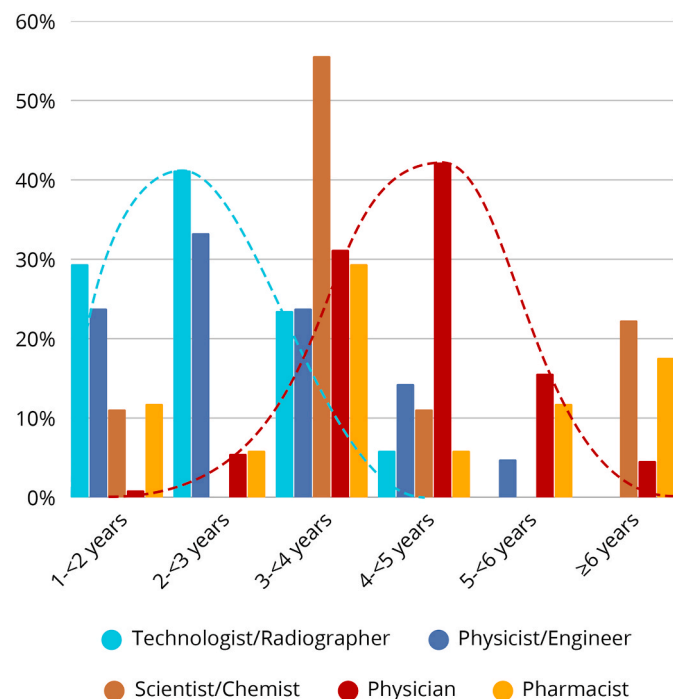


Fig. 5. Training duration by professional role ($n = 204$). The distribution shows significant interprofessional variation, with technologists/radiographers typically completing training in 1-3 years, physicians predominantly in 4-5 years (42.2%), and pharmacists and scientists/chemists demonstrating the highest variability across all duration categories.

anticipated challenges, and 6.1% (95% CI 3.1-10.7%) expressed uncertainty. A qualitative analysis of the comment fields showed that respondents' reasons included themes about the medical field as a whole, such as poor investment and limited career development opportunities in certain countries.

4. Discussion

In this Europe-wide survey of 239 nuclear-medicine professionals, we observed high overall career satisfaction alongside persistent staffing shortages (Fig. 2). Notably, disparities were evident in career evolution and leadership representation. Because nuclear medicine spans multiple professions with distinct training pathways, shortages manifest heterogeneously, most acutely among technologists/radiographers, highlighting the need for profession-specific rather than generic workforce strategies. Beyond the traditional physician-centered career model, the expansion of theranostic applications is creating new opportunities for advanced practice, academic, and coordination roles among technologists, physicists, pharmacists, and scientists, underscoring the evolving multidisciplinary nature of the field.

The multidisciplinary and innovative character of nuclear medicine continues to motivate professionals throughout their careers (Fig. 3), confirming observations from our previous resident survey [8]. However, these intrinsic strengths coexist with structural barriers to career advancement, indicating that leveraging appeal alone will not bridge vacancies or leadership gaps; instead, targeted initiatives are required.

Similar workforce pressures have been reported in related domains: the ENEN2+ study in medical physics found that 7% of physicists expect to retire within 5 years and highlighted shortages in radiochemistry expertise, which parallels our findings [13]. In addition, training durations were reported to vary widely across EU countries in both fields (Fig. 5), limiting mobility and standardisation. Globally, a survey across 189 countries concluded that even high-income settings lack sufficient staff to meet projected growth in nuclear medicine [14].

Compared with oncology, where 43% of professionals report poor work-life balance and 8% intend to leave within five years, nuclear medicine appears relatively resilient [15]. This comparative advantage, combined with high career satisfaction (Fig. 4) and strong institutional loyalty, represents a strength to build upon while addressing the identified gaps. Retention efforts should focus on early-career professionals and address profession-specific challenges. Although differences were not statistically significant, lower satisfaction among technologists/radiographers, who simultaneously face the highest vacancy rates and lower work-life compatibility, warrants further qualitative exploration.

Respondents expressed an overall optimistic outlook for the field, offering a strong foundation for growth-oriented strategies. Yet, national heterogeneity suggests that some drivers (e.g., broader health system pressures) also contribute to workforce constraints. The emphasis on continuous learning and mentorship underscores the importance of structured educational initiatives and mentorship programmes as core development strategies.

Despite near gender parity, leadership remains male-dominant, a pattern across medical specialities. This imbalance supports continued initiatives such as the EANM's Women's EmpoWERM programme [16, 17]. Career advancement also varies by profession: technologists/radiographers progress less frequently suggesting systemic barriers that may exacerbate existing shortages. A UK study among nuclear medicine technologists reveals that, despite different backgrounds, they develop a unified role competence and a shared identity as providers of care and users of science and technology. Yet, regulatory disparities between statutorily registered radiographers and voluntarily registered clinical technologists can create professional hierarchies that may affect career advancement opportunities [18]. In addition to structural factors, societal dynamics such as more frequent career interruptions among women and limited hierarchical progression

pathways for technologists/radiographers further constrain advancement opportunities, highlighting the multifaceted nature of workforce inequalities in nuclear medicine.

Ultimately, the high rate of open, persistent vacancies poses the most immediate challenge (Fig. 2): over four in five departments reported open positions, and nearly three in five reported long-standing posts. Shortages are most acute among technologists/radiographers and physicians, threatening service delivery and quality of care. Persistent vacancies point to underdeveloped training and retention strategies, compounded by limited exposure to nuclear medicine during foundational education and potentially restricted access to training positions in several countries.

Interestingly, our data indicate a gap between knowledge provision and inspiration, consistent with the field's low visibility in the general public [18] and among junior doctors [19]. Indeed, up to 80% of nuclear medicine technologists indicate that they entered the field by chance [18].

Despite these challenges, several high-leverage opportunities exist to expand and stabilise the workforce. First, integrating nuclear medicine concepts into undergraduate curricula across medicine, physics, chemistry, pharmacy, and allied disciplines could convert passive awareness into active career interest. Nevertheless, it is recognized that training pathways are lengthy, and these initiatives will therefore mature slowly. Second, nearly one-third of respondents entered nuclear medicine mid-career, particularly technologists/radiographers and physicists/engineers. Their high satisfaction validates the potential of tailored recruitment packages for career changers. Materials should emphasise multidisciplinary, innovation, supportive work environments and flexible conditions, while addressing barriers specific to each source profession. A dual strategy, combining early exposure with structured mid-career pathways, could significantly widen the workforce pipeline.

4.1. The EANM INSPIRE programme

In response to the workforce challenges and in light of this survey's findings, EANM launched the "Initiatives in Nuclear medicine to Support Professional Interest and Recruitment in Europe" (INSPIRE) programme in early 2024. INSPIRE provides a comprehensive programme to address workforce challenges by engaging students, educators, educational institutions, associations, and key stakeholders to foster sustained interest and recruitment (Table 2). Led by the EANM Young Professionals Council, INSPIRE is built on three strategic pillars: Engagement & Outreach, Education & Experience, and Innovation & Sustainability [19].

Under the outreach pillar, the successful Science Day pilot at the EANM '24 and '25 annual meetings provided a free, immersive experience welcoming undergraduate from around the world and local high school students to access scientific presentations, expert debates, and guided industry exhibition tours. INSPIRE has also successfully piloted a summer school franchise in September 2025, targeting Master students at career crossroads, featuring networking, professional skills workshops, and nuclear medicine content.

INSPIRE's awareness initiatives include the INSPIRE Exhibit, featuring compelling video testimonials that showcase the diversity of nuclear medicine careers, which will travel across Europe to universities and career fairs. In parallel, a collaboration with the European Medical Students Association (EMSA) was established to increase medical students' exposure to nuclear medicine.

To promote awareness and facilitate career transitions, INSPIRE is developing structured career pathway and guidance materials derived from a survey among EANM's member societies. These materials will be available through a dedicated INSPIRE website. Collectively, INSPIRE positions EANM to address both immediate workforce gaps and long-term sustainability through evidence-based interventions that directly respond to the challenges and opportunities identified in this workforce assessment.

Table 2

Priority workforce findings and proposed targeted strategic responses based on survey results.

Finding	Targeted actions
Critical vacancy rates	<ul style="list-style-type: none"> • Develop profession-specific recruitment materials highlighting career pathways • Launch a targeted website as a platform for outreach campaigns to related professional communities • Create a job mobility portal connecting European opportunities
Limited educational exposure	<ul style="list-style-type: none"> • Develop educational modules for undergraduate curricula • Create interactive case libraries and virtual learning resources • Integrate student engagement activities into existing EANM congresses and educational activities • Foster collaborations with societies representing graduate students • Develop educational formats targeting graduate students that National Societies can implement in the local language
Career transition opportunities	<ul style="list-style-type: none"> • Design career transition pathway materials for mid-career professionals • Integrate bridging programmes recognising prior expertise into the current educational offering • Create testimonials from successful career changers
Professional disparities	<ul style="list-style-type: none"> • Create profession-specific networking and mentorship opportunities • Develop advanced practice pathways for technologists and other underrepresented groups • Integrate with Women's Empowerment leadership coaching and mentorship networks
Unique profile	<ul style="list-style-type: none"> • Emphasise theranostics, AI, and hybrid imaging in recruitment materials • Create innovation showcases at conferences and online platforms • Develop "day-in-the-life" content highlighting interdisciplinary collaboration • Partner with patient organisations to demonstrate societal impact

4.2. Limitations

Several factors limit the conclusions that can be drawn from this exploratory survey. First, the survey employed convenience sampling through EANM communication channels (newsletter and social media), yielding 239 responses from an estimated 7,500 distributed invitations (approximately 3% overall, with 172 fully completed, resulting in a 72% completion rate). However, this denominator reflects distribution reach rather than confirmed individual recipients, and we cannot determine respondents' EANM membership status from the anonymous data. Some respondents may have been recruited through social media or colleague invitation rather than direct EANM membership. The resulting response rate calculation is therefore imprecise, but the sample is clearly self-selected and small relative to the broader European nuclear medicine workforce. Nonresponse bias is a recognized concern in voluntary surveys, though its direction and magnitude are difficult to predict. Dissatisfied professionals might avoid participation, leading to over-estimation of career satisfaction. Conversely, dissatisfied individuals might be disproportionately motivated to voice concerns through survey participation, while highly satisfied professionals with competing time demands might be less likely to respond. The observed high career satisfaction could therefore reflect either scenario, or a relatively unbiased sample. Our findings should be interpreted as hypothesis-generating insights into workforce sentiment rather than definitive population parameters. Second, the questionnaire was delivered only in English and was not psychometrically validated or piloted beyond a face review, meaning that its validity and measurement error are unknown. Third, all data are self-reported, which introduces recall and other biases, particularly for sensitive items such as vacancy counts and leadership roles. Fourth, multiple statistical tests were performed without

correction for multiple comparisons, thereby increasing the probability of false-positive associations. Fifth, some subgroup analyses involve low counts (e.g., technologists), resulting in wide confidence intervals and possibly unstable estimates. Finally, the cross-sectional design precludes causal inference or assessment of trends. Future follow-up surveys should employ probability sampling, validate the instrument in multiple languages, link responses to administrative vacancy data, and track cohorts longitudinally to identify temporal dynamics and the effects of interventions, such as INSPIRE.

5. Conclusions

This Europe-wide survey revealed a professionally diverse, educationally advanced, and generally satisfied European nuclear medicine workforce facing significant structural challenges. The critical vacancy rates call for immediate action through coordinated recruitment strategies and systematic outreach and awareness programmes, coupled with expansion of training opportunities to facilitate access to nuclear medicine careers. Profession-specific disparities in career advancement and leadership highlight the need for targeted, inclusive workforce development strategies. In response the EANM has launched INSPIRE, a dedicated programme that combines educational outreach, structured career pathway resources, and professional development initiatives, creating multiple touchpoints to attract, develop, and retain the next generation of nuclear medicine professionals, strengthening the field's long-term sustainability across Europe. Future studies should employ probability sampling methods and validated instruments to provide more robust workforce estimates.

CRedit authorship contribution statement

Tim Van den Wyngaert: Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Formal analysis, Conceptualization. **Conrad-Amadeus Voltin:** Writing – review & editing, Validation, Conceptualization. **Katharina Luckerath:** Writing – review & editing, Validation, Conceptualization. **Désirée Deandreis:** Writing – original draft, Validation, Conceptualization. **Damion Bailey:** Writing – review & editing, Validation, Conceptualization. **Ann-Christin Eder:** Writing – review & editing, Validation, Conceptualization. **Margret Schottelius:** Writing – review & editing, Validation, Conceptualization. **Sophie E.M. Veldhuijzen van Zanten:** Writing – review & editing, Validation, Conceptualization. **Gopinath Gnanasegaran:** Writing – review & editing, Validation, Conceptualization. **Silvia Marchetti:** Writing – review & editing, Validation, Methodology, Data curation, Conceptualization. **Michel Koole:** Writing – review & editing, Validation. **Felix M. Mottaghy:** Writing – review & editing, Validation. **Paola A. Erba:** Writing – review & editing, Validation.

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Declaration of competing interest

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.eanmj.2026.100015>.

Data availability

Data will be made available on request.

References

- [1] Krause B, Lassmann M, Bardiès M, Gear J, Verburg F, Covens P, et al. SAMIRA study on the implementation of the Euratom and EU legal bases with respect to the therapeutic uses of radiopharmaceuticals. Publications Office of the European Union; 2025.
- [2] Abdel-Wahab M, Giammarile F, Carrara M, Paez D, Hricak H, Ayati N, et al. Radiotherapy and theranostics: a lancet oncology commission. *Lancet Oncol* 2024; 25(11):e545–80.
- [3] Fischer-Barnicol M, Lechtenfeld R, Prasad N, Şuta C-M, Tanius C, Carta E, et al. EURES report on labour shortages and surpluses 2024. Luxembourg: European Labour Authority; 2025.
- [4] Grubanov-Boskovic S, Ghio D, Goujon A, Kalantaryan S, Belmonte M, Scipioni M, et al. Healthcare and long-term care workforce: demographic challenges and potential contribution of migration and digital technology. Luxembourg (Luxembourg); 2021. 2021.
- [5] OECD/European Commission. Health at a glance: europe 2024. Paris: OECD Publishing; 2024.
- [6] European Observatory on Health Systems Policies. From great attrition to great attraction: countering the great resignation of health and care workers. *Eurohealth* 2023;29(1):6–10.
- [7] Hricak H, Abdel-Wahab M, Atun R, Lette MM, Paez D, Brink JA, et al. Medical imaging and nuclear medicine: a lancet oncology commission. *Lancet Oncol* 2021; 22(4):e136–72.
- [8] Ambrosini V, Carrilho Vaz S, Ahmadi Bidakhvidi N, Chanchou M, Cysouw MCF, Serani F, et al. How to attract young talent to nuclear medicine step 1: a survey conducted by the EANM oncology and theranostics committee to understand the expectations of the next generation. *Eur J Nucl Med Mol Imag* 2023;51(1):3–11.
- [9] European Commission. A cancer plan for Europe [Available from: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/promoting-our-european-way-life/european-health-union/cancer-plan-europe_en].
- [10] European Commission: European Health Digital Executive Agency. Analysis on workforce availability, education and training needs for the quality and safety of medical applications involving ionising radiation in the EU – status and recommendations – final report. Publications Office of the European Union; 2025.
- [11] European Union of Medical Specialists (UEMS). Training requirements for the specialty of nuclear. *Medicine* 2023 [Available from: <https://www.uems.eu/european-training-requirements>].
- [12] International Atomic Energy Agency (IAEA). Training curriculum for nuclear medicine physicians. Vienna: International Atomic Energy Agency (IAEA); 2019.
- [13] Visvikis D, Rocha Paulo A, Deja K, Telloli C, Ferrucci B, Marques R, et al. Report on HR needs in non-power nuclear sector applications. ENEN2plus Consortium; 2023. 2023-05-31. Report No.: Project Number: 101061677.
- [14] Scott AM, Zeglis BM, Lapi SE, Scott PJH, Windhorst AD, Abdel-Wahab M, et al. Trends in nuclear medicine and the radiopharmaceutical sciences in oncology: workforce challenges and training in the age of theranostics. *Lancet Oncol* 2024;25(6):e250–9.
- [15] Ceelen W, Crul M, Oldenmenger W, Eni A, Kiss A, Lorenzo i Sunyer N, et al. Under pressure: safeguarding the health of Europe's oncology workforce. Brussels: European Cancer Organisation; 2024.
- [16] Evangelista L, Pietrzak A, Ekmekcioglu O, Ovarcicek PP, Ambrosini V, Balogova S, et al. Gender issues in the nuclear medicine community: results from a survey promoted by the EANM women empowerment task force. *Eur J Nucl Med Mol Imag* 2022;49(7):2106–12.

- [17] L'Hôte M, Rubio I, Erba P, Kiss A. Women & cancer: more than 12 million reasons for actions. European Cancer Organisation; 2024.
- [18] Bailey DS, Harding D. Professional identity and role perception of radiographers and clinical technologists in nuclear medicine – an exploratory qualitative study. *Radiography* 2024;30(1):73–9.
- [19] European Association of Nuclear Medicine. Discover INSPIRE by EANM [Available from: <https://eanm.org/the-eanm-community/initiatives/inspire-by-eanm/>; 2024.