Rialtas na hÉireann
Government of Ireland

Spending Review 2022

Health Capital Investment in Ireland

An Analysis of Healthcare Infrastructure Capacity

Conan Shine, Mark Hennessy

Irish Government Economic and Evaluation Service
Research Services & Policy Unit, Department of Health

September 2022

Paper Summary

1. This paper provides an analysis of healthcare infrastructure as it relates to service capacity, such as beds and radiological equipment by region.

2. We find that healthcare infrastructure capacity varies by Regional Health Area, informing considerations around the spread of planned healthcare infrastructure investment. While the levels of healthcare infrastructure capacity by region will naturally vary due to underlying differences in demographics, health status and the presence of national centres of excellence among other factors, the findings in this paper provide a baseline from which a future, more detailed assessment of infrastructure need by service-area region can take place.

3. The analysis provided in this paper provides the groundwork for evidence informed prioritization of infrastructure projects facilitated by the upcoming Strategic Healthcare Investment Framework (SHIF).

Findings

- **CCU Capacity:** There is variation in CCU bed access by RHA adjusting for population, with RHA A, B and E having more CCU beds relative to population than RHA C, D & F. This variation is likely to be partially reflective of the presence of National Centres of Excellence in some RHAs and the associated higher acuity care provided in these hospitals.

- **General Hospital Bed Access:** The number of general hospital beds available per RHA is uneven, with RHA F having 247 beds per 100,000 compared to RHA C with 207 beds. The relationship between occupancy and bed capacity in each region is weak, highlighting the need for further analysis of acute care performance.

- **Trolleys:** The number of patients on trolleys is consistent across five out of seven RHAs. RHA A appears to have lower numbers of patients on trolleys than all other RHAs, indicating the relative effectiveness of their emergency departments.

- **Access to Day Procedures:** The number of patients on waiting lists per ambulatory beds available is highly skewed, with 36 patients waiting per bed in RHA F, compared to just 12 patients per bed in RHA E.

- **GPs by RHA:** The levels of access to GPs providing treatment to GMS patients varies across the state with 82 GPs per 100,000 in RHA C versus 48 GPs per 100,000 in RHA B.

- **Access & Occupancy of long-stay beds:** The distribution of long-stay beds relative to older populations by region is proportional. Occupancy levels vary more by regions, with some LHOs having over 90% occupancy, compared to a national average of 75% occupancy.

- **Access to radiological equipment:** The levels of access to radiological equipment varies across RHAs with RHA F having 8.4 X-rays per 100,000 population compared to 5.5 in RHA E. This may influence the levels of unmet need and delayed discharge in each region. 47% of X-ray machines are over ten years old, implying the need for a replacement strategy for these assets.

- These findings will serve as an important input for further investment considerations, however further analysis will be required to determine the appropriate level of healthcare infrastructure by RHA by taking account of factors including future demand, different population structures, health requirements and the presence of national centres of excellence.

Recommendations

- **Investment Considerations:** The identified differences in healthcare infrastructure capacity by region should be used to inform future healthcare investment decisions in a range of areas, including CCU, general acute care, primary care, and community care.

- **Strategic Health Investment Framework:** the analysis supports the publication and implementation of the first Strategic Healthcare Investment Framework, ensuring planned healthcare infrastructure investment is supported by evidence, is policy aligned and achieves relevant Departmental objectives. The potentially large investment associated with historic projects may be one area where re-examination is warranted, with planned investment updated to take account of the better evidence and data that is now available in some areas.

- **Data Reporting:** The paper highlights how the collection and use of data to inform future investment is essential. Policymakers should therefore endeavor to improve reporting of health infrastructure data and consider the creation of a dynamic reporting system for community, acute and primary care capacity data.

Table of Contents

1 Context

This paper builds on the analysis presented in the first 3 papers of the Healthcare Capital Investment in Ireland series, published December 2021. The initial papers in this series identified a lack of centralized strategic direction for healthcare infrastructure investment historically (Hennessy, et al., 2021). A key recommendation emerging from this analysis was the need for planned investment to better account for the long-term strategic priorities of the health system while incorporating the existing capital stock profile and population needs by care setting and region.

To facilitate a more evidence-based approach to capital investment, it was decided in Q4 2021 that a Strategic Investment Framework for Health (SHIF) would be produced by the Department of Health, enabling prioritization of healthcare investment projects to address long-term strategic priorities, balancing multiple objectives including patient safety, value for money and future healthcare demand. A key input required for the SHIF to operate is a baseline assessment of healthcare capital stock by region, allowing for this information to be considered when proposed projects are being evaluated.

Building on this identified need, this paper aims to deliver an overview and analysis of Ireland's Healthcare Capital Service Stock, defined in broad terms encompassing:

1) The physical healthcare infrastructure owned and operated by the HSE.
2) Wider healthcare infrastructure such as premises operated by Section 38[1] bodies, and where available private institutions.
3) Measures of publicly funded practitioners, as these are an important determinant and indicator of primary care capacity.

The data analyzed in this paper primarily focuses on healthcare capacity, i.e., infrastructure characteristics that relate to throughput such as beds, radiological equipment and healthcare practitioners by region. This analysis is complemented by the exploration of built infrastructure characteristics in the 5th paper of the series, "Analysis of Healthcare Infrastructure" which is published alongside this one. While this paper focusses on service capacity, the subsequent paper in this series focuses on infrastructural characteristics,

[1] Section 38 Hospitals are hospitals owned by voluntary organisations which provide publicly funded care

such as m^2, condition and functional suitability of built infrastructure in community residential and acute care settings.

The collated information and findings from both papers will then feed into investment prioritization decisions for new healthcare infrastructure projects via the SHIF. While differences in healthcare infrastructure by region and care setting are presented throughout the paper, further analysis will be required in each case to evaluate investment needs by region. This is because some level of variation in healthcare infrastructure access is justified, taking account of differences in current and future healthcare demand, different population structures and the presence of national centres of excellence among other factors. Although our analysis provides **no definitive indication of where planned investment should be prioritized,** analysis presented, and associated data collected will be a crucial input into supplementary exploration of investment needs that are specific to particular regions and service areas. For example, the potentially large investment associated with historic projects may justify a thorough re-examination in some cases, with planned investment updated to take account of the better evidence and data that is now available, e.g. updated demographic and demand forecasting and technological advancements in care.[2]

1.1 Regional Health Areas

The analysis also directly feeds into the going implementation of Regional Health Areas in the Irish healthcare system. The Department of Health in partnership with the HSE is currently in the process of introducing Regional Health Areas as a new administrative system underpinning the work of clinical staff throughout the country. Regional Health Areas (RHAs) recognise the value of geographical alignment for population-based resource allocation and governance to enable integrated care. There are currently nine Community Health Organizations (CHOs) and six Hospital Groups (HGs) plus Children's Health Ireland. As these do not align geographically nor overlap in terms of geographies, management, clinical oversight, or budgets for defined populations, this hinders the delivery of integrated care (Department of Health, 2022). Regional Health Areas will enable better integration of community and acute care services, as well as introduction of a population-based approach to service planning by region.

The agreed Regional Health Areas (RHAs) can be seen below in Fig 2.1. There are six regional health areas in all, with the geographies based on population data including how people currently access health

[2] The high level of investment in maternity services planned to 2027 was previously identified as potentially incompatible with Ireland's future demographic projections (Hennessy, et al., 2021).

services, while being mindful of disruptions to existing services. The proposed geographies have good alignment to existing Community Healthcare Organisations & Hospital Groups, with some exceptions. Where required, some data was re-aligned at an LHO level to enable analysis at an RHA level.

The six RHAs will cover the following areas:

Area A: North Dublin, Meath, Louth, Cavan, and Monaghan.

Area B: Longford, Westmeath, Offaly, Laois, Kildare, and parts of Dublin and Wicklow.

Area C: Tipperary South, Waterford, Kilkenny, Carlow, Wexford, Wicklow, part of South Dublin.

Area D: Kerry and Cork.

Area E: Limerick, Tipperary and Clare.

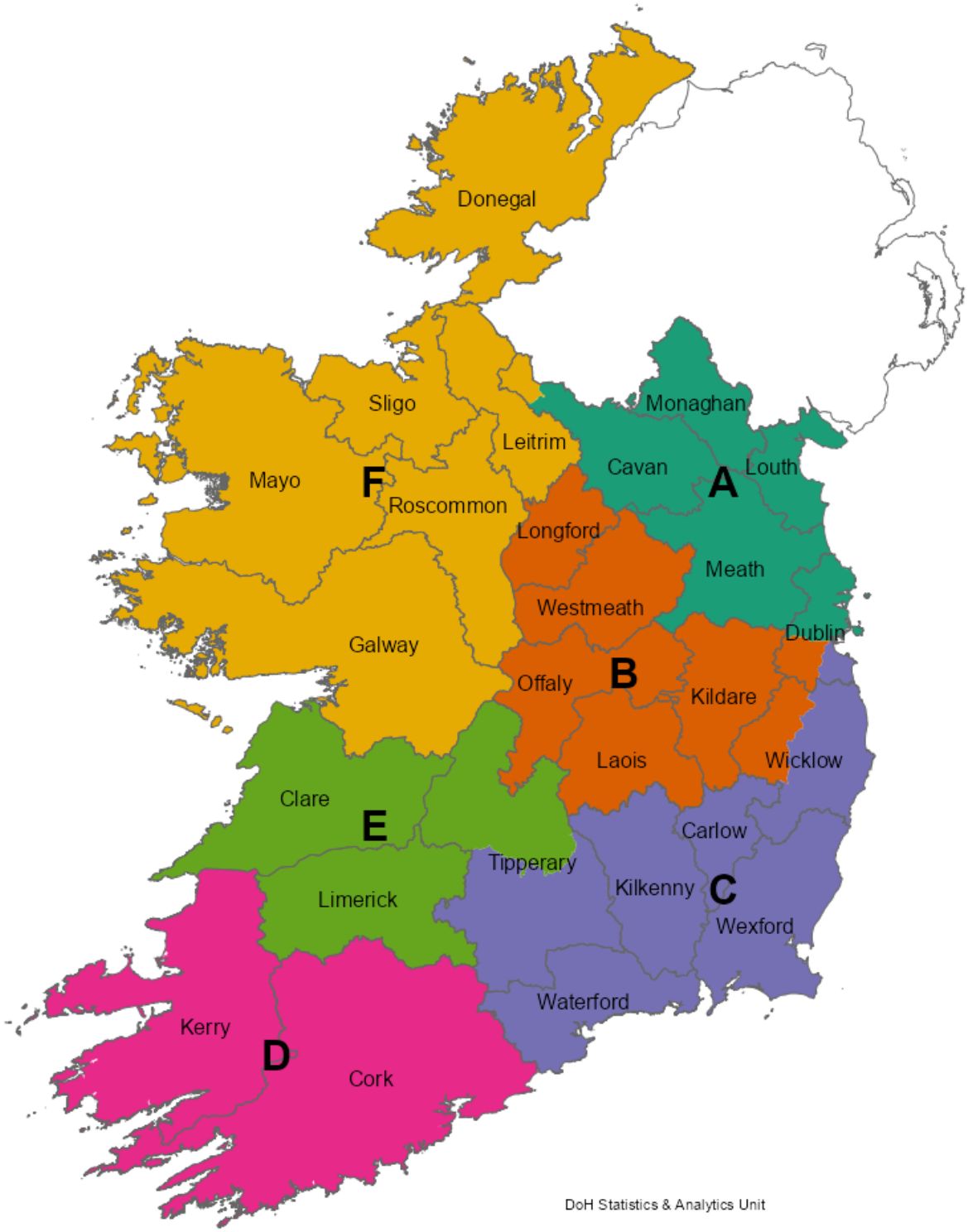
Area F: Donegal, Sligo, Leitrim, Roscommon, Mayo, and Galway.

The six RHAs are further broken down into 96 Community Healthcare Networks (CHNs). CHNs deliver primary and community services to an average population of 50,000 people each[3].

The CHN framework supports multi-disciplinary teams to bring decision-making closer to the point of care. CHNs also function to provide targeted and coordinated care based on identified health and social care needs of local communities. 39 CHNs have already been established with leadership posts in place and at least 25% staff recruited, with the remainder of the total 96 due to be rolled out by end 2022.

[3] https://healthservice.hse.ie/staff/news/hse-to-establish-six-regional-health-areas/

Fig.2.1: Regional Health Areas Map



Source: Department of Health Statistics & Analytics Unit

2 Methodology

2.1 Data Sources

The data analyzed in this paper was obtained from Departmental, HSE and Agency sources. This involved the identification and sourcing of available data in a given area of health policy to enable the best possible understanding of the overall health portfolio. Data availability shaped the analysis performed, with focus shifting towards areas where healthcare infrastructure data was available. This has presented limitations to the depth of analysis undertaken in areas, primarily in the area of community care. Data was obtained by authors through engagement with various health stakeholders, including:

Table.2.1: Data Sources

Data	Contents	Source
Daily CCU Capacity and Occupancy Reports	• Staffed Beds • Closed Beds • Open Beds • Occupied Beds • Capitally funded beds	National Office of Clinical Audit Bed Information System (NOCA-BIS) HSE Critical Care Plan
Nursing Home Annual Occupancy Survey	• Occupied Beds. • Patient Age. • Total Beds. • Average LOS. • Total Beds by Unit.	Nursing Home Support Scheme-Department of Health
Open/Closed Beds Reports	• Open Beds. • Total Occupancy. • Closed Beds.	HSE Business Intelligence Unit
PCRS Contractor Reports	• Number of PCRS GPs. • Number of PCRS Optometrists. • Number of PCRS Dentists. • Numbers of PCRS Optometrists.	HSE PCRS
Acute Mental Health Beds	• Number of Mental Health Commission regulated approved mental health beds.	Mental Health Commission.

Radiological Database	• Age of Radiological Equipment (0-5,5-10,10+). • Number of Xray, Fluoroscopy, IR Cardio, Mammography and DXA machines.	Health Information and Quality Authority
TrolleyGAR	• Patients on Trolleys recorded at 8am,2pm and 8pm daily. • Patients waiting on trolleys broken down into time intervals.	Department of Health
International Metrics	• Mental Health beds internationally • CCU Capacity internationally • Acute inpatient occupancy	OECD

To contextualize our findings, healthcare infrastructure is compared on a relative basis by Regional Health Area ("RHA") using population estimates as an anchor for comparison. This enables determination of a relevant infrastructure metric per 100,000 population, thereby largely controlling for the differences in demand driven by demographics across regions. While this crude metric does not account for the many other factors that can drive healthcare infrastructure needs by region, it does provide a strong indication of where further investment may be required. In each case, planned investment should be supported by detailed supplementary analysis, taking into account the baseline infrastructure assessment contained in this paper but also factors including acuity of care by region, variations in health status by region, referral patterns, national specialties, etc.

2.2 Limitations

The analysis in the paper has a number of limitations due to considerations regarding the scope of the paper, and the data being primarily administrative in nature. In terms of scope, the paper is unable to adequately account for non-infrastructural drivers of healthcare throughput in all cases, including referral patterns, non-demographic demand drivers and efficiency. In addition, we are unable to determine the contribution of a given additional piece of healthcare infrastructure to overall output, with this

relationship likely varying depending on many context specific factors[4]. While the recommendations arising from the analysis are constrained by these limitations, there nonetheless remains value in providing a high-level understanding of healthcare service capacity by region, with this information enabling prioritization based on national and sector specific objectives as outlined in the discussion of the Strategic Investment Framework above.

An additional limitation to the analysis arises because of the administrative nature of the data collected in all cases. As healthcare infrastructure data is not systematically compiled, inferences are limited to what is available to researchers. While every effort has been made to include a suite of metrics which capture the overall healthcare system, in some cases, particularly in the community care setting, the data available may not be sufficiently detailed to enable a holistic understanding. In addition to this, some datasets have specific limitations, as follows.

- The HIQA radiological database was recorded in five-year intervals which evidently limits the level of inference from the data, given the recommended replacement age is 10 years. It is hard to decipher if all machines in the group over 10 years are 10 years old or older. Equally, the staffing of diagnostic machines can dictate the number of images produced daily and therefore a greater level of machines may not mean greater access to diagnostics.
- The NOCA ICU Bed Information System (ICU-BIS) dataset is recorded daily and uploaded to an internal DoH dashboard; This data was originally intended for the measurement of COVID-19 patients in critical care and as such is only captured from February 2020. This means that analysts are unable to fully remove the impact of COVID-19 on occupancy and staffing levels. In addition, the inclusion of surge capacity in total bed figures may be distorting perceptions of CCU capacity by region. The effects which COVID-19 may have had on the availability of staff cannot be measured and therefore limitations exist around the inferences which can be made in some instances.
- The Critical Care plan deviates from National Office of Clinical Audit (NOCA) reports marginally and this raises uncertainty around the total number of beds in the system.
- The Open Bed Report contains an average of the monthly available beds. This data can fluctuate and be subject to change at a later date due to data remediations. Open beds are both a function of staffing and the physical availability of beds to deliver care. The deficiencies in the Open Bed Report

[4] This is further highlighted in DoH IGEES analysis of hospital performance based on Key Performance Indicators (Clancy, et al., Forthcoming).

have been recognized elsewhere in the Department, and work is currently underway to improve reporting in this area to enable real-time recording of available beds in line with the NOCA ICU-BIS data.

- TrolleyGar is a dataset collected daily by the HSE which records patients awaiting admission across all hospitals. This dataset can be subject to change and error due to differences in the classification of patients awaiting admission in different hospitals. Given that this dataset is reported at three intervals, the numbers of patients may fluctuate over the day due to inpatient admission and discharge patterns in different hospitals.
- The HSE PCRS reports the number of PCRS registered GPs, Pharmacists, Dentists and Optometrists monthly. This number includes only practitioners who are contracted to provide PCRS services, and therefore underestimates the true levels within each of these populations. While this comprises a large number of practitioners, the dataset remains useful for determining the capacity of the government to deliver public healthcare services through primary care (e.g, GP eligibility, DTSS).
- The NHSS survey is a point in time survey and therefore there may be differences in the occupancy rates across the state at different times over a year relative to the observed level. Occupancy may also be constrained at some facilities due to limitations arising during COVID-19 on the restriction of use of multi-occupancy rooms for patients. This may also limit inferences made in relation to total bed capacity by region, with HIQA describing 25% of nursing home facilities as non-compliant based on the sample of institutions inspected.[5]
- The Mental Health Commission provided the number of approved acute mental health beds across the state. This level of beds may not be available at a given time due to staffing, maintenance and other issues and therefore this level may not be indicative of true supply.

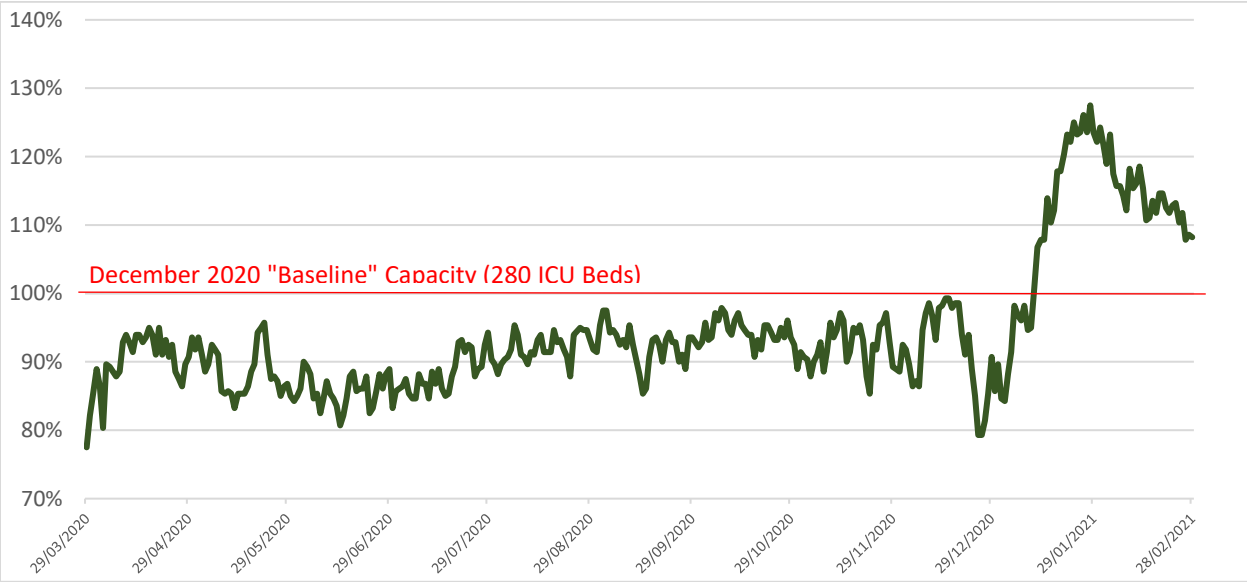
[5] However, NHSS estimates of total nursing home beds are nonetheless similar to Departmental and HIQA estimates.

3 Acute Critical Care Capacity

Critical care is essential for treatment of patients with high acuity needs. Ensuring adequate critical care capacity in hospitals across Ireland is important for patient outcomes, with the inability to access critical care posing a serious clinical risk along multiple dimensions (HSE, 2021). Consistently high critical care occupancy can also negatively impact patient health and staff wellbeing, leading to higher rates of delayed patient admission, early patient discharge and staff having to handle a higher workload (NOCA, 2020). High levels of CCU (Critical Care Unit) bed occupancy can also lead to cancellation of elective surgery and increased incidence of hospital-acquired infection.

With the ongoing implementation of Sláintecare reforms to the health system in Ireland, the utility of Critical care capacity is likely to increase. This is because a higher level of low acuity care is intended to be delivered in the community, with hospitals focused on treating patients with higher dependency needs than at present and demographic changes further influencing this level of demand (Department of Health, 2018) (Department of Health, 2021). The COVID-19 pandemic has additionally illustrated the value of critical care surge capacity, with some CCU wards having in excess of 100% of normal occupancy during periods where COVID-19 was particularly prevalent (HSE, 2021).

Figure 3.1: CCU Occupancy vs Baseline Capacity (March 2020 – March 2021)



Source: NOCA CCU-BIS Core Dataset

This section aims to provide an overview of critical care capacity as it currently stands and inform potential future infrastructure investment. Our analysis of critical care capacity has been completed using National Office of Clinical Audit Bed Information System (NOCA-BIS) data and the HSE Critical Care plan. This data provides Total, Staffed/Open, Occupied, and Closed beds by day by Hospital from March 2020 to March 2022. Further information on this dataset is included in the NOCA Report on CCU Activity During COVID-19 Pandemic.

Total beds are defined as potential physical bed capacity in an CCU/ High Dependency unit. Staffed/Open beds is the number of fully staffed beds which are open on a given day in an CCU unit. Occupied beds are beds that are currently occupied by an CCU patient, with some beds also given a "cleared for discharge" or "reserved" designation to facilitate patient flow. The total number of beds within the system differs from the total levels of Critical Care beds which have been funded. The Critical Care plan has allocated funding for the addition of 114 beds to bring total available beds to 446 by the end of Phase 2, it may also be noted that the delivery of the new National Children's Hospital will result in increased Pediatric Critical care capacity. Closed beds are beds that are not available for use by patients for reasons such as infection control, maintenance / refurbishment, or lack of resources. While closed beds were prominent earlier in the pandemic, peaking at 75 closed beds in January 2021, since August 2021 there have been less than 10 closed beds per day across the whole system. For this reason, we have chosen to focus our analysis on total beds[6]. It should also be noted that the total number of beds reported is above the number of beds which currently are funded within the system. By the end of 2022, there is expected to be 370 Critical Care beds in the system, with plans to increase this total capacity to 506. (Department of Health and HSE, 2021). This includes both the increased levels of critical care beds within the new Children's Hospital and the delivery of the Phase 2 critical care beds.

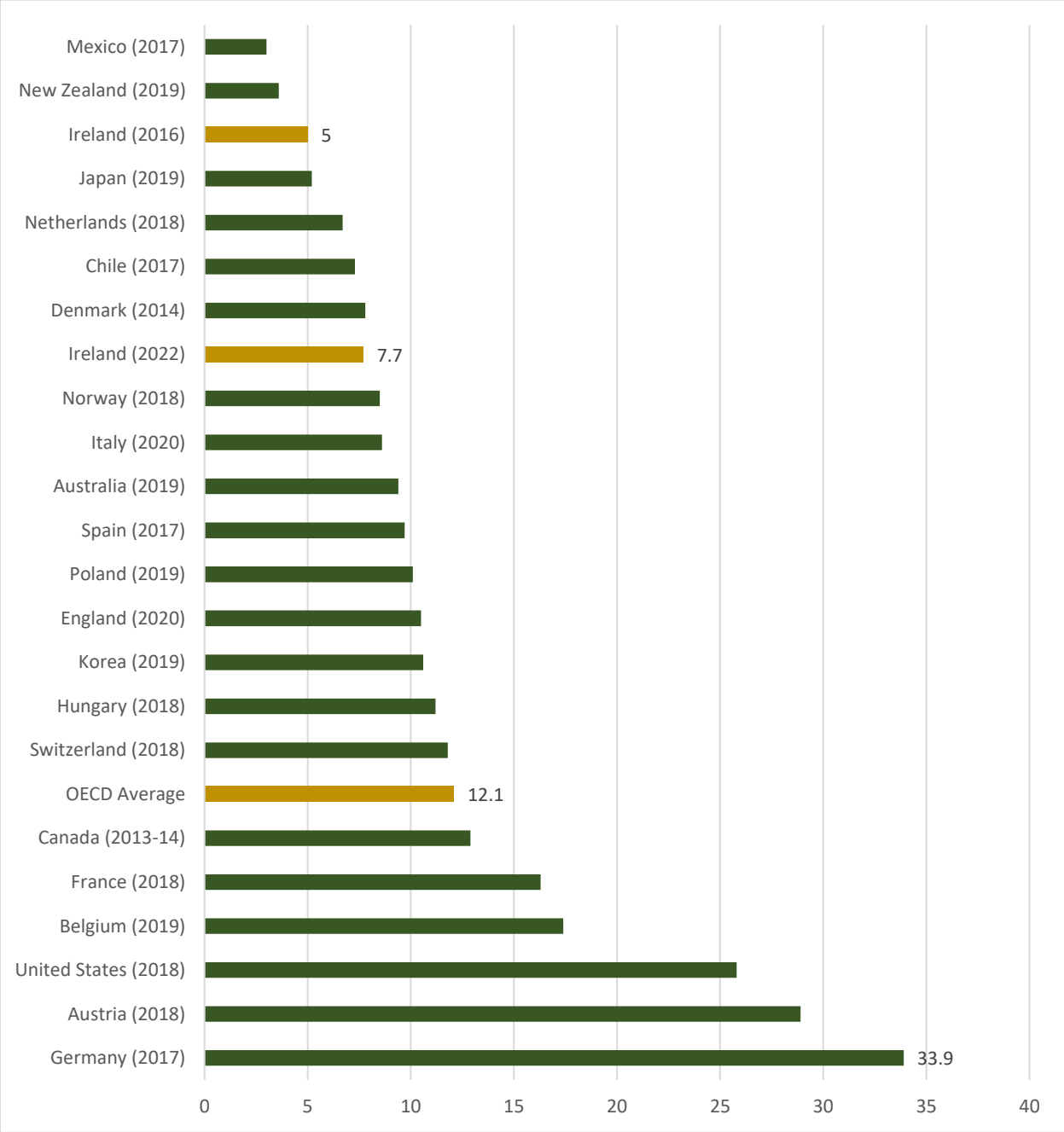
In addition to comparisons of CCU capacity by region, we can also compare current national level CCU bed capacity to international peers. In this context, Ireland's CCU bed capacity is low relative to most OECD countries. One can see that Ireland's CCU bed capacity has improved from our 2016 level[7], rising from 5 beds per 100,000 population to 7.7 per 100,000 population in 2022. Despite this improvement, Ireland still compares poorly to the OECD Average of 12.1 beds per 100,000 population. While these figures do

[6] Total Beds provided by NOCA describes the total potential beds available in a hospital to treat critically ill patients, rather than the number of beds "available for use" on a given day. Data received is reflective of a download of the dataset as of 7th of July 2022.

[7] It should also be noted that our 2020 level of CCU beds per 100,000 population was similar, reported to be 5.2 beds per 100,000 population in February 2020 (NOCA, 2021).

not reflect the model of care employed, efficiency and demographic needs, they nonetheless provide an indication of what an appropriate level of critical care capacity may be. The rollout of the phase 2 critical care plan is likely to alleviate this concern, as it adds significant numbers of beds to the system.

Fig.3.2: Critical care beds per 100,000 Population, Ireland vs OECD



Source: OECD (2020) & NOCA CCU-BIS

3.1 Critical Care Capacity

Table 3.1.1: Critical Care Capacity & Critical Care Beds per 100,000

RHA	Total CCU Beds[8]	Total Delivered Beds[9]	Population[10]	Total Phase 1 CCU beds per 100,000 population
A	91	97	806,607	**12**
B	74	80	737,495	**11**
E	28	28	288,732	**10**
F	51	45	532,749	**8**
D	47	35	522,033	**7**
C	52	53	683,747	**8**
CHI	32	32[11]	1,190,502	**2.7**
Total	375	370	4,761,865	**7.7**

Source: NOCA CCU-BIS Core Dataset

Looking at the national breakdown of CCU beds by region, Table 3.1.1 provides total CCU beds as of April 12th, 2022, and population by RHA[12]. One can see that there is variation in the level of CCU beds by RHA, with RHA C having 7 CCU beds per 100,000 population, versus RHA A with 12.3 per 100,000 population.

[8] This is the total capacity provided by NOCA as of July 7th, 2022
[9] This is the total number of beds delivered or capitally funding within the Capital Critical Care plan after phase 1
[10] Children are removed from RHA populations and instead included in "CHI". It should be noted however that in some cases, those aged 17 or under (the relevant population for Children's Hospital Group) are sometimes admitted to Adult Intensive Care Unit Beds. According to NOCA (2020) out of 1,625 admissions aged <16 years of age, 111 (6%) were admitted to Adult Intensive Care Units in 2019.
[11] The number of CCU beds within CHI are not accounted for within the Critical Care plan therefore the number of NOCA beds was assumed to be the total number of beds capitally funded.
[12] Population for each RHA is taken from the Health Atlas based on Census 2016 Reports.

CHI has the lowest level of CCU beds, owing to the significantly lower hospitalization rate of children relative to the general population (e.g., in 2020 patients under 15 made up 6.2% of total discharges while being 21% of the population (HPO, 2021) (CSO, 2016)).

Some of the variation in the level of CCU beds may be explained by differences in acuity needs by RHA, with model[13] four hospitals in particular likely to require a greater number of CCU beds due to the complexity of services provided in these locations as well as their catchment area (which can in some cases be supra-national) (HSE, 2013). From Table 3.1.2, we can see that the number of model four hospitals is relatively evenly spread across regions. For model three hospitals there is a more observed imbalance, with RHA E and D having the lowest number at zero and two model three hospitals respectively.

Table.3.1.2: Hospital "Model" & Total CCU/HDU Beds by RHA

RHA	Model 3	Model 4	Model 3+4 Hospitals[14]	CCU Phase 1 Beds
A	4	2	6	97
B	5	1	6	80
F	4	1	5	45
C	3	2	5	53
D	2	1	3	35
E	0	1	1	28
Total	**18**	**8**	**26**	**338**

Source: NOCA CCU-BIS Core Dataset & Author's calculations.

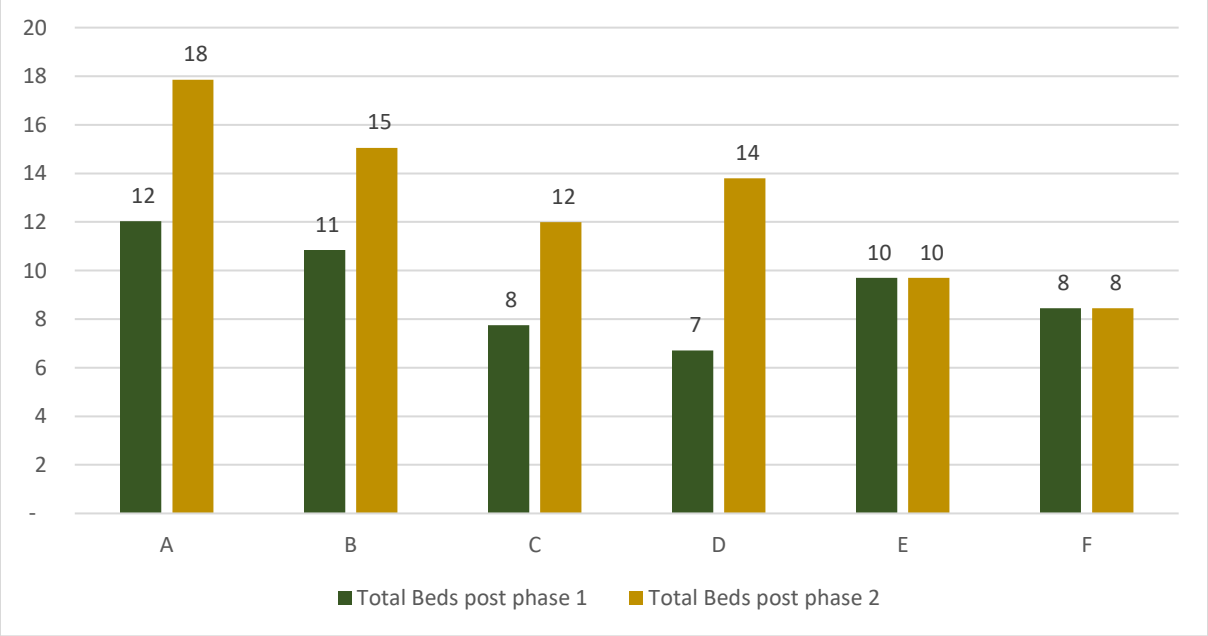
[13] https://www.hse.ie/eng/about/who/cspd/ncps/acute-medicine/

[14] Only model three and model four hospitals are equipped to provide critical care, with patients in model two hospitals transferred to a model three or four in cases where critical care is needed.

We can additionally see that the number of model three and four hospitals is not a perfect predictor of CCU beds by region, with RHA F and C being notable outliers having 53 and 45 respective CCU beds despite also having five hospitals of these types each (see Table.3.1.2). This analysis potentially highlights that regional differences in CCU capacity are not solely being driven by acuity needs and the presence of national specialties within some regions.

The Critical care plan aims to increase capacity across the system with a focus on increased capacity within Model 4 hospitals which provide national services. This increase in capacity adjusts the overall levels of access by RHA. The regions with the greater density of specialist care such as Neurosurgery, Organ Transplantation and major trauma services will have significant increases in capacity by the end of Phase 2 of this investment program. In regions which provide these services, CCU beds are set to significantly increase, with RHA D doubling its level of CCU beds per 100,000 population from 7 to 14, and RHA A and B also rising substantially. Given that these services are accessible to patients outside these RHAs, the total levels of access and demand evidently vary, in line with the differences in CCU beds by region observed. In regions which provide lower complexity procedures, the total demand for critical care beds is likely to be lower.

Fig 3.1.3: Total Adult CCU Beds per 100,000 after both Phases of the Critical Care plan



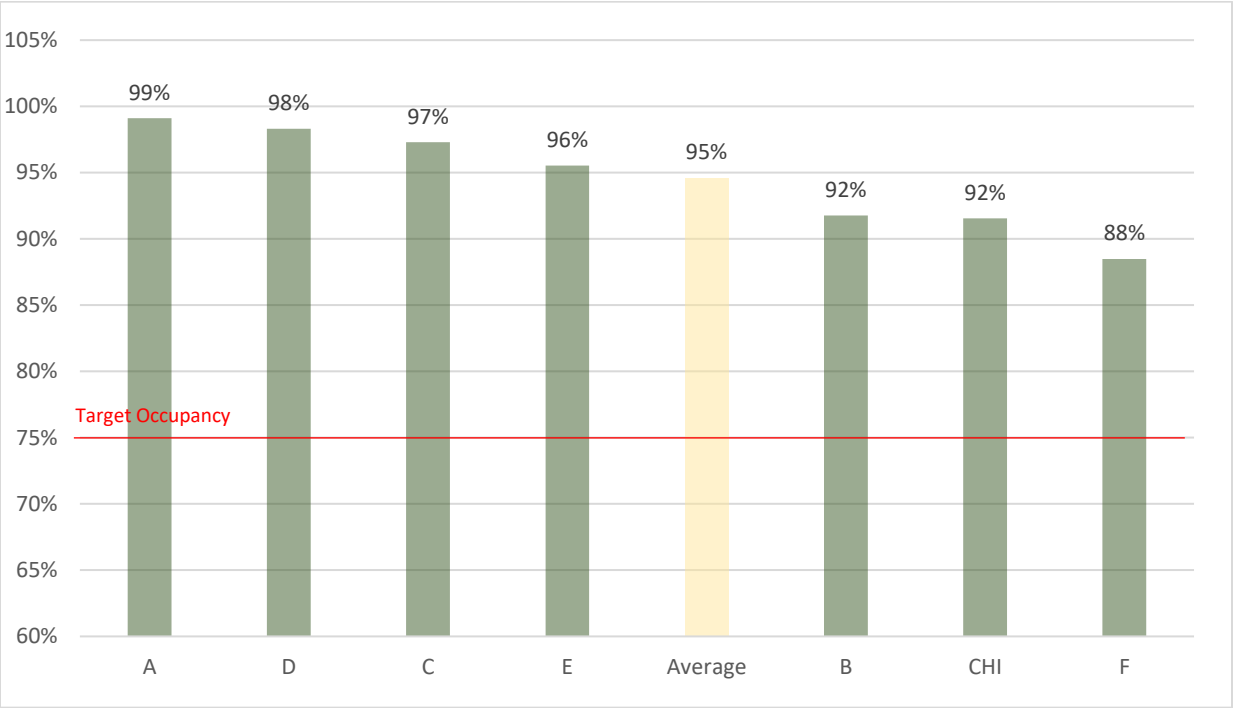
Source: HSE Critical Care Plan

3.2 CCU Occupancy[15]

While the level of beds can inform investment requirements, we can also examine the level of occupancy across RHAs to provide further clarity on potential need for critical care capacity by region. Implicitly, CCU Occupancy accounts for a larger number of factors, such as contemporaneous population health, hospital efficiency and care complexity by region. Reference to clinically recommended occupancy levels can also be informative from the perspective of optimising patient outcomes, safety, and staff welfare.

[15] Because of variability during COVID – a 6-month average from October to April is taken from Occupancy and Staffing. Evidently this analysis has significant limitations with regards to the effects COVID may have had on staff infections and absenteeism.

Fig.3.2.1: Occupancy % of Staffed Beds (Oct 2021 – April 2022):



Source: NOCA CCU-BIS Core Dataset & Recommended Occupancy from (ESICM, 2011)

Figure 3.2.1 provides average occupancy of staffed CCU beds by RHA. One can see that occupancy Is high in all regions, varying from 99% average occupancy in RHA A, to 88% average occupancy in RHA F. Occupancy is considerably higher in all regions than the recommended level from the European Society of Intensive Care Medicine, which recommends occupancy levels of 75% (ESICM, 2011). A balance in occupancy levels is also recommended in this context, with occupancy below 75% indicating the underuse of expensive critical care beds and inappropriate use of resources (NOCA, 2018).

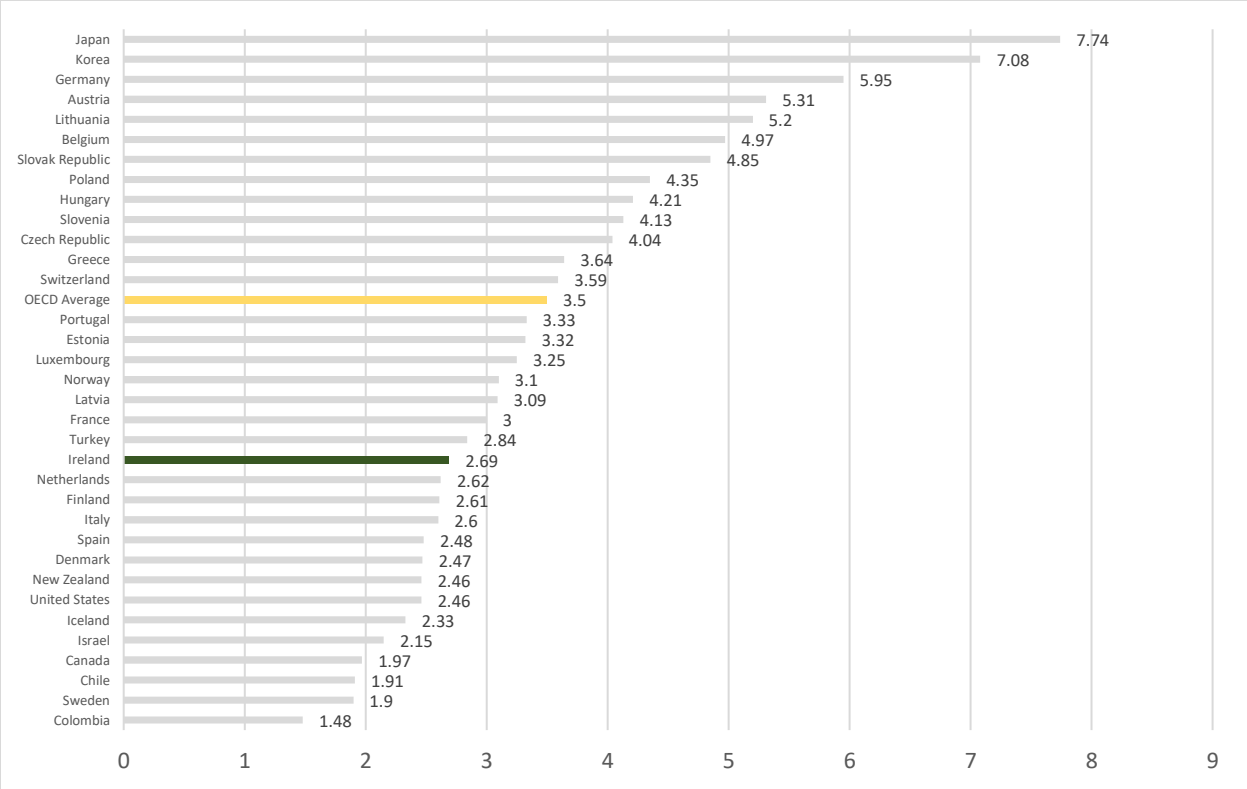
3.3 Key Findings

- There is variation in CCU bed access by RHA adjusting for population, with RHA A, B and E having more CCU beds relative to population than RHA C, D & F. This variation is likely to be partially reflective of the presence of National Centres of Excellence in some RHAs and the associated higher acuity care provided in these hospitals.
- Occupancy of ICU beds is considerably higher than the recommended level in all RHAs over the period examined, though some variation exists between regions.

4 General Inpatient and Day Bed Capacity

The number of beds within the Acute sector is a key determinant of capacity for emergency and elective patients across the country. The number of inpatient and day beds in the system has also long been an issue of major policy and public interest, with the low number of acute beds per 1,000 inhabitants in Ireland versus other OECD countries highlighted as a concern on numerous occasions (see figure 4.1). The required number of beds is also a key public interest issue, with the Health Service Capacity Review (2018) recommending the provision of between 2,590 – 7,150 additional acute care beds by 2031 (Department of Health, 2018). The expected provision of additional acute care beds over the next decade as outlined in the Capacity Review motivates an analysis of existing acute care capacity by region. This will help inform targeted investment in this area, prioritizing investment which best achieves departmental and governmental objectives.

Fig.4.1: Hospital beds per 1,000 inhabitants, 2020 or latest year



Source: (OECD, 2021)

To achieve an analysis of general inpatient and day case beds by region, the authors obtained a dataset from the Acute Business Intelligence Unit of the HSE, outlining available inpatient, day case and closed beds for certain months where available between 2019 and 2022. Occupancy rates for general occupancy beds were available for 2019 and 2020, although 2019 was chosen for the analysis completed in this respect to mitigate potential distortions due to the COVID-19 pandemic.[16] In addition to available open or day case beds, beds closed per month for staffing or infection control reasons were also reported between January and March 2022, allowing for additional insight into the remainder of beds beyond those available at a given time.

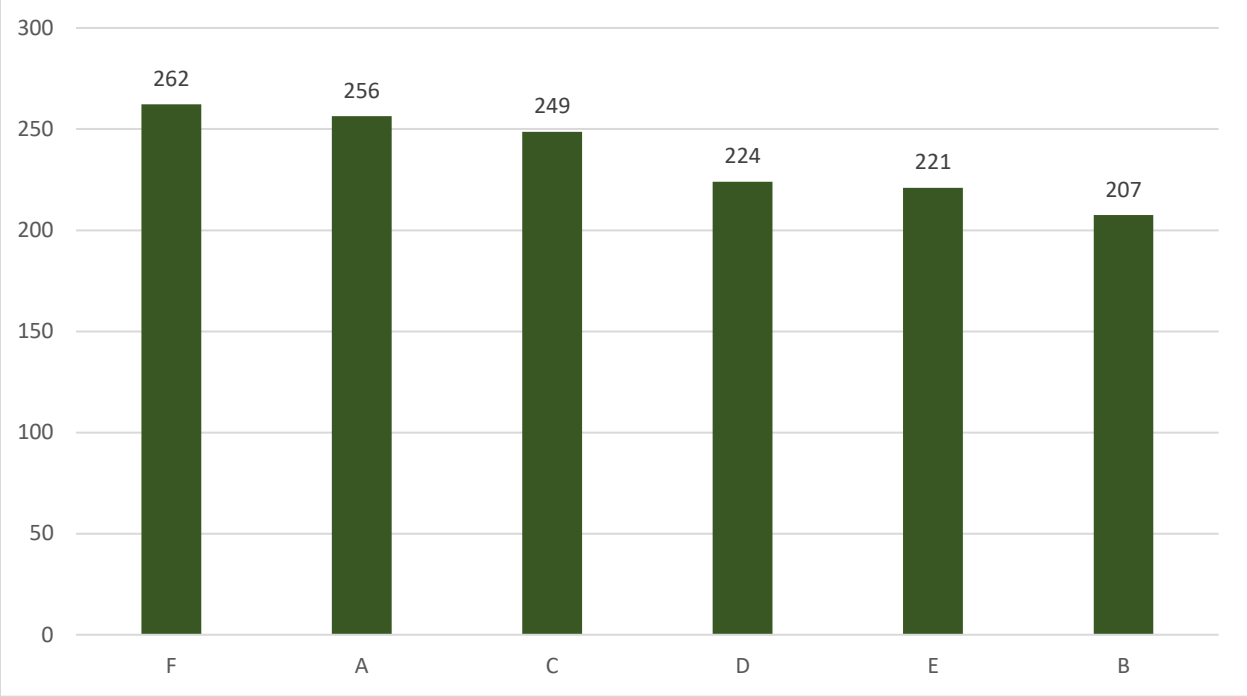
4.1 Available & Closed Inpatient Beds by RHA

Firstly, looking at the number of available acute beds by RHA we can see in Figure 4.1.1 that beds adjusted for population have a moderately even spread across the six RHAs[17] with all regions having at least 200 beds per 100,000 population. RHA F and RHA A have the highest number of beds by population, with 262 and 256 beds respectively per 100,000 persons. RHA B has the lowest number of beds, with 207 per 100,000 population. Variation in the number of acute beds by region has immediate implications for acute care service accessibility, although this priority would need to be balanced relative to the differing health needs by region, and the provision of higher acuity care in some hospitals. Available private beds may also compensate for the lower levels of provision in some region, as this data was not available to authors.

[16] As observed in Hennessy et al. (2021), hospital occupancy in 2020 was suppressed due to measures restricting the provision of non-essential care in hospitals during this period.

[17] CHI is excluded in this instance as beds are not proportionate to population for this hospital group due to the lower hospitalisation rate of children compared to the general population.

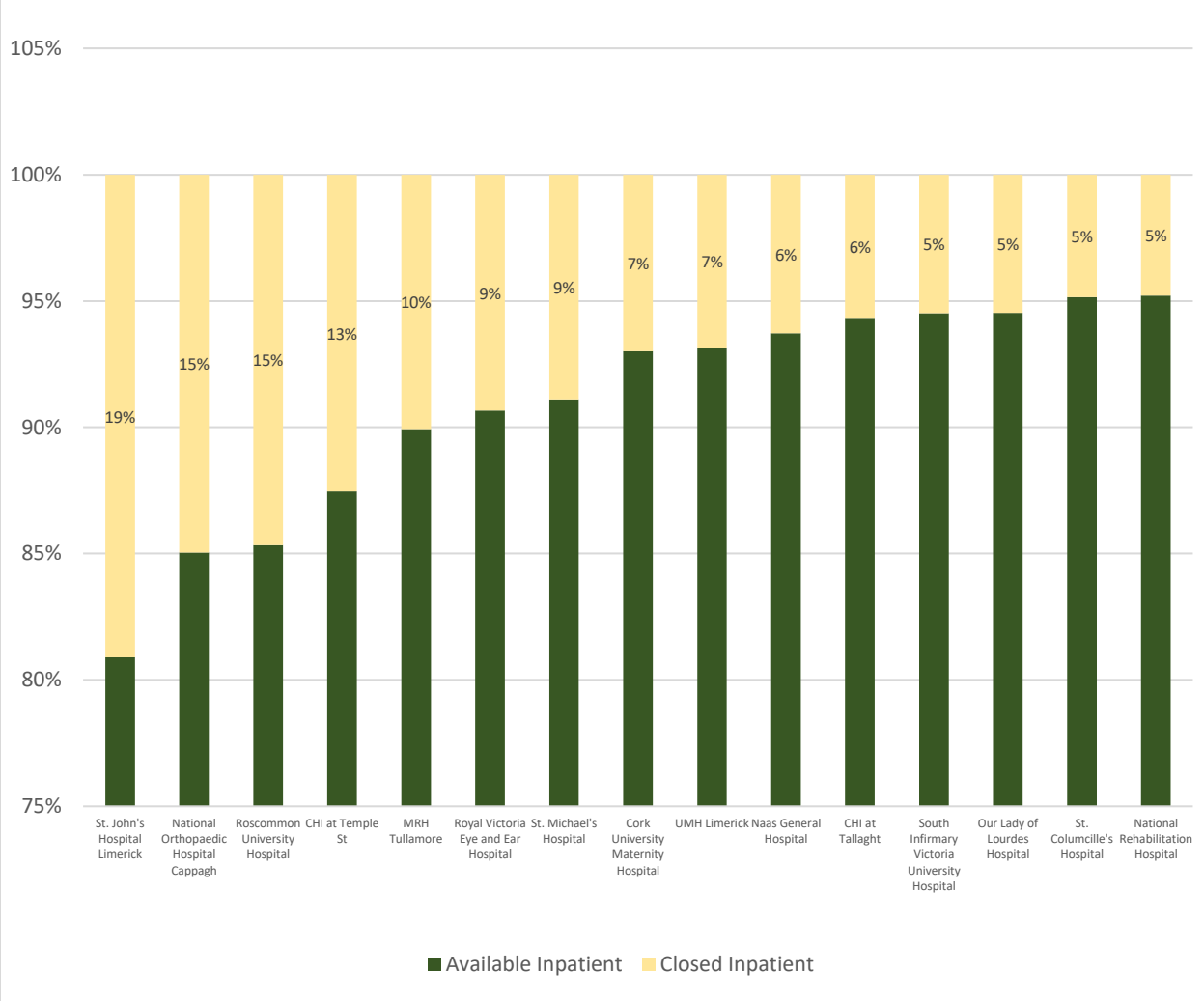
Fig.4.1.1: Available Acute Inpatient beds per 100,000 per RHA



Source: Author's Calculations, HSE BIU-March 2022

In addition to looking at the number of available beds by region, we can also examine closed beds to see available capacity over and above those beds that are currently staffed and in use. Taking an average of closed beds from January to March 2022 reveals that 2.6% of inpatient beds and 1.3% of day beds are typically closed in a given month. While bed closures are not a prominent issue across the system as a whole, the spread of closed beds by hospital is uneven, meaning some hospitals may not be able to fully utilise their available capacity due to staff shortages, infection control purposes or maintenance and refurbishment issues. Figure.4.1.2 provides the hospitals with the highest percentage of closed beds relative to their overall stock of beds. It can be seen that five hospitals have over 10% of beds closed, with a further ten hospitals having over 5% of beds closed. Further exploration of the specific issues causing a high level of bed closures in a given hospital would be needed before remediatory action could be taken.

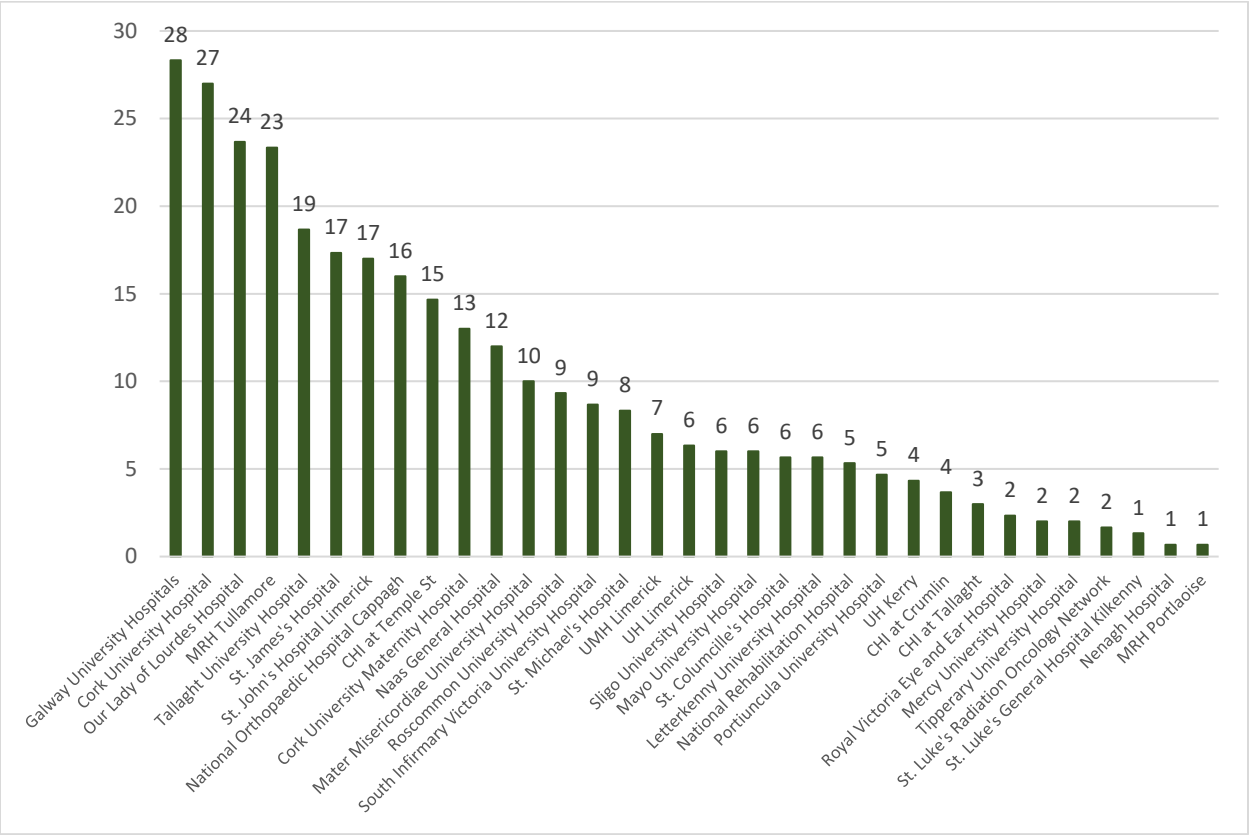
Fig.4.1.2: Highest Closed Inpatient Beds by Hospital % total (January to March) 2022



Source: Author's Calculations, HSE BIU

Overall, the variation in the number of closed beds is noteworthy, with the total number of beds closed in smaller hospitals tending to be greater than larger hospitals. For example, for comparison, University Hospital Galway had 4% of its beds closed over this period. Overall, as Fig 4.1.3 highlights the total number of beds closed on average is low with the high rates of closure present in hospitals with lower levels of capacity in general.

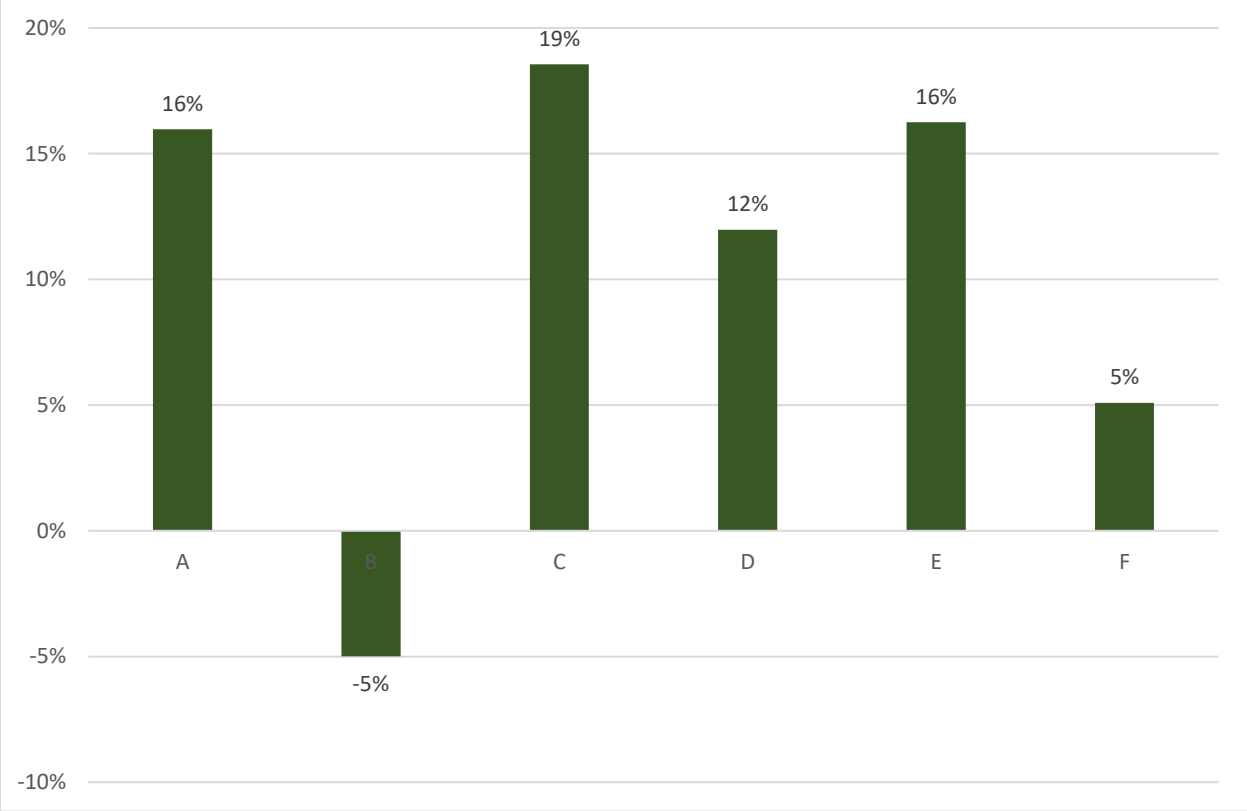
Fig.4.1.3: Average Number of Closed Beds by Hospital January-March 2022



Source: HSE BIU, 2022

Examining the change in capacity over time by region can also be informative. In Fig.4.1.4 below, the change in the total number of beds available by RHA can be seen. In Regions such as RHA E significant improvements in the levels of access have been made over the 5-year period 2017-2021 with an increase in total bed capacity by 16%. In contrast in RHA B, a 5% decrease in total capacity has occurred over this period. This is a point in time analysis and therefore may not be fully reflective of investment after this period or beds unavailable due to ongoing refurbishment. Overall, the increase in capacity has accounted for an additional 1,000 beds in the system, which accounts for 48% of the additional beds required by 2031 under the Health Capacity Review reform scenario (Department of Health, 2018).

Fig.4.1.4: Changes in Available Beds 2017-2022



Source: HSE BIU, Health Statistics 2017-Open Bed Report March 22.

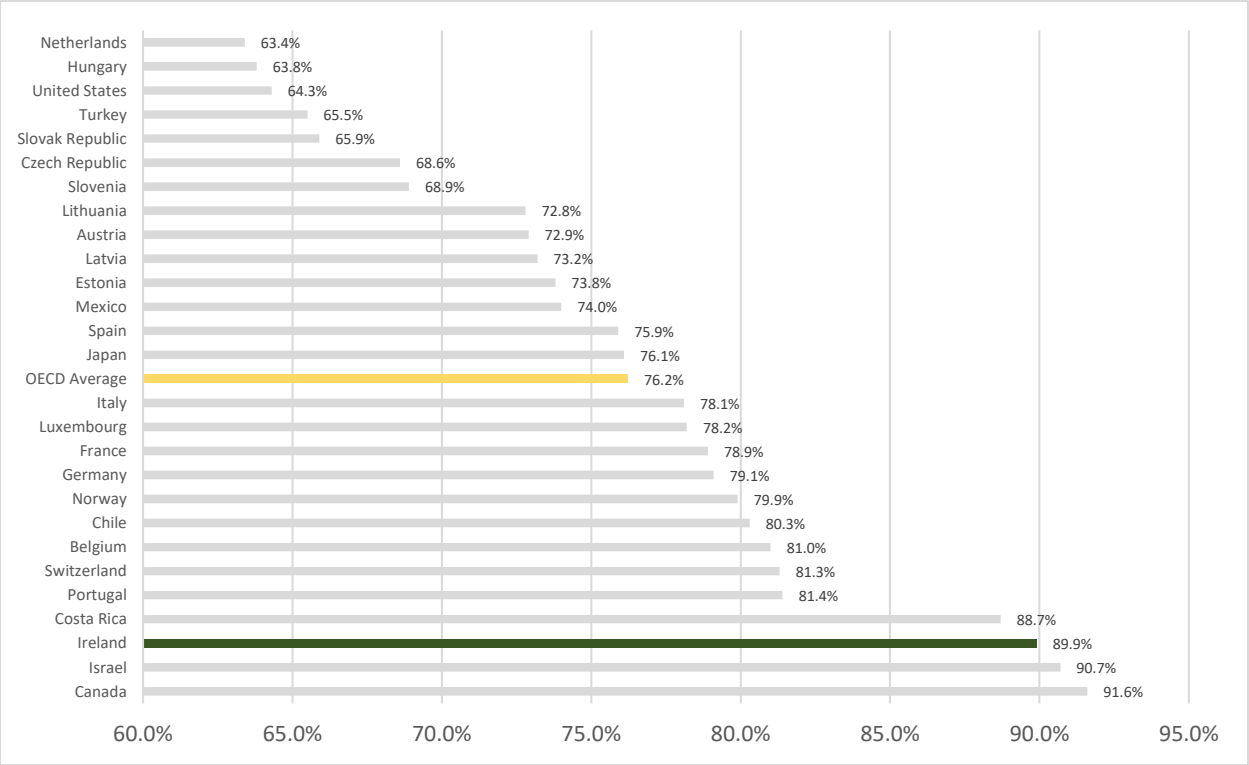
4.2 Occupancy

Acute care occupancy is indicative of how much demand there is within the population for acute medical care relative to the system's capability to meet this demand. A high level of occupancy in acute care beds can be indicative of a system under strain and can be associated with negative clinical outcomes arising from unmet need and an inability to deal with clinical surge events (OECD, 2021). While there is no consensus around the optimal occupancy rate of acute care beds, occupancy levels of 80-85% are commonly recommended, with a meta-analysis from the UK National Institute for Health and Care Excellence finding an 85% level is effective at reducing the risk of bed shortages (NICE, 2018).

Figure 4.2.1 examines acute care occupancy levels across countries in 2019 based on OECD data. Relative to international peers, Ireland's level of acute care occupancy is high, with average occupancy of 90% reported in Ireland in 2019, compared to an OECD average of 76.2%. Most countries adhere to an occupancy level below the 85% recommendation, with just four countries including Ireland having an

average acute care occupancy level above 85%. Occupancy rates within many of these countries may be skewed by an ageing population which inevitably leads to a higher utilization rate of acute services.

Fig.4.2.1: Occupancy rates of Acute care beds, OECD 2019



Source: (OECD, 2021)

Looking at occupancy levels in Ireland by region presents a similar picture. While acute care occupancy varies between 97% in RHA F to 84% in RHA A, occupancy in all regions is high relative to international peers. Only RHA A, and Children's Hospital Ireland have occupancy levels below the 85% recommended level. It can also be observed that the relationship between total beds and occupancy is relatively weak. For example, while RHA F has the highest occupancy of all regions, it also has the highest number of inpatient beds per 100,000. In tandem, RHA A has both second highest level of acute beds per 100,000, and the lowest occupancy rate out of the six RHAs. This indicates the need for further research to inform future investment requirements and fully develop the relationship between occupancy, capacity and hospital throughput. This future research will be iterative and enable the updating of the SHIF as further demand drivers and solutions are identified. In parallel to this body of research, work to understand the

population demographics by RHA is being undertaken by colleagues in the Department[18]. This body of work has identified that some regions have higher levels of over 85s and this may in turn induce higher levels of resource utilization, pointing to the additional analysis in this context that may be required.

Table.4.2.2: 2019 Average Acute Care Occupancy by RHA

RHA	Total Beds	Occupancy
F	1752	97%
B	2094	92%
C	1601	88%
E	807	88%
D	1519	87%
A	2653	84%
CHI	323	83%

Source: HSE BIU, 2019

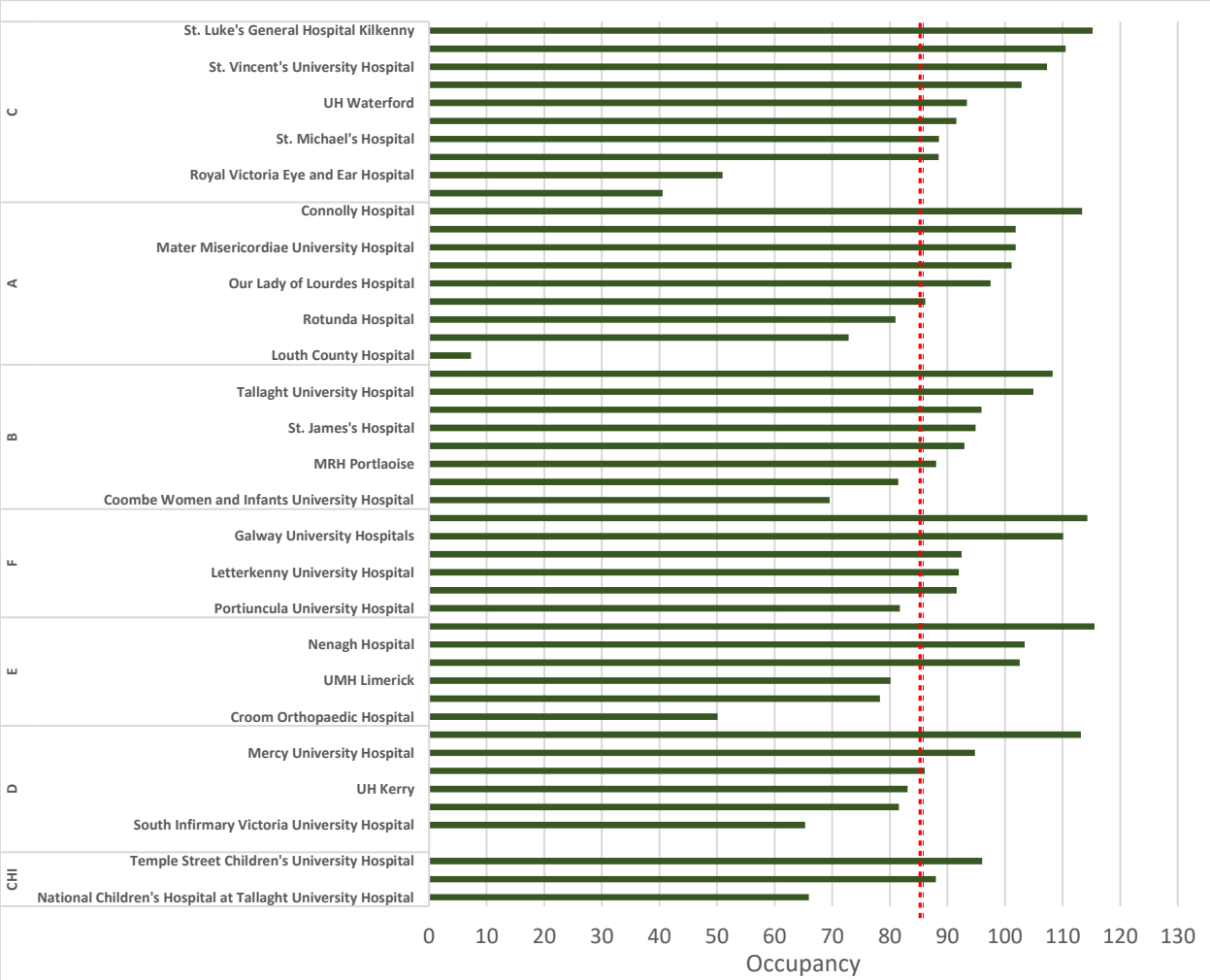
Acute care occupancy can also be examined on a per-hospital basis to identify healthcare facilities under severe demand pressure, and those where beds are relatively under-utilised. Figure 4.2.3 shows occupancy by hospital, categorized by RHA. One can see that there is a considerable number of hospitals experience severe pressures, with 16 hospitals (33% of total) experiencing average occupancy rates above 100%.[19] Demand pressures are particularly apparent in RHA F, with both Galway University Hospital and Sligo University Hospital having average occupancy rates above 110%, equivalent to 104 patients more than their combined capacity on average. Equally RHA C has multiple hospitals with capacity issues, with 93 patients on average more than the available capacity across this RHA. RHA D has the least pronounced

[18] *Informing the Development of a Population Based Health Funding Model for Ireland, Tiago McCarthy 2022*

[19] This indicates that temporary and surge capacity is being used on a continuous basis in these hospitals.

issues with overcapacity only having 6 patients on average above the total capacity. In general, the majority of the hospitals below the 85% recommended occupancy level are elective and maternity facilities. The identification of high and low occupancy hospitals further helps to inform investment requirements, with remediation of key pressure points in the system likely having a greater return on investment than non-targeted capacity investment[20].

Fig.4.2.3: Acute Care Occupancy by Hospital (%) - 2019



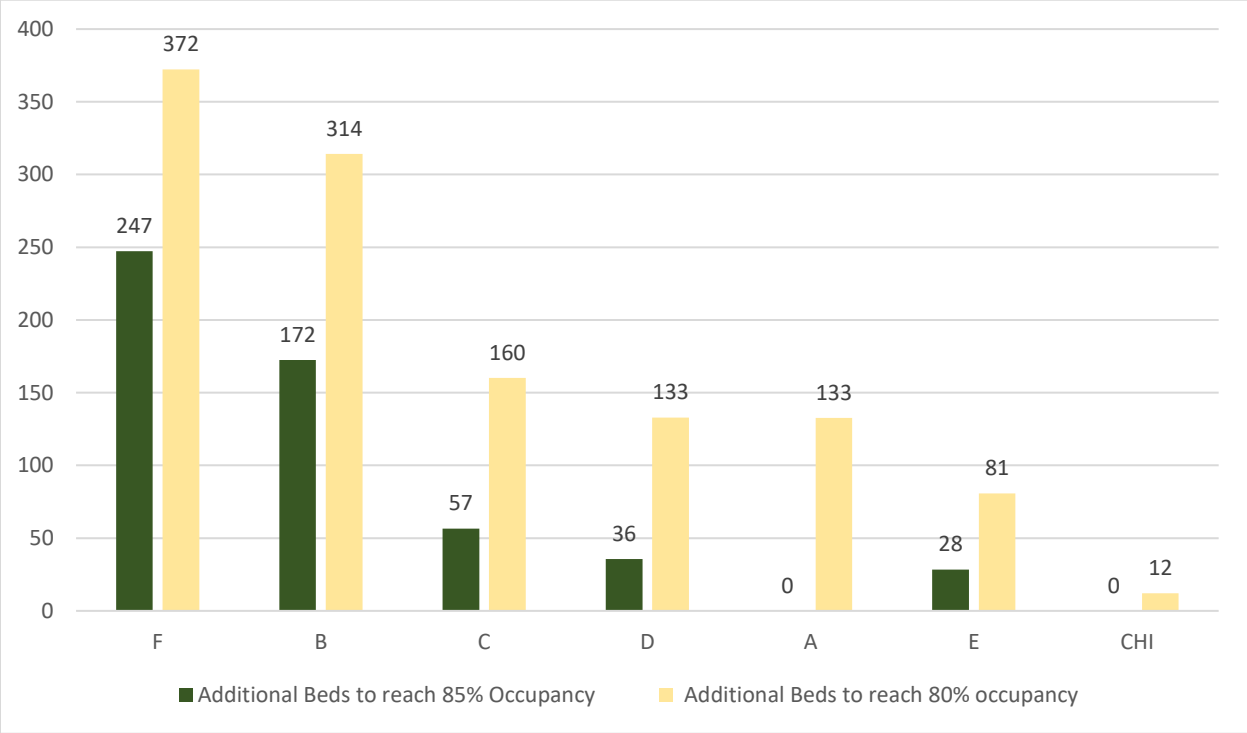
Source: HSE BIU, 2019

The high level of hospital occupancy in Ireland across all RHAs motivates further investment in acute care facilities. To illustrate potential investment to achieve a desired occupancy level, we can use 2019

[20] For example, Jones et al. (2022) indicates 1 extra death for every 82 patients delayed for more than 6-8 hours in ED.

occupancy rates as a measure of steady state demand[21] to estimate additional bed requirements by RHA as in figure 4.2.4. One can see that based on 2019 occupancy levels 550 beds are required to achieve an occupancy level of 85% while 1,200 beds are required to reach an occupancy level of 80%. The distribution of these beds is also heavily skewed, with RHA F and B requiring roughly double the number of additional beds as in any other RHA, illustrating the demand and capacity pressures in these particular regions. Of course, investment requirements will also change based on updated post-pandemic occupancy levels, investment since 2019, future demographic and non-demographic demand pressures, and shifts in policy direction as highlighted in the Capacity Review. Rather, this analysis is illustrative in nature and allows for the identification of regional disparities which will need to be considered when future investment decisions are being made.

Fig.4.2.4: Additional Beds to reach 80%/85% Occupancy per RHA (2019)



Source: Authors Calculations

[21] This assumes that the level of supply in 2019 had low levels of unmet demand

4.3 The number of patients on trolleys

An additional measure of demand pressures can be gleamed from the "TrolleyGAR" system from the HSE. At three intervals throughout the day acute hospitals report the number of patients in Emergency Departments awaiting admission to an inpatient hospital bed. While this measure is primarily used as a way to flag the need for additional ED resources in a given hospital, it can also be used to identify which emergency departments across the system are under the most pressure. In this context, one can see that the number of persons on trolleys per inpatient bed is consistent across five out of seven RHAs. One can see also that there is a moderate but imperfect relationship between occupancy and persons on trolleys, which suggests differences in emergency department performance and effective resource allocation across RHA emergency departments. It is also notable that RHA A has markedly lower patients on trolleys relative to its capacity than other RHAs, indicating the relative effectiveness of emergency departments and other services in this region relative to other regions.

In general, analysis of the number of patients on trolleys may be most relevant to future investment considerations in the context of investment in new emergency department facilities and staff. The analysis presented here will be complemented by reference to hospital level key performance indicators for emergency departments, such as ED wait times and readmissions[22].

[22] Clancy. C, Shine. C, Hennessy. M, An Analysis of Hospital Performance, forthcoming

Table.4.3.1: Total Patients on Trolleys 2019

RHA	Total on trolleys	Total Beds	Trolleys per Day	Occupancy	Trolleys per bed
F	23,383	1,752	64	97%	13
C	23,760	1,870	65	88%	13
E	8,423	725	23	88%	12
D	17,832	1,601	49	87%	11
B	22,614	2,094	62	92%	11
A	16,578	2,653	45	84%	6
CHI	1,859	323	5	83%	6

Source: Department of Health, 2019-8am

4.4 Ambulatory beds

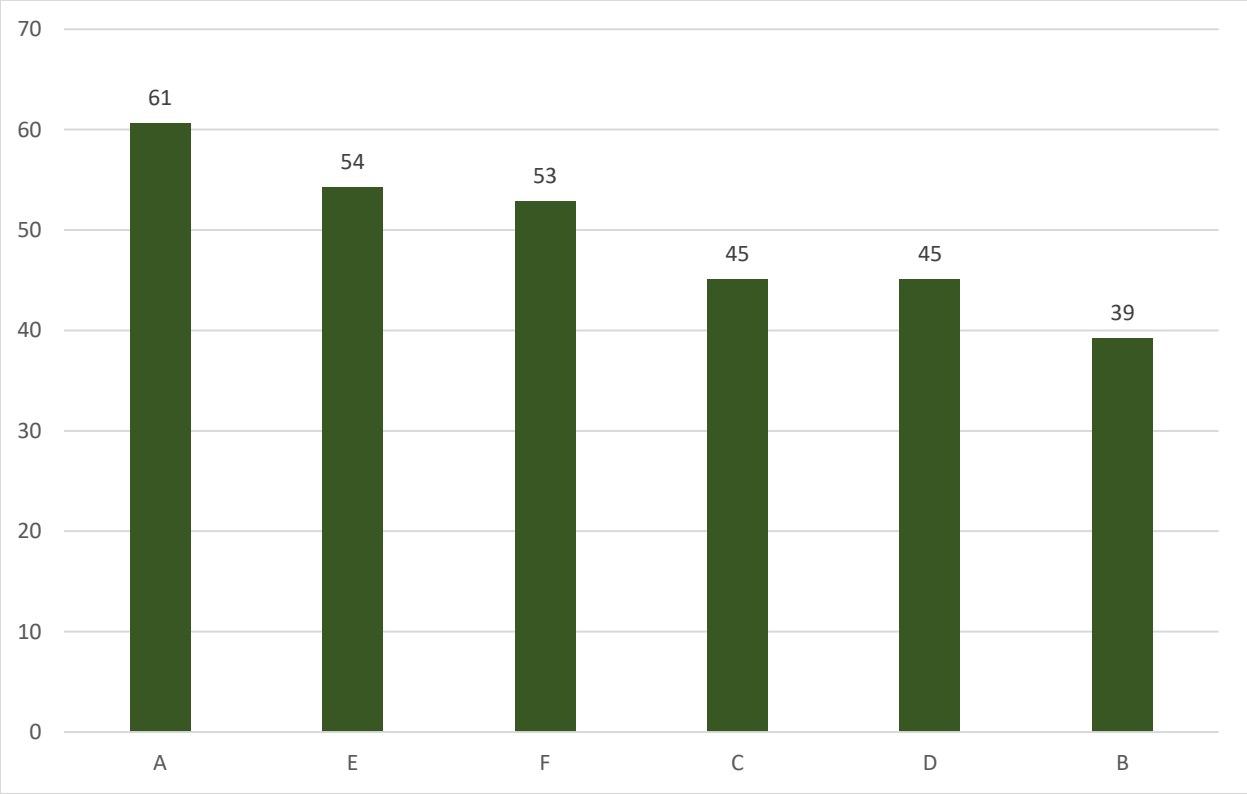
The number of beds available within a hospital can be classified as either inpatient or ambulatory beds. Ambulatory beds refer to beds utilised by patients for "day case" procedures. These beds are usually occupied by patients undergoing procedures which result in discharge on the day of the procedure (HSE, 2018). Ambulatory care is a significant proportion of Acute hospital activity with 930,000 ambulatory discharges completed in 2020 compared to 569,000 inpatient discharges (HPO, 2021).[23] Ambulatory care capacity is identified as a driver of hospital efficiency, with the separation of ambulatory and non-ambulatory care being a stated objective of the Sláintecare.

[23] Data for 2020 is the latest year available. Discharges in 2020 declined by 15% from 2019 due to COVID-19 activity restrictions, with day case procedures declining by 17% over the same period.

4.4.1 Ambulatory beds by RHA

The number of ambulatory beds per 100,000 inhabitants by RHA shows the level of access the population within each RHA has to ambulatory care. There is variation in the level of access to Ambulatory care beds by region, with RHA A having 61 beds per 100,000 population, compared to RHA B with 39 beds.

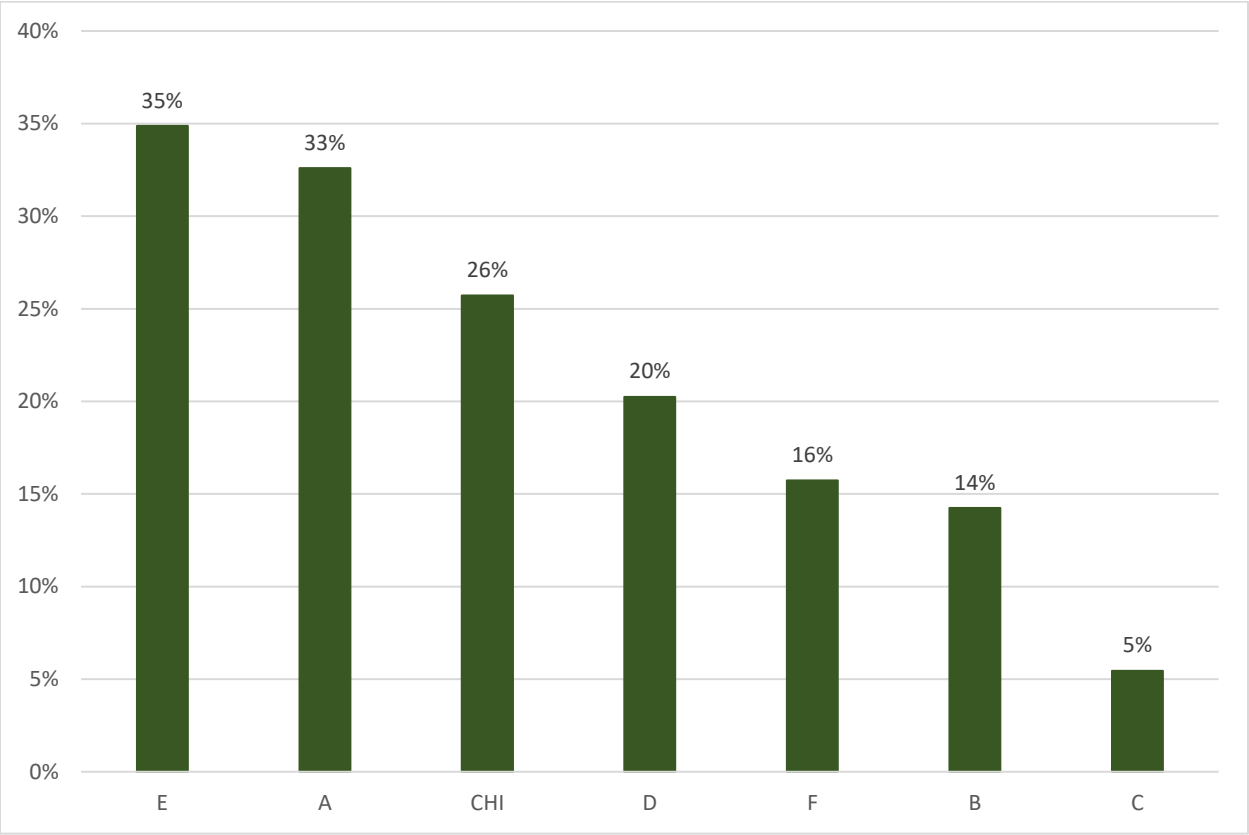
Fig.4.4.1: Ambulatory Beds per 100'000 Inhabitants



Source: HSE BIU, November 2021/ Authors Calculations

In Fig 4.4.2, Changes in ambulatory care beds from 2014 to 2021 are shown, with 381 ambulatory beds delivered in this period. This accounts for 98.5% of the target number of beds outlined in The Health Capacity Review assuming the reform scenario is implemented (Department of Health, 2018). This highlights the progress which is being made in achieving these targets in the context of ambulatory care.

Fig.4.4.2: Changes in Ambulatory Beds 2014-2021



Source: HSE BIU,2021

4.4.2 Waiting Lists by RHA

The supply of ambulatory beds per 100,000 provides insights into access to care. However, it doesn't necessarily provide insights into the demand for care within a given region, with different population segments having different ambulatory care needs. To complement the analysis of the distribution of ambulatory care beds, we can also examine numbers waiting for day procedures by RHA to better understand capacity relative to contemporary demand. In this context we can see that RHAs have different numbers of patients per available day beds, with RHA F having 36 patients waiting for a day procedure per day bed available, versus 12 patients waiting per day procedure per day bed available for RHA E.

In addition to the investment implications from this analysis, one can also point to the need to facilitate greater inter-regional referrals to address rising waiting lists. The utilisation of day beds on a 7-day rather than 5-day basis may also need to be explored as another mechanism to address waiting lists in regions

with particularly severe demand pressures. This would provide another avenue of intervention which would complement the current NTPF funded interventions.

Table.4.4.3: Waiting Lists by RHA

RHA	Total Day Waiting List	DC BEDS	Patients on Waiting List per DC BED
F	13,682	376	36
CHI	2,913	88	33
C	10,556	416	25
B	8,698	388	22
D	6,152	311	20
A	11,526	656	18
E	2,587	209	12

Source: NTPF, February 2022

4.5 Key Findings

- The number of general hospital beds available per RHA is uneven, with RHA F having 247 beds per 100,000 compared to RHA C with 207 beds. The relationship between occupancy and bed capacity in each region is weak, highlighting the need for further analysis of acute care performance.

- The number of patients on trolleys is consistent across five out of seven RHAs. RHA A appears to have lower numbers of patients on trolleys than all other RHAs, indicating the relative effectiveness of their emergency departments.

- The number of patients on waiting lists per ambulatory beds available is highly skewed, with 36 patients waiting per bed in RHA F, compared to just 12 patients per bed in RHA E.

5 Community, Primary and Mental Health Services

5.1 Introduction

Sláintecare aims to bring care into the community, aiming to majorly develop primary and community care infrastructure that allows people to stay healthy in their homes and communities for as long as possible (House of the Oireachtas, 2017). By enhancing the level of care to be provided in the community, there will be a reduced need for patients to attend acute public hospitals, enabling the healthcare system to better meet the rising healthcare demand emerging from changing demographics (Department of Health, 2018).

Sláintecare aims to deliver major reforms to the healthcare system as it currently operates. The current acute hospital system has 4 distinct 'models' of hospital with model 1 hospitals being community hospitals which provide short term care to patients recovering from procedures and long-term care to patients requiring nursing home care. In contrast, Sláintecare will enable access to many services outside the acute care system, such as providing GPs direct access to diagnostics and the ability to conduct minor surgeries. Other reforms include an expansion of community services such as pallative care, home care, services for people with disabilities and mental health.

In this section, an overview of capacity as it relates to the areas of community, primary, and mental health is provided. While broad, the interlinkages of these areas allow for an analysis of their capacity to be complementary. Although much of the primary care system is dominated by private rather than public providers, the public capacity of regions in this context is nonetheless relevant to policy considerations around patient safety, accessibility and the move towards greater Sláintecare implementation. In addition, primary care capacity can directly inform which localities are potential recipients of new Primary Care Centres ("PCCs"), which are highlighted as an important deliverable in the Sláintecare implementation Strategy (Government of Ireland, 2019). Future investment in nursing home and mental health beds is already underway, with nursing home beds being identified as another key area of growth by the 2018 Capacity review. A significant proportion of expenditure in this area has been allocated to the replacement of existing nursing home stock to achieve HIQA compliance. An analysis of the distribution of these beds across regions can therefore help inform the need for and location of this future investment. In the 5th paper in this series (Shine & Hennessy, 2022) an analysis of the quality and age of HSE owned community nursing units is provided. This enables the identification of regions which have comparatively poor community care infrastructure quality.

5.2 General Practitioners.

The General Practitioner is the first point of care for many in the population. General practitioners in Ireland are private contractors and therefore can choose the areas and the services they provide. The role of the GP includes the diagnosis and treatment of disease, referral of patients and the management of patients with long term disease. Because of the breadth of services provided, access to GPs is critical pathway for patient access. A major aim of Sláintecare is to facilitate treatment outside of the acute care setting. GP services will be a key enabler of this transition, providing new services in addition to their existing remit such as chronic disease management and access to community diagnostics (House of the Oireachtas, 2017). The number of GPs by region is therefore worthy of consideration, with this likely being a determinant of timely access through both associated travel times, capacity and pricing.

In the table 5.2.1 below the number of PCRS (Publicly contracted) GPs per RHA is presented[24]. One can see that the number of persons per GP varies across the RHAs, with the number of persons per GP in RHA B being higher than the number of persons per GP in RHA C. Intuitively, this raises concerns over whether healthcare is adequately accessible in regions with lower numbers of GPs relative to population.

[24] PCRS Registered GPs account for about 60% of the total number of self-reported GPs in 2020 by the Medical Council Survey

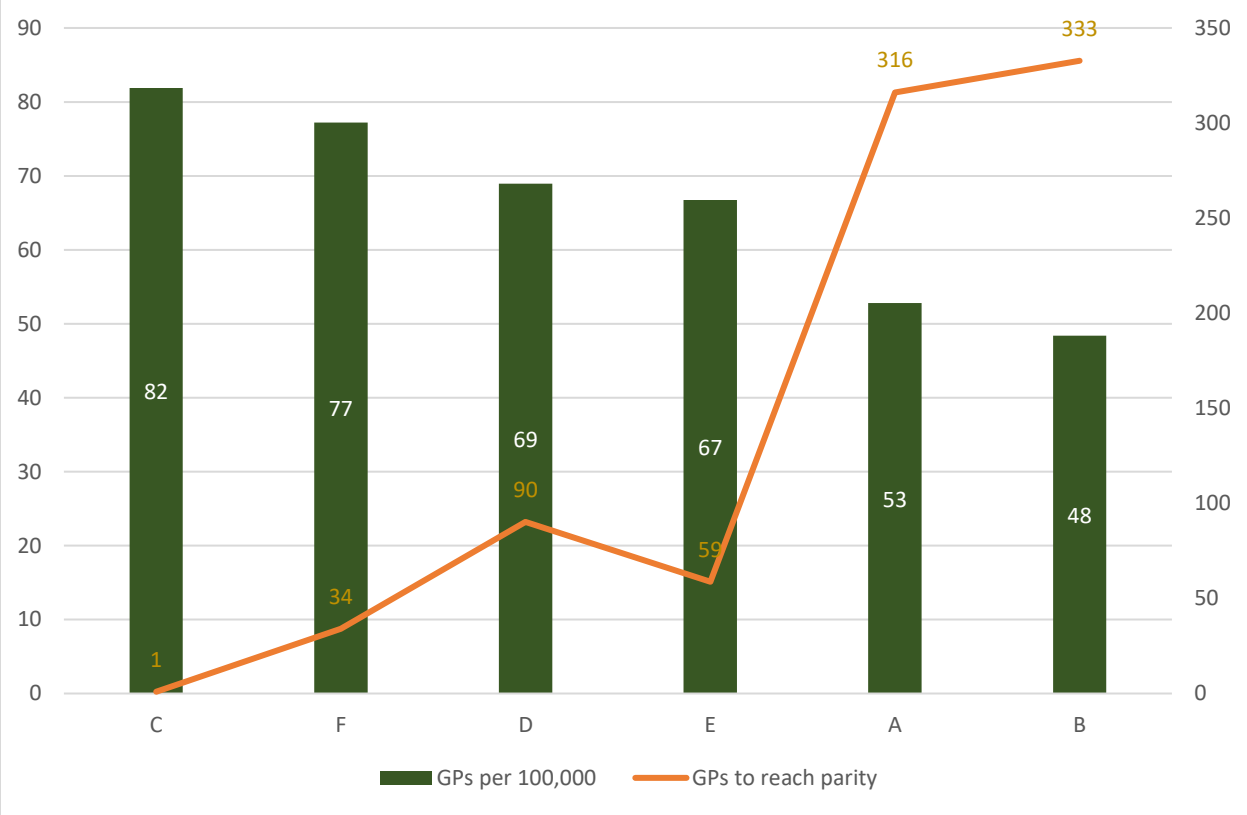
Table.5.2.1: Analysis of PCRS GP stock

RHA	GPs	Population (,000)	Population >65 per GP	Population per GP
C	740	904	178	1221
F	549	711	202	1295
D	476	691	207	1451
E	257	385	219	1498
A	571	1082	222	1894
B	479	990	236	2067

Source: PCRS

The unequal distribution of GPs by region motivates additional consideration of the pathways for training of GPs within the Irish Healthcare system, and how these GPs are distributed by region. Looking firstly at the existing disparity of GPs by region, Fig 5.2.2 shows that 832 GPs would be needed to reach 82 PCRS contracted GPs in each region. This can be compared to the current pathways for training of GPs. From HSE training data, we know that 208 new GP trainees entered the system in 2020, compared to 159 in 2015 (HSE, 2022).

Fig.5.2.2: GPs per 100,000 population & no. GPs for parity.



Source: PCRS Monthly Contractor Reports,2022

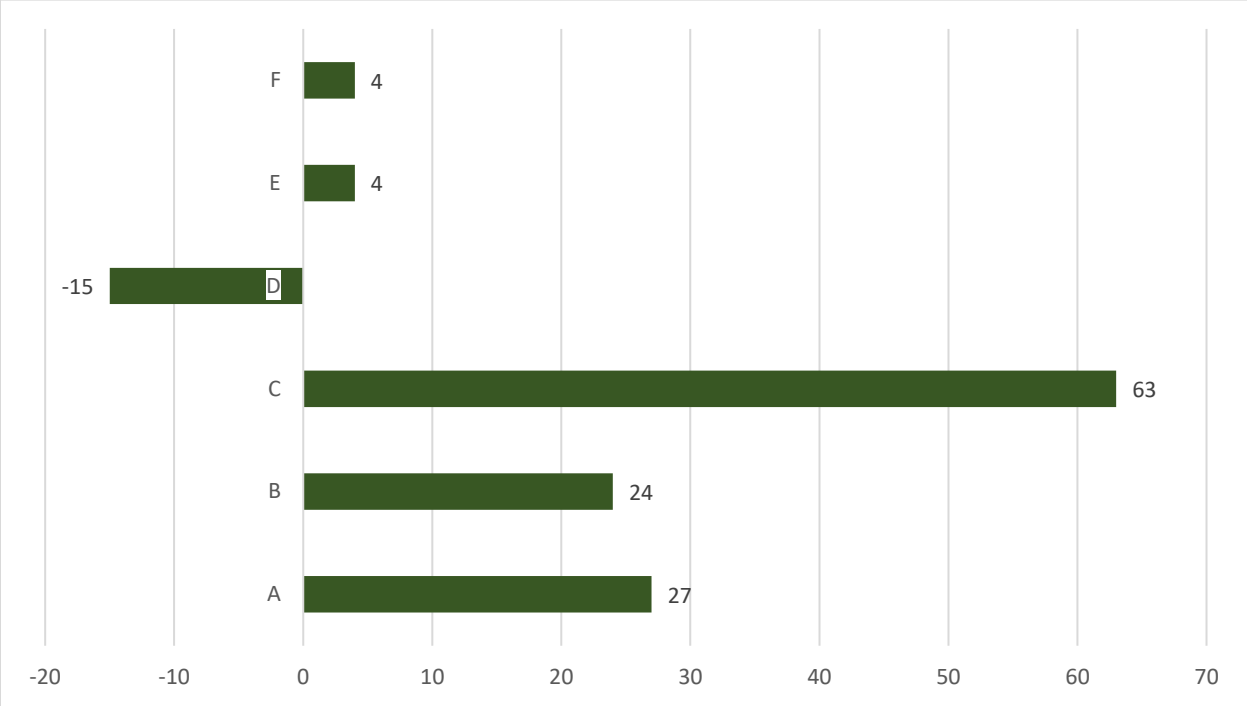
While the number of GPs in training has been increasing in recent years, the distribution of these GPs across the country continues to be uneven, owing to the unavailability of GP Out of Hours services in regions with low capacity, and the challenges of running and maintaining a GP practice in rural areas.[25] We can additionally look at GP entry and exits from the PCRS system to examine the dynamics in registered GPs over time. In Fig 5.2.3, 107 additional GPs have been added to the system since 2017. In addition, the regional distribution of these entries and exits can also be observed.[26] One can see a highly uneven spread in this context, emphasising the core issue identified in this section of unequal access to GP care. The addition of just 107 GPs over a four-year period is a concern. In light of this evidence, consideration is needed regarding additional routes to increase the supply of GPs, especially in regions that are currently under-serviced. While the overall number of GPs in training may not need to increase,

[25] It should be noted in the first instance that GPs are free to set up wherever they wish, meaning that regional differences in GPs are not a direct result of employment policy in this context.

[26] Entry and exit is driven by emigration, retirement or relocation to another region, with the number of publicly registered GPs potentially also driven by policy interventions.

Policymakers may need to consider methods to retain GPs and encourage them to set-up services in regions with a relatively low level of GPs. Efforts should also be made to anticipate the net impact of GP entries and exits in advance to facilitate better healthcare provision across regions, especially those that are currently under-serviced. In this context, upcoming research from O'Connor and Hynes (2022) is informative, as it maps change in the number of doctors using a system dynamics model. Equally, increased roll-out of free GP care in line with Sláintecare objectives may induce additional demand, further adding to the potential capacity issues already identified.

Fig.5.2.3: Change in Total Number of PCRS registered GPS 2017-2021 by RHA



Source: PCRS,2022

5.3 Dentists, Pharmacists and Optometrists

Dentists play an important role in maintaining the oral health of patients which has a multitude of clinical and social benefits. While roughly two thirds of dental care is privately funded (Henry, et al., 2021), the HSE is also a major provider of dental care, providing a third of dental care to the population by expenditure. Public dental care is primarily provided to adult medical card holders via the Dental Treatment Services Scheme (DTSS), to non-medical eligible adults via the Dental Treatment Benefit Scheme (DTBS), and to children under 16 years via the Public Dental Service (PDS) (Nolan, 2019).

Access to dentistry services is important, with this being emphasised by the recent public debate regarding ongoing access for medical card holders. The decline in the number of dentists willing to service patients on the DTSS prompted concerns that vulnerable groups would be unable to access routine dental treatment (Irish Examiner, 2022). In response, the Department of Health recently approved new measures to expand the provision of dental health care for medical card holders and endorsed a full review of the DTSS to ensure its viability (Department of Health, 2022). While the reasons for the decline of treatment under the DTSS are beyond the scope of this paper, it clearly highlights access to dental care as a public interest issue. Reform of the DTSS will take place in the context of implementation of the substantive service reforms set out in the National Oral Health Policy, *Smile agus Sláinte*, which was published in 2019.

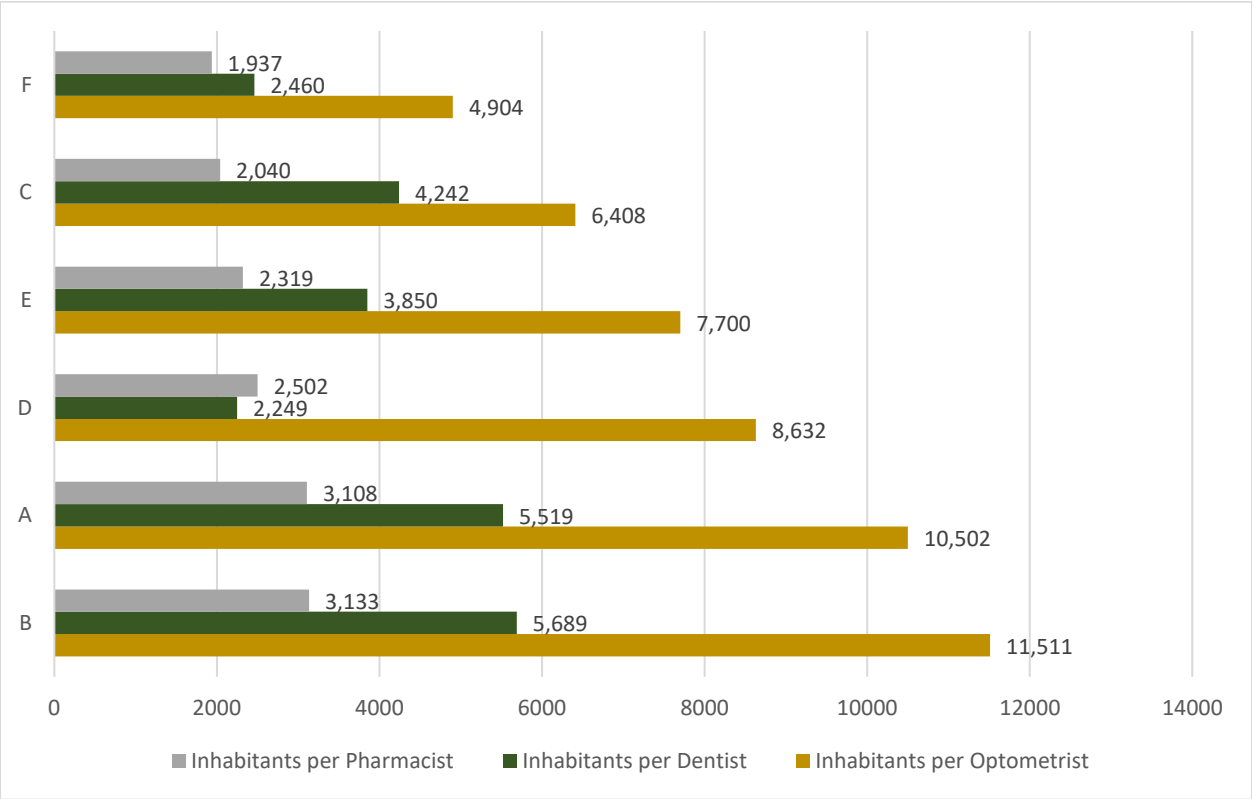
To provide a measurement of accessibility to dentistry treatment across regions, an analysis of PCRS registered dentists was analysed.[27] All dentists who provide dental care to public patients are recorded within this database, though in most cases these dentists also provide treatments to private clients. In Figure 5.3.1 below, the number of inhabitants per dentist within each RHA can be seen. One can see a disparity in dentists by region, with over 5,600 persons per public dentist in RHA B, compared to 2,250 persons per public dentist in RHA D.

PCRS data also enables analysis of pharmacists and optometrists per region, providing additional insight into access to these services. The number of PCRS contracted pharmacists across the state varies with some RHAs having a lower ratio of pharmacists to inhabitants. From Fig 5.3.1, one can see that RHA F has 1 pharmacist per 1,937 inhabitants, versus RHA B with 1 pharmacist per 3,133 inhabitants. For optometrists, the picture is similar, with RHA B having 1 optometrist for every 11,510 inhabitants, versus RHA F with 1 optometrist for every 4,903 inhabitants.

The difference in primary care providers across regions may prompt further inquiry into whether there are adverse health impacts from this apparent lack of access. In particular for dentistry, one would be concerned that the low number of dentists in some regions is limiting access to emergency and routine dental care. The introduction of mid-level dental professionals who can hold dental contracts and provide basic dental care and/or supportive preventive care, such as hygienists, directly to the public needs consideration. Prevention via community oral health promotion programs are essential to improve long term oral health outcomes in addition to practice-based treatment focused care.

[27] There are other schemes which some of these practitioners may provide who do not provide PCRS care such as the Treatment Benefit Scheme. Approximately 1300 of 2000 dentists in Ireland provide PCRS care.

Fig.5.3.1: PCRS Contractors



Source: PCRS

5.4 Analysis of Long Stay facilities

Long term residential care provides care to patients who are unable to continue to live at home in an unassisted manner. While these services are predominantly used by older patients, a small number of younger patients may also move into long term care due to the onset of a disability or progression of a disease (Citizens Information, 2019). While Sláintecare aims to reduce the need for admissions to long stay facilities (Government of Ireland, 2018), admissions are expected to remain common in the interim, with the health capacity review anticipating the need for at least 13,000 additional residential care beds by 2031 (Department of Health, 2018).

Public provision of long-term residential care is primarily provided via the Nursing Home Support Scheme (NHSS). This is a targeted service for those requiring nursing home care, providing financial support for those in need. The scheme is a co-funding model, with eligible individuals making a mean-assessed contribution to the cost of their care of 80% of assessable income and 7.5% of the value of any assets held

annually (Collins, 2019).[28] While not all patients are funded under the scheme, the vast majority are, with 79% of private nursing home residents in Ireland being NHSS funded (Eurofound, 2017). Given the breadth of coverage of the NHSS scheme, the supplementary survey of its recipients was identified by authors as an appropriate source of information on the capacity of the long-term residential care sector in Ireland.

Looking first at type of facility, we can see that care under the NHSS scheme is provided in facilities with a number of different operating models. From Table 5.4.1, we can see that out of all care provided in this context, 71% is provided by Private Nursing Homes with the remaining care provided by both the State and voluntary providers. The occupancy rates across these facility types varies, with Voluntary Welfare Homes having an average occupancy rate of 57%, compared to Private Nursing Home Occupancy of 77%.

Table.5.4.1: Breakdown of Long Stay facilities by Type[29]

Facility Type	*Total residents*	*Total beds*	*% Occupancy*
Private Nursing Home	*17413*	*22770*	*77*
HSE Residential Care Centre	*4052*	*5507*	*73*
Voluntary Home / Hospital for Older People	*1538*	*2237*	*69*
HSE Welfare Home	*299*	*426*	*70*
Voluntary Welfare Home	*227*	*400*	*57*

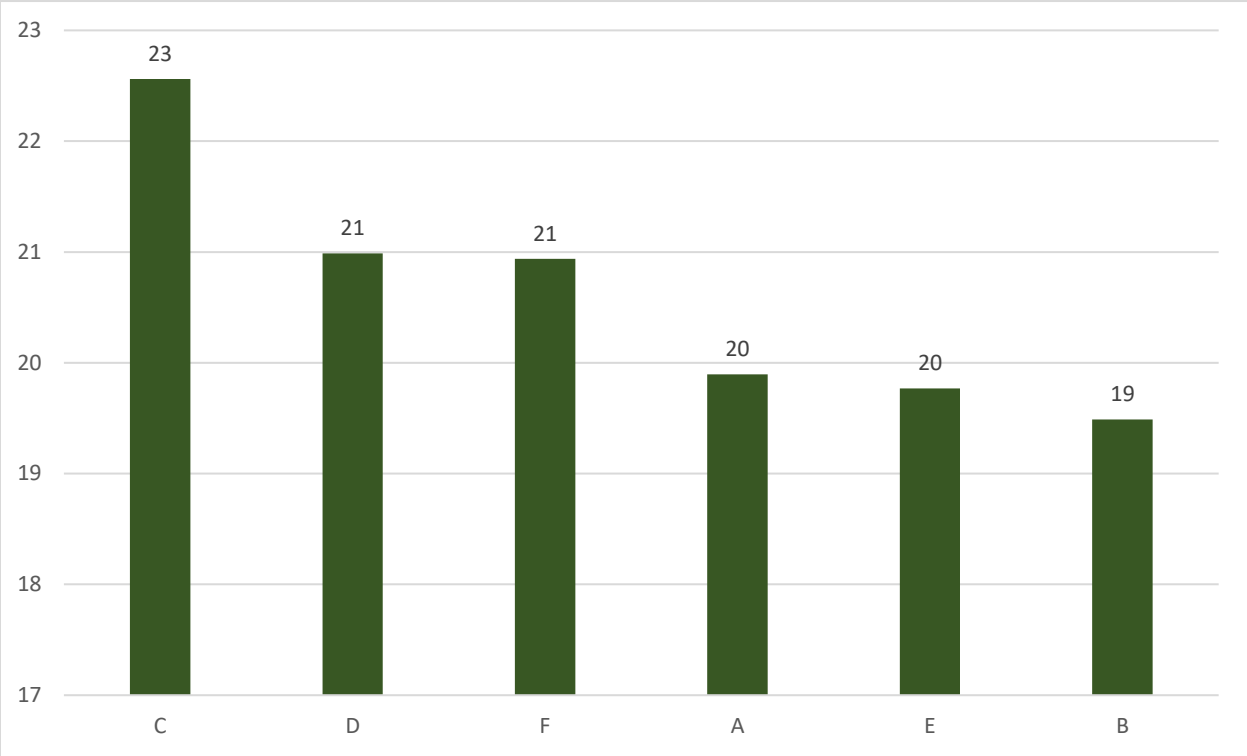
Source: Department of Health, 2018 Survey

As noted, demand for long-stay facilities arises primarily from older patients. Consequently, it is sensible to examine demand for long-stay beds relative to this subset of the population. In Figure 5.4.2 below, the

[28] If the sum of this statutory contribution is higher than the cost of care provided under the scheme then individuals can opt to instead pay in full the NHSS rate a given long-stay residential facility charges.
[29] Occupancy and Residency rates are calculated from NHSS data therefore this may underestimate the true population of residents in Nursing Home settings.

over-65 years population by RHA per long-stay bed is examined[30]. The distribution is mostly even across RHAs, varying from 19-23 older persons per long stay bed currently.

Fig.5.4.2: Population over 65 per long stay bed



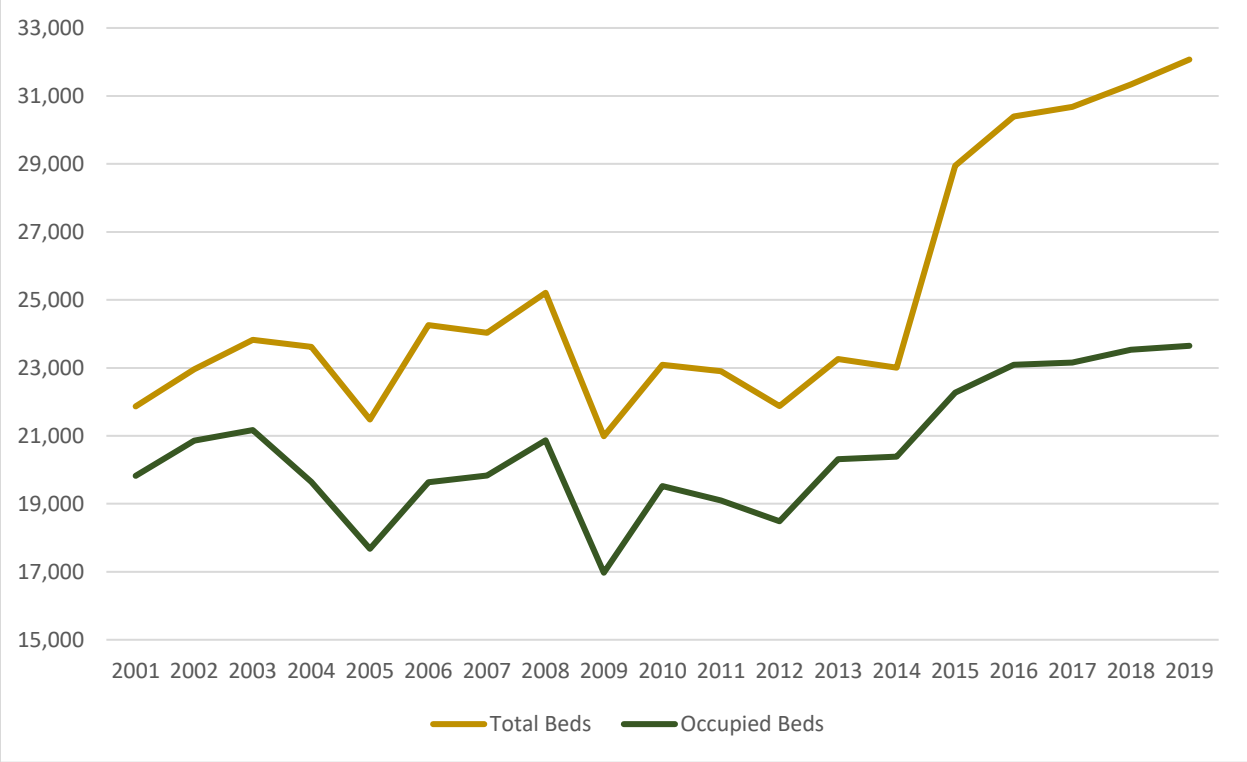
Source: Health Atlas Ireland/ Department of Health

In general, capacity in the long-stay sector has considerably increased in recent years, moving from 23,000 beds in 2013 to 32,000 beds in 2019. While capacity has increased in this area, occupancy has not followed suit, with utilisation declining from 93% of beds occupied in 2013, to 74% of beds occupied in 2019. Although occupancy is declining, some of this headroom may relate to an improvement in the quality of facilities via a wind-down of the provision of care in multi-occupancy rooms and therefore true occupancy relative to usable capacity may be much higher (HIQA, 2020). The total number of single occupancy rooms available in the system could therefore be much lower[31]. Excess capacity is also not a concern long term, with the capacity review anticipating a significant rise in nursing home demand over the next decade based on demographic trends (Department of Health, 2018).

[30] McCarthy,2022 identifies the demographics of RHAs and is published along with this paper

[31] 25% of all Nursing Homes are not compliant with HIQA regulation 17, with a further 46% partially compliant based on HIQA supplied information.

Fig.5.4.3. Trend analysis of Total beds vs Occupied beds over period 2001-2019 (,000)

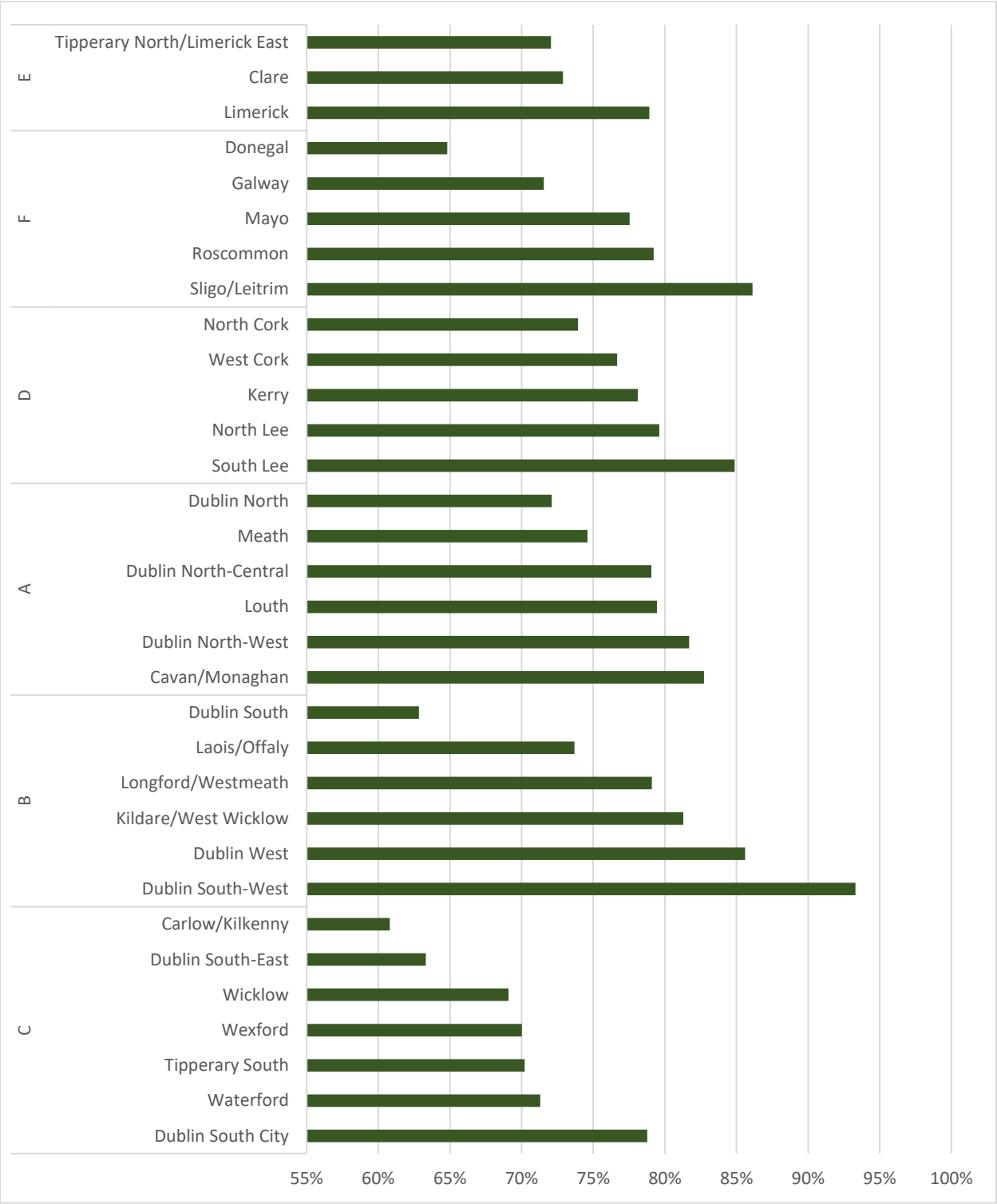


Source: Department of Health

A regional analysis of long-stay bed occupancy is also informative. While the population of persons over 65 Is consistent across RHAs, occupancy levels of facilities by LHO and RHA vary more substantially[32]. Figure 5.4.4 shows the level of occupancy in each LHO. One can see that the highest levels of occupancy nationally are in Dublin South-West, with an occupancy of 93% compared to an average of 75% nationally. The lowest levels of occupancy are in Carlow / Kilkenny, with occupancy of 61%. This is followed by Donegal, Dublin South, and Dublin Southwest, all of which have occupancy levels of below 65%. Only seven LHOs have occupancy rates above 80%. This would in theory imply that people are not necessarily relocating to access cheaper care or in less populated areas.

[32] This may be in part due to HIQA compliance issues with Nursing Homes as highlighted above.

Fig.5.4.4: 2019 NHSS Survey Occupancy by RHA and LHO

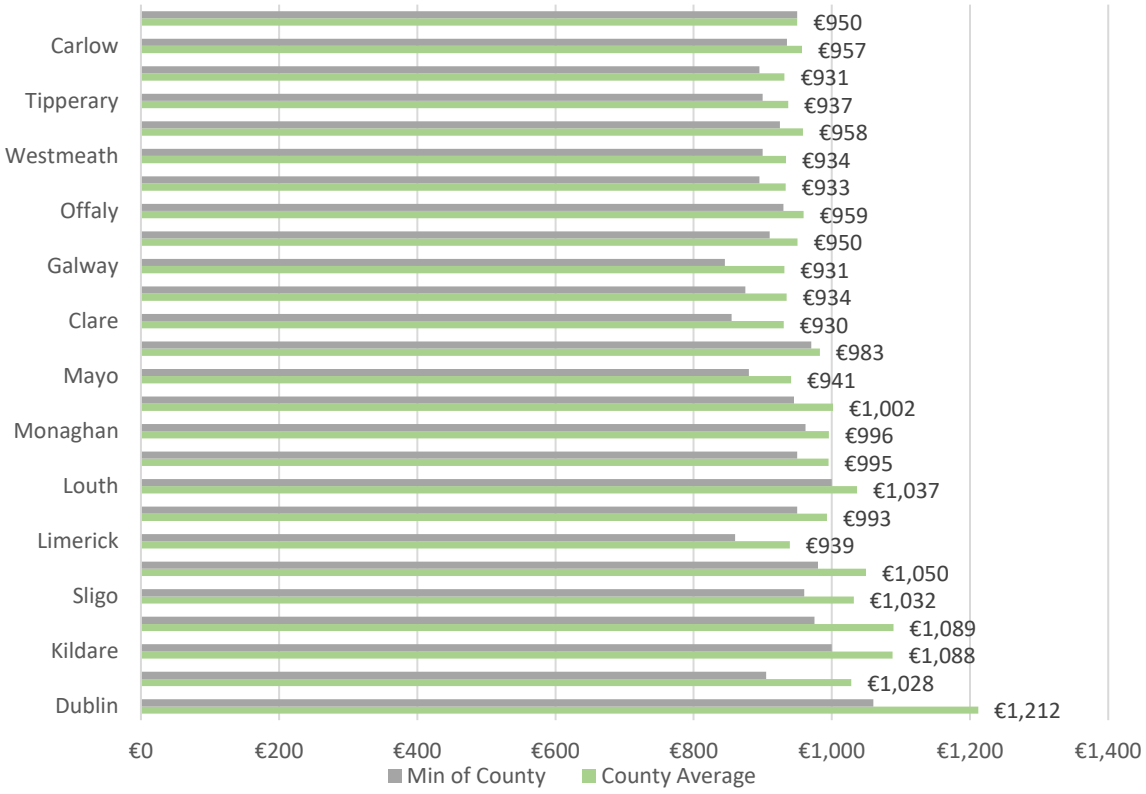


Source: NHSS,2019

The cost of nursing home care paid by the state (NHSS Fair Deal)[33] may also be informative in understanding regional divergence in nursing home occupancy levels. In Figure 5.4.5, nursing home costs by county are plotted. One can see that the weekly cost of a nursing home bed in most regions is similar, varying from €930 to €1,050 for 23 out of 26 counties. Only Dublin, Wicklow and Kildare have average costs above €1,050 per week, with Dublin a significant outlier at €224 euro higher than the national average.

The variation in occupancy and cost of access to nursing home care indicates that provision of this type of care should be very conscious of regional disparities when future investment in capacity is being considered and should therefore ensure that planned investment is cognizant of contemporary and future demand in a locality.

Figure.5.4.5: Weekly Cost of Fair Deal Nursing Homes Occupancy per County



Source: Department of Health-Fair Deal NHSS

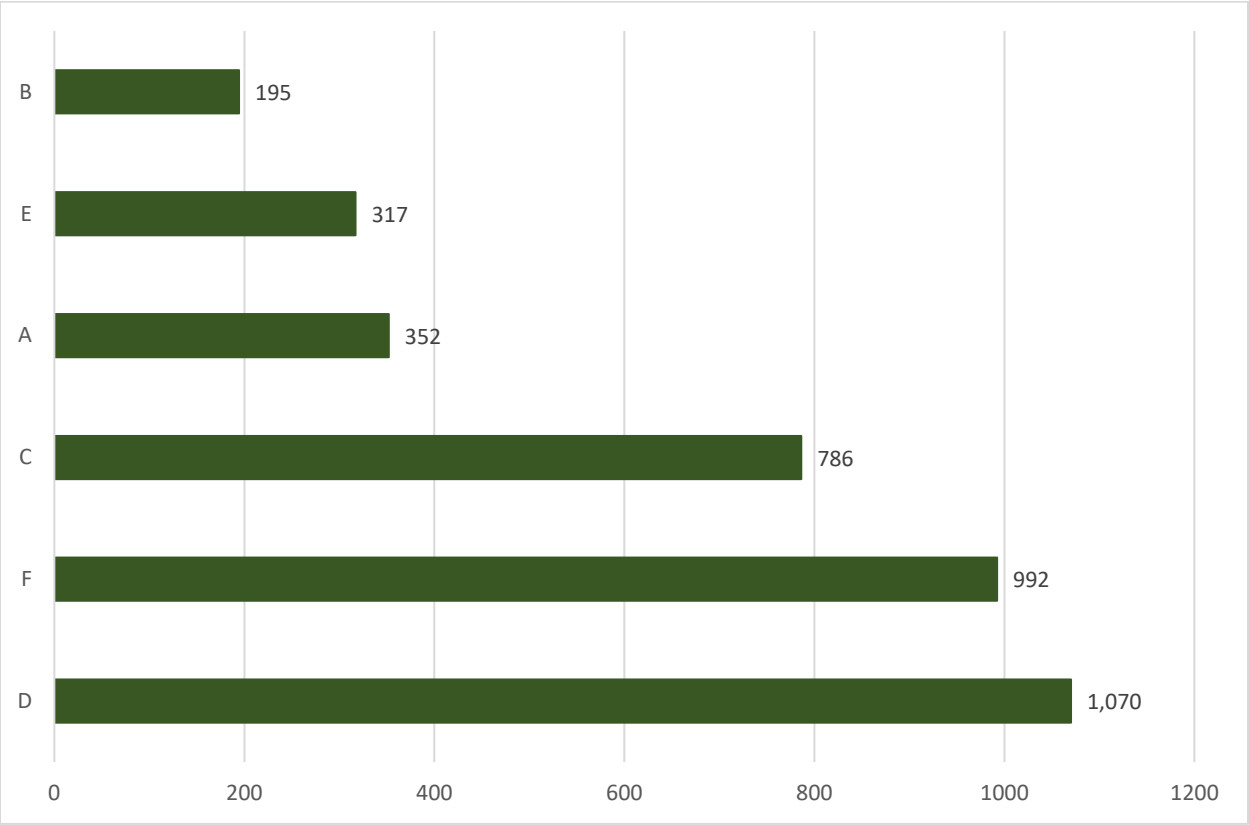
[33] https://www2.hse.ie/services/fair-deal-scheme/about-the-fair-deal-scheme.html

An indirect but influential factor on long-stay bed demand is the provision of home help hours across the country. Home help hours, provided publicly through the HSE Home Support Service aims to enable persons to remain in their own home for as long as possible (HSE, 2022). Home help workers provide assistance to older persons with daily tasks, thereby enabling them to live independently for a longer period of time. The provision of a greater level of homecare in Ireland is also supported by Sláintecare reforms, with the 2017 Sláintecare report proposing a new statutory home support scheme to complement the existing level of service provided (House of the Oireachtas, 2017).

The provision of public homecare has risen over time in Ireland. In 2021, the HSE funded over 24 million home help hours, up from 18.2 million in 2019 (Walsh & Lyons, 2019)[34]. Although overall provision has risen, the distribution of home-help support by region appears to be more varied, although this may be due to higher levels of privately delivered publicly funded care. In Figure 5.4.6, the number of registered Whole Time Equivalent HSE Home Helps by RHA is examined. One can see that RHA D has nearly five times the number of Whole Time Equivalent Home Helps than RHA B, a surprising finding given that RHA B actually has 14,000 (15%) more persons over 65 than RHA D (CSO, 2016). While the disparity in HSE provided home help hours is notable, the provision of care through HSE agency staff and family carers may explain this discrepancy. A proportion of all care provided by Home Helps is provided by Agency workers, meaning that the distribution of HSE Home Helps by region may not tell the full story in relation to access to homecare (Walsh & Lyons, 2019).

[34] According to Walsh & Lyons (2019), approximately 25% of home help hours are privately provided. Total home help hours provided in Ireland in 2021 were therefore likely closer to 30 million in total.

Fig.5.4.6: HSE Home Helps per RHA



Source: HSE Census

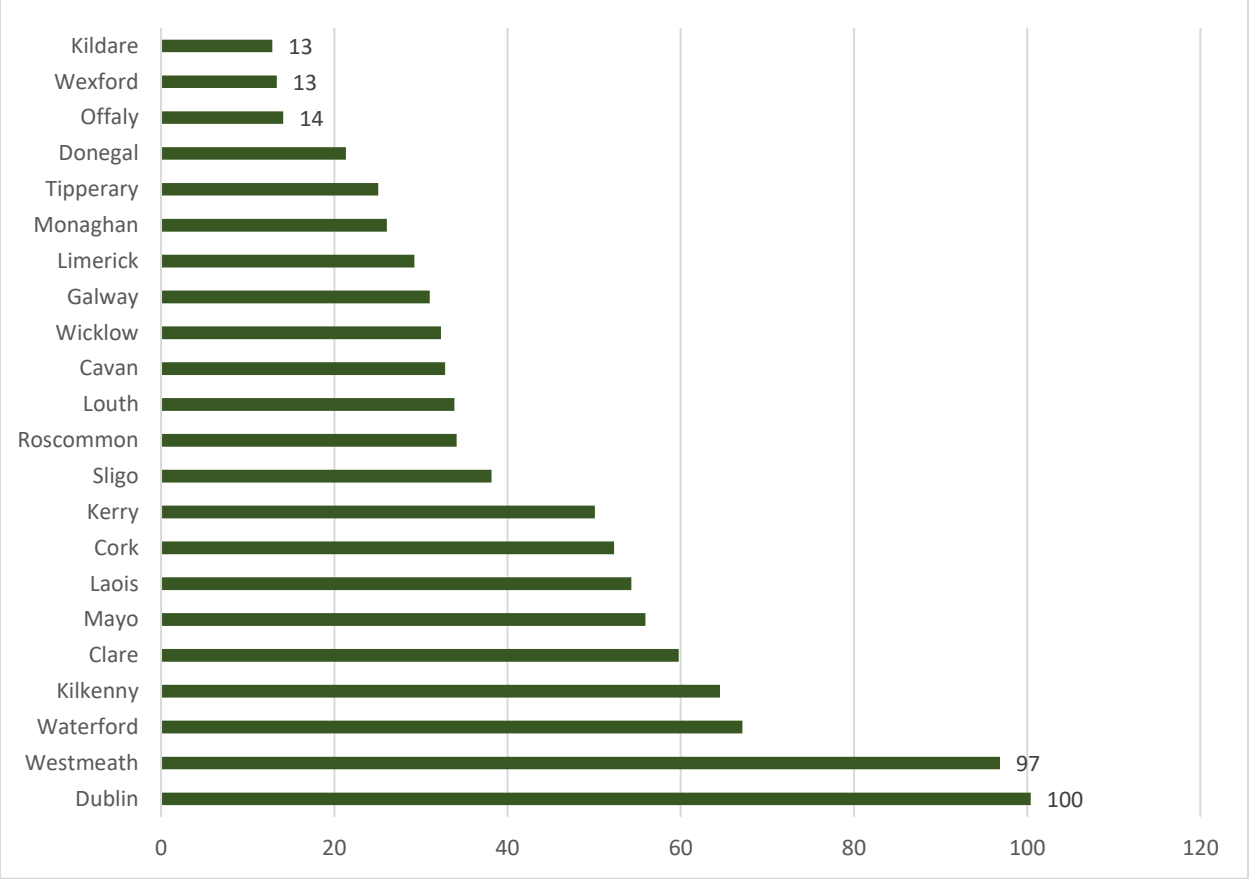
5.5 Mental Health

Mental Health has a wide-ranging definition, including both day to day emotional, psychological and social well-being, and more severe mental health issues that may require clinical assistance. Mental Health supports provided by the HSE are divided into four levels, from information and health promotion supports at level one, to inpatient and residential services at level four (HSE, 2022). In general, most mental health care is provided on an outpatient basis, with potential issues of supply arising from recruitment rather than infrastructural issues. A limited number of mental health services are delivered on an inpatient basis, with information provided by the Mental Health Commission ("MHC") being useful in scoping out potential capacity and accessibility issues in this context.

In 2022, there were 945 mental health inpatient beds available in Ireland. In terms of mental health beds per 100,000, beds by region is highly skewed, with Dublin and Westmeath having 100 and 97 beds respectively, compared to just 13-14 in Kildare, Wexford and Offaly[35]. While patients can be referred across regions, this disparity may be a cause of inadequate access to mental health services in some locations although further research would be required to determine whether this is the case.

[35] The beds within this analysis includes all forms of inpatient mental health beds audited by the Mental Health Commission.

Fig.5.5.1: Mental Health Beds per 100,000

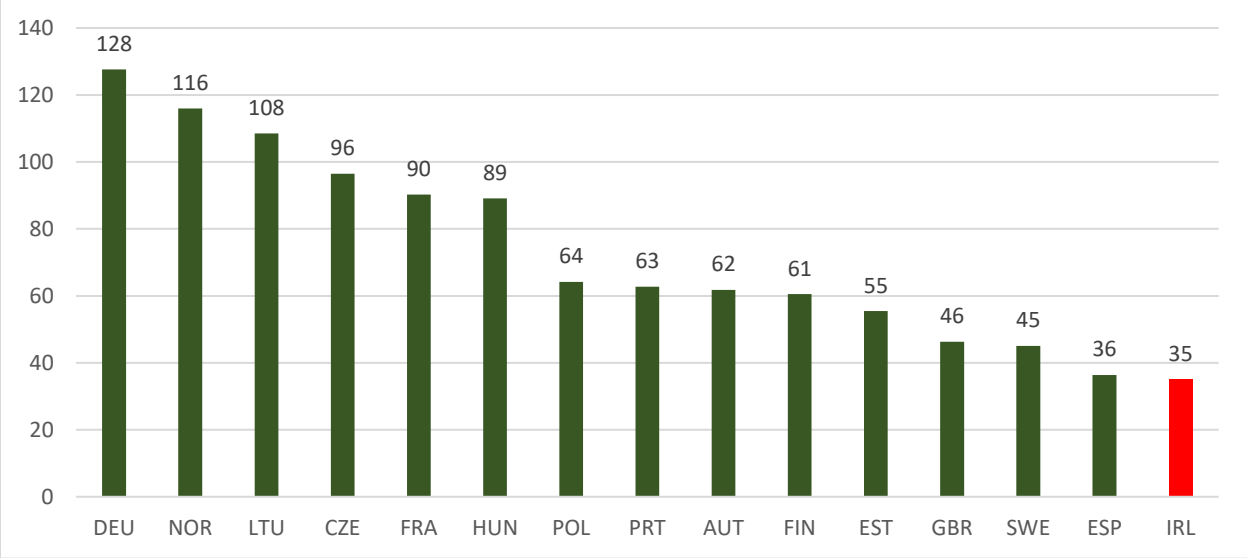


Source: Mental Health Commission,2022 / Authors Calculations

The provision of mental health beds in Ireland is also low internationally. Out of a sample of 16 countries, Ireland had the lowest numbers of mental health beds per 100,000 persons based on WHO data from 2014. While there has been a strong trend internationally towards "de-institutionalisation" of patients with more complex mental illness (OECD, 2014), it is important to ensure that the low level of provision of inpatient beds in Ireland is as a result of greater community care for patients rather than a low level of investment.[36] More recently literature is also supportive of the prioritization of care in the community, with Mundt (2021) finding that treatment of patients within the community where possible is the most cost effective and beneficial approach.

[36] It is also noted by the OECD (2014) that mental health beds are used for different conditions across countries depending on how many are currently available.

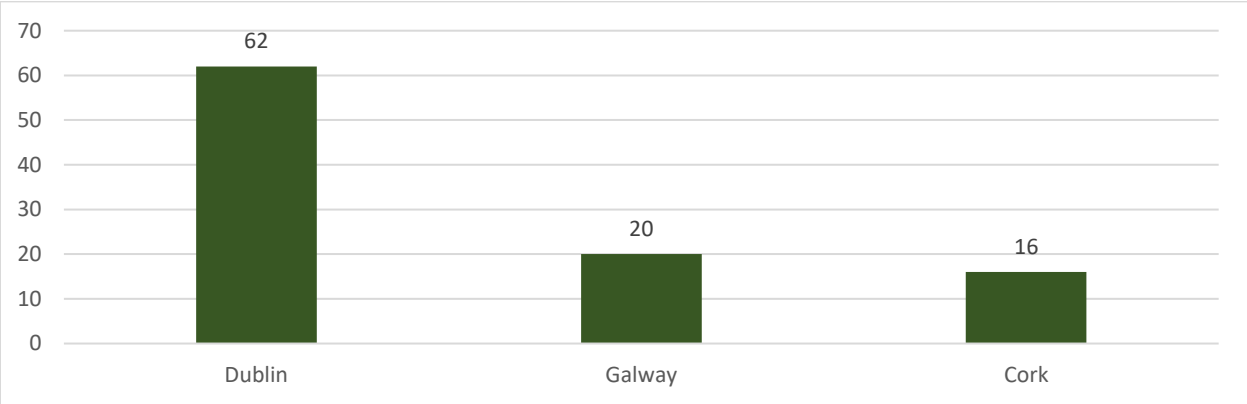
Fig.5.5.2: Mental Health Beds per 100,000



Source: WHO (2014)

Available Children and Adolescent mental health beds can also be examined. In total, there are 98 beds available in for patients of this type across the state. Within this, 63% of these beds are provided in Dublin, with the remainder split roughly evenly between Galway and Cork. While this may give rise to some concerns regarding accessibility, the low level of beds in total likely means that issues of scale would arise with a more noticeable division between regions.

Fig.5.5.3: CAMHS Beds by Location



Source: Mental Health Commission, 2022

5.6 Key Findings

- The numbers of PCRS contracted GPs, Pharmacists, Dentists and Optometrists varies across regions, potentially indicating issues in relation to timely access to primary care. In each case, further analysis is required to determine optimal allocations of primary care practitioners across regions, and the associated costs of under-supply.

- The distribution of long-stay (nursing home) beds relative to older populations by region is proportional. Occupancy levels vary by regions, with some LHOs having over 90% occupancy, compared to a national average of 75% occupancy.

- The occupancy rates of NHSS registered nursing homes may be artificially reduced by the compliance issues presence in the state, with 25% of all sites being non-compliant with HIQA premises regulations.

- The levels of HSE provided home help hours varies by RHA.

- The number of mental health beds varies by region, although policymakers will need to also be cognisant of the delivery of outpatient care in this context and the move towards lower in-patient care.

6 Radiological Equipment

Radiological equipment plays an important role in medicine and is utilised in the diagnosis of many diseases and injuries. Swift access to diagnostic equipment can improve hospital efficiency, allowing for prompt diagnosis and remediation of injuries and illnesses (Daly, et al., 2015) (S. Cournane, 2016). Equally, delayed access to diagnostic equipment is also linked to delayed discharge from hospital, increasing average length of stay in hospitals, and reducing hospital activity. Within the Irish Health system there are multiple forms of radiological equipment used for the treatment and diagnosis of patients. In the below analysis, the HIQA radiological database was used to analyze the current stock of Xray's, DXA scanners, IR Cardiology Machines, Mammography machines and Fluoroscopy machines. Each of these machines plays a unique role is the diagnosis and treatment of disease. The analysis presented on the current composition of these machines by age and quantity provides valuable insights into per capita access, replacement concerns and the current composition of the radiological equipment stock in Ireland. It must be noted that this is a small portion of all of the equipment used in the treatment and diagnosis of patients.

Firstly, looking at the composition of radiological equipment in Table 6.1 provided via the HIQA Radiological Database, one can see the number and age of each equipment type in Ireland. X-rays are by far the most common equipment type in the county, with 375 units in Ireland versus less than 100 units of all other type of equipment.

Table.6.1: Composition of Radiological Equipment in the Health System[37]

Machine	Total	0-5yrs	6-10yrs	10yrs+	%<5yrs	%6-10yrs	%>10yrs
X-ray	375	148	74	175	39%	20%	**47%**
DXA	31	11	5	14	35%	16%	**45%**
IR Cardiology	87	32	35	21	37%	40%	**24%**
Fluoroscopy	98	39	38	23	40%	39%	**23%**
Mammography	60	49	6	5	82%	10%	**8%**

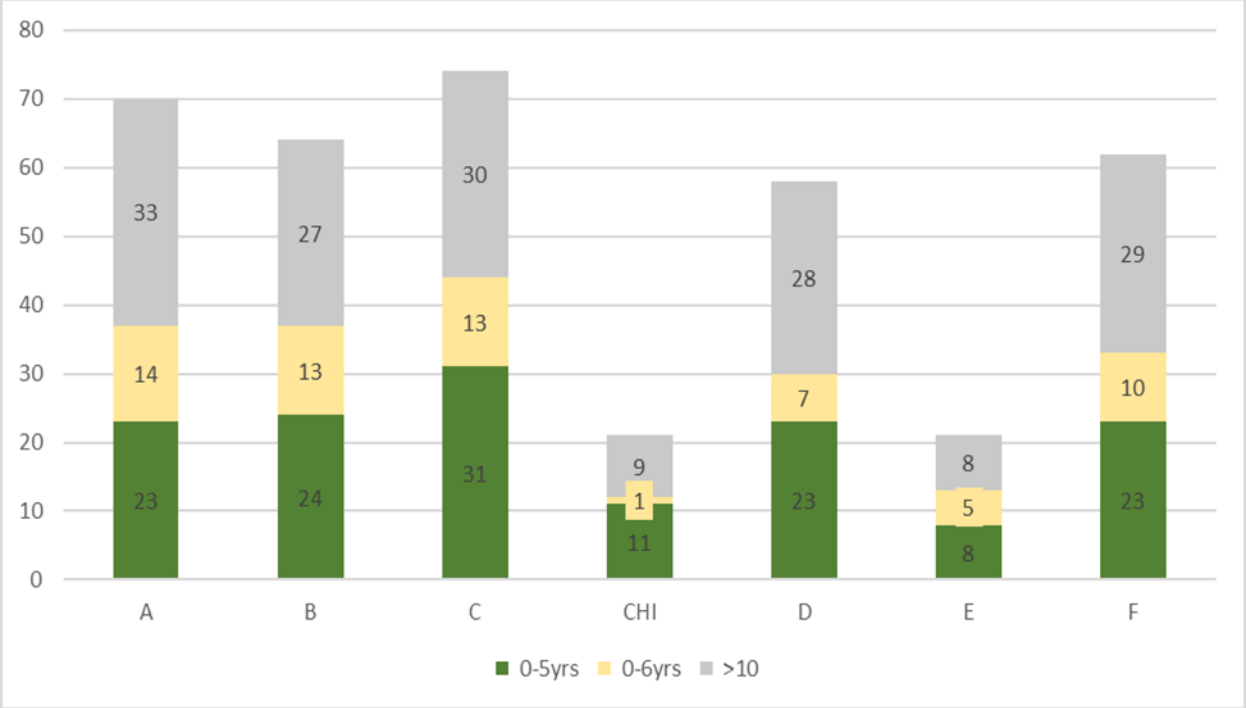
Source: HIQA Radiological Database, 2022

The age of this stock is also informative. One can see that a large volume of equipment are over ten years old. The age of radiological equipment is materially relevant to considerations around the level of replacement and maintenance spend required in this area. The European Society of Radiology and others have recommended for example that only 10% of radiological equipment should be over ten years old. (Healthcare in Europe, 2017) (European Society of Radiology (ESR), 2014). It follows that the older age of Irish radiological stock could be a clinical and economic risk, with machine breakdowns preventing timely diagnostics and requiring high maintenance costs (WHO Europe, 2018).

In light of this finding, the high maintenance and replacement costs likely to emerge in relation to radiological equipment should be accounted for. In general, the short economic lifespan and high annual depreciation rates of radiological equipment means that ongoing monitoring of condition and replacement requirements are important (Health Service Executive, 2016) (Public Spending Code, 2021).

[37] The total numbers of diagnostic equipment reported by HIQA and the HSE differ, likely due to private activities in this context.

Fig.6.2: Distribution of Xray's by RHA and Age



Source: HIQA Radiological Database

The level of access to radiological equipment can also be impactful. Timely access to radiological equipment can allow for expedited diagnosis and discharge of patients, with lack of access to diagnostic equipment being identified as a driver of overcrowding and cancellations in some hospitals[38] and in the literature as a source of slow hospital throughput (European Society of Radiology (ESR), 2014). Access to diagnostics can be dictated both by the number of machines and the operating hours of the diagnostic equipment with both being core drivers of patient access. The National Radiological Quality Improvement Programme provides some insights in this context, mapping utilisation by NQAIS site. Unfortunately, authors were unable to access non-anonymised data, so insights in this context are limited to published annual reports (e.g, NRQI 2020 report).

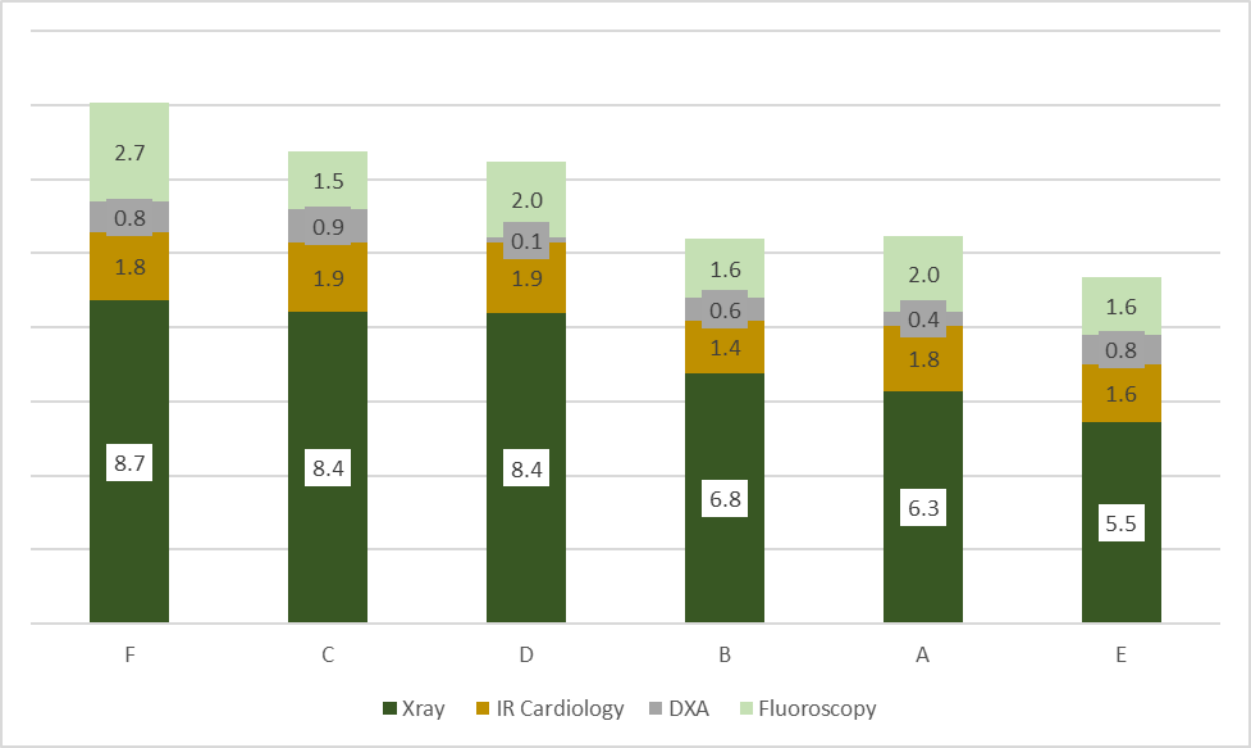
Figure 6.2 plots the distribution of radiological equipment by RHAs per 100,000 inhabitants, which is a good proxy for radiological equipment access. One can see an even distribution of most types of equipment across RHAs, with the exception of X-ray machines. RHA F, C and D have 8.4 or above machines

[38] For example, the recent deferral of elective surgeries and outpatients appointments at UHL was in part ascribed to a lack of access to diagnostic equipment (RTE, 2022).

per 100,000 persons, versus 6.8-5.5 in RHA B, A and E. These variations in radiological equipment access could be a cause of longer wait times and lower efficiency of health services in these regions.

The levels of access to DXA machines across the state is also generally low, with less than 1 machine per 100,000 persons in all regions. This compares poorly to international peers, with France (20 per 100,000), Sweden (10.2) and UK (3.7) among others all having a markedly greater supply of machines than Ireland (Hamidi, 2012).

Fig.6.2: Radiological Equipment per 100,000 inhabitants by RHA



Source: HIQA Radiological Database/ Authors Calculations

6.1 Key Findings

- The levels of access to diagnostic equipment varies by RHA, raising concerns of delays in the processing of patients through the healthcare system.

- The age of diagnostic equipment raises potential concerns in relation to the cost of maintenance and replacement, with a large proportion of machines above the recommended replacement age of 10 years.

7 Findings

7.1 Variations in Capital Stock by RHA

There is a noted variation in the amount of infrastructure available in a given RHA relative to population. **While further research is required to determine the appropriate level of stock by RHA relative to other factors such as utilization, acuity of care and productivity**, variations in capital stock will need to be carefully considered when future investment is being planned. Figure 7.1 provides a summary of the metrics examined in the paper and an associated ranking by RHA.

Fig.7.1: Stock by Service Area per 100,000 inhabitants by RHA

RHA	Xray	IR Cardiology	DXA	Fluoroscopy	GPs	Ambulatory beds	Acute Inpatient beds	Total CCU beds after Phase 1
A	6.3	1.8	0.4	2	53	61	245	12
B	6.8	1.4	0.6	1.6	48	39	212	11
C	8.4	1.9	0.9	1.5	82	45	207	8
D	8.4	1.9	0.1	2	69	45	220	7
E	5.5	1.6	0.8	1.6	67	54	210	10
F	8.7	1.8	0.8	2.7	77	53	246	8

Source: Authors Calculations

7.2 CCU Capacity:

There is variation in CCU bed access by RHA, even accounting for the population and the acuity of care delivered in each RHA. RHA A, B and E have more CCU beds relative to population than RHA C, D & F. This variation is likely to be partially reflective of the presence of National Centres of Excellence in some RHAs and the associated higher acuity care provided in these hospitals. The HSE is nearing completion of delivery of Phase 1 of the strategic multi-year plan to expand adult critical care capacity with attention now focused on delivering Phase 2 which looks to deliver a total of 446 CCU beds in the long-run.

7.3 General Hospital Bed Access:

The number of general hospital beds available per RHA is uneven, with RHA F having 247 beds per 100,000 compared to RHA C with 207 beds. The relationship between occupancy and bed capacity in each region is weak, highlighting the need for further analysis of acute care performance.

7.4 Trolleys:

The number of patients on trolleys is consistent across five out of seven RHAs. RHA A appears to have lower numbers of patients on trolleys than all other RHAs, indicating the relative effectiveness of their emergency departments.

7.5 Access to Day Procedures:

The number of patients on waiting lists per ambulatory beds available is highly skewed, with 36 patients waiting per bed in RHA F, compared to just 12 patients per bed in RHA E.

7.6 GPs by RHA:

The levels of access to GPs providing treatment to GMS patients varies across the state with 82 GPs per 100,000 in RHA C versus 48 GPs per 100,000 in RHA B.

7.7 Access & Occupancy of long-stay beds:

The distribution of long-stay beds relative to older populations by region is appropriate. Occupancy levels vary more by regions, with some LHOs having over 90% occupancy, compared to a national average of 75% occupancy.

7.8 Access to radiological equipment:

The levels of access to radiological equipment varies across RHAs with RHA F having 8.4 X-rays per 100,000 population compared to 5.5 in RHA E. This may influence the levels of unmet need and delayed discharge in each region. 47% of X-ray machines are over ten years old, implying the need for an investment and replacement strategy for these assets.

8 Policy Recommendations

Investment Considerations:

The identified differences in healthcare infrastructure capacity by region should be used to inform future healthcare investment decisions in a range of areas, including CCU, general acute care, primary care, and community care. While the findings of the paper are just one input into these considerations, policymakers should ensure that planned investment is appropriate in light of the base level of healthcare infrastructure by region described.

Strategic Health Investment Framework:

The analysis supports the publication and implementation of the first Strategic Healthcare Investment Framework for Health (SHIF), ensuring planned healthcare infrastructure investment is supported by evidence and achieves relevant Departmental objectives. This ensure that available evidence will be integrated into prioritization decisions for future healthcare infrastructure investment. The potentially large investments associated with historic projects may be one area where this is relevant, with planned investment updated to take account of the better evidence and data that is now available.

Data Reporting:

The paper highlights the benefits of the collection and use of data to inform future investment. Policymakers should therefore endeavor to improve reporting of health infrastructure data and consider the creation of a dynamic reporting system for community, acute and primary care capacity data. The upcoming National Estates Information System (NEIS) could serve as a platform for the delivery of this reform. The system should aim to capture relative static characteristics of infrastructure (e.g, build quality, age, functional suitability) as well as incorporate a dynamically updating element (e.g, available beds, planned maintenance and maintenance expenditure in year X, utilization). This information could then be integrated into decision making via asset management strategies at a local, RHA or national level.

9 References

HPO, 2021. *Activity in Acute Public Hospitals in Ireland Annual Report, 2020,* Dublin: Healthcare Pricing Office.

Central Statistics Office, 2016. *CSO-Profile 9 Health,Disability and Carers.* [Online]
Available at: https://www.cso.ie/en/releasesandpublications/ep/p-cp9hdc/p8hdc/p9cr/
[Accessed 17 05 2022].

Citizens Information, 2019. *Moving from Home to long-term care.* [Online]
Available at:
https://www.citizensinformation.ie/en/health/health_services/health_services_for_older_people/moving_from_home_to_long_term_care.html
[Accessed 27 May 2022].

Clancy, C., Shine, C. & Hennessy, M., 2022. *An Analysis of Hospital Performance,* s.l.: Government of Ireland.

Collins, D., 2019. *Social Impact Assessment Series Nursing Home Support Scheme,* s.l.: Irish Government Economic Evaluation Service.

CSO, 2016. *Census 2016 Reports,* s.l.: Central Statistics Office.

Daly, A. et al., 2015. *Irish Medical Journal.* [Online]
Available at: https://imj.ie/the-implications-of-delayed-access-to-mri-imaging-a-3-month-historical-prospective-study/
[Accessed 18 05 2022].

Department of Health and HSE, 2021. *Update on Critical Care,* Dublin: Department of Health and HSE.

Department of Health, 2018. *Health Service Capacity Review 2018 Review of Demand and Capacity Requirements in Ireland to 2031,* s.l.: Department of Health.

Department of Health, 2021. *Open Bed Report March 2021,* s.l.: Department of Health.

Department of Health, 2021. *Sláintecare Implementation Strategy & Action Plan,* s.l.: Department of Health, Government of Ireland.

Department of Health, 2022. *Minister Donnelly announces expansion of dental services for medical card holders,* s.l.: Department of Health.

Department of Health, 2022. *Sláintecare Regional Health Areas (RHAs),* Dublin: Department of Heatlh.

Department of Transport, 2021. *National Investment Framework for Transport in Ireland,* 2021: Government of Ireland.

ESICM, 2011. Working Group on Quality Improvement. *Intensive Care Med,* 37(10), pp. 1575 - 87.

Eurofound, 2017. *Care for older Europeans: Public, for-profit and non-profit providers,* s.l.: European Foundation for the Improvement of Living and Working Conditions.

European Observatory on Health Systems and Policies, 2009. *Investing in Hospitals of the Future.* s.l.:European Observatory on Health Systems and Policies.

European Society of Radiology (ESR), 2014. Renewal of radiological equipment. *Insights Imaging,* Volume 5, pp. 543-546.

Government of Ireland, 2018. *Sláintecare Implementation Strategy,* s.l.: Government of Ireland.

Government of Ireland, 2019. *Sláintecare Implementation Strategy and Next Steps,* s.l.: Government of Ireland.

Hamidi, Z., 2012. What's BMD and What We Do in a BMD Centre?. In: *Osteoporosis.* London: IntechOpen.

Health Service Executive, 2014. *Model of Care for Adult Critical Care,* Dublin: HSE.

Health Service Executive, 2016. *National Financial Regulation, Fixed Assets and Capital Equipment,* Dublin: HSE.

Healthcare in Europe, 2017. *Healthcare in Europe.* [Online]
Available at: https://healthcare-in-europe.com/en/news/a-worrying-age-increase-of-imaging-equipment.html
[Accessed 12 05 2022].

Hennessy, M., Shine, C. & Walker, C., 2021. *Health Capital Investment in Ireland: Strategic Considerations for Future Capital Investment in Healthcare,* Dublin: Merrion St.

Hennessy, M., Walker, E. & Shine, C., 2021. *Healthcare Capital Investment in Ireland Series: Analysis of Historical Capital Investment in Healthcare,* s.l.: Irish Government Economic Evaluation Service.

Henry, E., Brick, A. & Keegan, C., 2021. *UTILISATION OF PUBLICLY FINANCED DENTAL AND OPTICAL SERVICES IN IRELAND BASELINE ANALYSIS FOR THE HIPPOCRATES MODEL,* s.l.: ESRI.

HIQA, 2020. *The impact of COVID-19 on nursing homes in Ireland,* s.l.: Health Information and Quality Authority.

House of the Oireachtas, 2017. *Committee on the Future of Healthcare : Slaintecare Report,* Dublin: Merrion St.

HPO, 2021. *Activity in Acute Public Hospitals in Ireland,* s.l.: Healthcare Pricing Office.

HSE, 2013. *Securing the Future of Smaller Hospitals A Framework for Development,* s.l.: Health Service Executive, Department of Health.

HSE, 2018. *Children's Hospital Group Operational Plan,* s.l.: Health Service Executive.

HSE, 2018. *Framework for Ambulatory Care on the Acute Floor,* s.l.: National Acute Medicine Programme HSE.

HSE, 2021. *National Adult Critical Care Capacity - Census Report 2020,* s.l.: Health Service Executive - Acute Operations Division.

HSE, 2021. *NATIONAL ADULT CRITICAL CARE CAPACITY Census 2021 Report and Resource Allocation Framework,* Dublin: National Clinical Programme for Critical Care.

HSE, 2022. *Home Support Service for Older People - Information Booklet,* s.l.: Health Service Executive.

HSE, 2022. *Medical Workforce Report,* s.l.: Health Service Executive.

HSE, 2022. *Our Health Service - Mental Health Supports and Services Information,* s.l.: Health Service Executive.

Irish Examiner, 2022. *Sharp drop in dentists on medical card holder scheme ,* s.l.: Irish Examiner.

Jones, S. et al., 2022. Association between delays to patient admission from the emergency department and all-cause 30-day mortality. *Emergency Medicine Journal,* 39(3), pp. 168-173.

MHC, 2020. *Mental Health Commission Annual Report 2020,* s.l.: Mental Health Commission.

Mundt, A. P. D. L. S. R. S. E. S. M. &. P. S., 2021. Expert Arguments for Trends of Psychiatric Bed Numbers: A Systematic Review of Qualitative Data. *Frontiers in psychiatry,* 12(745247).

NICE, 2018. *Chapter 39 Bed Occupancy Emergency and Acute Medical Care in over 16s: Service Delivery and Organisation,* s.l.: National Institute for Health and Care Excellence.

NOCA, 2018. *Irish National ICU Audit Annual Report,* s.l.: National Office of Clinical Audit.

NOCA, 2020. *Irish National ICU Audit - Interim Report 2019,* s.l.: National Office of Clinical Audit.

NOCA, 2020. *Irish Paediatric Critical Care Unit - National Report 2017 - 2019,* s.l.: National Office of Clinical Audit, Irish Paediatreic Critical Care Audit.

NOCA, 2021. *NOCA Report on ICU Activity During COVID-19 Pandemic,* s.l.: National Office of Clinical Audit.

Nolan, A., 2019. *Reforming the Delivery of Public Dental Services in Ireland Potential Cost Implications,* s.l.: ESRI.

O'Connor, P. & Hynes, T., 2022. *Nursing Workforce Supply Model.* Dublin: Department of Health.

OECD, 2014. *Focus on Health - Making Mental Health Count,* s.l.: Organisation for Economic Cooperation and Development.

OECD, 2020. *Intensive Care Bed Capacity,* Paris: Organisation for Economic Cooperation and Development.

OECD, 2021. *Health at a Glance 2021,* s.l.: Organisation for Economic Cooperation and Development.

OECD, 2021. *Hospital Beds - Acute Care,* s.l.: Organisation for Economic Cooperation and Development.

OECD, 2021. *Hospital beds and occupancy,* Paris: OECD.

Prior, P. M., 2012. Introduction to Asylums, Mental health care and the Irish: Historical. In: *Asylums, Mental health care and the Irish: Historical studies 1800-2010.* s.l.:Irish Academic Press.

Public Spending Code, 2021. *Carrying out a financial analysis,* Dublin: Department of Public Expenditure and Reform.

RTE, 2022. *Elective surgeries, outpatient appointments deferred at UHL.* [Online]
Available at: https://www.rte.ie/news/munster/2022/0531/1302140-university-hospital-limerick/
[Accessed 31 May 2022].

S. Cournane, R. C. D. C. D. B. N. B., 2016. Radiology imaging delays as independent predictors of length of hospital stay for emergency medical admissions. *Clinical Radiology,* 71(9), pp. 912-918.

Shine, C. & Hennessy, M., 2022. *Healthcare Capital Investment in Ireland: An Analysis of Infrastructure,* Dublin: Department of Health.

Walsh, B. & Lyons, S., 2019. *Demand for the Statutory Home Support Scheme,* s.l.: Economic and Social Research Institute.

WHO Europe, 2018. *Rationalizing distribution and utilization of high value,* Copenhagen: WHO.

WHO, 2014. *Psychiatric hospital beds per 100 000,* s.l.: WHO.

Mika Marttunen, V. B., 2017. Are objectives hierarchy related biases observed in practice? A meta-analysis of environmental and energy applications of Multi-Criteria Decision Analysis. *European Journal of Operational Research,* 265(1), pp. 178-194.

Cathy Macharis, P. N., 2011. *Possible bias in multi-actor multi-criteria,* Amsterdam: VU University Amsterdam.

Department of Transport, 2021. *National Investment Framework for Transport in Ireland,* 2021: Government of Ireland.