Rialtas na hÉireann
Government of Ireland

Spending Review 2022

An Analysis of Medical Workforce Supply

Terence Hynes, Peter O'Connor

Research Services & Policy Unit, Department of Health

Irish Government Economic and Evaluation Service

MARCH 2023

Please cite this report as: Hynes, T., O'Connor, P. (2022). An Analysis of Medical Workforce Supply, Research Services and Policy Unit, Department of Health.

This paper has been prepared by Irish Government Economic and Evaluation Staff the Research Services and Policy Unit of the Department of Health. The views presented in this paper do not represent the official views of either the Department or Minister.

Acknowledgements: The authors would like to thank colleagues in the National Doctors Training and Planning Unit in the HSE, the subgroup of the Spending Review process, the

Health Vote in the Department of Public Expenditure and Reform for their guidance and feedback on this report. For guidance on technical aspects of modelling, thanks are due to Sarah Megan Wylie of the Strategic Investment Board and Conor Meehan of the Innovation Lab, Department of Finance both of Northern Ireland. Any and all errors remain those of the authors.

Abbreviations, Acronyms and Glossary

Acute Care	Acute Care refers to care provided in relation to critical, high-dependency and high clinical-need cases.
Acute Medical Assessment Unit	An Acute Medical Assessment Unit (AMAU) is a facility with beds separate from ED whose primary function is the immediate and early specialist management of acutely unwell adult patients who present to, or from within, a hospital requiring urgent medical care. AMAUs enable appropriate streaming of patients away from EDs to improve clinical care and patient experience.
BMQ	Basic Medical Qualification
BST	Basic Specialist Training
Circular Migration	The temporary, recurrent movement of people between two or more countries mainly for purposes of work or study.
Clinical Placement	The clinical training of medical students takes place through clinical placements to hospitals and primary care facilities (including General Practice). Such placements take place in the form of 'rotations', with students sent on several individual placements to different healthcare facilities.
Consultant	A Consultant is a clinically independent medical practitioner registered with the Medical Council's Specialist Division who by reason of their training, skill and expertise in a designated specialty is consulted by other registered medical practitioners and who has a continuing clinical and professional responsibility both for patients under their care or those patients on which they have been consulted.
Consultant-Led Service	A service supervised by consultants who lead and advise teams of doctors in training and other staff in the delivery of care to their patients.
Consultant-Provided Service (or Consultant-Delivered Service)	A service delivered by teams of Consultants, where the Consultants have a substantial and direct involvement in the diagnosis, delivery of care and overall management of patients.
CR	Health Service Capacity Review 2018: Review of Health Demand and Capacity Requirements in Ireland to 2031 – Main Report
CSCST	This is awarded to doctors who have successfully completed Higher Specialist Training and have demonstrated the advanced skills and knowledge required for practising independently as a specialist, leading a clinical team and managing the everyday challenges in the health service.
DETE	The Department of Enterprise, Trade and Employment
DG REFORM	The Directorate-General for Structural Reform Support is the European Union body which assists EU member states in the implementation of technical and structural reforms.
DoH	The Department of Health
DoH-RSPU	The Department of Health's Research Services and Policy Unit
DPER	The Department of Public Expenditure and Reform
DFHERIS	The Department of Further and Higher Education, Research, Innovation and Science
ED	Emergency Department
EEA	European Economic Area
ESRI	The Economic and Social Research Institute
ESRI Hippocrates Model	The Hippocrates Model was developed by the ESRI in a programme of research funded by the Department of Health. The model provides base year estimates and projections of healthcare demand, capacity and expenditure for selected Irish health and social care services.
EU	European Union
EU-TSI	European Union Technical Support Instrument
EWTD	European Working Time Directive
Flow	A Flow is material or information that enters or leaves a stock over a period.
GEM	Graduate Entry Medicine
General Register	A division on the medical register for those who are neither specialists nor in training to become specialists. Doctors with general registration may practice independently without supervision but may not represent themselves as being specialists.
GP	General Practitioner

Hospital Group	Hospitals in Ireland are organised into seven Hospital Groups. The services delivered include inpatient scheduled care, emergency care, maternity services, outpatient and diagnostic services.
HSE BIU	Health Service Executive Business Information Unit
HSE DIME	Health Service Executive Doctors Integrated Management E-system
HSE HPO HIPE	Health Service Executive Healthcare Pricing Office Hospital In-Patient Enquiry
HSE-NDTP	Health Service Executive National Doctor's Training and Planning
HST	Higher Specialist Training
Inpatient	A person who goes into hospital to receive medical care and stays there one or more nights while they are being treated.
IST	Initial Specialist Training
Junior Doctor	A medical graduate who has not yet completed specialist training.
Medical Education	The Medical Education of doctors in Ireland consists of a medical degree and the internship year.
Medical Internship Post (or Intern Year)	In the year following graduation from medical school, medical graduates in Ireland, aligned to a medical school within one of the six intern training networks, complete a training programme in hospitals and clinical settings. The year is structured so that a doctor can experience a variety of medical and surgical specialties. The HSE manages the annual intern recruitment process.
Model 1 Hospital	Model 1 Hospitals are community hospitals where patients are under the care of resident medical officers. These hospitals do not have surgery, emergency care, acute medicine (other than for a select group of low-risk patients) or critical care.
Model 2 Hospital	Model 2 Hospitals can provide the majority of hospital activity including extended day surgery, selected acute medicine, local injuries, a large range of diagnostic services (including endoscopy, laboratory medicine, point-of-care testing, and radiology (CT, US and plain film x-ray)) specialist rehabilitation medicine and palliative care.
Model 3 Hospital	Model 3 Hospitals provide 24/7 acute surgery, acute medicine and critical care.
Model 4 Hospital	Model 4 Hospitals are similar to Model 3 hospitals but provide tertiary care and, in certain locations, supra-regional care.
NCHD	Non-Consultant Hospital Doctor is a collective term referring to doctors employed as Interns, Senior House Officers (SHOs), Registrars, Senior Registrars, Specialist Registrars or otherwise, for the purpose of providing medical services and/or training.
NTPF	National Treatment Purchase Fund
NTSD	Non-Training Scheme Doctor. This term refers an NCHD who is not in a training scheme and registered with either the Supervised or General Divisions of the Medical Council’s register. Typically, NTSD posts are designated as SHO or Registrar grade.
Numerus Clausus Policy	A limit on the maximum number of students admitted in a particularly sought-after area of study.
OECD	Organisation for Economic Co-operation and Development
OT	Occupational Therapy
Postgraduate Education	Specialist training programmes undertaken by qualified medical professionals.
Primary Care	Primary Care refers to health or social care services provided in the community, outside of hospital.
Primary Care Centre	Primary Care Centres provide primary care services from a single site e.g., GP, public health nurse, home help, occupational therapy, physiotherapy etc.
Push-Pull Factors	Factors which initiate and influence the decision to migrate, either by attracting them to another country (Pull Factors) or by impelling or stimulating emigration (Push Factors).
Register of Medical Practitioners	The register of all doctors who are legally permitted to carry out medical work in Ireland.
Registrar	A non-consultant hospital doctor who has attained a certain level of experience and aptitude within a specialty and typically has completed IST/BST.
Retention Analysis	This refers to the HSE-NDTP’s analysis on retention in the public health system’s medical workforce
S&LT	Speech and Language Therapy

SAS Doctor	Doctors in the UK who are working neither consultants nor trainees are referred to as the Staff Grade, Associate Specialist and Specialty Doctors (SAS) group.
SD	System Dynamics
SDM	System Dynamics Modelling
SHO	Senior House Officer. A Senior House Officer is a non-consultant hospital doctor. SHOs are supervised in their work by Consultants and Registrars.
Specialist Register	Doctors with specialist registration may practice independently, without supervision and may represent themselves as specialists. Once a doctor completes HST they can register on the Specialist Division.
Stock	A Stock is an accumulation of material or information that has built up in a system over time.
Stock-Flow Supply Model	A model which, starting from a stock measured at year zero, estimates the evolution of the stock, assuming inflows and outflows that modify the initial stock year after year.
System	A System is a regularly interacting or interdependent group of items forming a unified whole.
Training Body	Postgraduate medical training bodies.
Training Register	Medical practitioners registered on the Trainee Specialist Division.
UG	Undergraduate medicine degree (i.e., school-leaver direct entry)
Ugrad.	Undergraduate medicine degree (i.e., school-leaver direct entry)
WHO	World Health Organization
WHO-GCP	World Health Organization Global Code of Practice on International Recruitment of Health Personnel
WTE	Whole Time Equivalent

Executive Summary

Introduction

Ireland is a signatory to the WHO Global Code of Practice on International Recruitment of Health Personnel (WHO-GCP) which entails attaining national self-sufficiency in health workforce requirements through the training of adequate numbers of local staff (WHO, 2010). This Spending Review describes the medical education and training system in Ireland and examines some of challenges facing the health system in meeting the WHO-GCP commitment to reduce Ireland's reliance on the foreign educated medical workforce and in achieving a Consultant-Delivered health service.

A Consultant-Delivered health service is one '…delivered by teams of Consultants, where the Consultants have a substantial and direct involvement in the diagnosis, delivery of care and overall management of patients' (Department of Health, 2003). The benefits of a Consultant-Delivered service include, inter alia, more rapid decision-making, improved outcomes, more efficient use of resources, better training of junior doctors (Academy of Medical Royal Colleges, 2012). Correspondingly, a preponderance of NCHDs, particularly NCHDs not in training, has negative implications for these same outcomes.

Previous research by The National Doctors Training & Planning unit in the HSE has outlined the need to increase total number of Consultant and specialists (including GPs) by 3,290 between 2018 and 2028 (Morris & Smith, 2021). This is equivalent to a 43% increase. A recent report by the ESRI utilised the Hippocrates Model to make projections about health workforce demand in the publicly funded acute hospital sector. It projects that there will be a 1.7% to 2.1% annual growth expected for the total number of doctors in this sector from 2019 to 2035. This equates to an increase of between 2,575 and 3,236 in the number of medical doctors in the acute hospital sector over the 16-year period. Including composition shifts to align more closely with the Hanly Report, 1,695 of the increase in medical doctors in the acute hospital sector would be required to be Consultants. This is equivalent to a 3.1 per cent increase in Consultant WTEs from 2019. In December 2022, there were 492 Consultant vacancies recorded on the Doctors Integrated Management E-system (DIME).[1]

[1] Accurate as at the 5th of December 2022.

In this context, the paper develops a medical workforce supply model using systems dynamics modelling to understand the implications of substituting Non-EU/UK places in Irish medical schools for students from the EU or UK and how this may better align student intake with specialist training capacity in the health system.

The supply modelling does not explicitly include demand into the projections. Further work is underway to develop evidenced-based demand estimates for the whole health system which will allow for a determination of the optimal medical student intake. The scenarios analysed in this paper would have significant funding implications for the higher education system and the health system which are not addressed in this paper.[2] During the development of this paper the government committed to an increase in medical student places of 200 over the period 2022-2026.[3] These increases are included in the scenario analysis section of this paper.

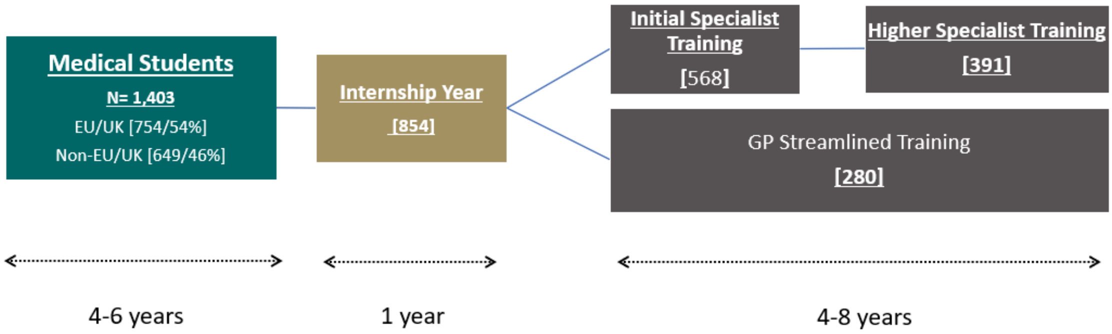
Findings

- Ireland has a very high proportion of foreign educated doctors (40.45%), the fourth highest of OECD member states.
- While international comparisons of health systems are fraught with data and comparability issues, Ireland OECD data suggests Ireland has an approximately average number of doctors per capita. Note, Ireland's population is generally younger than other developed countries which would suggest a lower requirement for doctors, all else equal. In 2020, Ireland had more doctors per capita than countries such as the UK, New Zealand and France, and less than countries such as Australia, Germany and Austria.
- Despite an approximately average number of doctors per capita, Ireland has a significantly below average number of specialist doctors. The number of specialists is the sixth lowest of OECD countries for which data is available.

[2] This paper benefits from, and would not be possible without, forthcoming analysis on retention for the public health system medical workforce which enables estimates of the number of specialist training places which may be taken up by Irish educated medical students in the future (Pierse, Morris, OToole, Kinirons, & Staddon, *Forthcoming*). This analysis is referred to as the 'Retention Analysis' throughout this document.

[3] https://www.gov.ie/en/press-release/4db4d-extra-60-medicine-places-in-irish-medical-schools-over-the-next-five-years-announced-by-ministers-harris-and-donnelly/

- The HSE consultant workforce increased from 2,918 to 3,563, (5.1% average annual growth) between 2017 and 2021. For NCHDs, the increase went from 6,466 to 7,923 (average annual growth 5.2%). For non-training scheme NCHDs the increase was 2,564 to 3,081, or a growth rate of 4.7% (NDTP, 2022).
- Medical education and training in Ireland is a long and complex process which creates challenges in reaching a Consultant-Delivered health service. See Figure below which outlines the timelines required to complete stages of medical and postgraduate training as well as the annual intake to each stage in 2021/22. There are also numerous specialties which doctors can specialise in.[4] In order for sustainable increases in supply to be achieved, each stage needs to be aligned to ensure capacity exists so that individuals are flowing from one stage to the next.



Medical and postgraduate education timelines and annual intake for 2021/2022
Source: NDTP and Authors Calculations
Note: IST and HST exclude intake figures for GP streamlined training programme. This breakdown reflects the structure of the supply model developed in this paper.
The timelines assume no employment gaps or career breaks between training programmes which, in practice, are a common feature in the careers of Irish educated doctors (who may temporarily work abroad, or intersperse specialist training with other education, research or periods of employment in non-training NCHD roles etc.,).

- In the 2021/22 academic year there were 1,403 medical student places available in the Irish Higher Education System. This is the highest medical graduate output per capita amongst OECD countries, however due to the large proportion of Non-EU students (46%) and availability specialist training capacity many of these graduates do not progress on to become consultants in Ireland.

[4] There are a wide number of specialities (15) provided for in Higher Specialist Training (National Doctors Training & Planning, 2022). Each of these lead to a distinct specialisation. Some of these specialities have sub-specialities, for example, General Medicine (17 sub-specialities) and Surgery (11 sub-specialities).

- In response to the above challenges, there were significant annual increases over the period 2017-2021 in internship posts (3.9%/year), Initial Specialist Training places (4.4%/year) and Higher Specialist Training places (6.9%/year) which move the health system closer to a Consultant-Provided health service (NDTP, 2022).
- Given the undersupply on domestically educated doctors in Ireland, this paper developed a system dynamics model of medical workforce supply to examine how changes in the EU/UK student intake might better align with the specialist training capacity in the health system. This included a baseline scenario and two reform scenarios. The table below summarises the main input parameters and projection outputs at varying time points for each stage of the medical education and training route to Non-GP specialist. The main reforms are:
  - Scenario A shows an increase in EU/UK students from 754 to 1,000 between 2022 and 2028
  - Scenario B shows an increase in EU/UK students from 754 to 1,263 between 2022 and 2028. This is 90% of current medical degree capacity.

	Student Cohort by domicile				Internship Places		Initial Specialist Training (excluding GP training programme) *		Higher Specialist Training excluding GP training programme) *	
	EU/UK		Non-EU/UK		Irish BMQ		Irish BMQ		Irish BMQ	
Scenario	**2021**	**2031**	**2021**	**2031**	**2021**	**2035**	**2021**	**2038**	**2021**	**2044**
Baseline (Steady State)	754	754	649	649	854	854	1,031	1,031	1,031	1,031
Scenario A	754	1,000**	649	403**	854	1000	1031	1094	1803	1912
Scenario B	754	1,263	649	140	854	1,190	1,031	1,406	1,803	2,457

Summary of supply model parameters and projection outputs at varying time points for each stage of the medical education and training route to (Non-GP) specialist

* IST & HST exclude GP Training places. It is expected that the intake to GP training in 2026 will be 350 places.[1] There are currently 236 GP training places in 2021/22 (NDTP, 2022). As noted in Appendix C, the number of places is reduced by the proportion of places which are currently being utilised by Irish educated doctors of 78%. This reduction is included to ensure the model is projecting only for Irish educated doctors. This scenario increases GP training places from 184 to 273 between 2021 and 2026.[2]
** Numbers of EU/ UK and Non-EU/UK students reach these values by 2028 and remain at this level throughout the remainder of the projection period.
Note: These results are highly sensitive to modelling assumptions on attrition which may vary into the future.

- This supply model analysis highlights that:
  - A long timeframe is required to increase medical education and training places. These places need to be carefully aligned to ensure the optimal pathway from student to consultant. Increased medical degree places necessary to redress the undersupply of Irish educated doctors require increased downstream capacity in specialist training programmes.

- For example, increasing undergraduate places in medicine by 100 requires an increase in internship places of 92 five years later and an increase in specialist training places (IST or GP training) of 75 approximately eight years later.
- For example, in a scenario where internship places are gradually increased to 1,000 by 2034, EU/UK medical student places should be increased to 1,000 by at least 2028 and it may be optimal to increase EU/UK medical student places beyond 1,000 due to the attrition of medical students between the degree and internship year.
- Increasing the intake of EU/UK students to 90% (1,263) of the 2021 intake levels by 2031 would require significant increases in specialist training capacity into the future. These increases occur over long-time horizons. In the case of HST, peak capacity is only required by 2044.
- These results are sensitive to modelling assumptions on student dropout rates, attrition and emigration which may vary into the future.

Conclusion

- This paper highlighted an historic undersupply of doctors in which has contributed to a situation where there is an overreliance on foreign-educated doctors and relatively few Consultants when compared against our international peers. This is not in alignment with the WHO-GCP or the aim to provide a Consultant-Delivered health service. While Ireland produces the highest numbers of medical graduates per capita, these do not translate into doctors working in Ireland as many are Non-EU/UK students who leave after their medical degrees and before the internship year. Taken together these indicate a need to significantly increase the number of EU/UK medical students completing education in Ireland and going on to become consultants practicing here. In this context, this paper developed a medical workforce supply model to examine the effects of increasing medical student places for EU and UK students on specialist training requirements into the future i.e., to align student intake with the aim of achieving national self-sufficiency and a Consultant-Delivered health service.
- The analysis highlights that there is significant complexity involved in aligning student intake to match specialist training capacity. Very long and varied time-horizons occur between when a medical student begins university and when they complete specialist training, demanding a careful balance between student intake, specialist training capacity and the Consultant workforce. Even with large-scale increases in medical degree student intake in the short term, reducing Ireland's reliance on the foreign educated medical workforce will be a long-term endeavour.

- Because of the high proportion of Non-EU students educated here there is significant capacity to increase EU/UK student places within the educational system already. There are greater supply constraints within the postgraduate training system, though growth in capacity in recent years has been high.
- This paper looked at a range of scenarios which increased EU/UK medical student and specialist training intake, however does not define the optimal student intake. Nor does it estimate the potential for increasing postgraduate training capacity, for which the main constraint is the availability of Consultants. Further work is underway to identify the optimal medical student intake in Ireland, in particular estimating the total demand for doctors across the whole health system and the supply-side capacity required to meet this demand.

1 Introduction

Ireland is a signatory to the WHO Global Code of Practice on International Recruitment of Health Personnel (WHO-GCP) which entails attaining national self-sufficiency in health workforce requirements through the training of adequate numbers of local staff (WHO, 2010).[5]

While international comparisons are subject to significant data limitations and comparability challenges, the number of doctors per capita in Ireland is similar to the average across the OECD. However, the proportion of foreign-trained doctors in Ireland stood at 40.45% in 2021 – the fourth highest of all member states.[6] Surprisingly, this is not because Ireland is not educating a sufficient number of medical students in the higher education system.[7] According to the most recently available data, Ireland educated more medical students per capita than any other OECD country. A substantial proportion of these are foreign students that do not complete the internship year in Ireland which is a core part of the basic medical qualification of a doctor. Furthermore, some students of Irish origin also emigrate after their internship year or upon the completion of specialist training (Heffron & Socha-Dietrich, 2019).

One important driver of this emigration is the perceived availability and quality of training and work experience provided in other, larger health systems. A second important driver is the quality of working conditions.[8] For some, particularly non-EU doctors, the availability of speciality training post-internship drives emigration (Brugha, Clarke, Hendrick, & Sweeney, 2021) (Medical Council , 2021). While number of doctors per capita is similar to the average across the OECD, the State has a relatively low number of specialists per capita. This is not consistent with Government policy which aims to align medical student intake with specialist training places to achieve a Consultant-Delivered Health Service (Strategic Review of Medical Training and Career Structure, 2014) (Department of Health, 2003).

---

[5] The WHO-GCP centres on the topic of ethical international recruitment. Participating countries have committed to meeting their health personnel requirements with their domestic human resources through increased local production of health workers (such as doctors) and thus ending active recruitment of health personnel from developing countries, particularly those facing critical shortages (WHO, 2010)

[6] The proportion of foreign-trained doctors rose from 13% of all registered doctors in 2000 to 42% in 2016 (Heffron & Socha-Dietrich, 2019) before falling to 41% in 2019 (OECD, 2021).

[7] https://data.oecd.org/healthres/medical-graduates.htm#indicator-chart

[8] See RCSI Hospital Doctor Retention and Motivation Project website (Link: https://www.rcpi.ie/hdrm/)

There is a twin need to increase the number of specialist training places for doctors in Ireland and reduce the reliance on foreign educated doctors, particularly those not on training schemes.

Firstly, this Spending Review paper:

- describes the medical education and training system in Ireland; and,
- examines some of the challenges facing the health system in achieving a Consultant-Delivered Health Service and meeting the WHO-GCP commitment to reduce Ireland's reliance on the foreign educated medical workforce.

Having established the various complexities and challenges facing the education and health systems it goes on to develop a medical workforce supply model based on system dynamics modelling to:

- examine the implications of substituting Non-EU/UK places in Irish medical schools for students from the EU or UK, and;
- discuss how this may better align student intake with specialist training capacity in the health system.

During the development of this paper the government committed to an increase in medical student places of 200 over the period 2022-2026.[9] These increases are included in the scenario analysis section of this paper.

This paper does not include an assessment of demand for medical doctors. Due to differences in revenues received by EU/UK and Non-EU/UK medical schools the scenarios analysed in this paper would have significant funding implications for Irish Medical Schools which are not addressed in this paper.

This paper benefits from, and would not be possible without, forthcoming analysis on retention for the public health system medical workforce which enables estimates of the number of specialist training places which may be taken up by Irish educated medical students in the future (Pierse, Morris, OToole, Kinirons, & Staddon, *Forthcoming*). This analysis is referred to as the 'Retention Analysis' throughout this document.

---

9 https://www.gov.ie/en/press-release/4db4d-extra-60-medicine-places-in-irish-medical-schools-over-the-next-five-years-announced-by-ministers-harris-and-donnelly/

2 Medical Doctor Workforce Policy Overview

Hanly Report, (Department of Health, 2003)**:** The 2003 report of the National Task Force on Medical Staffing, known as the "Hanly Report", outlined several priorities including:

- the delivery of safe, high-quality services to all patients at all times,
- reducing the working hours of doctors in line with the European Working Time Directive (EWTD),
- substantially increasing the number of Consultants as part of a move to a team-based Consultant-Provided Service,
- ensuring a critical volume of patients so that hospital services can be safely provided, and
- the reorganisation of Acute Hospitals and staffing practices e.g., rostered Non-Consultant Hospital Doctor (NCHD) staff working appropriate shift patterns, to allow for the safe provision of emergency and elective care.

The report recommended a doubling of Consultant numbers and a reduction in NCHD numbers, leading to a Consultant to NCHD ratio of approximately 1.64:1 and highlighted the benefits of consolidating Consultants in a smaller number of hospitals which would then be able to open for acute admissions on a 24/7 basis. The report noted that all rosters must provide for a safe level of medical cover, allow for sufficient handover time, ensure that training time can be safeguarded, and meet service needs and EWTD requirements while allowing NCHDs, consultants and other staff a satisfactory quality of life. It explored how better rostering in hospitals could meet the needs of the EWTD.

Fottrell Report (2006): The 2006 report "Medical Education in Ireland – A New Direction", known as the "Fottrell Report", set out a strategy to enhance and modernise medical education and training to ensure that that Ireland had enough highly trained doctors to service the needs of the growing population. It recommended that the intake of Irish/EU students should be increased from 305 places per year to approximately 700 to 740 students per year, partly through the introduction of Graduate Entry Medicine (GEM) programmes.[10] The range was based on an assessment of the intake required to move towards national medical workforce self-sufficiency. It commented that it was unusual among developed countries for non-national

[10] As shown in **Table 1**, in most years 2010, the intake of Irish, EU and UK students has been fewer than 700 individuals.

students to comprise more than 10% of the total medical student body and proposed reducing non-EU students to 25% or less of the annual intake. The report also noted that non-EU graduates of Irish medical schools in most cases do not remain within the Irish health service following internship and full registration.[11] The development of more postgraduate specialist training opportunities and the phasing out of non-training NCHD posts report was envisaged as a solution to improve the retention of graduates. On the composition of medical student intake across undergraduate school-leaver direct entry (UG) and graduate entry medicine (GEM) degrees it indicated a 60:40 split weighted towards the UG intake.

Buttimer Report (2006): The 2006 report of the Postgraduate Medical Education and Training Group entitled "Preparing Ireland's Doctors to Meet the Health Needs of the 21st Century", known as the "Buttimer Report", focused on postgraduate medical education and training issues arising from a range of developments, including the implementation of EWTD, the anticipated growth of Primary Care services and the alignment of NCHD posts with speciality training programmes. It noted that delivering high-quality care is dependent on the availability of a sufficient number of doctors trained in the competencies and specialities required by the Irish health system. It discussed the fragmented nature of the management of specialist training in Ireland. It also noted the importance of graduate retention as a means of protecting the State's investment in the education and training doctors (and outlined various 'push' and 'pull' factors influencing the emigration of Irish doctors).

MacCraith Report (2014): The 2014 Strategic Review of Medical Training and Career Structure Report (and its progress reports), known as the "MacCraith Report", carried out a strategic review of medical training and the medical career structure with a view to:

- Improve graduate retention in the public health system,
- Understand recruitment and retention issues in certain specialties such as General Practice, psychiatry and public health,
- Align specialist training intakes to future service requirements, and
- Offer greater advice and clarity to Junior Doctors on career structures and opportunities for specialist training.

[11] A decision was made in 2015 to prioritise Irish and other EU graduates from Irish medical schools in the first round of the intern-matching process to protect the public investment in education of those students, thereby reducing greatly the opportunities for non-EU graduates to get a place (Heffron & Socha-Dietrich, 2019). However, the number of intern places made available to non-EU graduates of Irish medical schools has significantly increased since 2019.

The report noted that the gradual increase in Consultant numbers had been insufficient to generate the critical mass required to move to a fully Consultant-Provided Service as foreseen in the Hanly Report. However, it also noted progress in the proportion of NCHD posts designated as training posts.

Sláintecare Report (2017): The key initiative driving strategic change in the Irish health system (including health workforce planning) is the Sláintecare reform programme, which has been set out in a series of reports.[12] This 10-year strategy envisages a healthier Ireland, with improved health and wellbeing for all, and with the right care delivered in the right place at the right time. The Sláintecare reforms include a move towards consultants only carrying out public work in public hospitals. In addition, that recruitment of hospital Consultants and NCHDs should be at the level of Hospital Groups rather than to individual hospitals, as part of meeting the medical staffing needs of smaller hospitals. The Sláintecare Report also acknowledges the central role that the medical profession will play in meeting population health need and reducing waiting lists and the importance of creating conditions which attract high-calibre applicants to all health service positions, including Consultant posts.

[12] Sláintecare Report (Houses of the Oireachtas, 2017), the Action Plan (DoH, 2019) and the Implementation Strategy (Government of Ireland, 2021).

3 Overview of the medical workforce in Ireland

3.1 Demand for Medical Doctors

OECD member states now employ more doctors than ever before, with the number of doctors employed in these countries growing from 2.8 million in 2000 to 4.1 million in 2019. In addition, the number of doctors increased more rapidly than population size i.e., the number of doctors per 1,000 population rose from 2.7 in 2000 to 3.6 in 2019.[13]

The World Health Organisation (WHO) estimated a global needs-based shortage of 2.6m physicians in 2013 which is expected to reduce to a shortage of 2.3m in 2030 (WHO, 2016).

The 'Health Service Capacity Review 2018: Review of Health Demand and Capacity Requirements in Ireland to 2031 – Main Report' ("CR") was undertaken to inform health system reform, service planning and capital investment. The CR developed projections based on scenarios which reflected the expected major drivers and policies impacting health system capacity in 2018. These major policies and drivers were (i) improved health and wellbeing, (ii) improved models of care centred around comprehensive community-based services and (iii) hospital productivity improvements. Notably, the CR highlights the growing role that General Practices (GPs) will play in the delivery of health care in Ireland in the years up to 2031 (DoH, 2018). Specifically, there will be an estimated 39% increase in demand for GP appointments. Demand for hospital care is also projected to increase with a 16% increase in Emergency Department attendances, a 37% increase in Acute Medical Assessment Unit attendances and a 24% increase in Inpatient non-elective admissions (DoH, 2022).

The National Doctors Training & Planning (HSE-NDTP) report entitled "Demand for Medical Consultants and Specialists to 2028 and the Training Pipeline to Meet Demand: A High Level Stakeholder Informed Analysis" is a comprehensive multi-specialty analysis of the supply and demand of medical consultants, GPs and trainees in Ireland using an evidence-based approach (including stakeholder engagement and the use of data to benchmark the level of medical specialists in Ireland against other jurisdictions). The report makes recommendations on the level of expansion required across the individual medical specialties. It outlined the need to increase the total number of Consultant and specialists (including GPs) by 3,290

[13] See the OECD website (https://data.oecd.org/healthres/doctors.htm#indicator-chart)

between 2018 and 2028 (Morris & Smith, 2021). This is equivalent to a 43% increase. Drivers of demand for medical specialists are outlined such as population growth, epidemiology, service reconfiguration, policy and legislation, technological advances, new models of care, new ways of working, service utilisation level and levels of current unmet demand for services (Morris & Smith, 2021).

A recent report by the ESRI utilised the Hippocrates Model to make projections about health workforce demand in the publicly funded acute hospital sector. The ESRI's analysis considers the impact of healthy ageing and the expansion of care into the community alongside adjustments to workforce activity ratios which capture the potential impact of changes to workforce grade-mix and skill-mix. It projects that there will be a 1.7% to 2.1% annual growth expected for the doctors in the sector from 2019 to 2035. This equates to an additional 2,575 medical doctors, with 1,695 of these being Consultants.

3.2 Medical Doctor Supply in Ireland

Improving the quality of the population's health and delivering high quality, safe patient care is dependent on the availability of sufficient numbers of doctors trained in the competencies and specialties required by the Irish health system (DoH, 2006b). The growth rate in the HSE consultant workforce increased from 2,918 to 3,563, (5.1% average annual growth) between 2017 and 2021. For NCHDs, the increase went from 6,466 to 7,923 (average annual growth 5.2%). For non-training scheme NCHDs the increase was 2,564 to 3,081, or a growth rate of 4.7% (NDTP, 2022). For NCHDs overall the equivalent growth rate was 5.2%. For non-training scheme NCHDs it was 4.7%. As can be seen in Figures 1 to 5, despite having one of the highest rates of medical graduate production per capita and Ireland has one of the lowest levels of medical specialists in the OECD (OECD, 2019).[14] The proportion of foreign-trained doctors in Ireland stood at 40.45% in 2021 – the fourth highest among the OECD countries (OECD, 2021).

Caution should be taken when comparing health systems internationally. Health systems across all countries are financed and organised in ways which make like-for-life comparisons impossible. Additionally, data supplied to OECD does not always align well with OECD requirements which mean some countries capture or exclude cohorts of relevant doctors. For this reason, the area (upper/middle/lower) of the distribution of is more reliable to consider

[14]https://www.hse.ie/eng/staff/leadership-education-development/met/plan/comparison-of-ireland-with-uk-nchds-and-consultants-updated-15-01-21.pdf

than the specific ranking for each country. Figure 1 below shows the proportion of the medical workforce that is foreign educated across OECD member states:

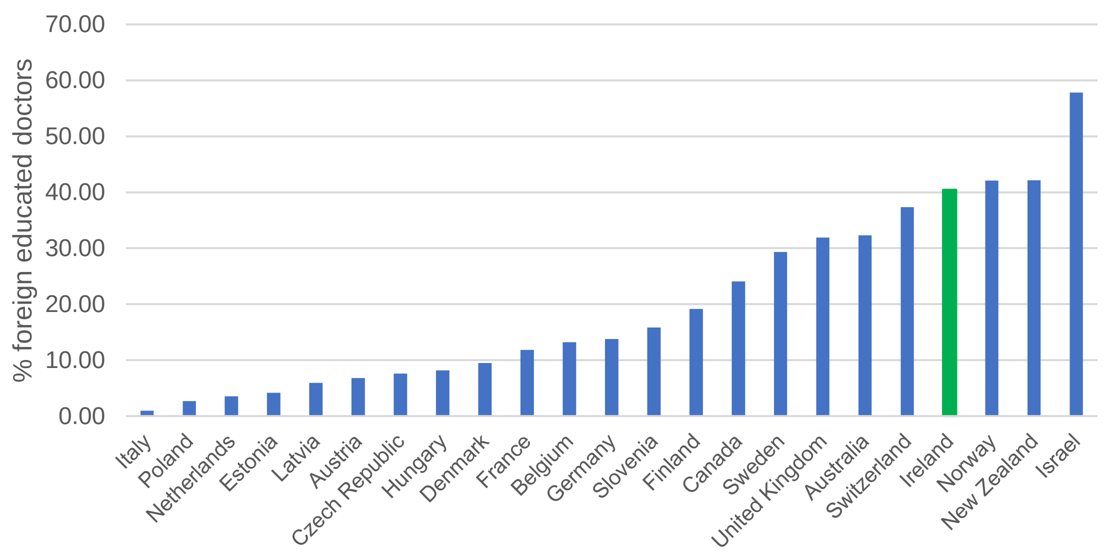


Figure 1: Percentage of foreign-trained doctors
Source: OECD (data accessed on 28/07/2022)
Note: In Israel, Norway and Sweden, a significant proportion of foreign educated doctors are citizens who completed their basic medical qualification abroad. The data for Australia, Canada, Finland, France, Germany, Hungary, Latvia, Netherlands and Switzerland relates to 2020. The data for Denmark and Sweden relates to 2019.

Figure 2 below shows trends in selected countries in relation to the proportion of the medical workforce that is foreign educated from 2010 to 2021.

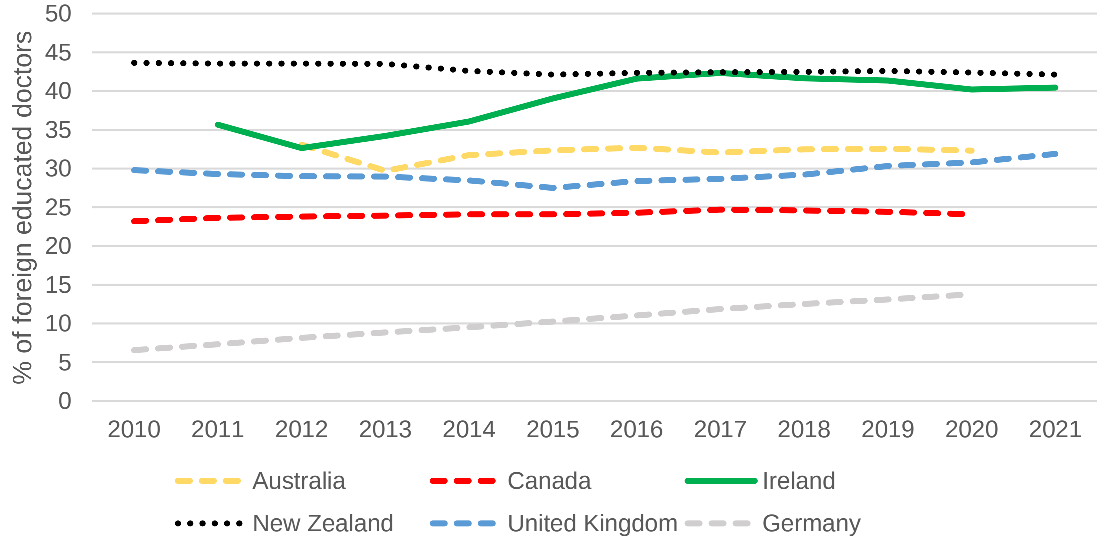


Figure 2: Trends in percentage of foreign-trained doctors in select countries (2010 to 2021)
Source: OECD (data accessed on 02/08/2022)

As can be seen in Figure 3 below, in 2021 the number of doctors per 1,000 population in Ireland was 4 per 1,000. Amongst the 10 OECD countries for which data was available the arithmetic mean was also 4 per 1,000. Ireland ranked sixth highest compared to these countries.

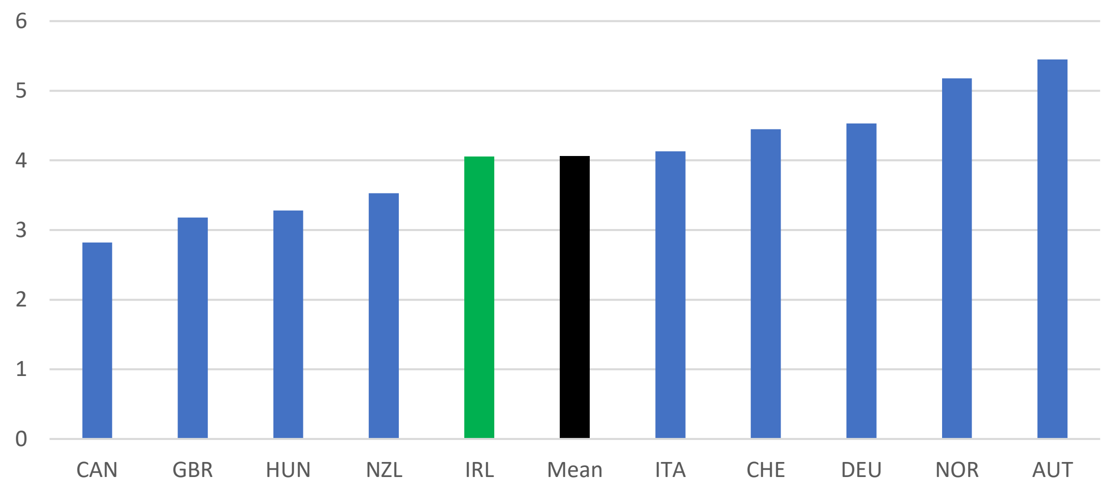


Figure 3: Doctors per 1,000 inhabitants 2021
Source: OECD Health Statistics, Data extracted on 03 Aug 2022
^'Mean' refers to the arithmetic mean of other countries' doctors per capita, rather the weighted average across OECD countries

In most OECD countries, the number of doctors per capita has been increasing in recent decades. Figure 4 shows the doctors per capita across a wider set of 23 OECD countries for the year 2020. This is a better representation of Ireland's relative position given the wider set of data. Ireland had 3.46 doctors per 1,000 population compared to the arithmetic mean of 3.64. In 2020, Ireland ranked 12th highest out of the 23 OECD countries. See Appendix A for similar graphs for the years 2018 and 2019.

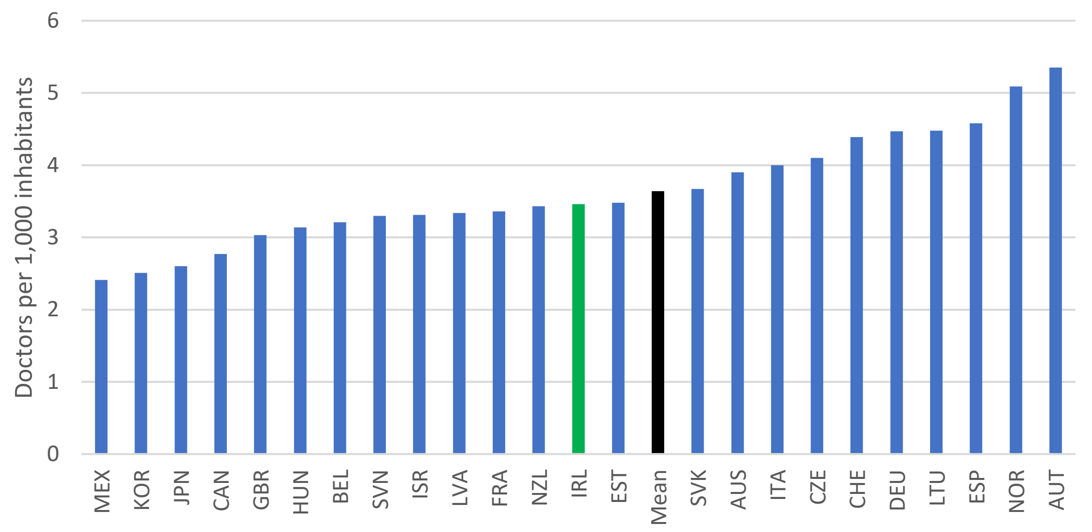


Figure 4: Doctors per 1,000 inhabitants 2020
Source: OECD Health Statistics, Data extracted on 03 Aug 2022
^'Mean' refers to the arithmetic mean of other countries' doctors per capita, rather the weighted average across OECD countries

However, as can be seen in Figure 5 below, Ireland has a relatively low level of medical specialists per capita. This is not in alignment with the aim of having a Consultant-Delivered Service. When making international comparisons between healthcare systems one should note that different models of care exist across the various countries and there may be differences in the collection and reporting of data.

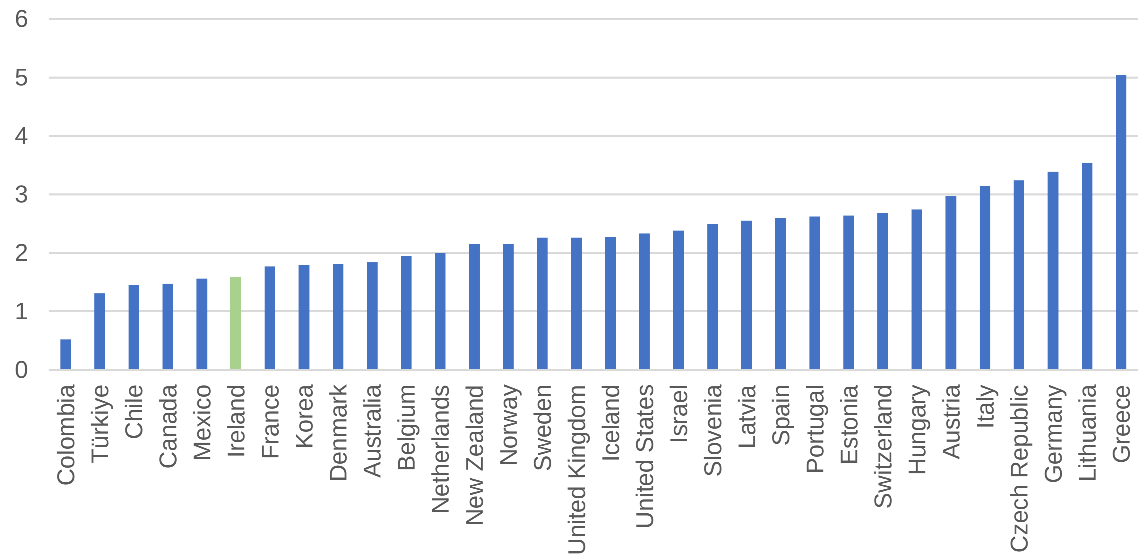


Figure 5: Physician Specialists per 1,000 capita, 2020 or latest year available
Source: OECD Health Statistics, Data extracted on 27 June 2022
**For Australia, Belgium, Czech Republic, Estonia, France, Germany, Greece, Hungary, Iceland, Israel, Korea, Latvia, Lithuania, Mexico, Netherlands, Portugal, Slovenia, Spain, Turkey, United States the data relates to 2019*

***For Sweden and Denmark the data relates to 2018*
Note: Specialist Medical Practitioners include – Paediatricians; Obstetricians and gynaecologists; Psychiatrists; Medical specialists; Surgical specialists; Medical interns or residents training for a specialty. They do not include - General practitioners; Dental practitioners; Dental surgeons; Oral and maxillofacial surgeons.

Figure 6 below shows that the total number of NCHDs and non-trainees/SAS doctors per 100,000 of the population in 2019/2020 is significantly higher in Ireland compared to the UK and Australia while the number of Consultants per 100,000 of the population is significantly lower.

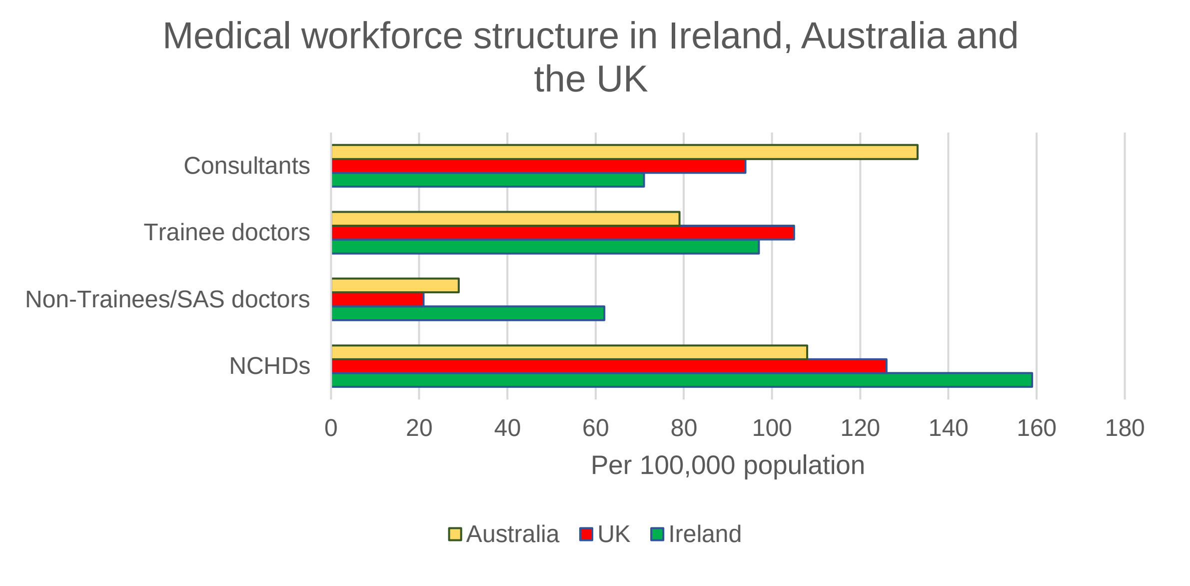


Figure 6: Medical workforce structure in Ireland, Australia and the UK
Source: (NDTP, 2022)

3.2.1 Increasing internationalisation of the Irish medical workforce

The movement of health workers from lower-income to higher-income countries has long been recognized as a challenge. The worldwide shortage of doctors has led to the recruitment of doctors and other healthcare professionals from developing countries by employers in wealthier countries. As mentioned in the introduction, Ireland has made a non-binding commitment to implement the WHO-GCP which entails attaining national self-sufficiency in health workforce requirements through the training of adequate numbers of local staff (WHO, 2010). Adhering to the WHO-GCP is a significant challenge for the Irish health system. While Ireland provides medical education to a large number of students, many (particularly Non-EU/UK domiciled students) leave the country upon graduation. As can be seen in Figure 7 and Figure 8 below, the Irish health system heavily relies on internationally recruited doctors to fill its domestic needs, particularly from countries such as Pakistan and Sudan. Many foreign-educated junior doctors in Ireland are employed in non-training NCHD posts in Model 2 and Model 3 hospitals (NDTP, 2022). Foreign-educated doctors report taking up service posts in Irish hospitals in the hope of career progression or accessing postgraduate training, but when this hope remains unrealised, and because of a fear of deskilling, the many actively seek to migrate onwards or return to their home country within a few years of arriving in Ireland (Heffron & Socha-Dietrich, 2019). It should be noted that changes to Ireland's immigration rules were announced in March 2022.[15] It is anticipated that these changes will make it easier for foreign doctors to access specialist training schemes and then apply for Consultant posts, which should help to address the issues outlined.

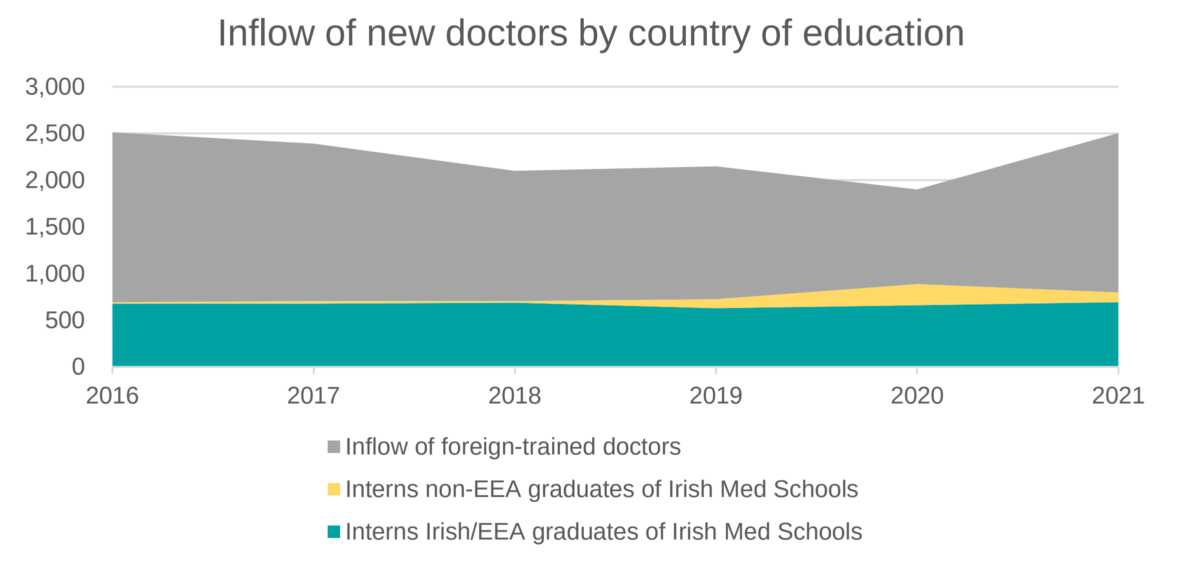


Figure 7: Inflow of new doctors registering in Ireland by country of education
Source: Medical Council

A breakdown of overseas doctors in Ireland by country of training can be seen in **Figure 9** below.

[15] DETE press release 08/03/2022

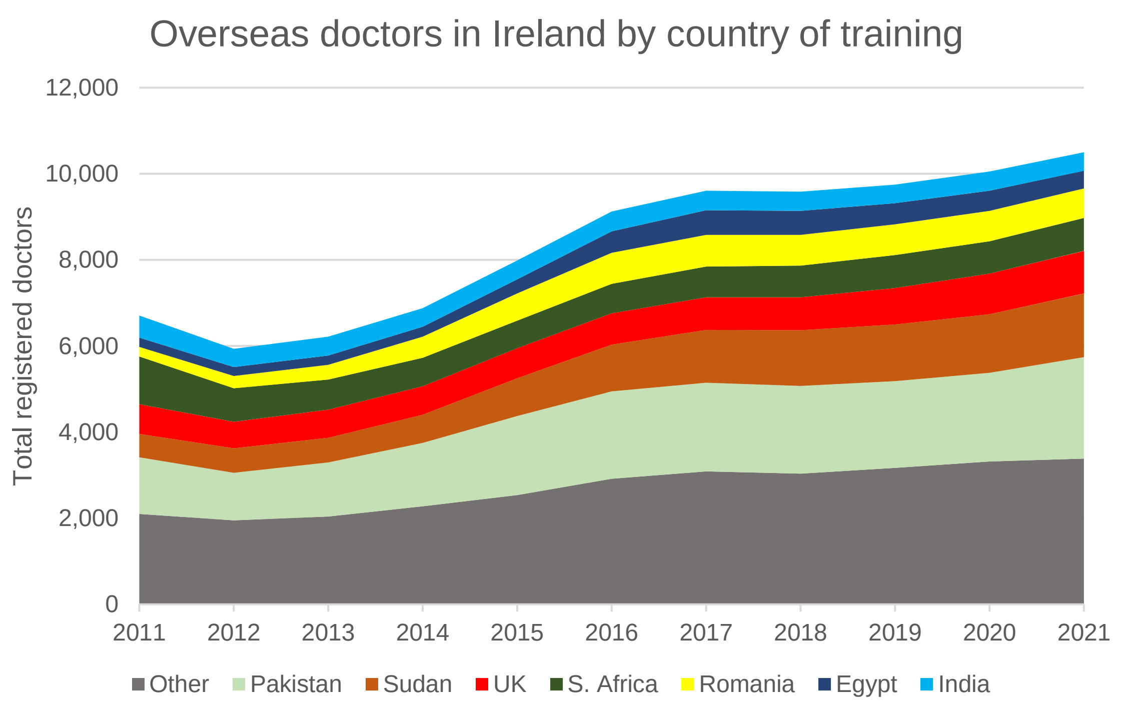


Figure 8: Foreign trained doctors registered in Ireland by country of origin
Source: OECD

3.2.2 Medical graduates

The annual production of new medical graduates has increased among OECD member states, growing from 93,000 in 2000 to 149,000 in 2019. As shown, in Figure 9 below, Ireland produces more medical graduates per capita than any other OECD member state.

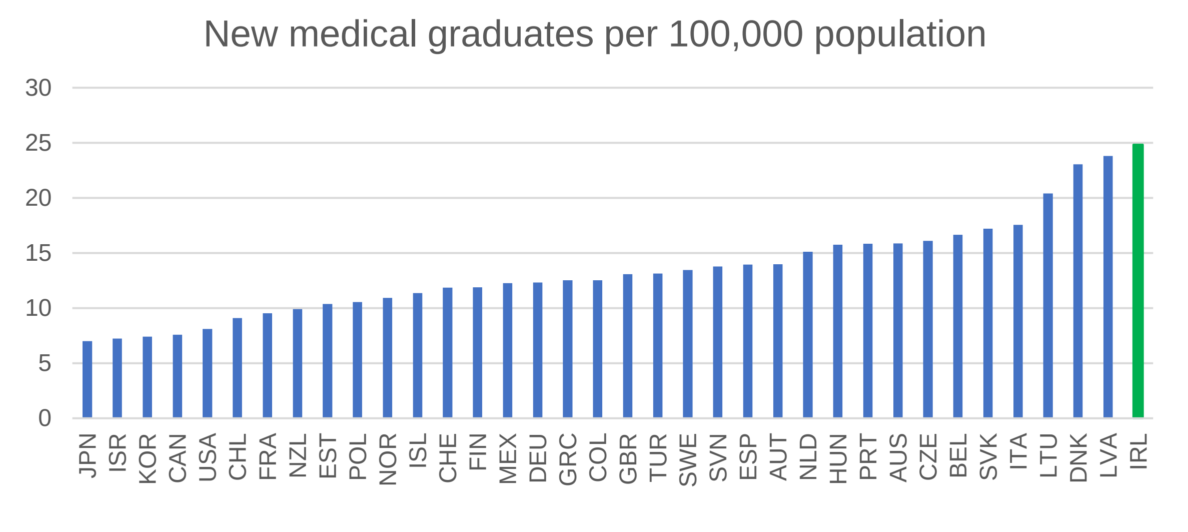


Figure 9: New medical graduates per 100,000 population
Source: OECD. Data extracted on 02 August 2022

The structure of the medical school student body in Ireland is unusual among developed countries as foreign medical students comprise approximately half of all medical students. Many students and graduates of Irish medical schools come from Canada,[16] Malaysia and the Gulf States (OECD, 2019). Upon graduation, many of these students leave to practice medicine in their country of origin or elsewhere.

As shown in Figure 10, there has been a significant increase in the production of medical graduates in the years since 2010.[17] In recent years, France and the UK have also increased medical student intake.[18][19] Last year, France adopted a new five-year plan for student admissions in medicine. This would involve a further increase of 20% over the five-year period 2021-2025 compared with the previous five-year period (2016-2020) (Ministère des Solidarités et de la Santé, 2021). Note, Figure 10 shows graduates rather than intake, so the increased student intake in France and the UK would not be expected to have appeared in 2021 data.

[16] Domestic Canadian medical students fees in Canada are generally publicly subsidised. Policies vary across provinces.

[17] Note that in 2003, the annual intake of students was 782, of whom 305 (39%) were EU and 477 (61%) were non-EU in origin. In 2002 the annual student intake into Irish medical schools was 831, of whom 315 (38%) were EU students and 516 (62%) were non-EU (DoH, 2006a).

[18] https://drees.solidarites-sante.gouv.fr/publications/les-dossiers-de-la-drees/quelle-demographie-recente-et-venir-pour-les-professions

[19] Universities and Colleges Admissions Service (UCAS), https://www.ucas.com/data-and-analysis/undergraduate-statistics-and-reports/ucas-undergraduate-sector-level-end-cycle-data-resources-2021

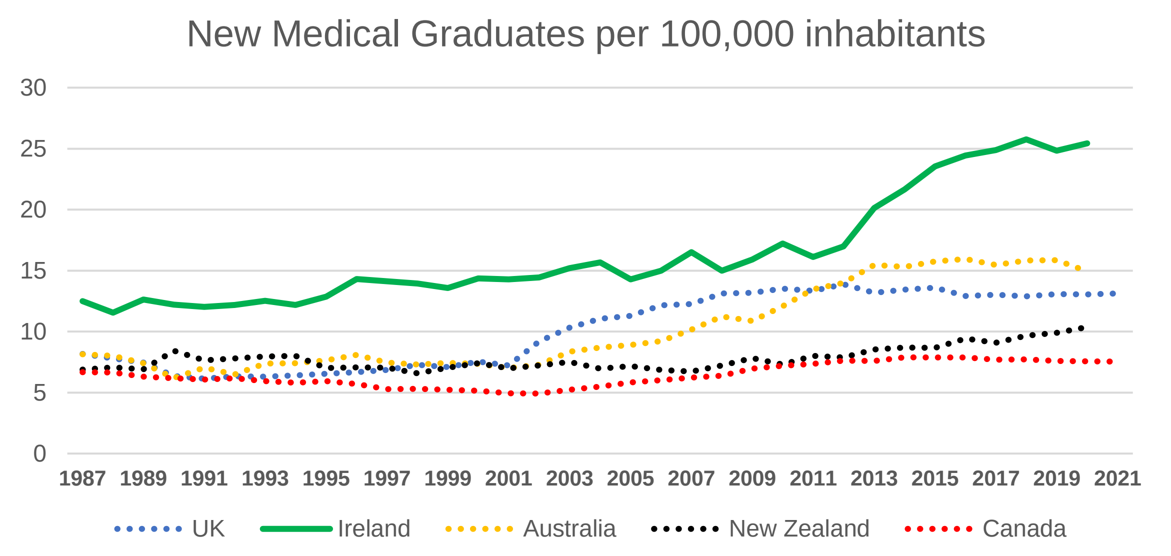


Figure 10: New medical graduates per 100,000 in select countries
Source: OECD. Data extracted on 02 August 2022

4 Medical education in Ireland

This section will provide a brief overview of medical education in Ireland. It highlights the long and complex pathways that medical education and training can take within the health system.

As can be seen in Figure 11 below, the Medical Education of doctors in Ireland consists of a medical degree and the Internship Year, which are collectively referred to as a Basic Medical Qualification (BMQ). Doctors are referred to as having an Irish BMQ if they completed both their medical degree and internship year in Ireland. Postgraduate Education occurs after the internship year and generally includes Basic Specialist Training (BST) followed Higher Specialist Training (HST), though for some specialities such as GPs there is a streamlined programme which obviates the need for a BST and HST. The time lag between entry into an undergraduate school-leaver direct entry medical degree and qualification as a specialist is in the region of 15 to 20 years (DoH, 2006b).

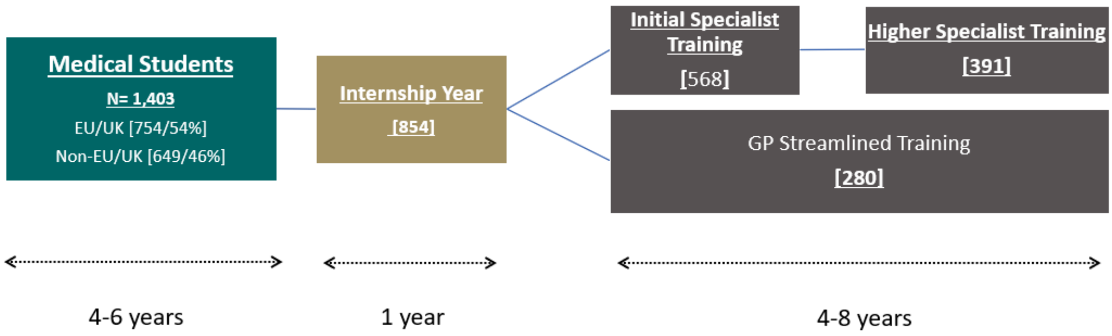


Figure 11: Medical and Postgraduate Education – annual intake to 1st year and timelines
Source: NDTP and Authors Calculations
Note: IST and HST figures include intake for streamlined programmes excluding GP training. This delineation reflects how the supply model structure in this paper.

4.1.1 Medical degrees

The Irish model of Medical Education takes place via two routes: (i) school-leaver direct-entry undergraduate (UG) programmes and (ii) graduate entry medicine (GEM) programmes.[20] In total, six higher education institutions (HEIs) offer programmes in medicine.

[20] Note that UG programmes typically last five years for domestic students and may last six years for international students (who may complete a premedical year). GEM programmes are four years in duration.

Evidence suggests that demand for medical education is robust with an oversubscription of places. There were 472 first-year Irish students in undergraduate (i.e., school-leaver direct entry) medicine courses in 2021. These courses received 4,031 first-preference applications.[21,22]

Irish medical schools attract a large number of international students because of the high standard of medical education (Heffron & Socha-Dietrich, 2019). The numerus clausus policy sets the intake of Irish/EU/UK students into medical school to around 700-740 per year,[23] which at the time of the 2006 Fottrell Report was specified as the appropriate level to get to self-sufficiency.[24] Note the government recently committed to an increase in medical student places of 200 beyond this range between 2022-2026.[25]

In recent decades, medical schools in Ireland have become increasingly dependent on the additional income received from the high tuition fees that non-EEA/non-UK students pay.[26] As can be seen in **Table 1**, almost half of the first-year student intake in Ireland is made up of students from outside of Ireland.

Academic Year 2021/2022 UG and GEM first-year intake by Domiciliary Grouping (and % of total intake)		
Year	**Ireland, EU and UK**	**Non-EU**
2010	680 (63%)	391 (37%)
2011	711 (63%)	418 (37%)
2012	669 (56%)	518 (44%)
2013	682 (57%)	524 (43%)
2014	754 (62%)	456 (38%)
2015	690 (61%)	446 (39%)
2016	648 (55%)	535 (45%)
2017	658 (52%)	603 (48%)
2018	690 (53%)	616 (47%)
2019	681 (52%)	635 (48%)
2020	715 (50%)	709 (50%)
2021	754 (54%)	649 (46%)

Table 1: Medicine Enrolments HEA data (course year one, breakdown by domiciliary grouping.

[21] See the CAO website (https://www.cao.ie/index.php?page=mediastats).
[22] The figure for 2019 was 3,223. The figure for 2022 was 4,058.
[23] Note that the number of first-year places available for EU students in Irish medical schools will increase by 200 on a phased basis from 2022 to 2026.
[24] Note that although there is no limit on the number non-EU/EFTA medical students it is within the remit of the Medical Council to inspect medical schools and to ensure that they possess the capacity for the overall number of students within the school (Heffron & Socha-Dietrich, 2019).
[25] https://www.gov.ie/en/press-release/4db4d-extra-60-medicine-places-in-irish-medical-schools-over-the-next-five-years-announced-by-ministers-harris-and-donnelly/

It should be noted that up to 50% of the overall medical curriculum may be delivered on health service locations such as hospitals and Primary Care Centres (DoH, 2006a). Clinical training is largely delivered by clinicians employed by the Health Service Executive (HSE). Costing these placements was beyond the scope of this paper. However, in 2017 the cost of clinical placements for an international student in the UK over the course of a medical degree was £110,000 per student (Dept. Health UK, 2017).

There is often an absence of service level agreements between medical schools and clinical sites in relation to the delivery of clinical placements for medical students. It is unclear whether the health service is fully compensated for providing these training services to students.[27] For this reason, the Fottrell Report suggested that the costs for the clinical training of non-EU students should be accounted for within the fees charged to these foreign domicile students.

4.1.2 Intern Year

Internship places are allocated according to a preference system whereby all eligible CAO entrants to Irish medical schools who are work permit exempt and received a taxpayer funded medical degree are given the first opportunity to apply for an intern post. Students from the EEA enter Irish medical schools through the CAO system.

Intern posts are then allocated to applicants from certain, predominantly EEA, countries i.e. graduates or final year students from medicals schools in Ireland, Norway, Denmark, Iceland, Italy, Lithuania, Luxembourg, Malta, Poland, Portugal, Slovenia, Sweden or the RCSI-UCD Malaysia Campus.[28]

Finally, any remaining posts are allocated to eligible non-EEA applicants. See a breakdown of Intern Year entrants in **Table 2** below:

---

[27] Anecdotally, some indirect funding of hospitals may be provided by HEIs through, for example, the funding of research buildings.

[28] See the HSE website (Link: Eligibility & Requirements - HSE.ie)

Year	2017	2018	2019	2020	2021
CAO Entry	679 (92.6%)	676 (92.1%)	606 (82.6%)	664 (66.7%)	698 (81.7%)
Non-CAO EEA and work permit exempt	26 (3.5%)	41 (5.6%)	27 (3.7%)	36 (3.6%)	27 (3.2%)
Non-EEA requiring work permit [29]	28 (3.8%)	17 (2.3%)	98 (13.4%)	295 (29.6%)	126 (14.8%)
Number of Intern Posts		734	734	995	854

Table 2: Numbers of posts and entry category of Interns for each of the years 2017- 2021.[30]
Source: NDTP
Note: Increase in Intern Posts in 2020 was covid related.

In 2022, there were 854 Intern posts available. At the conclusion of the matching process in June 2022, 32 posts remained unassigned requiring further efforts to fill internship posts.[31] The reasons for this are unclear. However, one potential explanation is that the EU/UK medical student has not increased in line with internship places. In 2017, there were 423 undergraduate (i.e., school-leaver direct entry) EU/UK medical students and in 2018 there were 240 graduate EU/UK medical students. Assuming no students dropped out, repeated or left the profession this would result in 663 EU/UK medical graduates eligible for Internship in 2022 which is significantly below the 854 places available. Additionally, Non-EU/UK students may not be applying for Internships in sufficient numbers. Though in 2020 it should be noted that the temporary increase in Intern places to 1,000 were filled by Non-EEA students. See Table 2 above.

The cost of training incurred per intern was estimated to be €32,272 to €44,579 in 2002/2003 (Indecon, 2005). More recent figures are not available for Ireland, though costs are likely to be significantly higher now. In the past, many interns of non-EEA origin went on to spend their working careers outside of Ireland (DoH, 2006a). When considering the cost incurred in providing the internship to these students it should also be noted that interns are regular employees that provide valuable services for the health service.

[29] According to HSE-NDTP data, the majority of those classified as "Non-EEA requiring work permit" are non-EEA students that received their education in Irish medical schools.
[30] See parliamentary question 23511/22

[31] https://www.hse.ie/eng/about/personalpq/pq/2022-pq-responses/july-2022/pq-37682-22-david-cullinane.pdf

4.1.3 Postgraduate education

A key objective for the health service has been to decrease the amount of non-training NCHD posts and increase the proportion of training posts i.e., those roles which offer a pathway to specialist training (DoH, 2014).

Postgraduate Education prepares doctors for independent practice as a medical specialist. In Ireland it is provided through a mixture of formal education and vocational training. Doctors in postgraduate training receive their formal training through the relevant Training Body and typically work in clinical environments, usually on a series of rotations, during their training. This period of training usually begins with the BST, after which the doctor will compete for a place on a HST programme for their preferred specialty. HST programmes are four to six years in duration depending on the specialty. Some specialist training programmes are streamlined e.g. General Practitioner training which takes four years from start to finish.

Within BST and HST there are a number of specialities. For example, in HST in 2020/2021 there were 15 specialities (National Doctors Training & Planning, 2022). Each of these lead to a distinct specialisation. Some of these specialities have sub-specialities, for example, General Medicine (17 sub-specialities) and Surgery (11 sub-specialities).

Upon successful completion of HST a doctor is awarded a Certificate of Satisfactory Completion of Specialist Training (CSCST) and is then eligible to apply to the Medical Council for entry on the Specialist Register (DoH, 2006b). See Figure 12 below for a timeline of postgraduate training duration by speciality.

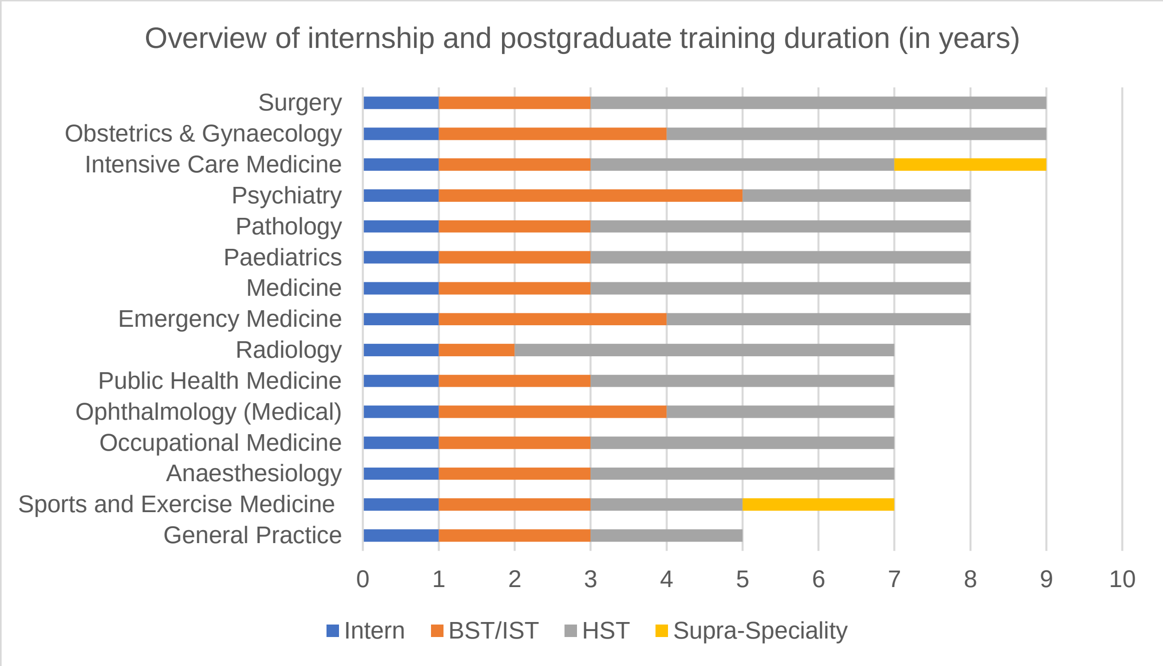


Figure 12: Overview of internship and postgraduate training duration
Source: Reproduced from (NDTP, 2022)

As noted previously, the number of specialist training places has grown over the last five years. **Table 3** shows the numbers of doctors in three categories of specialist training; IST, HST and General Practice during the 2021/2022 training year.

General Practice (Years 1, 2, 3 & 4)	**871**
IST*	1,395
HST*	1,726

Table 3: Specialist Training Places in 2021/2022 training year
Source: NDTP (NDTP, 2022) and Authors' calculations
NDTP reporting often includes GP trainees for year 1 & 2 in IST places. Similarly, GP trainees for year 3 & 4 are often reported as part of HST. In the figures included here, GP trainees are taken out and reported separately. This is done to reflect how these cohorts are modelled in the scenario analysis section of this paper.

Specialist places are predominantly, but not wholly, filled by doctors educated in Ireland. As **Table 4** shows, in 2021, 78% of GP training programme places, 82% of BST places, and 90% of HST places were occupied by doctors educated in Ireland. For doctors educated in the EU the respective figures were 13%, 8% and 7%.

	2019			2020			2021		
	EU	**Ireland**	**Non-EU**	**EU**	**Ireland**	**Non-EU**	**EU**	**Ireland**	**Non-EU**
GP	14%	81%	4%	15%	77%	8%	13%	78%	8%
BST	10%	85%	5%	9%	89%	2%	8%	82%	10%
HST	8%	89%	3%	8%	89%	2%	7%	90%	4%

Table 4: Percentage composition of specialist training places by region of education
Source: NDTP, personal communication

4.1.4 Emigration among Irish educated doctors

Professional experience abroad is recognised as being beneficial in the Irish medical sector. The Irish medical profession has a 'culture of migration' whereby the undertaking of short-to-medium term employment or fellowships in hospitals abroad is seen as a near essential component for career advancement (Humphries, Connell, & Buchan, 2019). This culture of medical migration developed with the expectation of circular or return migration, i.e., emigrant doctors would return to work in the Irish health system with the skills obtained abroad. Circular Migration is widely seen as a positive as it allows doctors to acquire new skills, experience different methods of working, learn how to operate in different workplace cultures and strengthen links with foreign health systems (DoH, 2006b).

A high rate of long term or permanent doctor emigration represents a loss of capacity in the Irish health system and erodes the State's return on investment in Medical Education (Humphries, Connell, & Buchan, 2019). Irish doctor emigration is particularly pronounced at certain career points such as shortly after completion of the intern year and post-CSCST. Much of the post-intern year emigration appears to be temporary in nature e.g., during the 2017/18 year, 291 Australian temporary visas (and 35 permanent visas) were issued to Irish citizen doctors (Humphries, Connell, & Buchan, 2019). Forthcoming analysis from the NDTP indicates that a significant proportion of interns that emigrate shortly after their internship year return to the public health system over the following five years with only 13% not identifiable on HSE databases, suggesting that they are either working in the private sector, working abroad, or have left the profession. Emigration is also a factor post-CSCST. Of the cohort of doctors receiving a CSCST in 2016 (excluding GPs, Public Health and Occupational Health specialists) 32% were either abroad or in an unknown location by 2021. (Pierse, Morris, OToole, Kinirons, & Staddon, *Forthcoming*). Emigration post CSCST is closely linked to the availability of Consultant posts in relevant disciplines at the time or emigration. For this reason, close alignment between expected demand for specialist skillsets 5-10 years into the future and specialist training programmes initiated in the present is an important factor in determining the retention of specialist doctors in Ireland (Department of Health , 2006).

4.1.5 Internationalisation of medical education

Many students and graduates of Irish medical schools come from Canada, Kuwait, Malaysia and other non-EEA countries. According to the Fottrell Report, after obtaining a medical degree (and in many cases subsequently completing the intern year), most leave Ireland as they prefer to pursue their careers in their home countries (DoH, 2006a). This contributes to the Irish health system's need to recruit doctors trained in other countries to address shortages (OECD, 2021).

Internationalisation of medical education is not limited to Ireland, with other countries displaying similar trends. In countries such as the Czech Republic, Hungary, Poland, Romania and Slovakia, several universities have built up large international student communities by offering English-language medical studies. More than one-fifth of Indian junior doctors working in NCHD posts in Ireland in 2015 graduated from a medical school in Poland. Around one-third of Romanian-educated doctors working in HSE posts in 2015 were in fact nationals from countries such as Pakistan, India and Nigeria (Heffron & Socha-Dietrich, 2019).

In some western countries, a significant proportion of students undertake undergraduate medical studies in central and eastern Europe before returning to their home countries. The number of Swedish school leavers studying medicine abroad grew rapidly in the years after 2000 (Polkowski, 2013). The 3,166 Norwegian-born medical students studying abroad represent 47% of all Norwegian medical students (Gritmad, Hunskar, & Braut, 2019). Similarly, a large share of doctors in Israel are Israeli-born people who have returned to Israel after completing their studies abroad because of the limited number of places in Israeli medical schools (OECD, 2021). Approximately 30 work permit exempt graduates of EEA universities access intern posts in the Irish health system each year (NDTP, 2022). This indicates that the practice of Irish citizens completing their medical degree abroad, and their internship in Ireland has not reached the same level. However, this does not measure the extent to which Irish citizens are completing their medical degree and intern year abroad and then returning to Ireland.

5 Literature Review

5.1 Objective of the Literature Review

To inform this spending review's modelling approach, an information search for literature on the use of system dynamics models (and related models) in health workforce projections was undertaken.

5.2 Scope

Within the scope of the literature review are the identification of existing system dynamics papers on the topic of nursing, midwifery and medical doctor workforce planning or health human resources.

5.3 Search Method and Strategy

The literature review included searches for peer reviewed articles using the PubMed, MedLine and EconLit[32] databases and a search of grey literature (i.e., non-peer reviewed literature) on Google Scholar. This was conducted during January and February 2022.

A snowball search of key literature was used to identify additional studies This was conducted between August and December 2021. The details of the search strategy are reported in Appendix B.

The search combined the concepts of system dynamics (and related terms), doctors, medicine, nursing, midwifery and workforce. The results were then reviewed by a single author for inclusion or exclusion. Studies were included if they contained the use of system dynamics or related techniques and focused on applying these methods to health workforce planning or health human resourcing topics. Studies were excluded if they did not use system dynamics modelling (or related methods) and/or were not specific to health workforce planning or health human resourcing.

---

[32] The MedLine and EconLit searches were performed together on the EBSCOhost platform.

5.4 Results

The search identified a total of 77 unique citations. Following review, 31 relevant studies were identified that use system dynamics (on related methods) that were applied specifically to health human resources or health human resourcing topics. The details of the studies included in the final set are reported in Appendix B.

5.5 Narrative description of results

All papers identified in the literature review deal with the supply of health professionals. The three main types of health workforce system dynamics (or related method) models are (i) supply-based models, (ii) demand-based models and (iii) needs-based models.

Supply-based models generally consider stock, inflow and outflow variables to determine the availability of health workers, e.g., the number of active health professionals, the number of newly registered health professionals and the level of annual attrition due to retirement, emigration or other factors. Supply-based models are sometimes criticised because it they may assume that the existing health workforce configuration is optimal (Gresenz, Auerbach, & Duarte, 2013), (Joyce, McNeil, & Stoelwinder, 2006), (Relic & Bozikov, 2020).

Demand-based models generally consider both supply and demand drivers which influence requirements for health professionals. Most demand-based models consider changes in trends in the utilisation of primary, community and hospital care as well as trends in health service consumption, organisational changes and epidemiological factors. In a similar fashion to supply-based models, demand-based approaches may perpetuate existing inefficiencies and inequalities in access to healthcare (Alonso, 2003), (Dill & Hirsch, 2021), (Ishikawa, Ohba, Yokooka, Nakamura, & Ogasawara, 2013), (Morii, et al., 2019), (Ricketts, et al., 2017), (Senese, et al., 2015), (Streeter, Zangar, & Chattopahyay, 2017), (Wu, Yu, & Huang, 2013).

Need-based models are seen as an alternative to demand-based models as they aim to detect population healthcare needs. Health workforce requirements are linked to population health need. These factors are then linked to the number and type of services required to address those needs. The distinction between need and demand is important because demand for healthcare is not independent of supply. The number of health professionals required is determined by factors such as demography, epidemiology, level of service, and productivity. Improvements in productivity associated with the adoption of new technology, staffing composition changes and changes in service delivery methodology as well as healthy aging trends may mean that fewer health professionals are required to deliver the same level of service (Lopes, Almeida, & Almada-Lobo, 2016), (Murphy, et al., 2012), (Abas, et al., 2017), (Barber & López-Valcárcel, 2010), (Morgan & Graber-Naidich, 2019), (Rafiei, Daneshvaran, & Abdollahzade, 2018), (Vanderby, Carter, Latham, & Feindel, 2014).

6 Methods

6.1.1 Overview of system dynamics modelling

The SD approach was developed by the computer engineer and systems scientist Jay Forrester in 1961. In the years since, the approach has been applied to a range of areas such as fisheries management, urban planning, and environmental resource management (Lyons & Duggan, 2015). It has also been successfully applied in the field of healthcare workforce planning in many countries (Joint Action Health Workforce Planning and Forecasting, 2015) (Vanderby, Carter, Latham, & Feindel, 2014).

SD models are widely applied as problem-solving tools as they can be used to represent complex systems visually and demonstrate how different qualitative factors relate and interact with each other, before numerical values are added. The ability to represent SD models visually is a key feature which contributes towards their applicability to public policy and the development of models which require input from a diverse range of stakeholders.

Decisions about undergraduate intake and overseas recruitment are time sensitive and the impact of retention and retirement on workforce supply in the future is uncertain. In addition, the lead times required to train staff and make any necessary adjustments to the capacity of medical schools are also significant factors. SD modelling has the capability to account for these sorts of factors, enabling more informed and effective policy decision-making (Barber & López-Valcárcel, 2010).

6.2 Using stocks and flows to model systems

Stock and flow diagrams are the building blocks of SD models. ‘Stock’ variables describe the states or amounts of the system (e.g., the number of doctors in 2021). Flow variables depict the rates of change - increases or decreases - of stocks (e.g., the retirement rate for doctors). A factor that distinguishes a stock from a Flow in the context of workforce planning is that a Stock represents the number of individuals qualified to work, or who are working, in a profession at a given point in time, whereas a ‘Flow’ relates to movements into and out of the Stock (e.g., newly qualified doctors entering the profession, retiring doctors) over time. Stocks accumulate or deplete in a model.

For an illustration of the basic modelling concepts, see the diagram in Figure 13 below which outlines factors that are relevant in the context of the healthcare workforces:

- Stock: Total Workforce.
- Inflows: Graduates, Immigrants, People returning to practice.
- Outflows: Attrition, Emigrants, Retirees.

Figure 13: Example of relevant factors in healthcare workforce stock and flow model

6.3 Data Sources

This section provides an overview of the main data sources used to develop this model. The full list of variables, data sources, parameters and assumptions is shown in Appendix C.

Relevant data sources and variables were identified through desk-based research and in consultation with stakeholders. Additional data was obtained from various sources including government agencies, government departments, independent commission reports and statutory organisations e.g., the Department of Further and Higher Education, Research, Innovation and Science (DFHERIS), various units within the Health Service Executive (HSE), the DoH, the Higher Education Authority (HEA), the Public Service Pay Commission (PSPC) and from reports produced by defunct organisations (e.g., the 2009 FÁS report).

6.3.1 NDTP data

The NDTP, established in 2014, has a statutory remit outlined in the Health Act 2004 and the Medical Practitioners Act 2007. The NDTP's role is to ensure that the Irish health service is provided with the appropriate number of specialists, who possess the required skills and competencies to deliver high quality and safe care, and whose training is matched to the model of healthcare delivery in Ireland, regardless of location.

The NDTP has three core functions:

1. Medical Education and Training
2. Medical Workforce Planning, and,
3. The Consultant Post Approval Process.

The NDTP collates a large quantity of data from a variety of sources including HSE DIME (consultant and NCHD demographics), HSE HPO HIPE (day case and inpatient utilisation), HSE BIU (outpatient utilisation), HSE Census (workforce demographics), Clinical Programmes (models of care), the CSO (population projections), the NTPF (waiting list numbers), Training Bodies (trainee demographics) and the Irish Medical Council (registration type, area of BMQ, private-only Consultants and non-training scheme doctors).

Data used for this model is principally from the retention analysis, but also includes data from the Medical Workforce Report (Morris & Smith, 2021) (NDTP, 2022).

6.3.2 Limitations of NDTP data

Much of the NDTP's data is sourced from DIME. Some DIME variables have a lower completion rate than others (e.g. no. of hours worked per week) and the quality of information varies between clinical sites. The DIME database relates to the public sector medical workforce only. DIME collects data in relation to Consultants and NCHDs and in clinical sites only. It does not include community-based specialists in Public Health, General Practice, Occupational Health or Ophthalmology. In addition, it does not contain a record of doctors employed in the private sector.

6.3.3 Other data sources

In addition to the NDTP, data from several other sources was used:

1. **DFHERIS data:** The DFHERIS data relates to spreadsheet information made available to the authors of this paper detailing medical school intake figures for 2021-2022.
2. **HEA data:** The HEA information used in this paper relates to data on completion rates per 100 students (HEA, 2021). A limitation of the HEA's completion analysis is that it is limited to entrants into study programmes from the academic years 2008/09, 2009/10 and 2010/11.[33] In addition, we assume that non-completion rates for Irish and foreign medical students are the same. Furthermore, only non-completion rates for

[33] See the HEA website (Link: hea.ie/statistics/interactive-reports-articles/completion-data-release-march2021/)

entire study programmes are provided and not the dropout rates for each academic year. The Graduate Outcomes Survey was also referenced for this analysis. Refer to Appendix D for further information.

3. **FÁS Report:** Existing reports such as the 2009 FÁS report act as a source of data for some inputs. A limitation is that some of this data is based on expert opinion and experience. In addition, some of the data is quite dated and may no longer be relevant 13 years after its publication. Refer to Appendix C for details of the relevant parameters.

7 Medical Doctor Workforce Supply Model Description

This section provides a narrative overview of the SD model which tracks the lifecycle of a doctor from medical school through to specialist training. It highlights the important variables (and the parameters underpinning them in the model). For a detailed description with explanatory notes for all variables, data sources and parameters in the model see Appendix C.

7.1 Model Sections

The supply model (shown in **Figures 13** to **17**) has five interacting sections: (i) the University Section, (ii) the Intern Section, (iii) Pre-Training Programme Section, (iv) GP Training Programme Section, (v) Initial Specialist Training & Higher Specialist Training Section.

In general, variable names are written in italics and in single quotation marks as follows '*Variable Name*'.

Note on the interpretation of Vensim Model Diagrams

As noted in a previous section, system dynamics modelling decomposes the workforce into inflows, Stocks and outflows. The images included in this document below reflect that decomposition by arrows and rectangles. Rectangles represent Stocks. When a stock has an arrow point towards it from the left – that is an inflow. When a Stock has an arrow exiting it from the right that is an outflow. The reader should also note that there are blue arrows which connect elements of the graphs together. These indicate that values are determined by other Stocks and Flows they are connected to. Mathematically, they indicate that they are used in the formulas

7.1.1 The University Section

Figure 13 below shows the University Section of the model. No differentiation is made between students from Ireland, the EU or the UK. In general, they are referenced in the model as 'EU UK' students.

Medical students enter Year 1 of medical school through four different intake variables which reflect the two medical degrees that can be undertaken in Irish medical schools - undergraduate (i.e., school-leaver direct entry) and graduate entry as well as the two regions from which students originate i.e., (i) EU/UK, and (ii) Non-EU/UK.

- Undergrad Intake EU UK;
- Grad Intake EU UK;
- Grad Intake Non EU UK; and,
- Undergrad Intake Non EU UK.

In Figure 14, for example, those students from the EU or UK entering a Graduate Entry Medicine (GEM) programme are added to the model through the inflow *'Grad Intake EU UK'*. Students either complete Year 1 and carry on to Year 2 or drop out of Year 1 and exit the model through the dropout outflow. This process is repeated for each of the stocks from Year 1 until the final year of each programme.

After the final year of the medical degree students from the EU and UK either leave the profession or apply for an internship post.

The parameters for the four inflows are set according to the data in Appendix C.

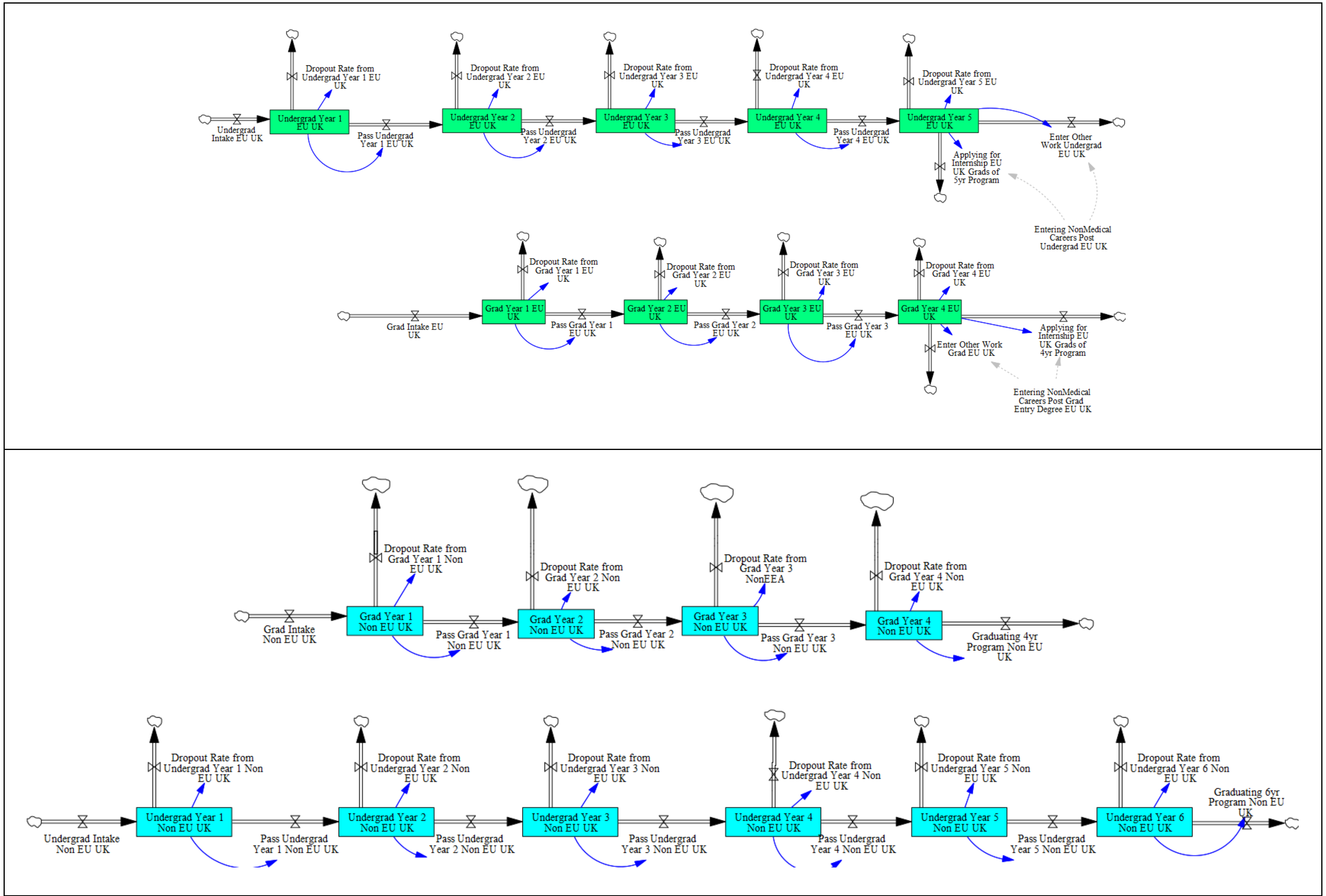


Figure 14: The University Section

7.2 The Intern Year

The Intern Year section of the model is shown in Figure 15. Students who complete their medical degrees and enter medical related careers upon graduation apply for the Intern Year.[34][35] In the model, new medical graduates from the EU/UK are grouped together in the variable '*Potential Interns EU UK'*.

On average over the last four years a small number (circa 32 students) of EU students (including Irish citizens that did their undergraduate degree in other EU countries, outside of Ireland) graduating from medical schools in the EU are successful in applying for an internship in Ireland. These individuals are referred to as '*Non-CAO and Work Permit Exempt'* and are also grouped together in the variable '*Potential Interns EU UK'*.

Internship Posts are limited in the model by the variable '*Intern Year Places available in Ireland*'. In the baseline scenario, internship posts are set at 854 throughout the projection period which was the number of internship places in Ireland in 2021. See **Table 2** for data on internship numbers in recent years and the composition of the intern by entry route and domicile.

These internship places are allocated to students from the EU/UK on a prioritised basis (see the variable '*Potential Interns EU UK*').[36] Any remaining places are allocated to Non-EU/UK students completing medical degrees in Ireland from the variable '*Potential Interns EU UK'*.

The Intern Year takes one year to complete. The model assumes that no Interns from the EU/UK drop out of the internship year. For Non-EU/UK students, there is small dropout rate of 0.5%.

[34] For more information on the eligibility requirements see here: https://www.hse.ie/eng/staff/leadership-education-development/met/medical-intern-unit/eligibility-and-requirements/

[35] Interns are selected by the HSE based on the following criteria:

1. Graduates who applied to and were accepted to an Irish medical school programme through the Central Applications Office (CAO);
2. Other non-CAO EEA applicants and non-EEA applicants not requiring a work permit (graduating from medical schools in Ireland and elsewhere in the EEA;
3. All other non-EEA applicants requiring work permits

[36] The HSE allocates places on the basis of EEA status, rather than EU status, however for the purposes of this model they are treated as the same. EEA countries include the EU plus Norway, Iceland, Liechtenstein.

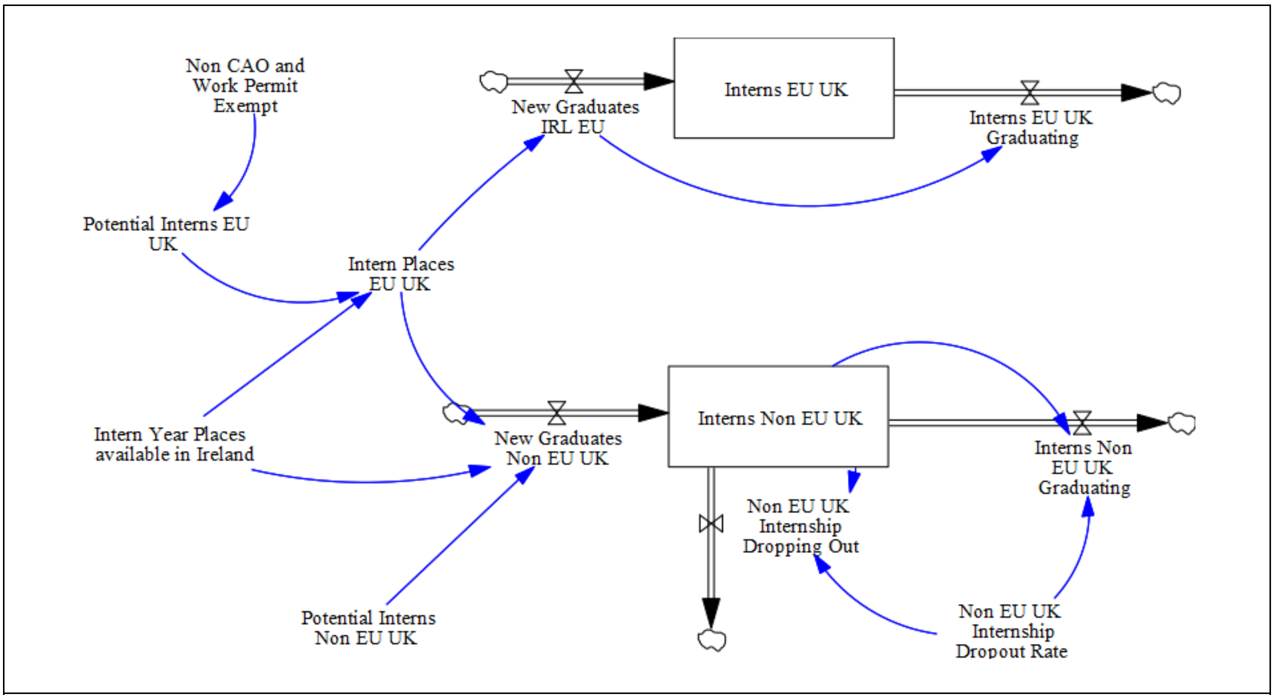


Figure 15: Intern Year

7.3 Pre-Training Programme Section

According to NDTP internal analysis, an average of 32% of interns begin IST in the year following their internship. Most either work for a period in Ireland in a non-training role or work abroad before entering IST. For the 2015 intern cohort (which is the most recently available data) 82% of Interns completed or started specialist training by 2021.

To partially reflect the different amounts of time it takes Interns to go on to specialist training, 82% of Interns each period are allocated to the stock *'Pre Training Programme'* where they wait for one year before going on to access specialist training through the outflow called '*Accessing IST or GPT*'. The remaining 18% (who are either working in the private sector, working abroad or have left the profession (13%) or in non-training roles in the public health service (5%) exit the model and are not accounted for any further.

The initial value of the stock '*Pre Training Programme'* is set in the initial period at the value of the variable *'Pre Training Doctors'* which reflects the fact that a cohort of doctors would already be waiting to access specialist training in 2021.

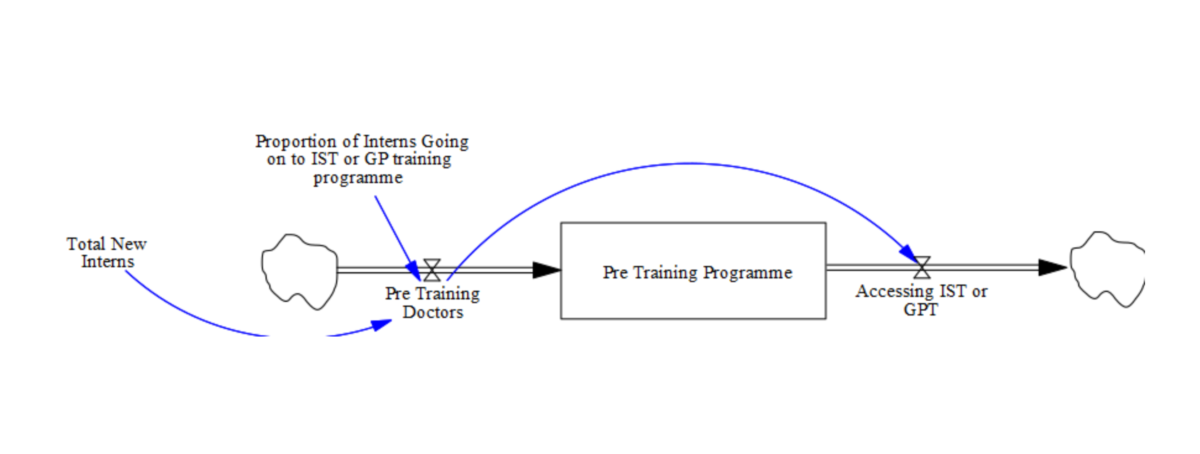


Figure 16: Pre-Training Programme Section

7.4 Initial Specialist Training & Higher Specialist Training

As noted previously, to become a specialist, a doctor generally needs to complete BST and HST. For some specialities, streamlined programmes are available which combine both BST and HST.[37] Often a HST programme for a particular specialty requires completion of a specific

[37] General Practice, Anaesthesiology, Surgery and Emergency Medicine.

BST programme, however this is not always the case e.g., Radiology, Immunology and Public Health Medicine. Some HST programmes accept doctors from a number of BST programmes e.g., Radiology, Immunology and Public Health Medicine. In this model, the GP training programme, which is streamlined, is separated out from IST and HST training on the basis that a significant proportion of trainees are in this programme and the length (four years) is shorter than other specialist training programmes.

IST training can take up to four years. However, in the 2021-22 almost 90% of doctors were participating in an IST programme that took two years. As such, IST is assumed to take two years in the model.

HST, which also includes the latter years of the streamlined programmes, can take anywhere from 2-6 years depending on the specialty. In the model, HST is assumed to take five years. In HST, the only programme which takes two years is General Practice (third and fourth years of the streamlined programme), and as noted previously, this is modelled separately. In the 2021-22 training period 421, or 19% of all HST places were in General Practice (NDTP, 2022). The number of those in a four-year HST programme was 198 or 9% of total HST places. The number of those in a five-year HST programme was 1,032 or 48% of the total. The number of people in a six-year HST programme was 471 or 22% of the total.

In the Pre Training Programme Section, doctors leave through the outflow *'Accessing IST or GPT'*. A number of these doctors are allocated to the GP Training Section of the model based on the total number of GP Training places available, reduced by the proportion of places taken up by Irish educated doctors in 2021 (see Appendix C). After two years, they either leave IST through attrition or complete IST. After completing IST they enter a stock '*Applying for HST'* where they wait one year. In practice, some doctors move straight on to HST but others wait for one or two years and/or complete a masters.

Only a proportion of these doctors who have completed IST are successful in attaining a HST place which is determined by the variable '*Rate of progression from BST to HST'*. In the baseline scenario this is set at 76%. Of the 2017-2019 cohort that completed BST this percentage went on to start HST or GP Training by 2021. Note that in this model the 76% is used for those moving between IST and HST, only. GP Training is likely to be a significant proportion of the 76% so this may be an overestimate. It should also be noted that participating in HST is a competitive process, and so not all doctors completing IST will want, or are competitive enough as candidates, to secure a place in HST.

For those doctors that access HST, they either leave through attrition or complete it after 5 years.

The parameter for attrition is determined on the basis of the Retention Analysis. Of the 2013 cohort of doctors recorded as starting HST training, 88% go on to complete training and receive a CSCST by 2021. As such, the assumed attrition rate is 12%.

The initial value of the stock '*Initial Specialist Training 2 Year Programme'* is set at twice the value of the inflow '*Starting IST'* reflecting the fact that it is a two-year programme. The initial value of the stock '*Higher Specialist Training Programme'* is set as five times the value of the inflow *'Beginning HST'*. This approach to estimating the initial values of stocks are slight overestimates as they do not account for attrition that would have reduced the initial value of the stock.

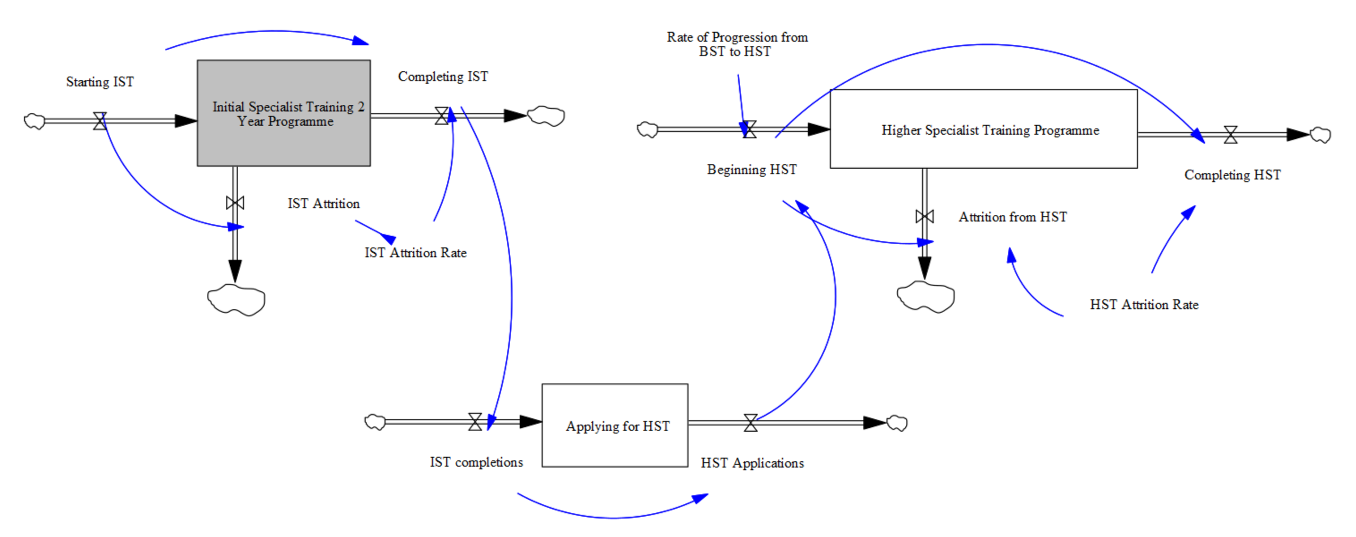


Figure 17: Initial Specialist Training, Applying for HST, and Higher Specialist Training

7.5 GP Training Programme

In the model, GP training is separated out from IST and HST due to the significant proportion of all doctors in specialist training that are part of GP training and because the programme is streamlined, taking four years from start to finish. This reduces any error caused by assuming HST takes five years. **Figure 17** below shows the training programme. The variable '*Places available in Streamlined Programme'* determines the number of interns taken into the training programme. Doctors either leave through an attrition outflow or complete the programme through the outflow variable *'Completing Specialist training'.*

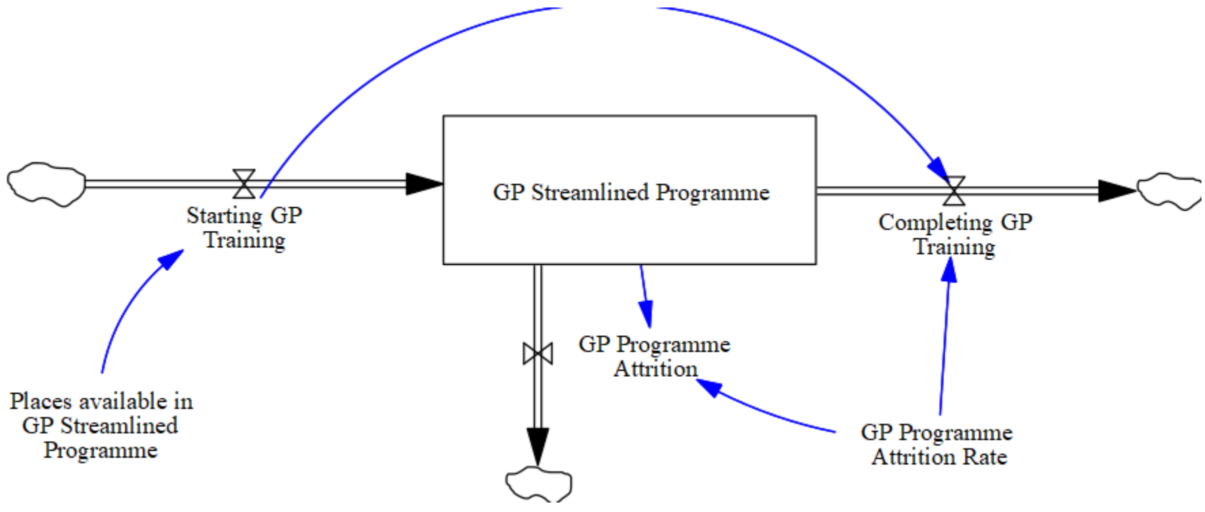


Figure 18: GP Training Programme

7.6 Baseline and Reform Scenarios

7.6.1 Baseline (Steady State) Scenario

The baseline (steady state) scenario parameters are as set out in Appendix C. In the baseline, all model parameters are unchanged throughout the projection period. This scenario does not include recent government commitments to increase medical student intake in the next five years or the expected growth in other specialist training places such as IST, GP training places, or HST that are planned.[38]

[38] https://www.gov.ie/en/press-release/4db4d-extra-60-medicine-places-in-irish-medical-schools-over-the-next-five-years-announced-by-ministers-harris-and-donnelly/

7.6.2 Description of Reform Scenario A – Substitution of Non-EU/UK Students for EU/UK students and increase in Internship posts

7.6.2.1 EU/UK Students

EU/UK student places are increased to 1,000 over the projection period. This is a 32% increase on the 2021 intake. Over the last 11 years the lowest EU/UK medical student intake was 648 in 2016 (See Table 1). This scenario shows a 54% increase on the 2016 intake.

EU/UK students are increased by 60 in 2022, 60 in 2023, 40 in 2024, 20 in 2025, 20 in 2026, 23 in 2027 and 23 in 2028. The intake from 2022-2025 is consistent with the increases in places announced in the summer of 2022.[39] The increases of 23 in the year 2027 and 2028 are undertaken to bring the total EU/UK intake to 1,000. Student intake from Non-EU/UK sources are reduced by commensurate amounts each year. So, for example, the increase in EU/UK students in 2022 is matched by a reduction in Non-EU/UK students in 2022 of 60.

7.6.2.2 Intern Posts

Intern posts are increased to 1,000 from 854 over the first 14 years of the projection period out to 2034, a 17% increase on the 2021 base. This is a 36% increase on the number of Internships in 2017 (See Table 2).

7.6.2.3 GP Training Programme

It is expected that the intake to GP training in 2026 will be 350 places.[40] There are currently 236 GP training places in 2021/22 (NDTP, 2022). As noted in Appendix C, the number of places is reduced by the proportion of places which are currently being utilised by Irish educated doctors of 78%. This reduction is included to ensure the model is projecting only for Irish educated doctors. This scenario increases GP training places from 184 to 273 between 2021 and 2026.[41]

---

[39] See press release here for further detail: https://www.gov.ie/en/press-release/4db4d-extra-60-medicine-places-in-irish-medical-schools-over-the-next-five-years-announced-by-ministers-harris-and-donnelly/

[40] https://www.icgp.ie/go/about/news/1DEDBF43-D2B4-4ADE-B0B60EDC21DF9F05.html

[41] As detailed in Appendix C, there were 236 approved places in the GP streamlined programme in the NDTP Medical Workforce report 2020-2021. See, table 4.5 Specialist Training 2021 - 2022: Distribution of Trainees by Year of Training. In 2020, 78% of doctors on the GP training programme were Irish educated. The number of places has been reduced by this proportion to reach a figure for the number of places available for Irish-Educated doctors. As such, the number of places taken up by Irish Educated Doctors in period 0 is assumed to be 0.78*236=184.

7.6.3 Description of Reform Scenario B –EU/UK students increased to 90% of intake

Scenario A examines the increases in EU/UK student places required to match the number of Internship places available. Reform Scenario B inverts this line of inquiry to examine the increase in internship, IST, and HST places required for a given EU/UK intake. Fottrell noted that, at the time of its publication in 2006, it was unusual for more than 10% of the medical student intake to be foreign students. More updated figures across the OECD could not be found for this report. In 2017, UK medical schools were allowed to fill up to 7.5% of their places with overseas students from outside of the European Union (Dept. Health UK, 2017).[42] It is not clear to what extent this limit was met by medical schools with reports of schools exceeding this due to the revenue available from international students (Enoch, Ooi, & Ooi, 2022). However, it should be noted that a policy change in the 2018/2019 academic year removed that limit on the basis that new international students funded their own clinical placements, in addition to the tuition and living costs. In 2021, the proportion of the medical student intake that were not from the UK was 10%.[43] This does not directly compare with Irish data as the UK now treats EU students differently post-Brexit.

Reform Scenario B increases the intake of EU/UK students to 1,263 incrementally from 2021 to 2031. The intake figure of 1,263 in 2031 is 90% of the total number of medical students first-year intake from all domicile groups (i.e., all EU, UK and non-EU/UK students) in 2021. This is a 67% increase on the 2021 intake and a 95% increase on the 2016 intake.

The GP intake follows the same path as Scenario A.

---

[42] https://www.medschools.ac.uk/news/the-sunday-times-is-wrong-about-international-medical-students

[43] The medical student intake for 2021-22 was 10,340. 9,280 of these students were categories as 'Home'. 'Home' fee status refers to those students eligible to pay the 'home' level of tuition fees. 1,060 of these students were categorised as 'Other'. 'Other' fee status refers to those students not eligible to pay the 'home' level of tuition fees, such as overseas students. https://www.officeforstudents.org.uk/advice-and-guidance/funding-for-providers/health-education-funding/medical-and-dental-intakes/

7.6.3.1 EU/UK Students

Table 5 below shows some of the key policy reforms for the Student Intake.

Scenario	Student Cohort	2021	2026	2031	2051
Baseline (Steady State)	EU/UK	754	754	754	754
	Non-EU/UK	649	649	649	649
Scenario A (EU/UK intake increased to 1,000 in 2028)	EU/UK	754	954	1,000	1,000
	Non-EU/UK	649	449	403	403
Scenario B (EU/UK intake increased to 1,263 over ten-year period)	EU/UK	754	954	1,263	1,263
	Non-EU/UK	649	449	140	140

Table 5

Table 6 below shows some of the key policy reforms for the Internship Year

Scenario	Internship Places
Baseline (Steady State)	**854 throughout the projection period**
Scenario A	**854 to 1,000 by 2035**
Scenario B	**854 to 1,190 by 2035**

Table 6

8 Results

8.1 Baseline (steady state) Scenario

The baseline (steady state) scenario uses the assumptions outlined above and described in detail in Appendix C.

8.1.1 Note on the interpretation of results

The baseline scenario results are shown in a steady state. This means that all model parameters are unchanged throughout the projection period. For example, in the baseline scenario its assumed that the number of Intern Posts is 854 throughout. The initial values for the number of places in IST and HST in 2021 are derived based on the number of Intern Posts. This modelling approach needs to be borne in mind when interpreting results. In practice, medical workforce planning as undertaken by the NDTP determines the number of HST places required for a medical specialty and works backwards to derive the number of IST places required. These IST places are constituted by doctors that completed Internship posts in previous years as well as foreign educated doctors. Additionally, this model is only projecting the IST and HST places for Irish educated doctors, whereas NDTP data will include doctors educated outside Ireland. This should be borne in mind when comparing these model outputs against NDTP data on IST and HST intake.

Results are shown for two main types of model output. The first type is Steady State Intake. This shows the numbers of students entering the first year of a medical degree programme or the number of doctors entering the first year of a specialist training programme each year. The second type is Steady State Participants. This shows the total number of students in a medical degree or the total number of doctors in specialist training programmes each year. This provides an estimate of the number of student/training places that would be necessary to provide in each year in the future.

Lastly, as the model adjusts to steady state values there may be small changes in trends of variables or numbers of doctors which include decimal places. These are ignored in the descriptive analysis of graphs and numbers are rounded.

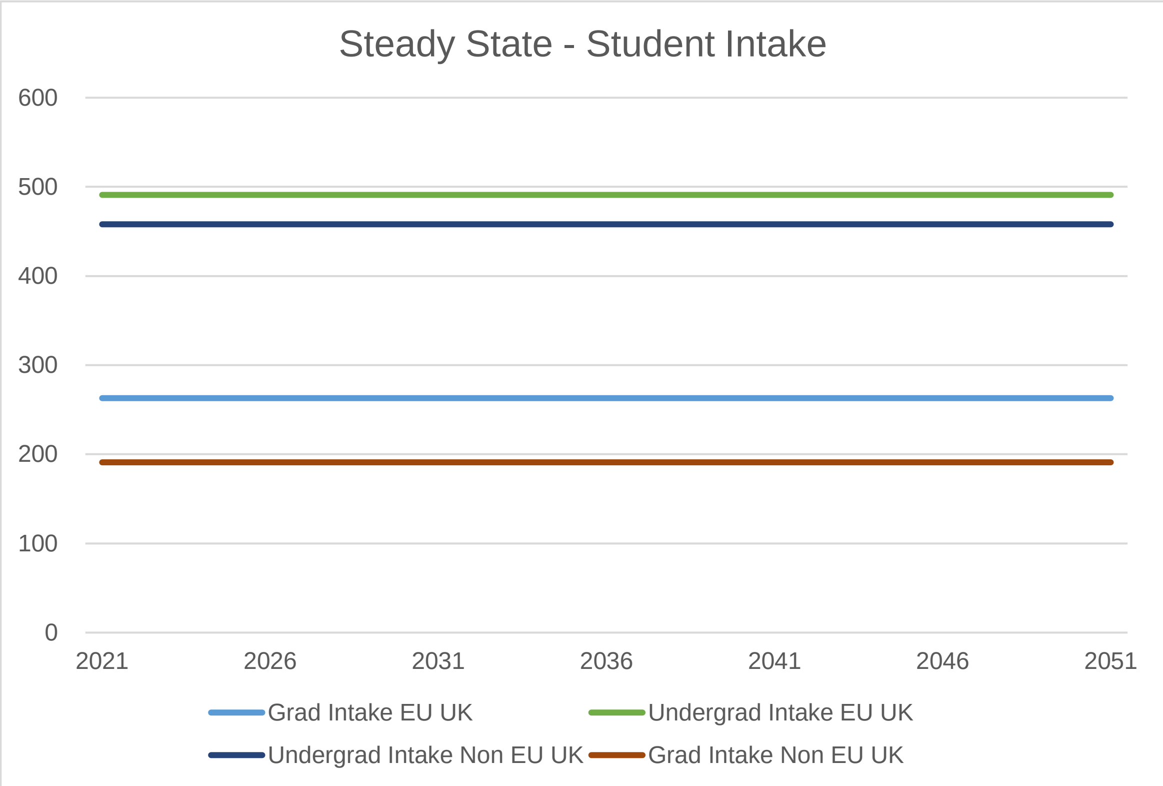


Figure 19: Steady State Intake in each year

Figure 19 shows the steady state student intake for each of the medical degree programmes for each cohort in the model. For EU/UK students the undergraduate (i.e., school-leaver direct entry) intake is 491 each year from 2021 to 2051 and the graduate entry intake is 263 for the same period. For non-EU/UK students the undergraduate (i.e., school-leaver direct entry) intake is 458 and the graduate entry intake is 191.

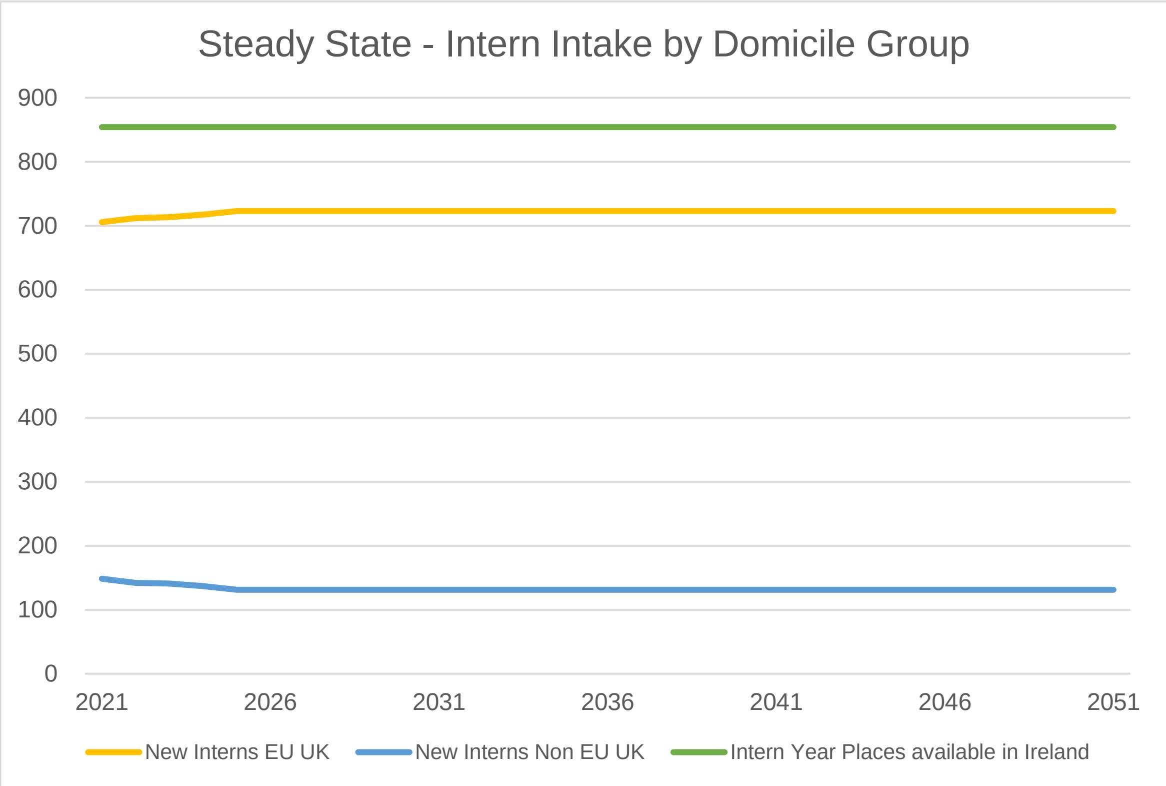


Figure 20: Steady State - Intern Intake by Domicile Group

Figure 20 shows the intake into the internship year by the domicile of the doctors. There is a small increase in the first five years for the variable '*New Interns EU UK'* before the variable settles at 723 doctors throughout the years 2021 to 2051. Correspondingly, the variable '*New Interns Non EU UK*' is dropping for the first five years before settling at an equilibrium value of 131. Both of these variables sum to the 854 i.e., the number of internship posts available.

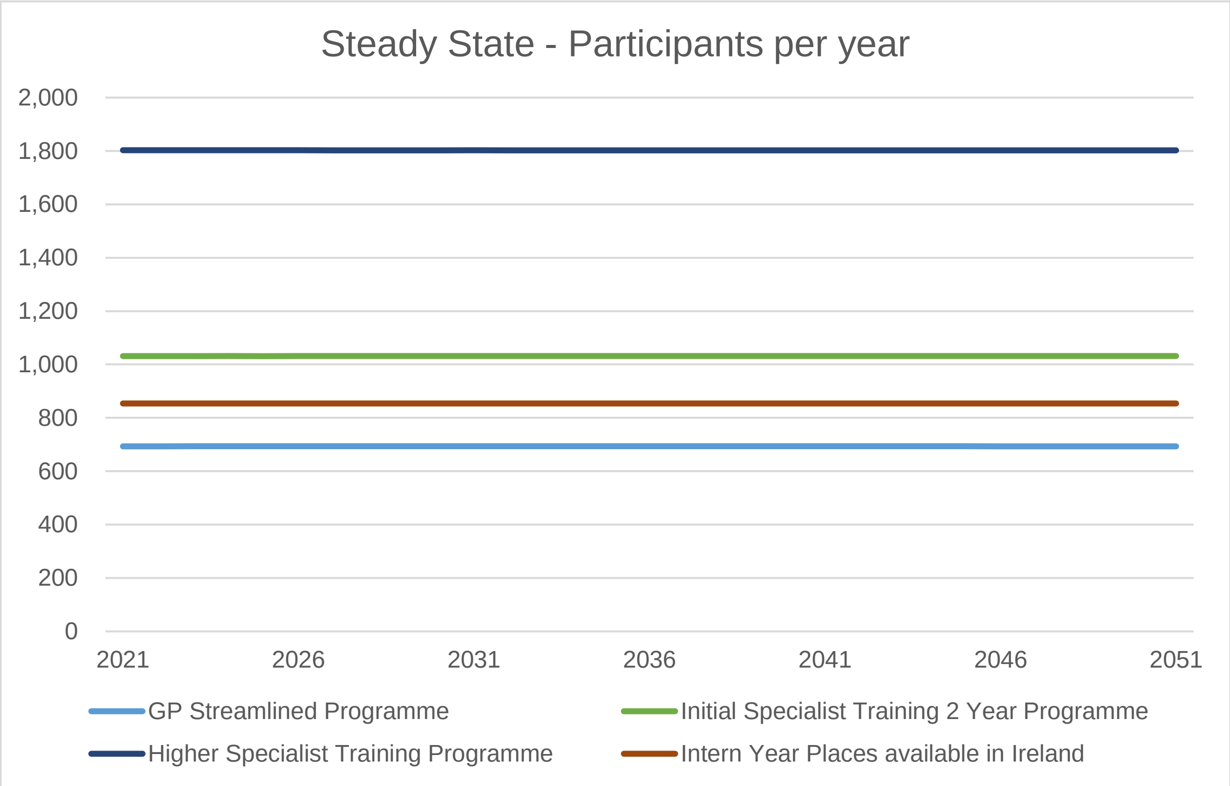


Figure 21: Baseline Participants per year

Figure 21 shows the steady state participants in the post-medical degree training programmes. This shows that there are 854 Internship posts throughout the period 2021-2051, 1,031 doctors participating in IST programmes and 1,802 doctors in HST programmes, with 693 doctors in the GP Streamlined Programme.

8.2 Reform Scenario A

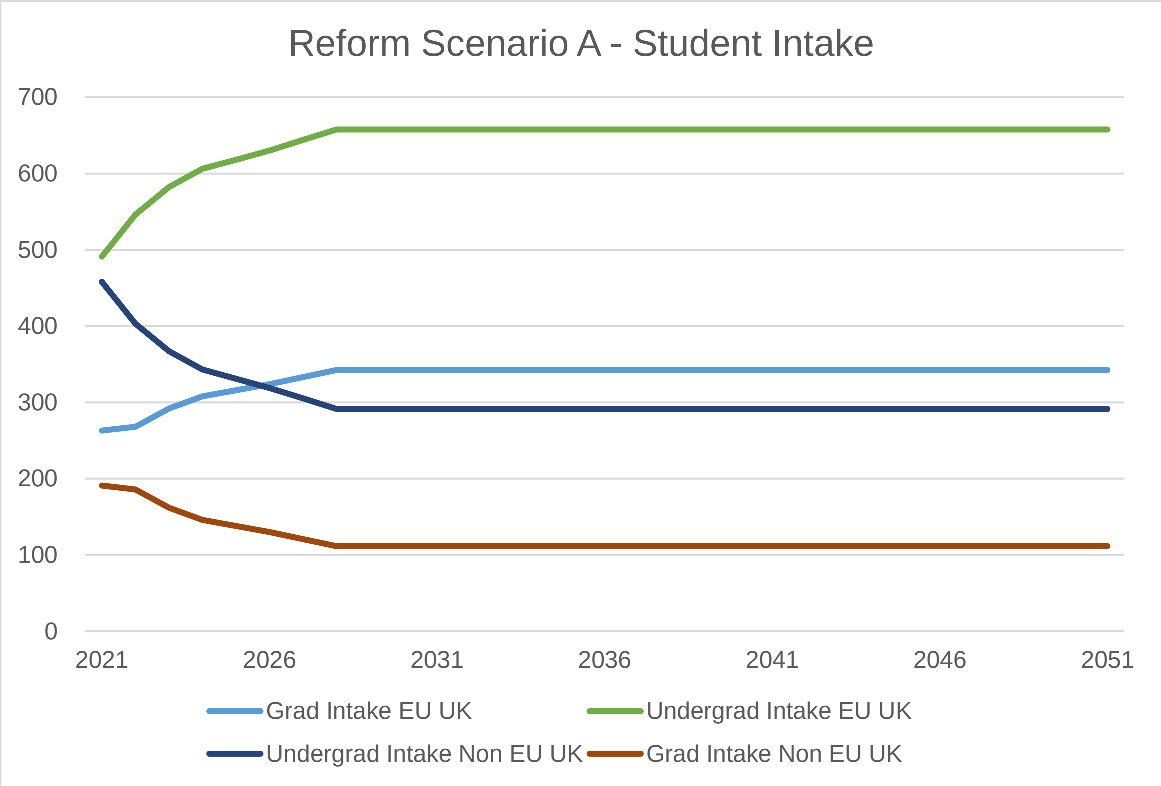


Figure 22: Reform Scenario A - Student Intake

Figure 22 shows increasing student numbers for students from the EU/UK with corresponding reductions for Non-EU/UK students. The variable *'Undergrad Intake EU/UK'* rises quickly over the first 10 years from 491 to 658. Similarly, the variable *'Grad intake EU/UK'* rises from 263 to 342 from 2021 to 2028. The paths for Non-EU/UK students are the inverse. The variable *'Undergrad Intake Non-EU/UK'* drops from 458 to 291. *'Grad Intake Non-EU/UK'* drops from 191 to settle at a long-run value of 112. The EU/UK intake rises from 54% of first-year intake in 2021 to 71% of intake in 2031 and stays at that level for the duration of the period.

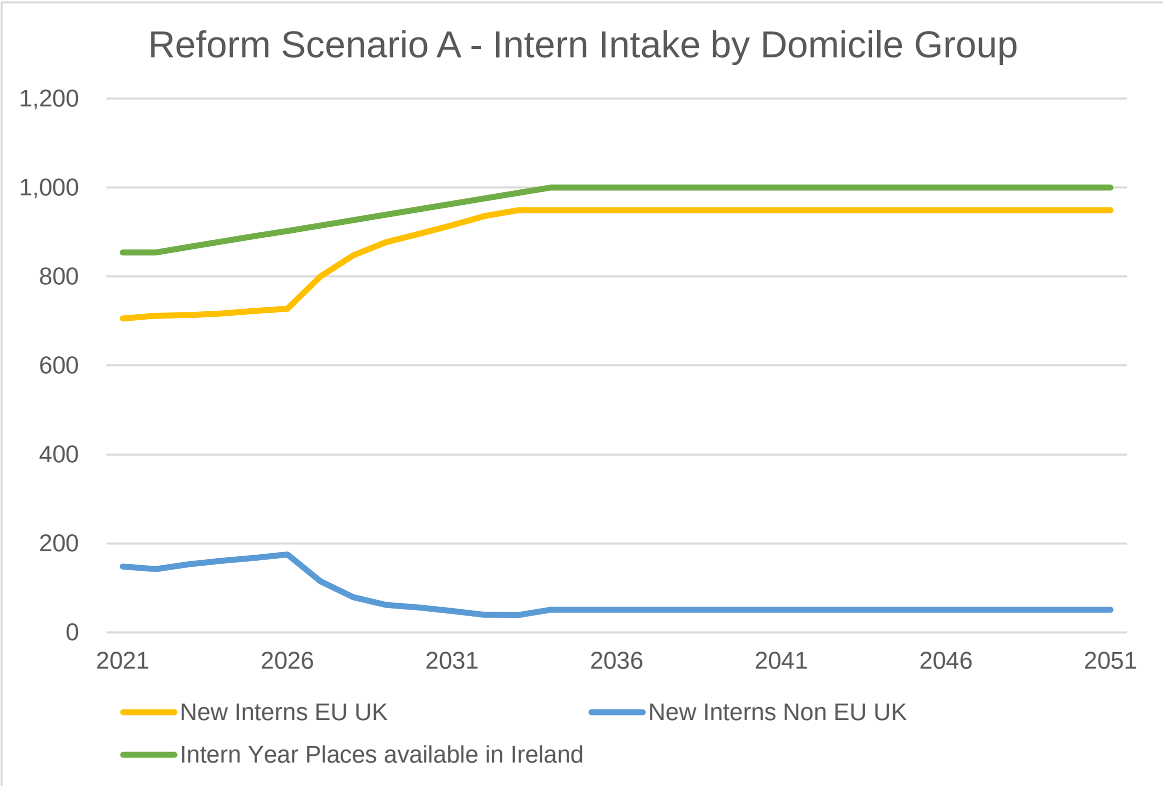


Figure 23: Reform Scenario A - New Interns by Domicile Group

Figure 23 shows how the intake into the Internship Year for EU/UK and Non-EU/UK graduates changes over the period. There is a small increase in the intake from Non-EU/UK regions from 2023 to 2026 reflecting the fact that internship posts are increasing before new EU/UK students have come onstream.

There is an incremental increase in Interns from the EU/UK between 2026 and 2033 before it settles at a long-run value of 949. This value of 949, is lower than the student intake of 1,000 due to dropouts from the medical degree and the numbers of students which choose to work in another profession after graduation. Thus, the model is showing that for each EU/UK student that enters medical school, 0.94 students graduate and enter the Internship year. Note this percentage is highly sensitive to three modelling parameters – the proportions of students that are in undergraduate (i.e., school-leaver direct entry) versus GEM degrees, the annual student dropout rates between each year of the degree and the proportion of graduating students that chose not to enter the profession. For this reason, the long-run equilibrium value of Interns from Non-EU/UK sources is 51.

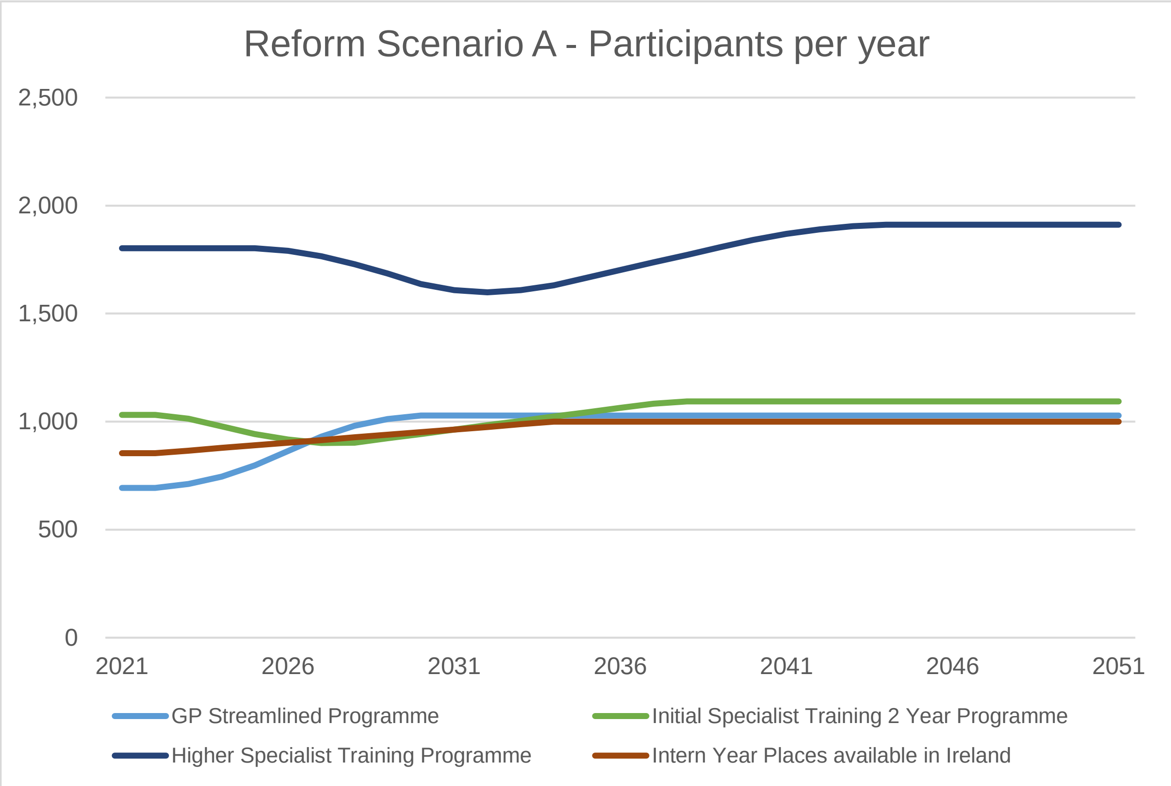


Figure 24: Reform Scenario A - Programme Participants

Figure 24 shows the number of doctors in specialist training programmes in any given year. For each programme the number of participants is roughly equal to the intake each year times the number of years of the programme less the annual attrition rate. The numbers in the '*GP Streamlined Programme'* increase from 693 in 2025 to 1,028 by 2030. The numbers of those in '*Initial Specialist Training 2 Year Programme'* increase from 1,031 in 2021 to 1,094 by 2038. The numbers of those in 'Higher Specialist Training Programme' start at 1,803 and eventually rise to 1,912 by 2044.

It can be seen from Figure 24 that the number of doctors in IST and HST drops briefly during the projection period. This is because this scenario includes the increase in GP training places which are planned for 2021 to 2026. The model allocates post-internship doctors to GP training programmes first, with any remaining doctors entering IST. The nadir in IST intake occurs in 2026 when the increase in GP training places stops. The drop in HST places happens three years after the drop in HST places due to the fact that IST is modelled as requiring two years and the post-IST wait of one year assumed in the model.

8.3 Reform Scenario B

Figure 25 below shows the increase in student numbers for students from EU/UK as well as corresponding reductions for Non-EU/UK students. The variable *'Undergrad Intake EU/UK'* rises quickly between 2021 and 2031 from 491 to 815. Similarly, the variable *'Grad intake EU/UK'* rises from 263 to 448 over the period 2021 to 2031. The paths for Non-EU/UK students are the inverse. The variable *'Undergrad Intake Non-EU/UK'* drops from 458 to 134. *'Grad Intake Non-EU/UK'* drops from 191 to settle at a long-run value of 6. The EU/UK intake rises from 54% of total first-year intake in 2021 to 90% in 2028 and stays at that level for the remainder of the period.

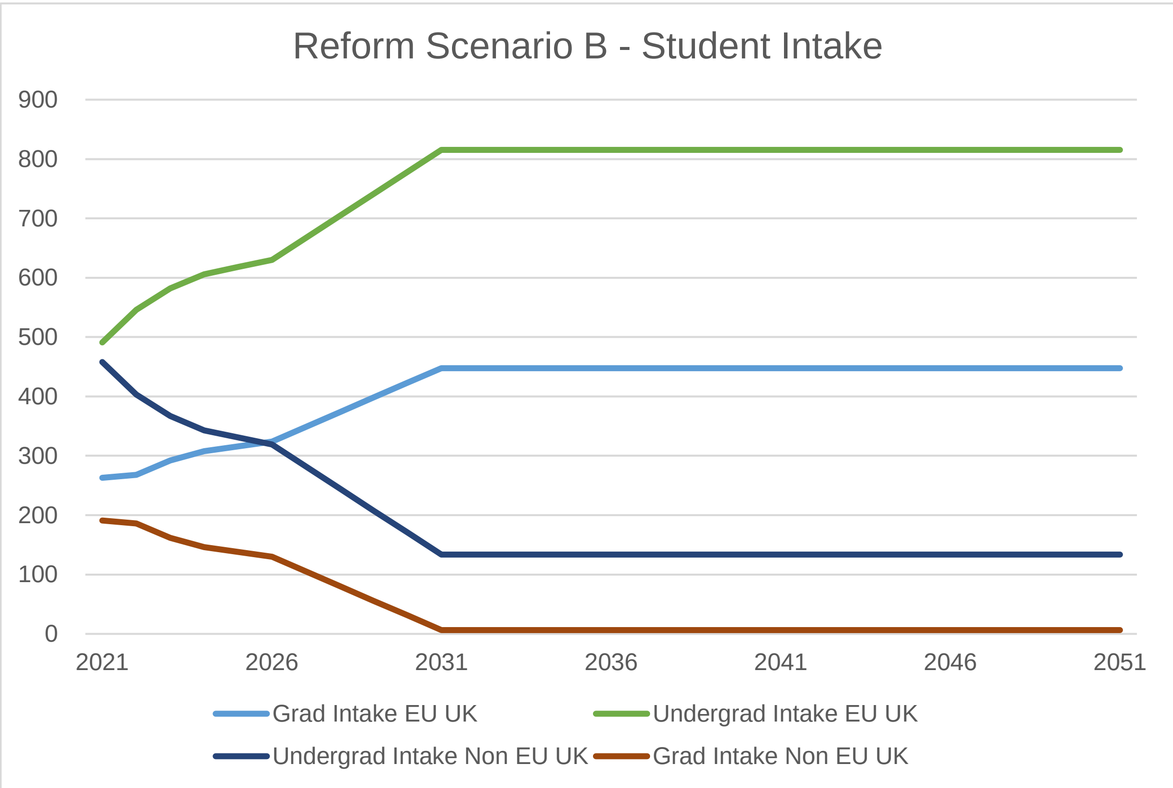


Figure 25: Reform Scenario B - Student Intake

Figure 26 below shows how the intake into the Internship Year for those from EU/UK and Non-EU/UK domiciles changes over the period. The initial period of five shows a small increase in the intake from Non-EU/UK regions reflecting the fact that the number of available Internship Posts are increasing before additional EU/UK students have come onstream. There is then a rapid increase for Interns from the EU/UK between 2026 and 2036 before it settles at a long-run value of 1,190. The value of Interns from Non-EU/UK sources is zero from 2036 onwards.

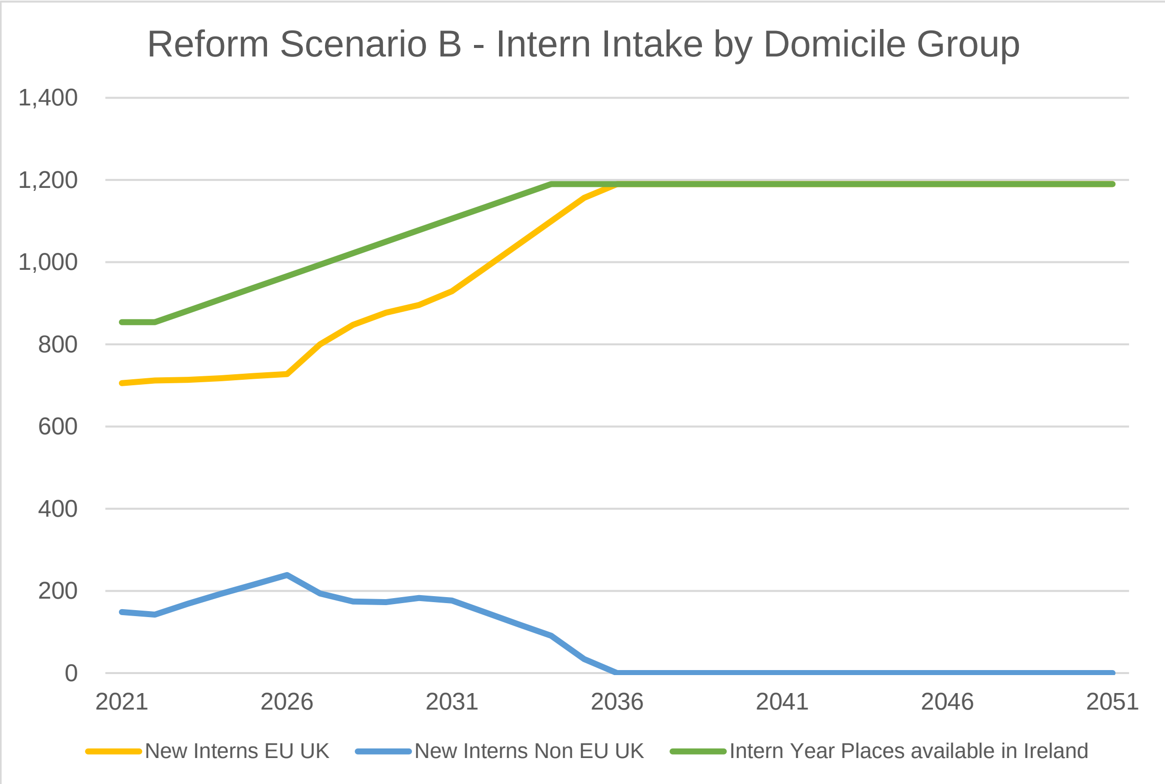


Figure 26: Reform Scenario B - Intern Intake by Domicile Group

Figure 27 shows how increases in Internship places on the numbers of participants in GP Training, IST and HST. For each programme the number of participants is roughly equal to the intake each year times the number of years of the programme less the annual attrition rate. As in Scenario B, the numbers in the '*GP Streamlined Programme'* increase from 693 in 2025 to 1,028 by 2030.

The numbers of those in '*Initial Specialist Training 2 Year Programme'* increase from 1,031 in 2021 to 1,405 by 2038. The numbers of those in 'Higher Specialist Training Programme' start in 2021 at 1,803 and eventually rise to 2,457 by 2044. Similarly, to Scenario B, the increase in GP training places to 2026 causes a short term reduction in the number of doctors in IST however this begins to reverse by 2026 for IST and has exceeded its baseline value by 2029.

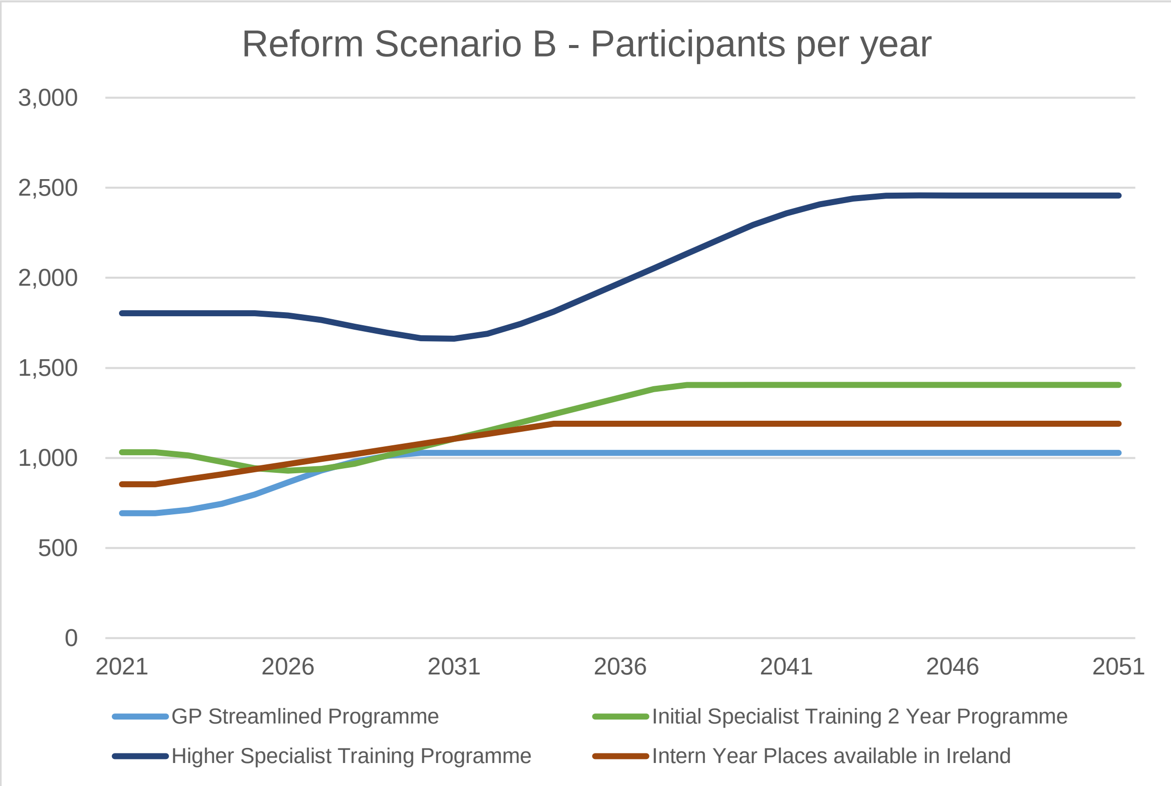


Figure 27: Reform Scenario B - Programme Participants

8.4 Discussion of Scenario Analysis Results

This section examines some of the insights highlighted by the results of the modelling exercise.

8.4.1 Baseline Scenario (Steady State)

Looking at the baseline results in Figure 19 and Figure 20 it can be seen that with an EU/UK student intake of 753, only 723 EU/UK students go on to access an internship. This is due to a combination of the dropout rates in each year of the medical degree and the percentage of graduates that chose not to enter the model. In the model, the dropout rates are between 1.0-1.5% for each year of the medical degree and 3.0% are assumed to leave the profession at this point.

The model allocates Intern places towards EU/UK students on a prioritised basis and allocates any excess places towards Non-EU/UK students. This broadly reflects how places are allocated in practice. See section 4.2.1 for detail on how Intern allocation is undertaken by the NDTP. It can be observed in the Figure 20, that the number of Non-EU/UK domicile students in the Internship year is the difference between the number of Intern places and the number of EU/UK domicile students participating in the internship year.[44] However, as noted previously, in 2022 the Intern matching exercise closed in June with 32 places in the intern programme unfilled. Anecdotally, this may be because of reduced barriers for entry to the equivalent of the internship year in England. As such the assumption that any Intern places unfilled by EU/UK students would be taken up by Non-EU/UK students going forward may not bear out in practice.

Figure 21 highlights that the number of participants in HST is significantly higher than IST. Though fewer people are taken into HST each year, the fact that it is specified as a five-year training programme within the model, versus two years for IST, means that the number of HST participants will generally be higher than for IST.

8.4.2 Reform Scenario A

Reform Scenario A increases the EU/UK student intake to 1,000 between 2021 and 2028. This includes the agreed government increases of 200 places by 2026. It also increases Intern places to 1,000 by 2034. Matching EU/UK medical student intake to the number of Intern places is undertaken to ensure that EU/UK medical students in Ireland have an internship place available to them on completion of their medical degree. Looking at Figure 22 and Figure 23 together it can be seen that with an increase in Internships to 1,000 by 2034 it is possible to match EU/UK intake to this number by 2028, or even earlier, due to the time delay involved in starting a medical degree and completing one. It is five years for undergraduate (i.e., school-leaver direct entry) and four years for GEM. This suggests that EU/UK medical student intake increases should lead increases in intern places if the policy aim is to maximise EU/UK student uptake of intern places.

Figure 23 highlights that even when Intern places and EU/UK student intake are matched that a small proportion of the Intern places are still taken up by Non-EU/UK medical students. Again, this is due to the assumptions that a small proportion of EU/UK students drop out of the medical degree and leave the profession before the Intern year. This suggests that it may be optimal for EU/UK student intake to be set a higher value than the number of expected Intern places available in 4-5 years' time. However, this result is sensitive to the modelling assumptions for dropout rates and exits of medical graduates from the profession. See

[44] As noted in Appendix C, the model assumes a constant rate of 31 EU/UK students graduating from medical schools outside Ireland, but from within Europe take up an internship each year. This reflects the average take up from this cohort over the last 4 years.

Appendix D for an overview of the range of potential values these assumptions may take on based on the Graduate Outcomes Survey.

Figure 24 also highlights the long timeframe between when an EU/UK student starts their degree and when they finish HST. Though this varies by speciality in practice, in the model it takes 14 or 15 years, depending on whether they take an undergraduate (i.e., school-leaver direct entry) or graduate entry degree, and inclusive of the one year wait periods between Intern and IST, and IST and HST. This highlights the very long-time horizons required for medical workforce planning.

8.4.2.1 Comparison of Reform Scenario A against current specialist training capacity

Figure 24 shows Reform Scenario A projections for IST and HST as a result of the increased medical student intake. In the opening years of the projection period the number of doctors in IST is 1,031 but rises to 1,094 by the year 2038. As seen in **Table 3**, the number of IST places (excluding GP streamline programme) in the 2021/2022 training year is 1,395. The projected IST places is 301 below the number of IST training places (excluding GP places) recorded in 2021/22. For HST, it opens the projection period at 1,803 doctors and settles at a long-run value of approximately 1,912 in 2044. The actual number of HST places (excluding the GP streamline programme) in the 2021/2022 training year is 1,726. The projected HST places is 186 above the number of recorded HST training places (excluding GP places).

8.4.3 Reform Scenario B

Reform Scenario B increased the proportion of EU/UK student places to 90% of the total places available in 2021 to ascertain the number of intern places that would be required to ensure that each EU/UK student could access one.

Figure 26 shows that if EU/UK medical student was increased to 1,263 by 2031 it would require Intern places to increase to 1,190. Again, this result is sensitive to the assumed student dropout rates in the model and the assumed exits of medical graduates from the profession.

8.4.3.1 Comparison of Reform Scenario B against current specialist training capacity

Figure 27 shows projections for IST and HST as a result of the increased medical student intake. In the opening years of the projection period the number of doctors in IST is 1,031 but rises to 1,406 by the year 2038. As seen in **Table 3**, the number of IST places (excluding GP streamline programme) in the 2021/2022 training year is 1,395. This is 11 places above the number of recorded IST training places (excluding GP places) in 2021/22. For HST, it opens the projection period at 1,803 doctors and settles at a long-run value of approximately 2,457 in 2044. The actual number of HST places (excluding the GP streamline programme) in the 2021/2022 training year is 1,726. This is 731 places above the number of recorded HST training places (excluding GP places). This suggests that reducing the proportion of foreign-educated students to 10% of the medical student population would require significant increases in IST and HST training places but that these increases would only be required to begin after long periods of time – approximately seven years for IST and eight years for HST.

9 Findings

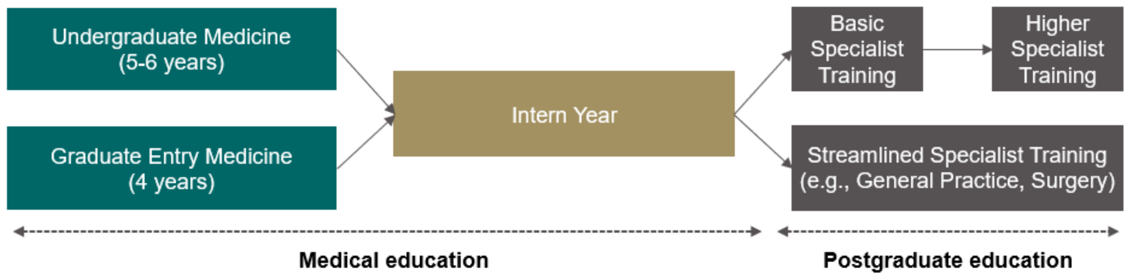
Medical workforce planning in Ireland aims to deliver a Consultant-Delivered Health Services as set out in the Hanly Report and to achieve national self-sufficiency in the production of local staff (Department of Health, 2003), (WHO, 2010). Achieving these aims requires a careful balance between medical student intake and specialist training places while having regard to the career structure of doctors within the health service to ensure the specialist skills created by the medical education and training system are retained (DoH, 2006a) (DoH, 2006b). Previous research by the NDTP and the ESRI has highlighted the growing demand for doctors, including consultants, into the future.

Overall, this paper highlights that:

- Ireland has a very high proportion of foreign educated doctors (40.45%), the fourth highest of OECD member states.
- While international comparisons of health systems are fraught with data and comparability issues, Ireland OECD data suggests Ireland has an approximately average number of doctors per capita. Note, Ireland's population is generally younger than other developed countries which would suggest a lower requirement for doctors, all else equal. In 2020, Ireland had more doctors per capita than countries such as the UK, New Zealand and France, and less than countries such as Australia, Germany and Austria.
- Despite an approximately average number of doctors per capita, Ireland has a significantly below average number of specialist doctors. The number of specialists is the sixth lowest of OECD countries for which data is available.
- A more detailed comparison of trainee, non-trainee doctors, and consultants with the UK and Australia underlines this and shows that Ireland has an excess of NCHDs not in training and relatively fewer consultants. However, it is worth noting that the number of trainees in Ireland is higher than Australia's.
- The HSE consultant workforce increased from 2,918 to 3,563, (5.1% average annual growth) between 2017 and 2021. For NCHDs, the increase went from 6,466 to 7,923 (average annual growth 5.2%). For non-training scheme NCHDs the increase was 2,564 to 3,081, or a growth rate of 4.7% (NDTP, 2022).
- Medical education in Ireland is a long and complex process. See Figure below. To become a doctor, an individual needs to complete a medical degree (4-6 years depending on student domicile and degree entry-route) and a post-degree Internship

year. To continue on to become a consultant, a doctor is required to complete some combination of Initial Specialist Training (IST) (2-4 years) followed by Higher Specialist Training (3-6 years). Depending on the route taken and type of specialism, the time taken to turn a first year undergraduate (i.e., school-leaver direct entry) medical student into a specialist doctor can be 10 years in the case of GPs, or 14 years in the case of surgeons. This assumes no employment gaps or career breaks between training programmes which, in practice, are a common feature in the careers of Irish educated doctors (who may temporarily work abroad, or intersperse specialist training with other education, research or periods of employment in non-training NCHD roles etc.,).

- There are a wide number of specialities (15) provided for in Higher Specialist Training (National Doctors Training & Planning, 2022). Each of these lead to a distinct specialisation. Some of these specialities have sub-specialities, for example, General Medicine (17 sub-specialities) and Surgery (11 sub-specialities).



Source: Reproduced from (Medical Council, 2013)

- In the 2021/22 academic year there were 1,403 medical student places available in the Irish Higher Education System. This is the highest medical graduate output per capita amongst OECD countries, however due to the large proportion of Non-EU students (46%) and availability specialist training capacity many of these graduates do not progress on to become consultants in Ireland.
- In response to the above challenges, there were significant annual increases over the period 2017-2021 in internship posts (3.9%/year), Initial Specialist Training places (4.4%/year) and Higher Specialist Training places (6.9%/year) which move the health system closer to a Consultant-Provided health service (NDTP, 2022).
- In 2017, the clinical placement costs for an international student in the UK was £110,000 per student (Dept. Health UK, 2017). It remains unclear whether the Irish health system is fully compensated for the cost of educating Non-EU/UK students.
- The cost of training incurred per intern was estimated to be €32,272 to €44,579 in 2002/2003 (Indecon, 2005). More recent figures are not available for Ireland.

- This paper developed a system dynamics model of medical workforce supply to examine how changes in the EU/UK student intake might better align with the specialist training capacity in the health system. This included a baseline scenario and two reform scenarios. The main elements of the reform scenarios are described below:
    - In Reform Scenario A, EU/UK student places are increased to 1,000 over the projection period. This is a 32% increase on the 2021 intake. Non-EU/UK student places are reduced to 403, down from 649 in 2021. This is a 37% reduction. Intern posts are increased to 1,000 from 854 over the first 14 years of the projection period out to 2034, a 17% increase on the 2021 base.
    - In Reform Scenario B increases the intake of EU/UK students to 1,263 incrementally from 2021 to 2031. The intake figure of 1,263 in 2031 is 90% of the total number of medical students first-year intake from all domicile groups (i.e., all EU, UK and Non-EU/UK students) in 2021. This is a 67% increase on the 2021 intake. Non-EU/UK students are reduced to 140 a year. This requires internships to be increased to 1,190 by 2035.
- The tables below summarise the key policy reforms for the Student Intake and Intern Year

Scenario	Student Cohort	2021	2031
Baseline (Steady State)	EU/UK	754	754
	Non-EU/UK	649	649
Scenario A (EU/UK intake increased to 1,000 in 2028)	EU/UK	754	1,000
	Non-EU/UK	649	403
Scenario B (EU/UK intake increased to 1,263 over ten-year period)	EU/UK	754	1,263
	Non-EU/UK	649	140

Scenario	Internship Places
Baseline (Steady State)	**854 throughout the projection period**
Scenario A	**854 to 1,000 by 2035**
Scenario B	**854 to 1,190 by 2035**

- This supply model analysis highlights that:
    - A long timeframe is required to increase medical education and training places. These places need to be carefully aligned to ensure the optimal pathway from student to consultant. Increased medical degrees places necessary to redress the

undersupply of Irish educated doctors require increased downstream capacity in specialist training programmes.

- For example, increasing undergraduate places in medicine by 100 requires an increase in internship places of 92, five years later and an increase in specialist training places (IST or GP training) of 75 approximately eight years later.
- For example, in a scenario where internship places are gradually increased to 1,000 by 2034, EU/UK medical student places should be increased to 1,000 by at least 2028 and it may be optimal to increase EU/UK medical student places beyond 1,000 due to the attrition of medical students between the degree and internship year.
- Increasing the intake of EU/UK students to 90% (1,263) of the 2021 intake levels by 2031 would require significant increases in specialist training capacity into the future. These increases occur over long-time horizons. In the case of HST, peak capacity is only required by 2044.

9.1.1 These results are sensitive to modelling assumptions on student dropouts rates, attrition and emigration which may vary into the future. Limitations

The models analyses IST and HST training places in aggregate. Workforce planning for doctors takes place at the specialty and subspecialty level (Morris & Smith, 2021). As noted, these each have their own timelines for completion of specialist training and can be combined in multiple ways. As such, the abstraction to group all IST and HST places together in two- and five-year programmes introduces some error to the projections, particularly if the composition of IST and HST programme specialties changes in the future.

The parameters utilised from the Retention Analysis are historical and reflect the situation at a given point in time. The attrition or retention of doctors is the result of many micro and macro factors which vary over time. It is likely that these retention figures will change into the future and would therefore give rise to different projections of IST, GP and HST training places in the future. For example, the retention rate for doctors completing their Internship Year in Ireland was based on doctors of any national background. The Fottrell Report noted non-Irish doctors were less likely to remain in Ireland post-internship. Given Scenario A expands the proportion of internships taken up by EU/UK doctors this might suggest higher retention in the future which, if true, would give rise to greater requirement for specialist training places.

Similarly, the retention analysis indicated that 76% of those completing BST went on to start HST or GP Training. This figure of 76% partly reflects the availability of BST and HST places over that period of time. So, utilising it to project the progression of doctors from IST to HST may not be reliable, particularly for future scenarios where the number of HST places is changing. Current policy is to expand the number of places in HST relative to IST into the future.

A number of initiatives are underway (see MacCraith Reports) which aim to increase retention. In addition, there has recently been a large increase in the numbers of Consultant posts available in Ireland which may further impact on the retention rates. Equally, a number of other factors such as the economy and conditions in the workplace could increase emigration in the future, and potentially reduce the take up of specialist training places by Irish educated doctors.

At the outset of this paper, it was noted that there is a twin need to increase the number of specialist training places for doctors in Ireland and reduce the reliance on foreign-educated doctors, particularly those not on training schemes. The WHO Code of Conduct also emphasises equal employment opportunities for foreign educated staff. This paper looks only at the Irish educated medical workforce. These objectives can be met by increasing the provision specialist training for foreign educated doctors as means to reduce the prevalence of Non-Training Scheme Doctors and increase the numbers of specialists. **Table 4** demonstrates that this is already a mechanism being utilised within the health system. Additionally, changes to Ireland’s immigration rules were announced in March 2022 which are expected to make it easier for foreign educated doctors to access specialist training.[45] This version of the model is not able to comment on this issue directly as it only includes Irish educated doctors in the scope of the model.

Lastly, while the model projects requirements for specialist training based on historical retention rates, it is not able to comment on the capacity of the health system to train this many doctors to specialist level at one time. Capacity to train doctors as part of IST and HST is principally, but not wholly, enabled by having a sufficient number of Consultants available to train Junior Doctors.

9.1.2 Further research

Further research to improve the model outputs could be undertaken in the following areas:

[45] DETE press release 08/03/2022

- Compare model outputs against historical outturn to calibrate the model further.
- Include foreign-educated doctors not in training as means to assess Ireland’s compliance with the WHO Code of Conduct under different scenarios.
- Include the number of Consultants and Non-Consultant Hospital Doctors not in training in the model. This would allow us to measure progress towards a Consultant-Delivered Health Service and provide an insight into potential specialist training capacity in the health system.
- The routes through specialist training in the model are presented in linear fashion, in reality doctors’ routes through IST, GP training and HST can take multiple forms and more system dynamics models in other countries attempt to account for this (Centre for Workforce Intelligence , 2012) (Joint Action Health Workforce Planning and Forecasting, 2015).
- Recent challenges allocating intern places to medical students in Ireland highlight the need for further work to understand the transition between medical degree and specialist training for EU/UK and Non-EU/UK graduates. This could take advantage of the Graduate Outcomes Survey.

10 Conclusion

- This paper highlighted an historic undersupply of doctors in which has contributed to a situation where there is an overreliance on foreign-educated doctors and relatively few Consultants when compared against our international peers. This is not in alignment with the WHO-GCP or the aim to provide a Consultant-Delivered health service. While Ireland produces the highest numbers of medical graduates per capita, these do not translate into doctors working in Ireland as many are Non-EU/UK students who leave after their medical degrees and before the internship year. Taken together these indicate a need to significantly increase the number of EU/UK medical students completing education in Ireland and going on to become consultants practicing here.
- In this context, this paper developed a medical workforce supply model to examine the effects of increasing medical student places for EU and UK students on specialist training requirements into the future i.e., to align student intake with the aim of achieving national self-sufficiency and a Consultant-Delivered health service. The analysis highlights that there is significant complexity involved in aligning student intake to match specialist training capacity. Very long and varied time-horizons occur between when a medical student begins university and when they complete specialist training, demanding a careful balance between student intake, specialist training capacity and the Consultant workforce. Even with large-scale increases in medical degree student intake in the short term, reducing Ireland's reliance on the foreign educated medical workforce will be a long-term endeavour.
- Because of the high proportion of Non-EU students educated here there is significant capacity to increase EU/UK student places within the educational system already. There are greater supply constraints within the postgraduate training system, though growth in capacity in recent years has been high.
- This paper looked at a range of scenarios which increased EU/UK medical student and specialist training intake, however does not define the optimal student intake. Nor does it estimate the potential for increasing postgraduate training capacity, for which the main constraint is the availability of Consultants. Further work is underway to identify the optimal medical student intake in Ireland, in particular estimating the total demand for doctors across the whole health system and the supply-side capacity required to meet this demand.

11 References

Abas, Z., Ramli, M., MI, D., N, S., Hanafiah, A., Aziz, N., . . . Musa, H. (2017). *A supply model for nurse workforce projection in Malaysia.*

Alonso, M. (2003). *Management of allocation of positions for specialist medical training.*

Anash, J., Kornre, D., Bayer, S., Pan, C., Jayabaskar, T., Matchar, D., . . . Quek, D. (2015). *Future requirements for and supply of opthamologists for an aging population in Singaopre.*

Arends-Kuenning, M., Calara, A., & Go, S. (2015). *International Migration Opportunities and Occupational Choice: A Case Study of Philippine Nurses 2002 to 2014.* Bonn: Institute for the Study of Labor.

Barber, P., & López-Valcárcel, B. (2010). Forecasting the need for medical specialists in Spain: application of a system dynamics model. *Human resources for health*.

Barlet, M., & Cacillon, M. (2016). *Projection of the supply of nurses in France: a microsimulation model.*

Brugha R, C. N. (2021). *Doctor Retention: A Cross-sectional Study of How Ireland Has Been Losing the Battle.*

Brugha, R., Clarke, N., Hendrick , L., & Sweeney , J. (2021, June). Doctor Retention: A Cross-sectional Study of How Ireland Has Been Losing the Battle. *International Journal of Health Policy and Managemetn, 10*(6), Pages 299-309. doi:10.34172/ijhpm.2020.54

Chalfin, D., Trzeciak, S., Likourezos, A., Baumann, B., & Dellinger, R. (2007). Impact of delayed transfer of critically ill patients from the emergency department to the intensive care unit. *Critical care medicine*.

Chalk, D., & Legg, A. (2017). *What factors are driving increasing demand for community nursing?*

Chung, M., Hung, K., Chiou, J., Fang, H., & Chiu, C. (2021). *Nursing manpower forecast for cancer patients.*

Copeland, M. (1949). Social accounting for moneyflows. *The Accounting Review*.

Cosgrave, C., Malatzky, C., & Gillespie, J. (2019). Social Determinants of Rural Health Workforce Retention: A Scoping Review. *Int J Environ Res Public Health*.

De Silva, D. (2017). How many doctors should we train for Sri Lanka? System dynamics modelling for training needs.

De Silva, D. (2017). How many medical specialists do Ministry of Health - Sri Lanka need by 2025: Use of system dynamics modelling for policy decisions.

Department of Public Expenditure and Reform. (2021). *National Development Plan 2021-2030.* Department of Public Expenditure and Reform.

Dept. Health UK. (2017). *Expansion of Undergraduate Medical Education: A consultation on how to maximise the benefits from the increases in medical student numbers.* Department of Health UK.

Dill, M., & Hirsch, G. (2021). *The Association of American Colleges' Local Area Physician Workforce Modeling Project.*

DoH. (2006). *Medical Education in Ireland: A New Direction.* Dublin: Department of Health.

DoH. (2006). *Preparing Ireland's Doctors to Meet the Health Needs of the 21st Century: Report of the Postgraduate Medical and Training Group (Buttimer Report).* Department of Health and Children.

DoH. (2014). *Strategic Review of Medical Training and Career Structure.* Department of Health.

DoH. (2018). *Health Service Capacity Review 2018: Review of Health Demand and Capacity Requirements in Ireland to 2031 - Main Report.* Department of Health.

DoH. (2022). *Report of the Expert Review Body on Nursing and Midwifery.* Department of Health.

Dolfman, M., Insco, M., & Holden, R. (2017). *Nursing and the Great Recession.* U.S. Bureau of Labour Statistics.

Edwards, J., Datta, I., Hunt, J., Stefan, K., Ball, C., Dixon, E., & Grondin, S. (2014). *A novel approach for the accurate prediction of thoracic surgery workforce requirements in Canada.*

Edwards, J., Datta, I., Hunt, J., Stefan, K., Ball, C., Dixon, E., & Grondin, S. (2016). *Forecasting the impact of stereotactic ablative radiotherapy for early-stage lung cancer on the thoracic surgery workforce.*

Enoch, T., Ooi, R., & Ooi, S. (2022). Impact of the implementation of the additional cost of teaching (ACT) levy on prospective international medical students applying to Northern Ireland and Scotland. *Postgrad Med Journal*.

Ferrari, T. (1978). *Elements of system-dynamics simulation.* Wageningen: Centre for Agricultural Publishing and Documentation.

Frances Cronin, N. C. (2019). The impacts of training pathways and experiences during intern year on doctor emigration from Ireland.

Government of Ireland. (2020). *Programme for Government – Our Shared Future.* Government of Ireland.

Gresenz, C., Auerbach, D., & Duarte, F. (2013). *Opportunities and challenges in supply-side: physician based models.*

Gritmad, H., Hunskar, S., & Braut, G. (2019). *Studieplasser i medisin i Norge.* Trondheim: Norwegian University of Science and Technology.

HEA. (2021, March). *Higher Education Authority*. Retrieved November 19, 2021, from hea.ie/statistics/interactive-reports-articles/completion-data-release-march2021/

Heffron, M., & Socha-Dietrich, K. (2019). *The Irish Paradox: Doctor shortages despite high numbers of domestic and foreign medical graduates.* Organisation for Economic Cooperation and Development.

HENSE. (2012). *Review of Medical and Dental School Intakes in England.*

Hernández, D. (2021, May 2). *An outline of System Dynamics*. Retrieved November 24, 2021, from https://www.linkedin.com/pulse/outline-systems-dynamics-daniel-hern%C3%A1ndez

Higgins, J. (2002). Nonlinear Systems in Medicine. Yale Journal of Biology and Medicine. *Yale Journal of Biology and Medicine*.

Humphries, N., Connell, J., & Buchan, J. (2019). Tracking the leavers: towards a better understanding of doctor migration from Ireland to Australia 2008-2018. *Human Resources for Health*.

Indecon. (2005). *The Cost of Undergraduate Medical Education in Ireland.* Working Group on Undergraduate Medical Education & Training.

Ishikawa, T., Fujiwara, K., Ohba, H., Suzuki, T., & Ogasawara, K. (2017). *Forecasting the regional distribution and sufficiency of physicians in Japan with a coupled systems dynamics - geographical information systems model.*

Ishikawa, T., Ohba, H., Yokooka, Y., Nakamura, K., & Ogasawara, K. (2013). *Forecasting the absolute and relative shortage of physicians in Japan using a systems dynamics model approach.*

Jetha, A., Kernan, L., & Kurowski, A. (2017). *Conceptualizing the dynamics of workplace stress: a systems-based study of nursing aides.*

Joint Action Health Workforce Planning and Forecasting. (2015). *Handbook on Health Workforce Planning Methodologies Across EU countries.*

Joyce, C., McNeil, J., & Stoelwinder, J. (2006). *More doctors, but not enough: Australian medical workforce supply 2001-2012.*

Keegan, C., Brick, A., García-Rodríguez, A., & Hill, L. (2022). *Projections of Workforce Requirements for Public Hospitals in Ireland, 2019-2035: A Regional Analysis Based on the Hippocrates Model.* Dublin: ESRI.

Kinsella, S., & Kiersey, R. (2016). *Health Workforce Planning Models, Tools and Processes in Five Countries.*

Koichubekov, B., Kharin, A., Sorokina, H., Korshukov, I., & Omarkulov, B. (2020). *System dynamics modeling for general practitioner workforce forecasting in Kazakhstan.*

Koolstra, K. (2005). *Transport Infrastructure Slot Allocation.* Delft: TU Delft.

Lattimer, V., Brailsford, S., Turnbull, J., Tarnaras, P., Smith, H., George, S., . . . Maslin-Prothero, S. (2004). *Reviewing emergency care sytems I: insights from system dynamics modelling.*

Lopes, M., Almeida, Á., & Almada-Lobo, B. (2016). *Forecasting the medical workforce: a stochastic agent-based simulation approach.*

Lyneis, J., & Hines, J. (2007). The Standard Method for System Dynamics Modeling. Worcester Polytechnic Institute.

Lyons, G., & Duggan, J. (2015). System dynamics modelling to support policy analysis for sustainable health care.

McCarthy, G., Tyrrell, M., & Cronin, C. (2002). *National Study of Turnover in Nursing and Midwifery.* University College Cork.

McHugh, S. (2021). *Longer Term Review: Matters relating to Student Nurses and Midwives.* Department of Health (Ireland).

Medical Council . (2021). *Medical Workforce Intelligence Report.*

Medical Council. (2013). *Medical Education, Training and Practice in Ireland 2008-2013 A Progress Report.*

Morgan, J., & Graber-Naidich, A. (2019). *Small System Dynamics Model for Alleviating the General Practitioners Rural Care Gap in Ontario, Canada.*

Morii, Y., Ishikawa, T., Suzuki, T., Tsuji, S., Yamanaka, M., Ogasawara, K., & Yamashina, H. (2019). *Projecting future supply and demand for physical therapists in Japan using system dynamics.*

Morris, R., & Smith, M. (2021). *Demand for Medical Consultants and Specialists to 2028 and the Training Pipeline to Meet Demand: A High Level Stakeholder Informed Analysis.* Dublin: HSE - National Doctors Training & Planning.

Murphy, G., Birch, S., MacKenzie, A., Alder, R., Lethbridge, A., & Little, L. (2012). Eliminating the shortage of registered nurses in Canada: An exercise in needs-based planning. *Health Policy*.

National Doctors Training & Planning. (2022). *Medical Workforce Report 2021-2022.*

NDTP. (2022). *Medical Workforce Report 2021-22.* HSE National Doctors Training & Planning.

NMBI. (2020). *NMBI Statement of Strategy 2020-2022.* Nursing and Midwifery Board of Ireland.

NMBI. (2021). *MyNMBI Registrant User Guide.* Nursing and Midwifery Board of Ireland.

OECD. (2019). *Recent Trends in International Migration of Doctors, Nurses and Medical Students.*

OECD. (2021). *OECD 2021 Health at a Glance 2021: OECD Indicators,.* Paris: OECD Publishing.

Pierse, T., Morris, R., OToole, L., Kinirons, B., & Staddon, E. (2022). The Retention of Training Doctors in the Irish Health System.

Polkowski, R. (2013). *Swedish medical students abroad: a case of return migration policy-making.* Gothenburg: Gothenburg University.

PSPC. (2018). *Report of the Public Service Pay Commission: Recruitment and Retention Module 1 (August 2018).* Public Service Pay Commission.

Rafiei, S., Daneshvaran, A., & Abdollahzade, S. (2018). *Forecasting the shortage of neurosurgeons in Iran using a system dynamics approach.*

Relic, D., & Bozikov, J. (2020). *Application of a system dynamics model in forecasting the supply and age distribution of physicians.*

Report of the National Task Force on Medical Staffing. (2003).

Ricketts, T., Adamson, W., Fraher, E., Knapton, A., Geiger, J., Abdullah, F., & Klein, M. (2017). *Future Supply of Pediatric Surgeons: Analytical Study of the Current and Projected Supply of Pediatric Surgeons in the Context of a Rapidly Changing Process for Speciality and Subspeciality Training.*

Royston, G., Dost, A., Townshend, J., & Turner, A. (1999). *Using system dynamics to help develop and implement policies and programmes in health care in England.*

Rutter, H., Savona, N., Glonti, K., Bibby, J., Cummins, S., Finegood, D., . . . White, M. (2017). The need for a complex systems model of evidence for public health. *The Lancet*.

Senese, F., Tubertini, P., Mazzocchetti, A., Lodi, A., Ruozi, C., & Grilli, R. (2015). *Forecasting future needs and optimal allocation of medical residency positions: the Emilia-Romagna Region case study.*

Sterman, J. (2000). *Business dynamics: systems thinking and modeling for a complex world.* Boston: McGraw-Hill.

(2014). *Strategic Review of Medical Training and Career Structure.*

Streeter, R., Zangar, G., & Chattopahyay, A. (2017). *Perspectives: Using Results from HRSA's Health Workforce Simulation Model to Examine the Geography of Prrimary Care.*

Vanderby, S., Carter, M., Latham, T., & Feindel, C. (2014). Modelling the future of the Canadian cardiac surgery workforce using system dynamics. *The Journal of the Operational Research Society*.

WHO. (2010). *The WHO Global Code of Practice on the International Recruitment of Health Personnel.* Geneva: World Health Organization.

WHO. (2016). *Global Strategy on Human Resources for Health: Workforce 2030.* Geneva: World Health Organization.

WHO. (2020). *State of the world's nursing 2020: Investing in education, jobs and leadership.* Geneva: World Health Organization.

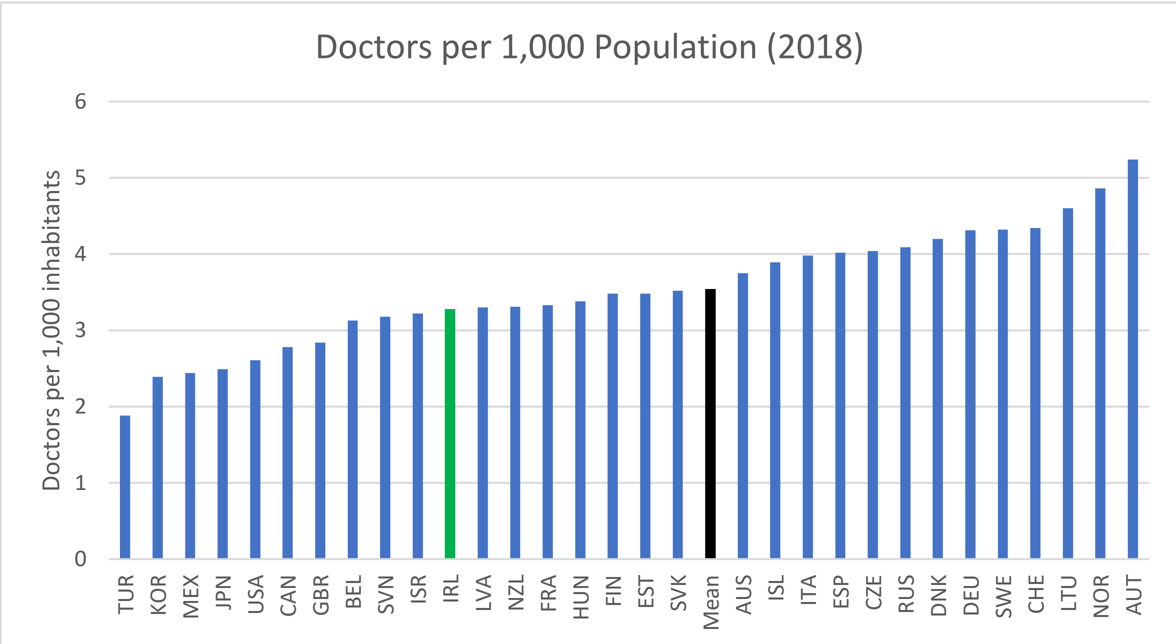
WHO. (2021). *World Health Organisation 2021 State of the World's Midwifery Report.* Geneva: WHO.

Willis, G., Woodward, A., & Cave, S. (2013). Robust workforce planning for the English medical workforce. *The 31st International Conference of the System Dynamics Society.*

Wu, M., Yu, J., & Huang, C. (2013). *Theoretical System Dynamics Modelling for Taiwan Paediatric Workforce in an Era of National Health Insurance and Low Birth Rates.*

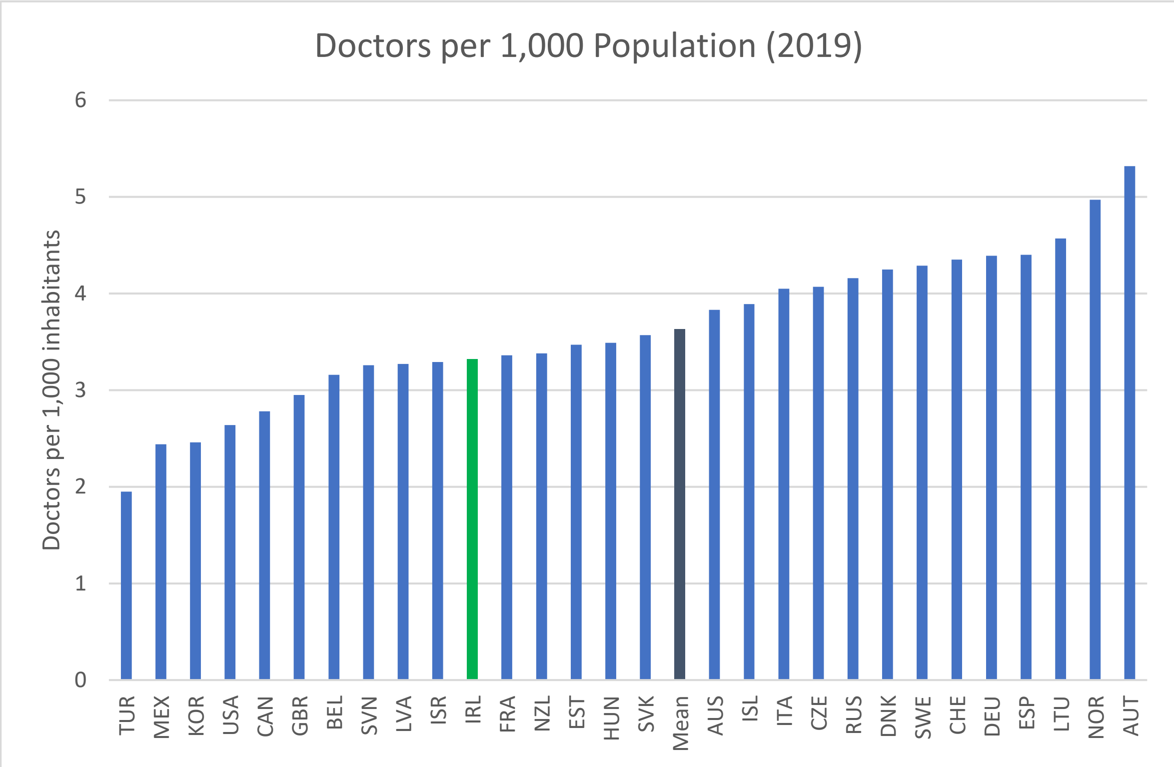
12 Appendix A: Doctors per 1,000 Inhabitants

Note that for OECD purposes, doctors are defined as "practising" doctors providing direct care to patients. However, for some countries (Canada, France, the Netherlands, Slovakia and Turkey), due to lack of comparable data, the figures correspond to "professionally active" doctors, including doctors working in the health sector as managers, educators, researchers, etc. (adding another 5-10% of doctors). Doctors are usually generalists who assume responsibility for the provision of continuing care to individuals and families, or specialists such as paediatricians, obstetricians/gynaecologists, psychiatrists, medical specialists and surgical specialists. This indicator is measured per 1,000 inhabitants.[46] Note that in the graphs below, 'mean' refers to the arithmetic mean of each dataset, rather the OECD average for doctors per 1,000 inhabitants.

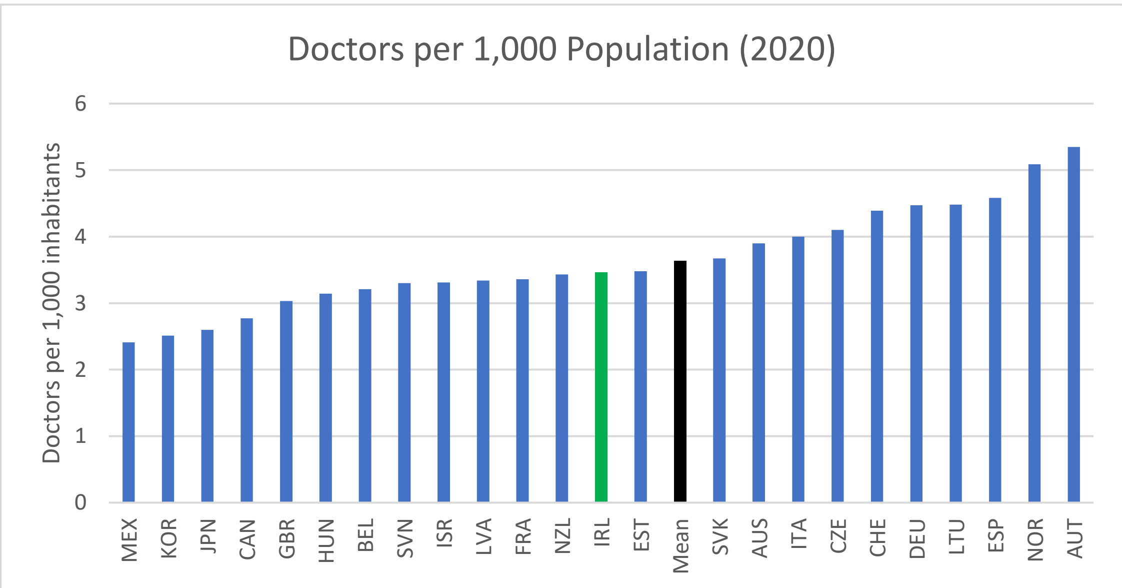


Doctors per 1,000 inhabitants 2018
Source: OECD (data accessed on 03/08/2022)

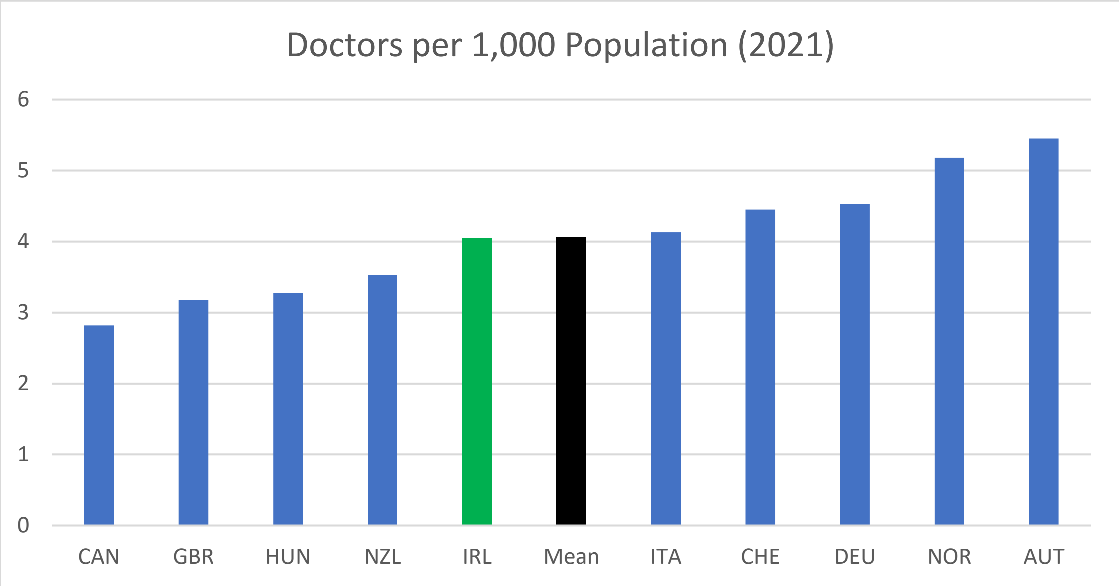
[46] See the OECD website (https://data.oecd.org/healthres/doctors.htm)



Doctors per 1,000 inhabitants 2019
Source: OECD (data accessed on 03/08/2022)



Doctors per 1,000 inhabitants 2020
Source: OECD (data accessed on 03/08/2022)



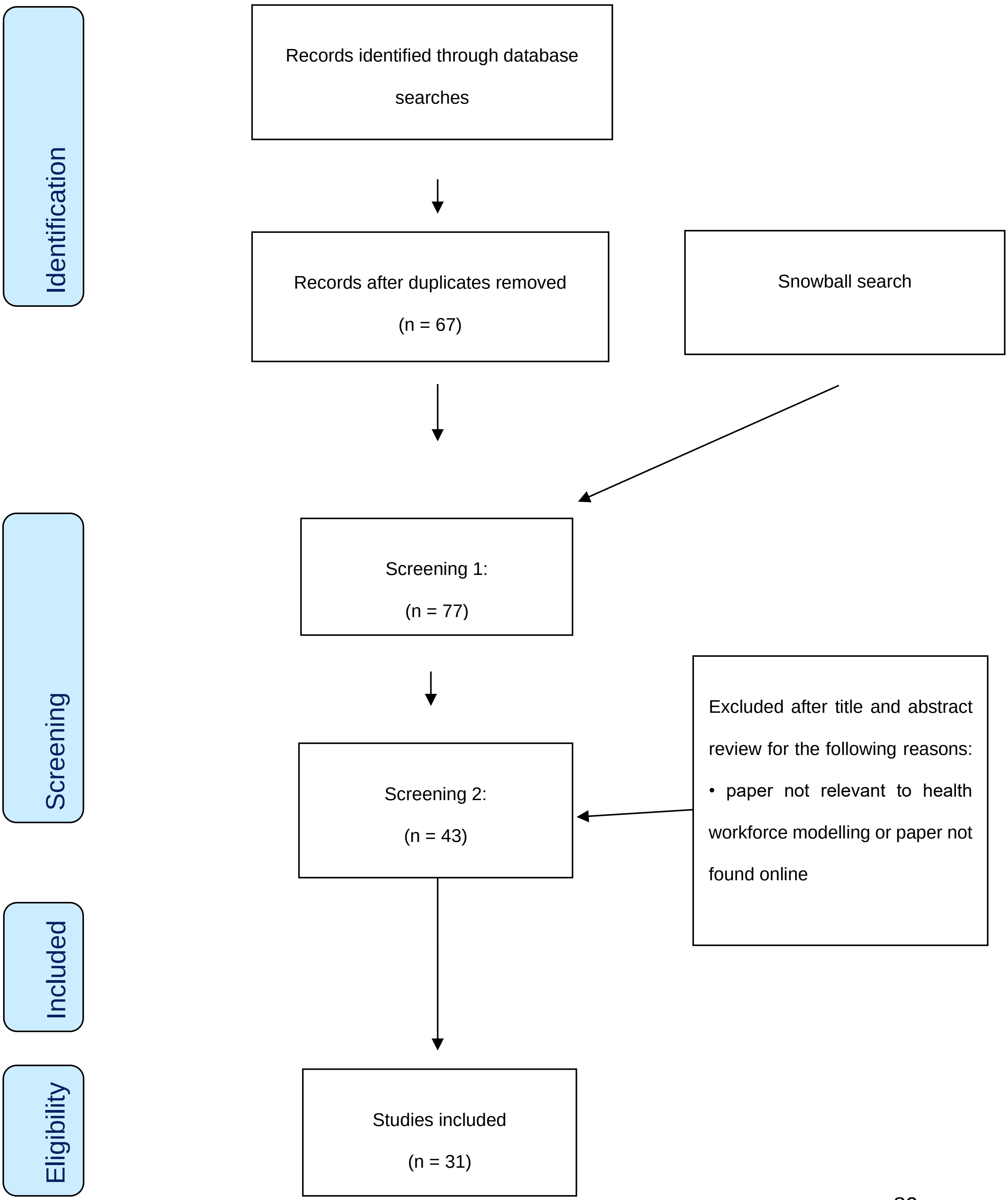
Doctors per 1,000 inhabitants 2021
Source: OECD (data accessed on 03/08/2022)

13 Appendix B: Search Strategy

No.	Sequence of steps
PubMed search string 20 January 2022	("system dynamic*"[Title/Abstract] OR " microsimulation "[Title/Abstract] OR " microanalytic simulation"[Title/Abstract] OR " microscopic simulation "[Title/Abstract]) AND (“Workforce"[Title/Abstract] OR "Planning"[Title/Abstract] OR "supply"[Title/Abstract] OR "demand"[Title/Abstract] OR " work force"[Title/Abstract]) AND (“nurs*"[Title/Abstract] OR "physician*"[Title/Abstract] OR "medical special*"[Title/Abstract] OR "medical prac*"[Title/Abstract] OR "surgeon"[Title/Abstract] OR "doctor*"[Title/Abstract] OR "midwife"[Title/Abstract] OR "midwi*"[Title/Abstract] OR " general prac*"[Title/Abstract])
EBSCO host (MedLine and EconLit) search string 20 January 2022	system dynamic* OR microsimulation OR microanalytic simulation OR microscopic simulation AND Workforce OR Planning OR supply OR demand OR work force AND nurs* OR physician* OR "medical special* OR medical prac* OR surgeon OR doctor* OR midwife OR midwi* OR " general prac*" OR GP*
Google Scholar search string 8 February 2022 (first two pages of results)	(intitle:"system dynamic*" OR intitle:"microsimulation") (intitle:Workforce OR intitle:Planning OR intitle:supply OR intitle:demand) (nurse* OR physician* OR "medical special*" OR "medical prac*" OR surgeon OR doctor* OR midw* OR GP*
Snowball search 4 August to 17 December 2021	

13.1 Prisma Flow Chart and abstracts of studies

The searches gave 77 citations after duplications were removed. After the title and abstract screening 31 publications were included in the final set.



13.2 Studies included in final set of literature review

Interpreting this table:

- Initial value means the value of a stock at the outset of the projection period. As stocks count the number of something at a point in time e.g. the number of doctors participating in specialist training, the model requires all stocks be populated with initial values. These initial values are then increased or decreased by the inflows and outflows from the stock.
- An inflow increases a stock over time.An outflow decreases a stock over time.
- Some parameter values are given as 'Determined within model'. The baseline parameter value for some of these variables can be observed in the Baseline Results section of the paper.
- In general, variable names are written in italics and in single quotation marks as follows 'Variable Name'

Author (Year)	Title	Country	Abstract
Abas ZA, Ramli MR, Desa MI, Saleh N, Hanafiah AN, Aziz N, Abidin ZZ, Shibghatullah AS, Rahman AF & Musa H (2017)	A supply model for nurse workforce projection in Malaysia	MYS	The paper aims to provide an insight into the significance of having a simulation model to forecast the supply of registered nurses for health workforce planning policy using System Dynamics. A model is highly in demand to predict the workforce demand for nurses in the future, which it supports for complete development of a needs-based nurse workforce projection using Malaysia as a case study. The supply model consists of three sub-models to forecast the number of registered nurses for the next 15 years: training model, population model and Full Time Equivalent (FTE) model. In fact, the training model is for predicting the number of newly registered nurses after training is completed. Furthermore, the population model is for indicating the number of registered nurses in the nation and the FTE model is useful for counting the number of registered nurses with direct patient care. Each model is described in detail with the logical connection and mathematical governing equation for accurate forecasting. The supply model is validated using error analysis approach in terms of the root mean square percent error and the Theil inequality statistics, which is important for evaluating the simulation results. Moreover, the output of simulation results provides a useful insight for policy makers as a what-if analysis is conducted. Some recommendations are proposed in order to deal with the nursing deficit. It must be noted that the results from the simulation model will be used for the next stage of the Needs-Based Nurse Workforce projection project. The impact of this study is that it provides the ability for greater planning and policy making with better predictions.
Alonso MI (2003)	Management of allocation of positions for specialist medical training	ESP	OBJECTIVE: Currently there is a large imbalance between supply and demand for medical specialists in the Spanish Health System. The aim of this study was to demonstrate the possible effects of current policies of allocating vacancies for interns and residents as well as to describe several measures and alternative policies. METHODS: Using the methodology of System Dynamics, we designed a simulation model of the allocation process. Based on the validated model, possible changes in the system through time in response to diverse allocation policies were simulated. Specifically, changes in the accumulated number of graduates who over the years have remained without specialty, the number of unemployed specialists, and the imbalance between supply and demand in the period under consideration were observed. RESULTS: The results obtained from the simulation indicate that allocation policies such as the current one tends to reduce the accumulated number of graduates without specialty, due to the philosophy characterizing this policy, but that it considerably increases the number of unemployed specialists and aggravates the supply-demand imbalance. In the simulation, this tendency remained over time even though more restrictive measures in numerus clausus and retirement age were adopted. Equally, a policy based on social needs and aware of delays in training would substantially contribute to eliminating unemployment among specialists and supply-demand imbalance over time. If such a policy were combined with the above-mentioned measures the results would be even better, more rapidly eliminating graduates without specialty, unemployed specialists, and supply-demand imbalances. CONCLUSIONS: If the Health Administration continues with the current system of allocation of places, the present imbalance in supply

			and demand will become even worse. Therefore, new and far-sighted measures and policies are required, as well as greater coordination between undergraduate and postgraduate training.
Ansah JP, Kornre DD, Bayer S, Pan C, Jayabaskar T, Matchar DB, Lew N, Phua A, Koh V, Lamoureaux E & Quek D (2015)	Future requirements for and supply of ophthalmologists for an aging population in Singapore	SGP	BACKGROUND: Singapore's population, as that of many other countries, is aging; this is likely to lead to an increase in eye diseases and the demand for eye care. Since ophthalmologist training is long and expensive, early planning is essential. This paper forecasts workforce and training requirements for Singapore up to the year 2040 under several plausible future scenarios. METHODS: The Singapore Eye Care Workforce Model was created as a continuous time compartment model with explicit workforce stocks using system dynamics. The model has three modules: prevalence of eye disease, demand, and workforce requirements. The model is used to simulate the prevalence of eye diseases, patient visits, and workforce requirements for the public sector under different scenarios in order to determine training requirements. RESULTS: Four scenarios were constructed. Under the baseline business-as-usual scenario, the required number of ophthalmologists is projected to increase by 117% from 2015 to 2040. Under the current policy scenario (assuming an increase of service uptake due to increased awareness, availability, and accessibility of eye care services), the increase will be 175%, while under the new model of care scenario (considering the additional effect of providing some services by non-ophthalmologists) the increase will only be 150%. The moderated workload scenario (assuming in addition a reduction of the clinical workload) projects an increase in the required number of ophthalmologists of 192% by 2040. Considering the uncertainties in the projected demand for eye care services, under the business-as-usual scenario, a residency intake of 8–22 residents per year is required, 17–21 under the current policy scenario, 14–18 under the new model of care scenario, and, under the moderated workload scenario, an intake of 18–23 residents per year is required. CONCLUSIONS: The results show that under all scenarios considered, Singapore's aging and growing population will result in an almost doubling of the number of Singaporeans with eye conditions, a significant increase in public sector eye care demand and, consequently, a greater requirement for ophthalmologists.
Barber P & López-Valcárcel BG (2010)	Forecasting the need for medical specialists in Spain: application of a system dynamics model	ESP	BACKGROUND: Spain has gone from a surplus to a shortage of medical doctors in very few years. Medium and long-term planning for health professionals has become a high priority for health authorities. METHODS: We created a supply and demand/need simulation model for 43 medical specialties using system dynamics. The model includes demographic, education and labour market variables. Several scenarios were defined. Variables controllable by health planners can be set as parameters to simulate different scenarios. The model calculates the supply and the deficit or surplus. Experts set the ratio of specialists needed per 1000 inhabitants with a Delphi method. RESULTS: In the scenario of the baseline model with moderate population growth, the deficit of medical specialists will grow from 2% at present (2800 specialists) to 14.3% in 2025 (almost 21 000). The specialties with the greatest medium-term shortages are Anaesthesiology, Orthopaedic and Traumatic Surgery, Paediatric Surgery, Plastic Aesthetic and Reparatory Surgery, Family and Community Medicine, Paediatrics, Radiology, and Urology. CONCLUSIONS: The model suggests the need to increase the number of students admitted to medical school. Training itineraries should be redesigned to facilitate mobility among specialties. In the meantime, the need to make more flexible the supply in the short term is being filled by the immigration of physicians from new members of the European Union and from Latin America.
Barlet M & Cavillon M (2016)	Projection of the supply of nurses in France: a microsimulation model	FRA	As of January 1, 2010, nearly 520,000 nurses working in France are listed in the Adeli directory. The number of nurses in this profession has multiplied by 1.7 in 20 years. They have grown at a much higher rate than the population. As a result, the density of nurses has increased significantly. In 2010, there were more than 800 active nurses per 100,000 inhabitants. This profession, which is predominantly female (88% of the workforce), works mainly in public hospitals (49% of the workforce) and, unlike doctors, has a stable average age. Nurses, especially private practice nurses, are not well distributed between regions and these strong spatial inequalities have not been reduced in the last 10 years. Regional migrations are infrequent but always to the benefit (or detriment) of certain regions. Classically, the southern regions benefit from these migratory flows. Men are more inclined to change their mode of practice and to choose to set up in

			private practice. Finally, salaried nurses in public hospitals stop working on average at the age of 56, salaried nurses in private hospitals at 59 and self-employed nurses at 61.
Chalk D & Legg A (2017)	What factors are driving increasing demand for community nursing?	UK	Demand for district nursing services is increasing significantly. With increasing economic pressures, services are struggling to meet increases in demand, and are looking to become more proactive in planning for future demand. Traditional quantitative forecasting methods have limited use, because of the complexity of inter-linking factors that potentially drive demand for community services. Qualitative system dynamics approaches can be useful to model the complex interplay of causal factors leading to an effect, such as increased demand for services, and identify particular areas of concern for future focus. We ran a facilitated qualitative system dynamics workshop with representatives working across community nursing services in Cornwall. The generated models identified 7 key areas of concern that could be significantly contributing to demand for district nursing services. We outline the identified problem areas in this paper, and discuss potential recommendations to reduce their effects based on causal links identified in the models.
Chung MH, Hung KC, Chiou JF, Fang HF & Chiu CH (2021)	Nursing manpower forecast for cancer patients	TWN	BACKGROUND AND OBJECTIVES: This paper presents a dynamic model aimed at predicting nursing manpower requirements for cancer care over the next ten years. The proposed model, based on the Taiwan Health Insurance Database (2000 to 2010), is meant to serve as a reference in establishing policy for government health units. METHODS: The proposed prediction model uses fuzzy sets to replace definite values with interval values in order to account for uncertainties in real-world data and enhance the flexibility of prediction results. RESULTS: Our results suggest that the demand for nursing manpower for cancer care will grow steadily in the foreseeable future. The gap between the demand for nursing staff and the supply is expected to peak in 2027. By then, the number of oncologists is expected to reach 7,083 (54.32% of the total number of in-hospital physicians), but the number of oncology nurses will be less than 26,297 (56.5% of the total healthcare manpower). It is also expected that there will be fewer than 1,613 outpatient physicians (71.81% of the total number of physicians) and fewer than 4,967 outpatient nurses (68.46% of the total nursing manpower). CONCLUSIONS: This paper provides a valuable reference for government agencies involved in the nursing manpower planning to improve the quality of nursing care.
De Silva D (2017)	How many doctors should we train for Sri Lanka? System dynamics modelling for training needs	LKA	INTRODUCTION: Over the years, Sri Lanka has achieved remarkable health gains for the money spent on health. Currently about 1450 doctors enter the health system annually. While some advocate opening up of new medical schools to address an apparent shortage of doctors in the country, others argue against it. OBJECTIVE: To identify the number of doctors Sri Lanka need. METHODOLOGY: System dynamics, an analytical modelling approach and a methodology for studying complex feedback systems was used. Two sub models of “need” and “supply” were developed and simulated for a period of 15 years from 2017 to 2032 RESULTS: At present the doctor to population ratio is 1:671 and 91% of the need has been met. This study shows that currently there is a shortage of doctors in the country. However, the supply will match the need by 2025/26. Increasing the number of doctors, will result in oversupply of doctors towards the latter part of the next decade. CONCLUSIONS: There is no acute necessity to open up new Medical Schools. However comprehensive health workforce analysis needs to be done once in 5 years and the number of doctors to be trained, decided accordingly.

De Silva MD (2017)	How many Medical specialists do Ministry of Health - Sri Lanka need by 2025: Use of system dynamics modelling for policy decisions	LKA	INTRODUCTION: The Ministry of Health is the largest health care provider in Sri Lanka in terms of funding, coverage and human resources. Long duration and high training cost of a medical specialist highlights the importance of health human resource planning. Ministry of Health, Sri Lanka has no scientific cadre planning for medical specialists. METHODS: System dynamics, an analytical modelling approach and a methodology for studying complex feedback systems was used. Two sub models of "need" and "supply" were developed and simulated over a period of 10 years from 2016 to 2025. RESULTS: By December 2015 there were 1860 clinician medical specialists with an average age of 46.8 years, in the government hospitals in Sri Lanka. In the surgical group of specialties, the Proposed Training Rate is more than Current Training Rate while in Medical and Paediatric groups and in Radiology, Anaesthesiology, Psychiatry, Dermatology and Haematology Proposed Training Rate is less than the Current Training Rate. CONCLUSIONS: In Surgical specialities the number of trainees enrolled in the Pre-MD programme should be increased from 55 to 71 and while in medical specialities the number of trainees enrolled in Pre- MD programmes should be reduced from 107 to 68 and in the Paediatric specialities from 47 to 39. During the 2016-2025 period, 765 specialists will be lost to the Ministry of Health costing nearly Rs 7.6 billion and there will be 4050 consultants by 2025, which is a 120% increase.
Dill MJ & Hirsch GB (2021)	The Association of American Medical Colleges' Local Area Physician Workforce Modeling Project	USA	Physician workforce planning must address multiple concerns such as having sufficient numbers and adequate geographic distribution of physicians and pressures for physicians to adapt to new models of care and payment. Though there are national workforce planning tools, planning tools for local areas have been scarce. This article describes a dynamic simulation model developed as a pilot project to support physician workforce planning in 2 metropolitan areas, Cleveland and Albuquerque (February 2014-June 2016). This model serves as a prototype for planning tools that could be used by medical educators and local health systems to project the effect of different policies on physician supply and demand. System dynamics and group model building approaches were used to develop the model with the participation of local stakeholders to create the model's causal structure. The model included determinants of the demand for primary and specialty care for the local population and projected the effects of births and deaths, aging, level of chronic illness present, and migration on demand. Physician supply was disaggregated by primary versus specialty care, age, sex, and work setting and projected based on completions of local residency programs, physician migration in and out of the area, and retirements. Feedback relationships between supply and demand (e.g., adequacy of care affecting the distribution of chronic illnesses, demand for care influencing in- and out-migration of physicians) were also included and had important effects on the results produced by the model. Scenarios were simulated that projected increased demand for care (e.g., through expanded insurance coverage) and increased supply (e.g., through practice incentives to encourage in-migration) and a combination of these. An expanded advanced practice registered nurse and physician assistant capacity scenario was also simulated. In Albuquerque, the combination scenario yielded the greatest increases in local physician supply.
Edwards JP, Datta I, Hunt JD, Stefan K, Ball CG, Dixon E & Grondin SC (2014)	A novel approach for the accurate prediction of thoracic surgery workforce requirements in Canada	CAN	OBJECTIVE: To develop a microsimulation model of thoracic surgery workforce supply and demand to forecast future labour requirements. METHODS: The Canadian Community Health Survey and Canadian Census data were used to develop a microsimulation model. The demand component simulated the incidence of lung cancer; the supply component simulated the number of practicing thoracic surgeons. The full model predicted the rate of operable lung cancers per surgeon according to varying numbers of graduates per year. RESULTS: From 2011 to 2030, the Canadian national population will increase by 10 million. The lung cancer incidence rates will increase until 2030, then plateau and decline. The rate will vary by region (12.5% in Western Canada, 37.2% in Eastern Canada) and will be less pronounced in major cities (10.3%). Minor fluctuations in the yearly thoracic surgery graduation rates (range, 4-8) will dramatically affect the future number of practicing surgeons (range, 116-215). The rate of operable lung cancer varies from 35.0 to 64.9 cases per surgeon annually. Training 8 surgeons annually would maintain the current rate of operable lung cancer cases per surgeon per year (range, 32-36). However, this increased rate of training will outpace the lung cancer incidence after 2030. CONCLUSIONS: At the current rate of training, the incidence of operable lung cancer will increase until 2030 and then plateau and decline. The increase will outstrip the supply of thoracic surgeons, but the decline after 2030 will translate into an excess future supply. Minor increases in the rate of training in response to short-term needs could be problematic in the longer term. Unregulated workforce changes should, therefore, be approached with care.

Edwards JP, Datta I, Hunt JD, Stefan K, Ball CG, Dixon E & Grondin SC (2016)	Forecasting the impact of stereotactic ablative radiotherapy for early-stage lung cancer on the thoracic surgery workforce	CAN	OBJECTIVES: To predict variation in thoracic surgery workforce requirements with the introduction of stereotactic ablative radiotherapy (SABR) for the treatment of early-stage non-small-cell lung cancer (NSCLC). METHODS: Using Canadian census microdata and the Canadian Community Health Survey, a microsimulation model representing the national population was developed. The demand component simulates the incidence of lung cancer, incorporating the impact of computed tomography (CT) screening for high-risk individuals (>30 pack-year smoking history; age 55-74 years). The supply component simulates the number of thoracic surgeons. SABR was introduced into the model to predict changes in the number of operable NSCLC cases per thoracic surgeon, modelling 30, 60 and 90% compliance with SABR for Stage IA and then for both Stage IA and IB NSCLC. RESULTS: In the absence of SABR, the volume of operative NSCLC per surgeon increases by a peak of 49.4% (by 2027) and then gradually declines to the present-day volume by 2049. More dramatic decreases are seen with increasing compliance with SABR for Stage IA/IB NSCLCs. If the number of new surgeons entering the workforce per year were reduced by 33%, the operative volume per surgeon would increase by a peak of 57.1% (30% Stage IA SABR compliance) and would decrease by up to 49.1% (90% Stage IA SABR compliance). CONCLUSIONS: With the implementation of SABR for treatment of early NSCLC, there would be a decrease in operative volume. The impact would depend on the stage of NSCLC for which SABR is recommended and on compliance. A national strategy for thoracic surgery workforce planning is necessary, given the complex interaction of CT screening and the treatment of medically operable early NSCLC with SABR.
Gresenz CR, Auerbach DI & Duarte F (2013)	Opportunities and challenges in supply-side simulation: physician-based models.	USA	OBJECTIVE: To provide a conceptual framework and to assess the availability of empirical data for supply-side microsimulation modelling in the context of health care. DATA SOURCES: Multiple secondary data sources, including the American Community Survey, Health Tracking Physician Survey, and SK&A physician database. STUDY DESIGN: We apply our conceptual framework to one entity in the health care market-physicians-and identify, assess, and compare data available for physician-based simulation models. PRINCIPAL FINDINGS: Our conceptual framework describes three broad types of data required for supply-side microsimulation modelling. Our assessment of available data for modelling physician behaviour suggests broad comparability across various sources on several dimensions and highlights the need for significant integration of data across multiple sources to provide a platform adequate for modelling. A growing literature provides potential estimates for use as behavioural parameters that could serve as the models' engines. Sources of data for simulation modelling that account for the complex organizational and financial relationships among physicians and other supply-side entities are limited. CONCLUSIONS: A key challenge for supply-side microsimulation modelling is optimally combining available data to harness their collective power. Several possibilities also exist for novel data collection. These have the potential to serve as catalysts for the next generation of supply-side-focused simulation models to inform health policy.
HENSE (2012)	Review of Medical and Dental School Intakes in England	UK	This review considers whether the current levels of medical and dental student intakes are in line with the predicted future workforce requirements and makes recommendations for the future.

Ishikawa T, Fujiwara K, Ohba H, Suzuki T & Ogasawara K (2017)	Forecasting the regional distribution and sufficiency of physicians in Japan with a coupled system dynamics-geographic information system model	JPN	BACKGROUND: In Japan, the shortage of physicians has been recognized as a major medical issue. In our previous study, we reported that the absolute shortage will be resolved in the long term, but maldistribution among specialties will persist. To address regional shortage, several Japanese medical schools increased existing quota and established “regional quotas.” This study aims to assist policy makers in designing effective policies; we built a model for forecasting physician numbers by region to evaluate future physician supply–demand balances. METHODS: For our case study, we selected Hokkaido Prefecture in Japan, a region displaying disparities in healthcare services availability between urban and rural areas. We combined a system dynamics (SD) model with geographic information system (GIS) technology to analyse the dynamic change in spatial distribution of indicators. For Hokkaido overall and for each secondary medical service area (SMSA) within the prefecture, we analysed the total number of practicing physicians. For evaluating absolute shortage and maldistribution, we calculated sufficiency levels and Gini coefficient. Our study covered the period 2010–2030 in 5-year increments. RESULTS: According to our forecast, physician shortage in Hokkaido Prefecture will largely be resolved by 2020. Based on current policies, we forecast that four SMSAs in Hokkaido will continue to experience physician shortages past that date, but only one SMSA would still be understaffed in 2030. CONCLUSION: The results show the possibility that diminishing imbalances between SMSAs would not necessarily mean that regional maldistribution would be eliminated, as seen from the sufficiency levels of the various SMSAs. Urgent steps should be taken to place doctors in areas where our forecasting model predicts that physician shortages could occur in the future
Ishikawa T, Ohba H, Yokooka Y, Nakamura K & Ogasawara K (2013)	Forecasting the absolute and relative shortage of physicians in Japan using a system dynamics model approach	JPN	BACKGROUND: In Japan, a shortage of physicians, who serve a key role in healthcare provision, has been pointed out as a major medical issue. The healthcare workforce policy planner should consider future dynamic changes in physician numbers. The purpose of this study was to propose a physician supply forecasting methodology by applying system dynamics modelling to estimate future absolute and relative numbers of physicians. METHOD: We constructed a forecasting model using a system dynamics approach. Forecasting the number of physician was performed for all clinical physician and OB/GYN specialists. Moreover, we conducted evaluation of sufficiency for the number of physicians and sensitivity analysis. RESULT & CONCLUSION: As a result, it was forecast that the number of physicians would increase during 2008-2030 and the shortage would resolve at 2026 for all clinical physicians. However, the shortage would not resolve for the period covered. This suggests a need for measures for reconsidering the allocation system of new entry physicians to resolve maldistribution between medical departments, in addition, for increasing the overall number of clinical physicians.
Joyce CM, McNeil JJ & Stoelwinder JU (2006)	More doctors, but not enough: Australian medical workforce supply 2001–2012	AUS	OBJECTIVE: To project the future size of the Australian medical workforce, from 2001 to 2012. DESIGN AND SETTING: Stochastic simulation modelling of the Australian medical workforce, taking into account recent increases in medical school capacity and trends in the intake of foreign graduates. MAIN OUTCOME MEASURES: Number of full-time equivalent (FTE) medical practitioners per 100 000 persons within various occupation groups from 2001 (baseline) to 2012. RESULTS: The total medical workforce was projected to rise from 53 384 in 2001 to 67,659 by 2012 (95% CI, 63 924–71 036). On a per capita basis, the number of FTE clinicians was projected to rise from 331 per 100 000 persons in 2001 to 382 (95% CI, 359–403) per 100,000 persons in 2012. The general practice workforce was projected to fall from 133 FTE general practitioners per 100 000 persons in 2001, to 129 per 100 000 persons in 2003, and then remain at around this level through to 2012. The specialist workforce was projected to show steady growth, rising from 162 FTE specialists per 100 000 persons in 2001 to 206 (95% CI, 194–218) per 100 000 persons in 2012. CONCLUSIONS: The general practice workforce is likely to face continued chronic shortages, necessitating innovative policy responses to ensure that the community’s need for primary medical care is met. Retirement rates are a key determinant of workforce supply, suggesting a need to encourage general practitioners to remain active as long as they remain effective. Further refinement of stochastic models will help facilitate a more proactive approach to workforce planning.

Kinsella S & Kiersey RA (2016)	Health Workforce Planning Models, Tools and Processes in Five Countries	AUS, NLD, NZ, UK	This evidence review examines examples from the health workforce planning frameworks of other countries to highlight the systems, tools, and models used to implement health workforce planning policy and strategies. The aim is to understand the functional requirements of a successful workforce planning approach. Five countries were chosen for examination during an initial scoping exercise by the Health Research Board based on their similarity in size to Ireland or their scattered rural population. The countries chosen were Australia, the Netherlands, New Zealand, Scotland, and Wales.
Koichubekov B, Kharin A, Sorokina M, Korshukov I & Omarkulov B (2020)	System dynamics modeling for general practitioner workforce forecasting in Kazakhstan	KAZ	BACKGROUND: Primary health care has been proven to be a highly effective and efficient way to address the main causes and risks of poor health and well-being today, as well as handling the emerging challenges that will threaten health and well-being tomorrow. In our study we used the System Dynamics approach to develop a model for the population and General Practitioner workforce to include multiple inputs and their relationships in the equations for each stock and flow. METHODS: We built the model in the Any Logic software to cover the flow of medical workers, demographic data of the population and the prevalence of the disease over time. Three scenarios were examined for forecasting primary health care personnel resources. The base year for forecasting was 2018, and the modelling was carried out until 2030. RESULTS: All of three scenarios indicate that with the current number of graduated General Practitioners, the shortage of primary care physicians will be exacerbated. In general, the shortage can reach more than 2,000 on a population of 18.3 million (2018). CONCLUSION: The projected shortage of doctors in the primary health care system requires special attention to human resource planning. Only one third of medical graduates in Kazakhstan go to work in the primary health care system. The government needs to develop measures to stimulate and support young medical doctors to become general practitioners.
Lopes MA, Almeida ÁS & Almada-Lobo B (2016)	Forecasting the medical workforce: a stochastic agent-based simulation approach	PRT	Starting in the 50s, healthcare workforce planning became a major concern for researchers and policy makers, since an imbalance of health professionals may create a serious insufficiency in the health system, and eventually lead to avoidable patient deaths. As such, methodologies and techniques have evolved significantly throughout the years, and simulation, in particular system dynamics, has been used broadly. However, tools such as stochastic agent-based simulation offer additional advantages for conducting forecasts, making it straightforward to incorporate microeconomic foundations and behaviour rules into the agents. Surprisingly, we found no application of agent-based simulation to healthcare workforce planning above the hospital level. In this paper we develop a stochastic agent-based simulation model to forecast the supply of physicians and apply it to the Portuguese physician workforce. Moreover, we study the effect of variability in key input parameters using Monte Carlo simulation, concluding that small deviations in emigration or dropout rates may originate disparate forecasts. We also present different scenarios reflecting opposing policy directions and quantify their effect using the model. Finally, we perform an analysis of the impact of existing demographic projections on the demand for healthcare services. Results suggest that despite a declining population there may not be enough physicians to deliver all the care an ageing population may require. Such conclusion challenges anecdotal evidence of a surplus of physicians, supported mainly by the observation that Portugal has more physicians than the EU average.
Morgan, JS & Graber-Naidich, A (2019)	Small System Dynamics Model for Alleviating the General Practitioners Rural Care Gap in Ontario, Canada	CAN	The disproportionate concentration of healthcare professionals in urban areas is a concern in many countries, including Canada. A need to address this rural care gap has driven a large number of government-led initiatives worldwide over the years. This paper presents a model that can be used as a tool to examine the efficacy of such policies on the workforce distribution in the long term. A small system dynamics model is employed to simulate the current and future distribution of general physicians at a jurisdictional level. The model represents the transition of general practitioners to provide insight into the dynamics of care provision over time. The movement, and competition, between rural and urban areas is modelled to enable detailed exploration of the ability for proposed measures to alleviate the care gap in the future. Among the tested policies are such commonly used initiatives as financial incentives to rural professionals, promotion of medical education in rural areas, expansion of rural education programs and the engagement of international medical graduates etc. We demonstrate how the model can be used as a tool to determine an efficient and well-chosen combination of policies which can help alleviate the rural care gap in the future, given that some policies are more effective than others alone but also combined with other initiatives. The presented small system dynamics model is tested on Canada's reality, but its simple nature lends itself to easy application to other countries that experience a similar problem.

Morii et al (2019)	Projecting future supply and demand for physical therapists in Japan using system dynamics	JPN	OBJECTIVES: Japan is the oldest country in the world, and its demand for medical care is expected to increase. Although a clear vision regarding the supply and demand for physical therapy services is necessary, there has been no research that forecasts the supply and demand for physical therapists in Japan. Consensus has not been reached on whether the supply of physical therapists is sufficient. This study projects this supply and demand to provide medical policymakers with basic data. METHODS: A system dynamics model was created to predict the number of physical therapists working in hospitals and clinics in Japan from 2014 to 2040. The future demand for physical therapy was estimated using the rehabilitation service utilization data from Open National Database, a publicly available nationwide health claims database. Sufficiency rates (supply/demand) were calculated, and sensitivity analysis was conducted on supply-related parameters. RESULTS: The number of physical therapists was projected to be 1.74 and 2.54 times greater in 2025 and 2040, respectively, than in 2014. The sufficiency rates were 1.72, 2.39, and 3.30 in 2015, 2025, and 2040, respectively. The sensitivity analysis revealed that attrition rates had the greatest effects on sufficiency. CONCLUSIONS: Although the current supply appears to be needed, considering the expected increase and uncertainty in medical needs. However, there is a possibility of a future oversupply, especially after 2025, when the rate of increase in demand will lessen. Further studies are required to evaluate the distribution of physical therapists among regions and specialties.
Murphy, GT, S Birch, A MacKenzie, R Alder, A Lethbridge & Little L (2012)	Eliminating the shortage of registered nurses in Canada: An exercise in needs-based planning	CAN	OBJECTIVE: To demonstrate the application of a needs-based framework for health human resources (HHR) planning to illustrate the potential effects of policies on the shortage of Registered Nurses (RNs) in Canada. METHODS: A simulation model was developed to simultaneously estimate the supply of and requirements for RNs based on data on the health needs of Canadians with current service delivery patterns and levels of productivity as a baseline scenario. The potential individual and cumulative effects of various policy scenarios on the 'gap' between these were simulated. RESULTS: A baseline scenario estimated a shortage of about 11,000 RN FTEs in 2007 for Canada, increasing to over 60,000 by 2022. However, multifaceted approaches have the potential to eliminate the estimated shortage. Conclusions: Estimating the requirements for health human resources must explicitly consider population health needs, levels of service delivery and HHR productivity while changing supply to meet requirements involves consideration of a broad range of comprehensive interventions. Investments in improved data collection and planning tools are needed to support more effective HHR planning. The estimated Canadian shortage of RNs based on current circumstances can be resolved in the short to medium term through modest improvements in RN retention, activity and productivity.
Rafiei S, Daneshvaran A & Abdollahzade S (2018)	Forecasting the shortage of neurosurgeons in Iran using a system dynamics model approach	IRN	CONTEXT: Shortage of physicians particularly in specialty levels is considered as an important issue in Iran health system. Thus, in an uncertain environment, long-term planning is required for health professionals as a basic priority on a national scale. AIMS: This study aimed to estimate the number of required neurosurgeons using system dynamic modelling. SETTING AND DESIGN: System dynamic modelling was applied to predict the gap between stock and number of required neurosurgeons in Iran up to 2020. SUBJECTS AND METHODS: A supply and demand simulation model was constructed for neurosurgeons using system dynamic approach. The demand model included epidemiological, demographic, and utilization variables along with supply model-incorporated current stock of neurosurgeons and flow variables such as attrition, migration, and retirement rate. STATISTICAL ANALYSIS USED: Data were obtained from various governmental databases and were analysed by Vensim PLE Version 3.0 to address the flow of health professionals, clinical infrastructure, population demographics, and disease prevalence during the time. RESULTS: It was forecasted that shortage in number of neurosurgeons would disappear at 2020. The most dominant determinants on predicted number of neurosurgeons were the prevalence of neurosurgical diseases, the rate for service utilization, and medical capacity of

			the region. CONCLUSIONS: Shortage of neurosurgeons in some areas of the country relates to maldistribution of the specialists. Accordingly, there is a need to reconsider the allocation system for health professionals within the country instead of increasing the overall number of acceptance quota in training positions.
Relić D & Božikov J (2020)	Application of a system dynamics model in forecasting the supply and age distribution of physicians	HRV	AIM: To predict the future supply and age distribution of physicians with a simulation model, which can be used as an advising tool for policymakers who decide on enrolment and specialization training (ST) quotas at the national level. METHODS: A simulation model was created using the system dynamics (SD) method. Changes in the number of physicians and their age distribution were projected in the context of the expected future changes of the Croatian population under different scenarios covering the period from 2017 to 2041. RESULTS: The two scenarios showed that Croatia would not face physician shortage in the future. The scenario 1 projected that Croatia would certainly reach the current European Union (EU) average of 360 physicians per 100 000 inhabitants by 2021, and that this figure would increase to 430 per 100 000 inhabitants by 2041. The scenario 2 suggested a similar trend, with Croatia reaching the current EU average by 2021 and the number of physicians increasing to 451 per 100 000 inhabitants by 2041. Both scenarios indicated that the Croatian physicians' age distribution will recover in favour of younger age groups of specialists. CONCLUSION: There is no need to increase the enrolment into the medical schools to ensure sufficient number of physicians per capita in Croatia, but it is necessary to keep the recently reached level of 550 licenses for ST per year. The developed dynamic model is available online and can be adapted to the analysis of different scenarios in different health care systems.

Ricketts TC, Adamson WT, Fraher EP, Knapton A, Geiger JD, Abdullah F & Klein MD (2017)	Future Supply of Pediatric Surgeons: Analytical Study of the Current and Projected Supply of Pediatric Surgeons in the Context of a Rapidly Changing Process for Specialty and Subspecialty Training	USA	OBJECTIVE: To describe the future supply and demand for paediatric surgeons using a physician supply model to determine what the future supply of paediatric surgeons will be over the next decade and a half and to compare that projected supply with potential indicators of demand and the growth of other subspecialties. BACKGROUND: Anticipating the supply of physicians and surgeons in the future has met with varying levels of success. However, there remains a need to anticipate supply given the rapid growth of specialty and subspecialty fellowships. This analysis is intended to support decision making on the size of future fellowships in paediatric surgery. METHODS: The model used in the study is an adaptation of the FutureDocs physician supply and need tool developed to anticipate future supply and need for all physician specialties. Data from national inventories of physicians by specialty, age, sex, activity, and location are combined with data from residency and fellowship programs and accrediting bodies in an agent-based or microsimulation projection model that considers movement into and among specialties. Exits from practice and the geographic distribution of physician and the patient population are also included in the model. Three scenarios for the annual entry into paediatric surgery fellowships (28, 34, and 56) are modelled and their effects on supply through 2030 are presented. RESULTS: The FutureDocs model predicts a very rapid growth of the supply of surgeons who treat paediatric patients-including general paediatric surgeon and focused subspecialties. The supply of all paediatric surgeons will grow relatively rapidly through 2030 under current conditions. That growth is much faster than the rate of growth of the paediatric population. The volume of complex surgical cases will likely match this population growth rate meaning there will be many more surgeons trained for those procedures. The current entry rate into paediatric surgery fellowships (34 per year) will result in a slowing of growth after 2025, a rate of 56 will generate a continued growth through 2030 with a likely plateau after 2035. CONCLUSIONS: The rate of entry into paediatric surgery will continue to exceed population growth through 2030 under two likely scenarios. The very rapid anticipated growth in focused paediatric subspecialties will likely prove challenging to surgeons wishing to maintain their skills with complex cases as a larger and more diverse group of surgeons will also seek to care for many of the conditions and patients which the general paediatric surgeons and general surgeons now see. This means controlling the numbers of paediatric surgery fellowships in a way that recognizes problems with distribution, the volume of cases available to maintain proficiency, and the dynamics of retirement and shifts into other specialty practice.
Senese F, Tubertini P,Mazzocchetti A, Lodi A, Ruozi C & Grilli R (2015)	Forecasting future needs and optimal allocation of medical residency positions: the Emilia-Romagna Region case study	ITA	OBJECTIVES: Italian regional health authorities annually negotiate the number of residency grants to be financed by the National government and the number and mix of supplementary grants to be funded by the regional budget. This study provides regional decision-makers with a requirement model to forecast the future demand of specialists at the regional level. METHODS: We have developed a system dynamics (SD) model that projects the evolution of the supply of medical specialists and three demand scenarios across the planning horizon (2030). Demand scenarios account for different drivers: demography, service utilization rates (ambulatory care and hospital discharges) and hospital beds. Based on the SD outputs (occupational and training gaps), a mixed integer programming (MIP) model computes potentially effective assignments of medical specialization grants for each year of the projection. RESULTS: To simulate the allocation of grants, we have compared how regional and national grants can be managed in order to reduce future gaps with respect to current training patterns. The allocation of 25 supplementary grants per year does not appear as effective in reducing expected occupational gaps as the re-modulation of all regional training vacancies.

Streeter RA, Zangaro GA & Chattopadhyay A (2017)	Perspectives: Using Results from HRSA's Health Workforce Simulation Model to Examine the Geography of Primary Care	USA	OBJECTIVE: Inform health planning and policy discussions by describing Health Resources and Services Administration's (HRSA's) Health Workforce Simulation Model (HWSM) and examining the HWSM's 2025 supply and demand projections for primary care physicians, nurse practitioners (NPs), and physician assistants (PAs). DATA SOURCES: HRSA's recently published projections for primary care providers derive from an integrated microsimulation model that estimates health workforce supply and demand at national, regional, and state levels. PRINCIPAL FINDINGS: Thirty-seven states are projected to have shortages of primary care physicians in 2025, and nine states are projected to have shortages of both primary care physicians and PAs. While no state is projected to have a 2025 shortage of primary care NPs, many states are expected to have only a small surplus. CONCLUSIONS: Primary care physician shortages are projected for all parts of the United States, while primary care PA shortages are generally confined to Midwestern and Southern states. No state is projected to have shortages of all three provider types. Projected shortages must be considered in the context of baseline assumptions regarding current supply, demand, provider-service ratios, and other factors. Still, these findings suggest geographies with possible primary care workforce shortages in 2025 and offer opportunities for targeting efforts to enhance workforce flexibility.
Vanderby SA,Carter MW,Latham T,Ouzounian M,Hassan A,Tang GH,Teng CJ,Kingsbury K,Feindel CM (2010)	Modeling the cardiac surgery workforce in Canada	CAN	BACKGROUND: Limited employment opportunities for recently trained cardiac surgeons are deterring medical students from entering cardiac surgery residency programs. Given the lengthy training period and the aging of both the general population and currently practicing cardiac surgeons, this reduced enrolment raises concerns about the adequacy of the future cardiac surgery workforce. A workforce model was developed to explore the future need for cardiac surgeons in Canada. METHODS: A novel system dynamics model was developed to simulate the supply and demand for cardiac surgery in Canada between 2008 and 2030 to identify whether an excess or shortage of surgeons would exist. Several different scenarios were examined, including varying surgeon productivity, revascularization rates, and residency enrolment rates. RESULTS: The simulation results of various scenarios are presented. In the base case, a surgeon shortage is expected to develop by 2025, although this depends on surgeons' response to demand-supply gap changes. An alternative scenario in which residency enrolment directly relates to the presence of unemployed surgeons also projects substantial shortages after 2021. The model results indicate that if residency enrolment rates remain at the 2009 level an alarming shortage may develop soon, possibly reaching almost 50% of the Canadian cardiac surgical workforce. CONCLUSIONS: These workforce model results project an eventual cardiac surgeon shortage in Canada. This study highlights the possibility of a crisis in cardiac surgery and emphasizes the urgency with which enrolment into cardiac surgery training programs and the employability of recently trained cardiac surgery graduates need to be addressed.
Willis, G, A Woodward, and S Cave (2013)	Robust workforce planning for the English medical workforce	UK	This paper describes the use of system dynamics in a major project for the UK Department of Health to inform a review of the intake to medical and dental school. It takes many years to train these professionals (typically 15 years or more for a hospital consultant), so an under or over-supply cannot be corrected quickly or easily. The cost of training and employing an individual is significant so the decisions to be made are highly important. The system dynamics approach meant that robust, evidence-based supply and demand models could be created to test potential policies and their impact. It also meant that the model was "transparent" and enabled the expertise of several hundred stakeholders from the healthcare system to be captured and synthesised. Significant decisions were made as a result of this work, including: • A 2% reduction in medical school intakes to be introduced with the 2013 intake, with a further review in 2014 • No immediate change to dental school intakes because of issues over data quality highlighted by the modelling, with another reviewn in 2013 • A rolling cycle of reviews of medical and dental student intakes should be established; to be undertaken every three years.

Wu (2012)	Theoretical System Dynamics Modelling for Taiwan Paediatric Workforce in an Era of National Health Insurance and Low Birth Rates	TWN	BACKGROUND: In an era of declining birth rates and a single-payer health care system, the paediatric workforce might overreact to its demands. System dynamics (SD) were therefore applied to establish models to predict the future need and demand for the paediatric workforce. MATERIALS AND METHODS: Data of population and workforce were extracted from national databases and models developed using Vensim software. RESULTS: In the past decade, the child-to-paediatrician ratio correlated with infant mortality in Taiwan (p < 0.001, r2 Z 0.88, child-to-paediatrician ratio Z 146 þ 354 infant mortality/1000 live births). Currently, the child-to-paediatrician ratio is 1742:1. Using the Millennium Development Goals (2.437/1000 live births) for infant mortality, the child-to-paediatrician ratio was estimated as 1009:1. The paediatric population model incorporated the birth and mortality rates in each age category, accurately predicted population changes between 1974 and 2010, and projected a decreasing trend until 2017. The paediatric workforce model, which considered rates of enrolment, completion, certification, and retention, predicted a decrease in the supply of paediatricians in the mid-2010s that could be delayed by policy incentives. When targeting the base scenario, the model indicated that discrepancies between demands and supply of paediatricians would occur in the late 2010s toward 2020. When targeting the Millennium Development Goals scenario, however, the discrepancies would be consistent.

14 Appendix C: Description of baseline model variables, data sources, and assumptions

Name of stock, flow or variable	Definition of variable/stock	Source of data	Model Parameter Value	Explanatory notes
Undergrad Intake EU UK	Inflow of the annual undergraduate intake of EU (including Irish) and UK students into Irish medical schools.	Source: DFHERIS	491 students in first year intake	There were 491 students from the EU or UK in the undergraduate programmes in the 2021/2022 academic year. Underlying data provided for the Academic Year 2021/2022 by Domiciliary Grouping. Domicile is defined as the country of permanent address prior to entry to the programme of study. It is not necessarily the correspondence/term address. If the student has been residing in Ireland for three of the five years previous to registering for their current course of study their domiciliary of origin would be Ireland. The domiciliary of origin should not change during their period of study.
Grad Intake EU UK	Inflow of the annual graduate programme intake of EU (including Irish) and UK students into Irish medical schools.	Source: DFHERIS	263 students in first year intake	There were 263 students from the EU or UK in graduate programmes in the 2021/2022 academic year. Underlying data provided for the Academic Year 2021/2022 by Domiciliary Grouping. Domicile is defined as the country of permanent address prior to entry to the programme of study. It is not necessarily the correspondence/term address. If the student has been residing in Ireland for three of the five years previous to registering for their current course of study their domiciliary of origin would be Ireland. The domiciliary of origin should not change during their period of study.
Grad Intake Non EU UK	Inflow of the annual graduate programme intake of Non EU/UK students into Irish medical schools.	Source: DFHERIS	191 students in first year intake	There were 191 Non EU/UK in graduate programmes in the 2021/2022 academic year. Underlying data provided for the Academic Year 2021/2022 by Domiciliary Grouping. Domicile is defined as the country of permanent address prior to entry to the programme of study. It is not necessarily the correspondence/term address. If the student has been residing in Ireland for three of the five years previous to registering for their current course of study their domiciliary of origin

				would be Ireland. The domiciliary of origin should not change during their period of study.
Undergrad Intake Non EU UK	Inflow of the annual undergraduate programme intake of Non EU/UK students into Irish medical schools.	Source: DFHERIS	458 students in first year intake	There were 458 Non EU/UK students in undergraduate programmes in the 2021/2022 academic year. Underlying data provided for the Academic Year 2021/2022 by Domiciliary Grouping. Domicile is defined as the country of permanent address prior to entry to the programme of study. It is not necessarily the correspondence/term address. If the student has been residing in Ireland for three of the five years previous to registering for their current course of study their domiciliary of origin would be Ireland. The domiciliary of origin should not change during their period of study.
Student stocks for Graduate and Undergraduate by region of origin for each year	The student year stocks refer to the number of students in each year of study of the undergraduate and graduate-entry programmes in Ireland based on their origin, either EU/UK or Non EU/UK	Source: DFHERIS	Undergrad Years 1-5 EU UK = 491, 480, 480, 475 and 465. Grad Years 1-4 EU UK= 263, 250, 245 and 240. Grad Years 1-4 Non EU UK = 191, 175, 170 and 165 Undergrad Years 1-6 Non EU UK=458, 440, 430, 420, 410 and 400. (Initial values)	This model assumes that student intake has been constant in previous periods at the values outlined above in the student intake variables above. For example, it assumes that the intake of the undergraduate programme for EU/UK students has been 491 for the previous five years. A small reduction in numbers in each year is incorporated to reflect attrition. Underlying data provided for the Academic Year 2021/2022 by Domiciliary Grouping. Domicile is defined as the country of permanent address prior to entry to the programme of study. It is not necessarily the correspondence/term address. If the student has been residing in Ireland for three of the five years previous to registering for their current course of study their domiciliary of origin would be Ireland. The domiciliary of origin should not change during their period of study.
Dropout / Pass rate stocks and variables	The various Dropout and Pass rate stocks/variables refer to the completion rates of medical school years.	Source: HEA (2021)	1.0% to 1.5% per year	According to degree programme completion data collected by the HEA, medicine had a degree completion rate of 94.3%. A CAGR decline of 1.0-1.5% is used for the student stocks. 1% is used for the undergraduate programmes and 1.5% is used for the graduate programmes.

Entering Non-Medical Careers Post EU UK	Outflow of undergraduate and postgraduate EU/UK students that go into non-medical careers	Source: FÁS (2009)	3%	According to the 2009 FÁS report, for Irish/EU students, for 97% of the cohort the first destination following graduation was entering the intern year. This implies that 3% of students may successfully complete the course but pursue other careers afterwards. Any doctors that do not pursue another career are assumed to apply for an internship. Graduate Outcomes Data is available to provide a parameter estimate for this variable but it was not possible to incorporate in the time available. See also Appendix D for an overview of the potential range of values that this parameter could take on based on the Graduate Outcomes Survey.
Intern Year Places in Ireland	The number of internships available in Ireland in a given year	Source: NDTP	854	Figure 4.4 Number of Intern Posts Since 2012 of the NDTP's Workforce Report shows trend of internship places from 2012 to 2021. The number of intern posts has expanded by 284, at an average growth rate of 4.6% per year. In 2021, it's noted that "the 2021 intake was reduced by 14% to 854. The reduction in the number of intern post in 2021 reflects a return to a more sustainable level of interns post Covid 19, and is aligned with the number of IST Training Posts available and workforce demand estimates". As such the initial value is set at 854 in the baseline scenario.
Potential Interns EU UK / Potential Interns Non EU UK	These three variables calculate the number of potential intern candidates in each period.	NA	Determined within model	These two variables calculate the number of potential intern candidates from each domiciliary group in each year. Within the model, Intern places are allocated to those students from EU/UK, with any remaining places allocated to Non EU/UK students. A constant value of 30 is added to the variable '*Potential Interns EU UK*' throughout the projection period. Figure 5 of the NDTP Medical Workforce 2021-2022 indicates that between 2018 and 2021 there was on average 31.75 interns that were non-CAO EEA applicants and non-EEA applicants not requiring a work permit (graduating from medical schools in Ireland and elsewhere in the EEA). See section 2 for further detail on the criteria used by the HSE to allocate Internship places.
New Interns EU UK	Inflow of Interns from EU/UK each year	NA	Determined within model	Available Internship places are allocated to EU/UK students on a prioritised basis.

New Interns Non EU UK	Inflow of Interns from Non EU/UK each year	Source: Author's estimate	Determined within model	The value in each period is determined as the difference between '*Intern Year Places available in Ireland*' and '*Potential Interns EU UK*'
Interns EU UK	Stock of interns from EU/UK that completed either a graduate or post-graduate medical degree in Ireland or within the EEA.	NDTP	731 (initial value)	Initial value comes from "Figure 4.5 Intern Appointments by Entry Category in 2018 to 2021" of the NDTP workforce Report. It sums both data for CAO entry (698) and Non-CAO entry EEA (33) and work permit exempt for the year 2021. There is no attrition for interns from the EU/UK interns.
Interns Non EU UK	Stock of Interns from Non-EEA regions that completed either a medical degree in Ireland through either graduate or post graduate entry.	NDTP	123 (initial value)	Initial Value taken from "Figure 4.5 Intern Appointments by Entry Category in 2018 to 2021" of NDTP Medical Workforce Report 2021-2022. Specifically, "*Non-EEA requiring work permit*" which shows a value of 120. This figure shows that there were 854 funded internship places however there are three places unaccounted for between the three entry categories. This three are allocated to this stock in the initial period which results in an initial value of 123.
Non EU UK Internship Dropout	Dropout outflow for Non EU/UK Interns	No Data	0.5%	Advice from medical workforce planning experts in the HSE is that less than half a percent of Non EU/UK doctors drop out of the internship year. No EU/UK doctors drop out of the Internship year.
Interns EU UK Graduating	Outflow of Interns from EU/UK completing their Internship	NA	Determined within model	There is no attrition for interns from the EU UK so the value of this outflow defined as the value of the inflow 'New Interns EU UK' one year previous.
Interns Non EU UK Graduating	Outflow of Interns from Non EU/UK completing their Internship	NA	Determined within model	This outflow is equal to the value of the inflow '*New Interns Non EU UK*' one year previously, less the dropout rate mentioned above in the variable '*Non EU UK Internship Dropout*'
Total New Interns	Variable counting the number of new Interns in each period from any location	NA	Determined within model	Defined as the sum of *'Interns EU UK Graduating'* and *'Interns Non EU/UK'* in each period. From this point in the model onwards no distinction is made between doctors by region of domicile.

The proportion of Interns going on to IST or GP training programme	Proportion of Interns Going on to IST	NDTP	82%	According to NDTP internal analysis, 82% of interns who commenced intern training in 2015 subsequently completed or commenced a BST or General Practice training programme in the years (2016-2021). This model assumes that 82% enter specialist training one year later. This is a potential source of error in the short run. Analysis by the NDTP indicates that for the 2015 cohort 39% were in Basic Specialist Training one year later, and 60% of the 2015 cohort were in BST 2 years later. On average, half of Interns do not practice in the Irish health system in the year immediately after their Intern year with many working abroad in other health systems.
Pre Training Doctors	Inflow of doctors that have completed their internship year and are waiting to start specialist training	Author's Calculations	Determined within model	Determined as '*Total New Interns'* multiplied by the variable '*The proportion of Interns going on to IST or GP training programme'*
Pre Training Programme	Stock which accumulates doctors that completed an internship but have not yet applied for IST or GP training programme.	NA	Determined within model.	Typically, post-internship doctors do not immediately begin IST after their internship. According to NDTP internal analysis, an average of 32% of interns begin IST in the year following their internship. This rises to at least 82% after 5 years (which is the most recently available data). The period of time doctors remain in this stock is 1 year. Initial Value is assumed to be the value of the inflow *'Pre Training Doctors'*.
Accessing IST or GPT	Outflow of doctors moving onto an IST or GP training programme	NA	Determined within model	After 1 year in the *'Pre Training Programme'* stock students move on to either IST or GP training through this outflow.
Places available in GP Streamlined Programme for Irish-Educated Doctors	The places available for doctors on GP streamlined training programme each year.	NDTP	184	There were 236 approved places in the GP streamlined programme in the NDTP Medical Workforce report 2020-2021. See, table 4.5 Specialist Training 2021 - 2022: Distribution of Trainees by Year of Training. In 2020, 78% of doctors on the GP training programme were Irish educated. The number of places has been reduced by this proportion to reach a figure for the number of places available for Irish-educated doctors. Initial value is 78%*236=184.
Starting GP Training	Inflow of doctors accepted into GP streamlined training each year.	NDTP	184	This inflow is determined by the variable *'Places available in GP Streamlined Programme for Irish-Educated Doctors'* in each period.
GP Streamlined Programme	Stock of GPs in the four-year GP streamlined training programme	NDTP	693	GP Streamlined Programme takes four years. Initial Value of 871 taken from NDTP Medical Workforce Report 2020-2021. The inflow to this stock is "*Starting*

				GP Training". The outflows are "*Completing GP Training*" and "*GP Programme Attrition"*. Note that a small number of GP students graduate in three years. Approx. 10% or 25-30 places. These are not accounted for in the model. The initial value of this stock is set at four times the initial value of the inflow *'Starting GP Training'* less the attrition in each period. This value is 693 and was identified numerically by running the model for 100 periods and finding the equilibrium number of students in the stock by the end.
GP Programme Attrition, GP Programme Attrition Rate	Doctors leaving GP Training programme before completion	No data	2%	Assumption of 2%, arbitrarily chosen.
Completing GP Training	Outflow of doctors completing the GP streamlined programme	NA	Determined within model	Doctors complete the GP streamlined programme after four years. Value in each period equals those "Starting GP Training" four years earlier, reduced by the attrition rate of 2% mentioned above. 2% attrition rate is arbitrarily chosen.
Starting IST	Inflow of doctors starting IST each year	NA	Determined within model	The value of this stock in each period is the outflow "Accessing IST or GPT" training, reduced by the number of places available in the GP Streamlined Training Programme. See variable '*Places available in GP Streamlined Programme for Irish-Educated Doctors'* above**.** NDTP data reports the first two training years of the streamlined programme as IST places. However, as noted previously GP Training is treated separately in this paper.
Initial Specialist Training 2 Year Programme	Stock of doctors in a 2 year Initial Specialist Training Programme	NA	Determined withing model	The initial value of this stock is set at twice the inflow '*Starting IST'*.
IST Attrition Rate	Compound Annual Attrition Rate for 2 year IST. The proportion of those exiting IST training without completing it in each year.	No Data	8%	NDTP Retention analysis indicates that for those on BST (excluding GPs) approximately 92% of doctors complete it or start GP training. The analysis notes that it is not uncommon for people to transfer from a BST programme to GP training with 12% transferring in 2015 either prior to or after completing BST. This parameter is just used for those leaving IST and not progressing onto GP Training which is treated separately in the model. This is a potential source of error.
Completing IST	The outflow of those completing IST	NDTP (Initial value),	Determined within model	After two years in the IST programme successful doctors leave this stock. The outflow is set at the value of "*Interns entering IST*" reduced by the IST attrition rate.

IST completions	The inflow of those completing IST	NDTP (Initial value),	Determined within model	New doctors are added to the stock of doctors that have completed IST but are applying to access a HST programme. It equals the value of 'Completing IST' in each period.
Applying for HST	Stock of doctors that completed IST and are applying for HST	NA	determined within model	Some doctors immediately progress to HST, however for others there is a waiting period where they are apply to HST or undertaking a master's programme. In this model, doctors wait one year before progressing to HST. The initial value is determined as the value of IST completions.
Rate of Progression from BST to HST	Percentage of those completing BST that go on to HST	NDTP,	76%	NDTP Retention Analysis - BST Completions that start HST or GP training indicates that in 2017 76% of those completing BST went on to start HST or GP Training. Note that in this model the 76% is used for those moving between IST and HST, only. Whereas the Retention Analysis for BST completions includes HST or GP Training. GP Training is likely to be a significant proportion of the 76% so this may be an overestimate. It should be noted that HST is a highly specialised training programme and not all applicants will or should be successful in going on to HST.
Beginning HST	Inflow of doctors that are starting HST	NA	determined within model	Doctors with completed IST starting HST after a wait of two years
Higher Specialist Training	Stock of doctors that are undertaking HST having already completed IST	NA	Determined within model	The initial value of this stock is set at five times the inflow *'Beginning HST'*. This is an overestimate due to the fact that some of these people would have left the HST programme through attrition.
Attrition from HST, HST Attrition Rate, Beginning HST times Attrition from HST	Outflow of attrition from Higher Specialist Training	No Data	12%	NDTP Retention Analysis - tracks the progression of HST trainees by intake year. The table shows, for example, that of the 2013 cohort of people recorded as starting HST training, 88% go on to complete training and receive a CSCST by 2021.
Completing HST and staying in Ireland	The outflow of those completing HST after 5 years and remaining in Ireland	NA	Determined within model	Outflow determined as the value of those '*Beginning HST*' reduced by attrition accounting for the percentage of those completing HST that remain in Ireland. See variable *'Proportion of Specialist Doctors that emigrate'.*

15 Appendix D: Graduate Outcomes Survey

Introduction

This Appendix examines the Graduate Outcomes Survey to see what proportion of EU/UK students chose not to enter the profession after completing their medical degree. The model assumes 3% of those completing their medical degree do not go on to pursue the internship year based on the previous parameter used in the FÁS model.

Graduate Outcomes Survey Overview

The GOS is a national survey distributed to all graduates of HEA Higher Education Institutions (HEIs).[47] It is carried out 9 months after graduation and so is an early career snapshot only. It asks about graduates' main destination (including employment, further education, unemployment). For some data points, responses were provided by HEIs based on administrative data.

As noted in the body of the report, to achieve a Basic Medical Qualification the medical degree and post-degree Internship year need to be completed. The Internship year is a one-year period of employment.[48] As such, the GOS would be expected to be provided to people during their internship year assuming they immediately take it up in Ireland post-medical degree.

This total population for the survey across the years 2017, 2018, and 2020 is given in the table below.[49]

---

[47] Note this does not include RCSI medical Graduates.

[48] https://www.hse.ie/eng/staff/leadership-education-development/met/medical-intern-unit/intern-year/

[49] The Class of 2019 was not surveyed due to the onset of the Covid-19 pandemic

	Graduate Entry Medicine	Undergraduate Medicine
Total in population	645	1948

It is important to note that the response rate of the survey was approximately 62% (49% of GEM graduates and 66% of undergraduate medicine graduates).[50] That is, the survey had data for 1,610 individuals.

There are two sections of the survey which help to identify the number of medical graduates who remain in the profession post-degree. The first is that which looks at their current destination and employment by sector and the second looks at whether they needed their qualification to attain their current employment.

The data from these sections of the survey is reported in aggregate, not broken down by graduates' domicile. Therefore, the number of Irish medical graduates not from the EU or UK who are employed as doctors or completing the medical internship are not separated out, rather estimates are for all survey responders for the relevant question. 64% of the undergraduate medicine graduates and 65% of the graduate medicine graduates who provided responses to the survey were from either Ireland or Great Britain. Response rates were higher among Irish domiciled graduates than non-Irish domiciled graduates.

Current Destination and employment by Sector

Of the 1610 medical graduates surveyed, 1259 said that they were in full time employment of which 1250 reported that they were working in "Human Health and Social Work" or

[50] The majority of the 1610 responses were collected from responses to the survey [1337] while the remaining [273] responses were collected from administrative data i.e. those whose details were filled in on their behalf by their HEI.

“Professional, scientific and technical activities”.[51] Furthermore, 288 of the medical graduate survey respondents reported that they were engaged in full-time further study, training, or research of which 268 were medical interns. Therefore, it is assumed that 1518 (=1250+268) of the medical graduates surveyed were either employed as a doctor or completing their medical internship year. For those doctors working in the “Human Health and Social Work” or “Professional, scientific and technical activities” sectors it is assumed that they are participating in the internship year, however it may be possible that they are working in these sectors and not employed as interns at the time of the survey.

The remaining 92 medical graduates who responded to the survey (which equates to approximated 5.7%) reported that 9 months after graduating they were:

(i) Working full time but not in the in “Human Health and Social Work” or “Professional, scientific and technical activities” categories or working part time. [12]
(ii) Unemployed or looking for work or due to start a job in the next 3 months. [30]
(iii) Engaged in full time further study (Excluding the medical internship) or engaged in part-time further study. [39]
(iv) Engaged in “Other activity”. [11]

It is potentially possible that some of these categories continued to participate in their profession. For example, those working part-time, those in further study, in unemployment or looking for work, or due to start a job in the next 3 months may still be intending to pursue careers as doctors or may be carrying out medical research.

Relevance of qualification to current employment

The survey also asks the following question:

- Did you need the qualification you recently obtained to get the job (or start your business if self-employed)?

[51] While it is acknowledged that not all those who are employed in “Human Health and Social Work” or “Professional, scientific and technical activities” are doctors, the medical graduates who responded to the survey provided details of their employer at the time, these responses included, hospital, HSE, NHS and general practice which support the idea that those who said they worked in “Human Health and Social Work” or “Professional, scientific and technical activities” were working as doctors.

The response rate for this question was relatively low compared to the response rate above. 1,280 people respond. This figure includes those in full-time employment, part-time employment or due to start a job. Of these 1280 who were eligible to be asked this question:

- 436 provided a yes/no response;[52]
- 10 said I don't know; and,
- 834 provided no answer.

Note, because this is only asked of those in employment it will miss those people that are choosing not to become doctors but that are not in employment. For those graduates who are not in employment, different questions asked on continuing education, barriers to employment, other activities etc. From a review results of the survey, it would appear that very few graduates are going on to an activity that is not employment and not medical-related.

1280 of the medical graduates surveyed were working (part or full time) or due to start work in the next 3 months.

A number of graduates said that "Yes: the qualification was a formal requirement" when asked whether they needed their qualification to attain their employment, while others said that "No: the qualification was not required". However, from succeeding questions it is observed that all of those who responded that the qualification was not required were employed as medical interns within the HSE in which case the intended completion of their degree was required to attain their position.

On the basis of this data, it would appear that almost all those that provided a yes or no response to this question, were employed as a doctor or completing their medical internship at the time of the survey i.e. approximately 0.5% of medical graduates not working as a doctor or completing their medical internship 9 months after the completion of their degree.

[52] There were 4 yes/no potential responses to this question; "Yes: the qualification was a formal requirement", "Yes: while the qualification was not a formal requirement, it gave me an advantage", "No: the qualification was not required" and "No: I was already in the job when I received the qualification".

A number of graduates [10] responded that they did not know if their medical degree was a requirement for attaining their employment. If it is assumed that a medical graduate would know that to work as a doctor or complete the medical internship year, the medical degree is required, then these “I don’t know” responses can be categorised as a no. When this is assumed, the percentage of medical graduates who are not practicing as doctors or completing their internship year 9 months after their graduation rises to 2.7%. However, it is worth noting that in responding to surveys people may choose “I don’t know” to speed up completion. In this case, 2.7% would be an overestimate.

Conclusion

Using data from the GOS, and depending on the approach taken to answering the question, it is estimated that either 0.47%, 2.7% or 5.7% of graduates with a medical degree were not employed as doctors or completing a medical internship 9 months after their graduation and therefore are assumed to have entered non-medical careers.