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Towards Population-Based Funding for Health: Evidence Review & Regional Profiles

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Report Summary

Background

- Population-Based Resource Allocation (PBRA) is a funding model for health planning that seeks to distribute available healthcare resources according to population need to promote efficiency and equity in both health outcomes and distribution of resources.
- The Irish healthcare system is undergoing substantial reform with a commitment to implement new Regional Health Areas (RHAs) and a PBRA funding model by 2024.
- RHAs will be regional divisions within the Health Service Executive (HSE) with the objective of aligning hospital and community care services and promoting innovation, integrated care, efficiency, clinical and corporate governance and accountability.
- This paper builds upon the review by Johnston et al., (2021) which examined PBRAs across six countries and highlighted the importance of objectives, impacts, and outcomes.
- This work, however, focusses more on the practical nature of implementing PRBAs in an Irish context, with consideration given to methodology and data used.
- This Spending Review contributes to the evidence required to support decision-making on the most appropriate PBRA model to implement.

Methods

- This paper reviews methodological literature on PBRA formulae identified through reference mining of relevant literature. In addition, a sample of PBRA formulae are selected for investigation into how they are constructed by reviewing policy and technical documents.
- The selection of jurisdictions was based on three criteria: high-income countries, availability of documents in English, and similarities in health system funding models to Ireland.
- The selected jurisdictions are Alberta, Canada; England; New South Wales, Australia; New Zealand; Northern Ireland; and Scotland.
- Informed by the findings of the literature review, potential Irish data sources are considered, and statistical profiles of the new RHAs are presented with regard to relevant variables.

Findings

- While no two PBRA models are the same, some common variables (such as area population, age - structure, and socioeconomic status), methodology, and data used are observed.
- The CSO Census of Population and the Department of Health's 'Healthy Ireland' Surveys' were found to be the most useful and reliable data sources for the purposes of designing a PBRA in Ireland.
- The ability of Ireland to pursue a best practice approach is constrained by the lack of a fit for purpose unique health identifier and the inability to match utilisation and cost to other characteristics of people or groups (e.g., socioeconomic status).
- However, this paper provides data on the likely drivers of healthcare need in the Irish context. Work is ongoing with regard to estimating relationships between need variables and utilisation/expenditure, given data constraints, in order to inform the development of a PBRA model.

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Introduction

Policy Context

Population-Based Resource Allocation (PBRA) is a funding model for health planning that seeks to distribute available healthcare resources according to population need to promote allocative efficiency and equity in both health outcomes and distribution of resources (Johnston et al., 2021; Penno et al., 2013; Rice & Smith, 2001). PBRA policies are considered vital in decentralisation processes by distributing healthcare resources in a manner which reflects variation in regional/local population profiles (Johnston et al., 2021).

The Irish healthcare system is undergoing substantial reform, with a commitment to regionalisation and implementation of a PBRA funding model by 2024. Set out in the Sláintecare reform programme is the commitment to implement Regional Health Areas (RHAs) in order to align acute, community, and social care services (Houses of the Oireachtas Committee on the Future of Healthcare, 2017). The Sláintecare report (2017) also contained a commitment towards implementing PBRA as the means to allocate funding to the proposed RHAs:

'*A resource allocation model is required that allows for equity of access to health services across different geographic areas, taking into account population need, demographics, deprivation and other measures'* (Houses of the Oireachtas Committee on the Future of Healthcare, 2017: p. 21).

The geographies of the six RHAs were determined by Government in 2019 and the Programme for Government in 2020 committed to bring forward detailed proposals on the RHAs to enable delivery of local services for patients that are safe, of high quality, and fairly distributed (Department of the Taoiseach, 2020). Further to this, the Sláintecare Implementation Strategy and Action Plan 2021-2023 set out the development of a PBRA funding model (Department of Health, 2021). In April 2022, a business case that considered two different potential models of regionalisation that could meet Sláintecare objectives was presented to Government. Government decided to proceed on the basis that RHAs be set up administratively within the Health Service Executive (HSE) structure as regional divisions of the HSE. An implementation plan which will include the detailed design of the new RHA structures is now being developed and is due to be completed by 2023 with RHAs being fully operational from January 2024. As part of the implementation plan under development, a resource allocation model will be approved, also to be introduced in 2024.

Objective of Review

The purpose of this Spending Review is to contribute to the evidence building required for the consideration of the most appropriate PBRA model to be implemented in 2024. This work can feed into the work of the implementation team tasked with finalising the approach. This work seeks to build upon the review carried out by Johnston et al., (2021) which examined the objectives, impacts, and outcomes of population-based resource allocation models across six high-income countries with a view to informing strategic decision-making as Ireland progresses its universal healthcare reform agenda. Johnston et al., (2021) 'Moving beyond formulae: a review of international population-based resource allocation policy and implications for Ireland in an era of healthcare reform' was commissioned by the Department of Health, HSE and HRB, and is recommended reading for anyone interested in this area. Other reviews of international PBRA funding models have also been undertaken in Ireland and internationally previously (Brick et al., 2010; Penno et al., 2013; Rice & Smith, 1999; Vega et al., 2010).

This current review, however, focusses more on the practical nature of implementing PRBAs in an Irish context, to synthesise the methods used to construct PBRA funding formulae, and to provide more detailed information on indicators of need, adjustments, and data used internationally.

Furthermore, indicators observed to be of general relevance internationally are considered in an Irish context. Availability of data, and appropriateness are assessed, before presenting preliminary statistical profiles of the populations of the six RHAs.

Methods

This paper reviews methodological literature on PBRA formulae identified through reference mining of PBRA reports and literature reviews. Methodologies used to construct and update PBRA formulae internationally are considered. The construction and updating of PBRA formulae relate to the technical aspects of how resources are allocated. A sample of PBRA formulae are selected for investigation into how they are constructed by reviewing policy and technical documents. The selected jurisdictions are Alberta, Canada; England; New South Wales, Australia; New Zealand; Northern Ireland; and Scotland. The selection of jurisdictions for a detailed review was based on three criteria: high-income countries, availability of documents in English and similarities in health system funding models to Ireland. Several European countries use a universal health insurance funding mechanism where health insurers compete in a regulated market. This can introduce differences in the objectives as well as operational aspects of PBRA models (Rice & Smith, 2001). The majority[1] of the selected countries adopt a similar health system funding model to the one Ireland is seeking to implement, a single-tier system financed through general taxation in the main.

Findings

While no two PBRA models are the same, some common variables, methodology and data used are observed. Informed by the findings of the literature review, potential Irish data sources were considered. The CSO's Census of Population and Department of Health's 'Healthy Ireland' Surveys were found to be the most useful and reliable data sources for the purposes of designing a PBRA.

The ability of Ireland to pursue a best practice approach is constrained by the lack of a fit for purpose unique health identifier and the inability to match utilisation and cost to other characteristics of people or groups (e.g., socioeconomic status).

However, this paper presents data on what are likely drivers of healthcare need in an Irish context and work is ongoing with regard to, where possible, estimating relationships between need variables and utilisation/expenditure in order to inform the development of a PBRA model. Work is currently underway on the Health Information Bill which will legislate for the use of a fit for purpose unique health identifier. This would enable more robust patient-level data and assist in the development of the PBRA.

[1] Australia's health system is financed through federal and general taxation and a government levy with optional private insurance coverage available.

Methodologies to Construct PBRA Models – International Review

Policy Objectives of PBRAs

PBRA funding models are generally designed to distribute funding prospectively per head ('per capita') to a healthcare organisation (for example a regional health body) for a defined population. This funding model (also known as capitation) is thought to promote efficiency as there is an incentive for the recipient of the funds to reduce the activity as well as the cost of the activity provided (Rice & Smith, 1999). In addition, this funding model is considered to encourage allocative efficiency by incentivising provision of preventative services, health screening, and diagnostic screening with the argument that this is less expensive than providing treatment services, whilst incentivising care to be provided in the least complex setting required (Hornbrook & Goldfarb, 1983; Lewis & Agathangelou, 2018; Liu, 2003).

PBRA also promotes integrated care. As argued by The King's Fund (2013, p. 5):

> *'the ability to look at overall expenditure for defined populations and user groups and to use budgets flexibly is one of the hallmarks of integrated care. This is important in enabling commissioners and integrated or multidisciplinary teams to allocate resources efficiently and ensure that needs are met in the most appropriate and cost-effective way.'*

Capitation rates in PBRA models are adjusted to account for varying need for healthcare in the population; for example, need tends to be higher at the later stages of life, reflecting higher morbidity at older ages (Penno et al., 2013). Adjusting PBRA funding models to reflect healthcare need is important to ensure equity in resource distribution (ensuring equal access to healthcare to those in equal need) (Rice & Smith, 2001) and to reduce the risk of adverse incentives, such as adverse selection[2] (Connolly & Wren, 2016; Rice & Smith, 2001). Adjusted capitation models are also referred to as 'risk-adjusted capitation'[3] (Rice & Smith, 1999) or ''needs-based' capitation'[4] (Penno et al., 2013).

Built into the PBRA model is thus a capitation element to reflect the size of the population to be served (Penno et al., 2013), and characteristics of this population to reflect varying need for healthcare (Rice & Smith, 2001), as well as the cost of providing required services and supports (Johnston et al., 2021). The result of this is a PBRA funding formula with need indicators applied as cost weightings, and any other additional adjustments applied to reflect variations in the cost of providing required services.

Age is the fundamental starting point in any funding formula, and sex and socioeconomic factors are generally included (Rice & Smith, 2001). In practice, historical expenditure of healthcare utilisation by these characteristics are often analysed to construct a funding formula (Buck & Dixon, 2013; Rice & Smith, 2001). Implementing a population-based health funding model would link expenditure to population characteristics to estimate future need for healthcare and could improve transparency and predictability in the allocation of funding. This could allow for greater ability to forecast required healthcare expenditure over the medium and longer term.

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[2] Where capitation is the basis for allocating resources in a model operating on a choice basis, for example a health insurance or a 'money-follows-the patient' model, where citizens choose a healthcare organisation or provider to receive care from, there may be an incentive for the healthcare organisation/provider to attract healthier individuals (known as undertaking 'cream-skimming'), if compensation for variation in need is not built into the reimbursement system.

[3] 'Risk-adjusted' refers to the shift in financial risk when budgets are allocated on a prospective basis to healthcare organisations, as there is inevitably a degree of uncertainty in healthcare utilisation and in extent healthcare spending. Adjusting capitations to reflect population healthcare need is a way to adjust for such uncertainty, and in extent financial risk.

[4] 'Needs-based' refers to adjusting capitations to reflect varying population need for healthcare.

When constructing a PBRA model, or needs-based capitation formula, the following issues need to be considered (Diderichsen, 2004):

- The size of the defined population the healthcare organisation is expected to serve.
- The characteristics of individuals or populations that can be demonstrated to have significant influence on the need for health services and could therefore be useful in predicting the relative size of capitation or budget.
- The weight given to each of these factors when translated into monetary terms.

The first issue deals with the count of the population for which the healthcare organisation is responsible. Although population counts are usually valid, problems may arise if they rely on local reporting, potentially creating an incentive for healthcare organisations to inflate their reporting to increase the funding they receive (Smith, 2008). Addressing the issue of determining the population characteristics that are likely to reflect relative need for healthcare is discussed below, followed by an overview of methods for weighting factors and analytical methods.

Characteristics to Predict Healthcare Need

The future health of individuals is very difficult to predict (Diderichsen, 2004). However, relative need for healthcare across geographical areas can often be explained by sociodemographic indicators such as age, sex, marital status, education, employment, and ethnicity (these indicators are often referred to as need factors) (Diderichsen, 2004). Morbidity and mortality data could be used as proxies for healthcare need if need is proportional to morbidity and mortality rates (Diderichsen, 2004). Morbidity is in many respects a characteristic that is very closely related to healthcare needs; however, many health systems lack reliable and verifiable morbidity data (Rice & Smith, 2001). Contrary, mortality data is often universally recorded and verifiable, however the link between mortality rates and need for healthcare is debatable (Rice & Smith, 2001).

Rice & Smith (2001) argue that indicators that are included in PBRA capitation formulae should incorporate only characteristics that are:

- Universally recorded, consistent, and verifiable.
- Free from perverse incentives.
- Not vulnerable to manipulation.
- Reflects plausible determinants of individual need.
- Is not a measure of supply.
- Explains significant variation in the model.
- Feasible calibration to the model.

Weighting Need Indicators

The selection and weighting of indicators (or variables) has to be based on empirical analysis (Diderichsen, 2004). Most countries use existing patterns of utilisation, or preferably expenditure, to identify the best explanatory variables and determining variations across these (Diderichsen, 2004). However, health service utilisation or expenditure data will not only reflect needs but also variations in supply (Gordon et al., 2001; Rice & Smith, 2001). Using statistical methods to try to separate out supply and need factors' influence on utilisation is recommended (Gordon et al., 2001; Rice & Smith, 2001).

Analytical Methods

A common approach is to analyse utilisation/expenditure (dependent variable) against need (independent) and supply (confounding) variables in a regression model to determine the need variables that best predict utilisation/expenditure and identify supply variables that impact utilisation/expenditure (Diderichsen, 2004). To perform this type of analysis requires the ability to link data on utilisation or expenditure with data on the need and supply variables (Diderichsen, 2004).

There are two main types of study designs used, relating to the unit of analysis: using individual or aggregate levels of data. Analyses using aggregate data are often called 'ecological' studies. Aggregate data often has the advantage of being more available compared to individual level data (Diderichsen, 2004). However, aggregate level data introduces a risk of 'cross-level bias'[5], which means that weights estimated by group-level (or ecological) studies might be biased if applied in an individual-level capitation model (Diderichsen, 2004). This is a problem if the needs-adjusted capitation model is used at the individual level (Diderichsen, 2004). The issue of confounding (from supply factors) is generally a much more important problem in ecological analyses than in individual-level analysis, since variation of supply might be much stronger on the area-level (Diderichsen, 2004).

The two analytical approaches (individual versus aggregate) yield results for two different types of PBRA models (Diderichsen, 2004; Gordon et al., 2001):

- The matrix model calculates average healthcare expenditure per capita for each group defined as one or a combination of individual need-related variables &
- The index model is an ecological model calculating coefficients for each aggregate need-related variable (for example derived from censuses), based on a regression of healthcare expenditure.

Some jurisdictions, such as Scotland and England, use a mixed approach of the two models, where population data are cross classified by age and sex but other indicators, such as those reflecting socioeconomic variation are handled in an aggregate manner (Gordon et al., 2001).

PBRA Models

Scotland

Scotland's PBRA funding formula is constructed using disaggregated data by age and sex as well as data with a higher level of aggregation (Information Services Division, NHS Scotland, 2016). The formula is constructed to distribute funding for various care programmes[6] to fourteen NHS Health Boards and consists of four components; (i) population (share of population residing in the Health Board area), (ii) relative need due to age-sex profile, (iii) relative need due to morbidity and life circumstances and other factors, and (iv) relative costs of providing services to different geographical areas (unavoidable excess cost) (Information Services Division, NHS Scotland, 2016). The formula can be described as a weighted capitation model, where the first component, the population of an area, is multiplied by the three other components (age-sex profile, morbidity and life circumstances, and excess cost), constructed as indices, to arrive at a weighted population (Information Services Division,

[5] If estimating the effect of individual age on expenditure using age distribution and average expenditure at area level, cross-level bias might arise from two sources: i) if the cost level varies across areas among people of the same age (confounding by group) ii) if the absolute effect of age on costs at the individual level differs across areas (effect modification by group).

[6] These care programmes are; Acute, Mental Health & Learning Difficulties, Maternity, Care of the Elderly and Community which together make up the Hospital and Community Health Services, and GP Prescribing.

NHS Scotland, 2016). The indices are defined as the predicted cost per head of healthcare in the area divided by the national average cost per head (Information Services Division, NHS Scotland, 2016).

Calculations are based on small-area geographies, referred to as 'data zones'[7] designed with the intent to contain between 500 and 1,000 household residents (Information Services Division, NHS Scotland, 2016). Population projections are rebased[8] at Health Board level and then data zone populations are scaled so that Health Board totals match the rebased projections (this is done by single year of age and sex) (Information Services Division, NHS Scotland, 2016). The population used for the GP prescribing programme is based on an extract from the Community Health Index database[9] at the end of the most recent financial year, and this population is then adjusted to match the rebased population projection at council area level by single year of age and sex (Information Services Division, NHS Scotland, 2016).

An age-sex index is constructed by calculating the average cost per head of population treating patients in a particular age-sex band in a year (Information Services Division, NHS Scotland, 2016). These national average age-sex cost profiles are then applied to the projected population structure for each area to calculate the total expected cost for each small-area (Information Services Division, NHS Scotland, 2016). However, the GP prescribing care programme is based on the geographical location of GP practises which are then aggregated to the Health Board level (Information Services Division NHS Scotland, 2016).

The morbidity and life circumstances component of the formula is calculated as an index taking into account various indicators/explanatory variables that have been found to be good predictors of variations in healthcare use, over and beyond what can be explained by age and sex (Information Services Division, NHS Scotland, 2016). These indicators differ by care programme (Information Services Division, NHS Scotland, 2016). A linear regression analysis is used to establish the relationship between the need indicators and healthcare cost which is then used to predict cost (Information Services Division, NHS Scotland, 2016). Cost is predicted as a ratio of the actual cost to the cost that is expected based purely on the age and sex structure of the population, where a cost ratio greater than one indicates higher utilisation than the age and sex of the population would predict (Information Services Division, NHS Scotland, 2016). For most care programmes, the morbidity and life circumstances component of the formula is based on intermediate zones[10], which is a more aggregate level than data zones, due to data unavailability/sparsity at the data zone level (Information Services Division, NHS Scotland, 2016).

The unavoidable excess costs index compensates Health Boards for the excess costs of providing health services in different urban-rural areas (Information Services Division, NHS Scotland, 2016). For hospital care programmes, the excess costs component attempts to account for a relationship between the urban-rural setting and the unit cost of the activity (worked out at the data zone level) (Information Services Division, NHS Scotland, 2016). For community services, the index is calculated based on estimated durations of travel-based services and for clinic-based services, rurality weightings

[7] The data zones cover the whole of Scotland and nests within local authority boundaries as well as NHS Boards, with the exception of a few data zones that cross Board boundaries.

[8] Population projections are adjusted to account for any over- or under-estimation of the projection by the time of a more recent mid-year estimate. Mid-year estimates are published by the National Records of Scotland at the data zone level, but population projections are not available at the data zone level.

[9] The Community Health Index is a population register roughly equivalent to the proposed Individual Health Identifier system in Ireland.

[10] There are 1,279 Intermediate Zones in Scotland, with zones ranging from 2,500 to 6,000 households.

from the Scottish Allocation Formula for GP funding[11] (Information Services Division,NHS Scotland, 2016).

Northern Ireland

The PBRA formula in Northern Ireland allocates funding for nine care programmes[12] to five Local Commissioning Groups (Belfast, Northern, South Eastern, Southern and Western) (Department of Health, 2014). The PBRA formula is constructed in a similar way to the Scottish PBRA formula, where the population count is weighted using age-sex weights and 'additional need' weights (constructed as indices for the different care programmes) (Department of Health, 2014). Like the Scottish PBRA formula, additional cost adjustments are made to compensate areas for costs arising from geographical conditions; additional travelling times facing staff that provide community services (Department of Health, 2014) and healthcare service providers that due to their size do not promote optimal unit costs but need to meet a given level of demand (Department of Health, 2014; Health and Social Care Board, 2015).

New Zealand

New Zealand's PBRA funding formula is constructed as a matrix model, distributing funding to 20 District Health Boards (DHBs) (Ministry of Health, 2016; Penno et al., 2012). The population of each DHB is adjusted for demographic indicators; age, socioeconomic status (measured as deprivation quintile), ethnicity, and sex, where costs for each unique group of indicators are calculated in a cell-based model (Ministry of Health, 2016). The starting point of the funding formula is the DHB projected population (which includes a breakdown by age, sex, and prioritised ethnicity) produced by Statistics New Zealand for the Ministry of Health (Ministry of Health, 2016). Relative health need is calculated based on past health service use and the average cost of providing these services is broken down by age, sex, ethnicity, and deprivation level of population, which are then grouped into cost weights (Ministry of Health, 2016). A cost weight represents the average cost of providing health services to an individual based on their demographic indicators (Ministry of Health, 2016). Individual-level data on service use and expenditure is used, where available, to determine the cost weights (Ministry of Health, 2016). The data is aggregated into five major service groups: Personal Health: Hospital and Community Services; Personal Health: Primary Care; Health of Older People: Aged Residential Care; Health of Older People: Other; and Mental Health (Ministry of Health, 2016).

New South Wales, Australia

The Australian province of New South Wales (NSW) uses a 'Resource Distribution Formula' (RDF) to distribute funding from the NSW Department of Health to the region's eight geographically based Area Health Services (AHS) (NSW Health, 2006). AHS are the key organisational entities within the NSW public sector health system and are responsible for the planning and delivery of health care[13]. The system's key purpose is to ensure the equitable allocation of resources across each AHS (NSW Health, 2006). The formula incorporates size of the local population along with demographic characteristics of the AHS populations (specifically age and sex composition) and a Health Needs Index (Kirigia, 2009).

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[11] https://www.isdscotland.org/Health-Topics/General-Practice/Publications/2019-11-05/2019-11-05-ScotlandGPPayments2018-19-Report.pdf ; https://www.gov.scot/binaries/content/documents/govscot/publications/minutes/2019/10/legal-aid-payment-advisory-panel-minutes-july-2019/documents/agenda-item-1-presentation-on-gp-funding/agenda-item-1-presentation-on-gp-funding/govscot%3Adocument/Agenda%2Bitem%2B1%2B-%2Bpresentation%2Bon%2BGP%2Bfunding.pdf

[12] These care programmes are Acute Services (Non-elective and Elective), Maternity and Child Health, Family and Child Care, Elderly Care, Mental Health, Learning Disabilities, Physical and Sensory Disability, Health Promotion and Disease Prevention, and Primary Health and Adult Community.

[13] The Resource Distribution Formula Components are Population Health, Primary & Community, Emergency Department, Rehabilitation & Extended Care, Oral Health, Outpatients, Acute Inpatients, and Teaching & Research.

Similar to Scotland, the RDF is a weighted capitation model. The population of an AHS is weighted according to age-sex profiles. Census data is used to plan population projections at five-year intervals (NSW Health, 2006). This data is issued by the Department of Infrastructure, Planning and Natural Resources (DIPNR) at the Statistical Local Level. The growth between the five-year periods is assumed to be linear (NSW Health, 2006). To account for the influence that demographic characteristics have on the need for health care, the population in each area is weighted to its age and sex structure (Kirigia, 2009). These age and sex utilisation weights are done at five-year intervals for male and females. Like the population data, this breakdown relies on the use of census information (NSW Health, 2006). The weighted population figure is then multiplied by the Health Need Index (HNI) to arrive at a Need Adjusted Population. This is then supplemented with the Weighted Aboriginal and Torres Strait Islanders (ASTI) and Homeless Population to reach the Total Need Adjusted Population. This figure is then normalised with respect to the original population figure. A State-wide & Selected Specialty is added before reaching the final funding percentage.

The HNI reflects the impact of age, sex, mortality, socioeconomic, and geographic factors on the use of acute health services. According to NSW Health, approximately 81.7% of funding derived by the RDF pool of funds is influenced by the assessment of relative needs through the HNI (Kirigia, 2009). Variables included are the Standardised Mortality Ratio; Index of Education and Occupation; Accessibility and Remoteness Index of Australia, and the percentage of population that are Aboriginal & Torres Strait Islander. These indices are then inputted into a formula to arrive at the HNI level (NSW Health, 2006).

While the acute HNI is developed for the Acute Inpatient component of the RDF, it is also applied to Population Health, Primary & Community Based Services, Outpatients, and Emergency components (NSW Health, 2006). The Obstetrics Need Index is comprised of total fertility rates for AHS, the Palliative care need index relies on cancer standardised mortality ratios, and the Rehabilitation index draws on adjusted rates of people who live alone (weighted by three), the ABS socioeconomic status Index of Relative Disadvantage (weighted by two); and a rurality variable (weighted by one) (NSW Health, 2006).

England

The PBRA model used in England allocates funding to Clinical Commissioning Groups (CCGs) for three areas using different funding formulae: Core Services (Acute Services, Mental Health, Prescribing, Community Services and Maternity), Primary Care, and Specialised Services (49% of funding is based on the formula and 51% of funding is based on historic spending) (NHS England and Improvement - Analysis and Insight for Finance, 2019).

The weighted capitation formula is known as the 'fair shares formula'. It begins by establishing the population base for each CCG. These populations are then projected forwards based on Office for National Statistics projections. To account for varying demand for healthcare services, the weighted capitation model takes into account the relative need per head of different age-sex groups and the different age-sex profiles of local populations (NHS England – Technical Guide to Allocation Formulae and Pace of Change, 2019). An adjuster, also known as the 'Market Forces Factor' is included to reflect the higher input costs in certain regions of the country (e.g., London). Similar to other models, the England model makes adjustments on account of geography to cover the additional costs of providing ambulance services in sparsely populated areas and the higher costs of unavoidably small hospitals with 24-hour accident and emergency services in remote areas (NHS England – Technical Guide to Allocation Formulae and Pace of Change, 2019).

Alberta, Canada

The PBRA model used in Alberta, Canada is constructed as a matrix model, distributing funding for seven care programmes[14] to nine Regional Health Authorities (RHAs) (Alberta Health and Wellness, 2007). The model consists of RHA projected population, which is weighted by age, sex, and socioeconomic status (Alberta Health and Wellness, 2007). Similar to New Zealand, a cell-based method is used where individual-level expenditure activity is linked to the 136 demographic groups (age groups, sex, and socioeconomic status) (Alberta Health and Wellness, 2007). In addition, cost adjustments are made to compensate RHAs for additional costs associated with providing services to remote populations and for higher costs of travel, supplies and utilities faced by remote RHAs (Alberta Health and Wellness, 2002, 2007).

Formulating PBRA Models

Implementing a PBRA model is a complex and ongoing process and key stakeholder engagement can be crucial to ensure success (Johnston et al., 2021). Based on their review of PBRA models, Johnston et al. (2021) highlight that when implementing a PBRA model, it's important to establish a system for transparent research and reporting at the outset.

There are examples of jurisdictions having constructed a PBRA model based on another jurisdiction's PBRA model. The New South Wales PBRA formula was based in part on the Resource Allocation Working Party (RAWP) model which was introduced in England in 1976 (Kirigia, 2009). Wales are moving away from their 'Townsend' direct needs formula that has been in use since 2003 to adopt a new PBRA formula (Government of Wales, 2019). Following a review of PBRA formulae used in other countries, the Technical Advisory Group (TAG) have endorsed modelling the new formula based on the Scottish NHS formula (Government of Wales, 2019). This move reflects the fact that the Welsh Health Survey that was the main data source for the 'Townsend formula' has been replaced with the National Survey of Wales and changes mean it is no longer suitable (Government of Wales, 2019).

When Alberta, Canada set about developing a population-based needs adjusted funding model, its newly established Health Services Funding Advisory Committee (HSFAC) reviewed models implemented internationally in great detail and drew useful lessons from other jurisdictions' experience in design and implementation. HSFAC viewed the model arrived at "as representing the best of other constituencies' experience" (Health Plan Coordination Project Action Plan, 1994 in Smith & Church, 2008). Furthermore, the proposed approach was also widely shared with international, national, and provincial experts for their input (Smith & Church, 2008).

Following a survey of international capitation formulae, Rice & Smith (1999) make the following recommendations for developing and updating PBRA funding formulae:

- The scope for using individual-level data should be examined – the matrix approach to constructing a PBRA model is preferred as this approach minimises the risk of introducing bias, which is a problem when using aggregate data.
- The scope of using data on prior healthcare utilisation for determining capitation rates should be examined, in particular data relating to non-discretionary types of healthcare.
- Information on certain (high expenditure/high need) citizen groups should be examined to improve the sensitivity of indicators and thus improve capitations. For example, some PBRA

[14] These care programmes are; Acute Hospital Inpatient Care, Acute Ambulatory Care, Long Term Care, Home Care, Community Lab (non-hospital or community lab tests), Health Link (a telephone service which provides free 24/7 nurse advice and general health information) and Promotion/Protection/Prevention (PPP). Due to PPP data being limited this sector is excluded from the general formula with funding allocated by a modified population-based formula.

models use specific categories for higher healthcare need/higher expenditure need citizens, such as chronically ill categories.

- The financial risk embedded in the capitation system should be considered and if the design of the capitation system needs to be modified to take account of such risk.
- Variations in cost of providing standard levels of service should be examined. Such analysis could enable a better understanding of cost variations that are due to variations in need (legitimate factors), and those that are due to variations in the supply of services (illegitimate factors) (Carr-Hill & Dixon, 2008).
- The tendency to develop formulae for increasingly disaggregated service categories should be reviewed, to ensure substitutions between models of care/treatments are not foregone. The amount of disaggregation should be reduced wherever possible.
- PBRA models and formulae should be constructed with a view of obtaining simplicity. The English PBRA model is one of the more complex models, with separate formulae for various elements of need, making it difficult for politicians and decision-makers to understand, and it has been argued that it should be simplified (Buck & Dixon, 2013).

Indicators in PBRA Formulae

To account for differences between geographical areas, population size is the starting point for PBRA formulae. Beyond population size, the most common indicators are age and sex (Radinmanesh et al., 2021). Socioeconomic status or deprivation, ethnicity, standardised mortality ratio (SMR) or mortality, geographical area/place of residence (geographical) (rural versus urban), and cross-boundary flows are other common indicators included in PBRA formulae internationally (Radinmanesh et al., 2021).

As argued by Smith, Rice and Carr-Hill (2001),

'The general principles that should be applied when choosing need factors should be that, other things being equal, they represent demonstrably material influences on the need to consume the service under consideration' (p, 222, in New Zealand Ministry of Health, 2016).

However, as also highlighted by Smith, Rice and Carr-Hill (2001) selecting indicators can be a complex and sometimes controversial process. Reasons put forward for this are:

- Relevant data are often in short supply.
- Research evidence on appropriate need factors is sparse, dated, or ambiguous in its implication.
- There is great difficulty in handling covariance between need factors.
- It is very difficult to disentangle legitimate need factors from illegitimate (supply) influences on utilisation.
- The recipients of public sector budgets often feel that they have a clear idea about which need factors will favour their area, and so will seek to influence the choice of need factors through the political process.
- The central government (or distributor of funds) will often have a clear view on the result that it wishes to secure.

(Smith, Rice and Carr-Hill, 2001, in New Zealand Ministry of Health, 2016)

Demographics: Age and Sex

The correlation between age and need for healthcare, with higher need for healthcare at the beginning and later stages of life is the rationale for including age in PBRA formulae (NHS England and Improvement - Analysis and Insight for Finance, 2019). Due to different lifetime profiles of need and consumption of healthcare between men and women (Hurley et al., 2004), including sex as an indicator is common as well (Penno et al., 2013; Radinmanesh et al., 2021). As such, age-sex weights are often used in PBRA formulae (Department of Health, 2014; Information Services Division NHS Scotland, 2016). The level of disaggregation of age varies, as illustrated in Table one.

The most common level of disaggregation is to apply five-year bands up to 85+. However, Scotland use age bands up to 90+ and also applies two age bands for under five-year olds: 0-1 and 2-4 (Information Services Division,NHS Scotland, 2016). In Northern Ireland, using smaller age bands for the age-sex weights has been tested for acute care services and elderly care but no gain was seen from using a higher degree of disaggregation and therefore the five-year age bands were retained (Carr-Hill & Dixon, 2008).

Table One: Overview of level of disaggregation of age indicators in PBRA formulae[15].

Jurisdiction	Level of Disaggregation of Age Indicator	Formula Name & Source
Alberta, Canada	Five-year age bands except for the youngest under 5: <1, 1-4, 5-9…90+ (in total 20 age bands)	Population Funding Formula (Alberta Health and Wellness, 2007)
England	Five-year age bands: 5-year age groups (0-4…85+)	Weighted Capitation Formula/Fair Shares Formula (Department of Health Financial Planning and Allocations Division, 2011; NHS England and Improvement - Analysis and Insight for Finance, 2019)
New South Wales, Australia	Five-year age bands: 5-year age groups (0-4…85+)	Resource Distribution Formula (Johnston et al., 2021)
New Zealand	Five-year age bands: 0-4…85+ (Health for Older people: Aged Residential Care includes 90+)	Population-Based Funding Formula (Ministry of Health, 2016)
Northern Ireland	Five-year age bands: 0-4…85+	Capitation Formula (Department of Health, 2014)
Scotland	Five-year age bands except for the youngest under 5: 0-1, 2-4, 5-9…90+ (in total 20 age bands)	Resource Allocation Formula (Information Services Division, NHS Scotland, 2016)

[15] Age bands may vary between care programmes within the PBRA models.

Socioeconomics/Deprivation

Various measures of socioeconomic status or deprivation are used internationally (Penno et al., 2013; Radinmanesh et al., 2021).

New Zealand uses the New Zealand Index of Socioeconomic Deprivation (NZ Dep, 2018.) by quintiles to adjust for socioeconomics in the funding formula (Ministry of Health, 2016). It's a small area index developed by the University of Otago, Wellington School of Medicine using census data, and measures relative socioeconomic deprivation by assigning relative deprivation scores[16] to units called 'meshblocks' which is the smallest geographical units for which Statistics New Zealand gathers data (Ministry of Health, 2016). Linkage with expenditure is achieved through the National Health Index database which is a unique identifier assigned to each individual using health services and includes variables such as address, date of birth, sex, and ethnicity (Penno et al., 2012).

In Alberta, Canada, socioeconomics is accounted for by including two population groups that reflect low-income status; individuals receiving social assistance under age 65 during the year (welfare) and individuals under age 65 with subsidised healthcare premiums (subsidy) (Alberta Health and Wellness, 2007). These groups are applied alongside the ethnicity group (aboriginal) where if an individual belongs to more than one group, a decision hierarchy is applied, where welfare status is first, followed by aboriginal, followed by subsidy and with all other individuals grouped into 'other' applied last (Alberta Health and Wellness, 2007).

In New South Wales, Australia, the socioeconomic status of the Area Health Services (AHS) is measured via the Index of Education and Occupation (EDOCC) developed by the Australian Bureau Statistics SEIFA Index (NSW Health, 2006). The occupation variables categorise the workforce into major groups skill levels of the Australian and New Zealand Standard Classification of Occupations (ANZSCO) and the unemployed. A low score reflects lower education and occupational levels, and a higher score indicates relatively higher education and occupation status of people in the AHS (Australian Bureau of Statistics, 2018). Furthermore, homeless people are given an additional weighting to reflect their significantly lower health status, the Census' inadequacy in accurately capturing the population, and the need to provide them with targeted services (NSW Health, 2006). The lack of accurate and available data means that the homeless population per AHS is initially estimated and given an additional weighting of 2.5 (NSW Health, 2006). This weighted estimate for the homeless population is then added to the AHS's total population.

Morbidity and Life Circumstances/Standardised Mortality Ratio/Mortality

Scotland uses a morbidity and life circumstances index (Information Services Division, NHS Scotland, 2016). Each care programme uses need indicators that have been found to be good predictors of variations in healthcare use, over and above what can be explained by age and sex (Information Services Division, NHS Scotland, 2016).

Northern Ireland includes an additional needs weighting which is computed differently across the PBRA's nine Programme of Care (PoC) areas and combines results in an all PoC additional needs index (Department of Health, 2014). New South Wales, Australia uses a Health Needs Index which includes:

[16] Deprivation scores range on an ordinal scale from 1 to 10, equating to ten deciles, where decile 1 represents the least deprived areas and decile 10 the most deprived. The ordinal scale is designed so that each decile represents approximately ten percent of the national population. At District Health Board (DHB) level, the deciles reflect the respective DHB's population share of the respective decile.

a Standardised Mortality Ratio[17] for ages less than 70, an index of education and occupation developed by the Australian Bureau of Statistics[18] (Kirigia, 2009).

Geography

Several jurisdictions include an indicator to adjust for the impact of geography on costs of delivering health services. Indicators capturing rurality/remoteness compensate healthcare organisations for 'unavoidable excess costs' of providing services in remote/rural areas, including travel costs for providing services in these areas and economies/diseconomies of scales arising from providing care in healthcare facilities that do not promote optimal unit costs. In England, adjustments are also made to reflect that input costs such as staff, land and capital are higher in certain geographical areas (for example London).

Alberta, Canada adjusts for rurality through a 'cost adjustment factor' consisting of different adjustments for inpatient and non-inpatient services (Alberta Health and Wellness, 2007). For hospital inpatient services, the cost adjustment factor is based on a regression analysis, quantifying the impact of explanatory variables such as patient remoteness on regional inpatient costs per standardised unit of output (Alberta Health and Wellness, 2007). The results are used to predict regional cost variances from justifiable factors, and then converted into an index that is applied to each region's forecasted hospital inpatient budget (Alberta Health and Wellness, 2007). For non-inpatient services, regions are compensated based on rurality, applying two adjustments: 'Assured Access' and 'Cost of Doing Business', recognising the greater costs associated with delivering services in sparsely populated areas and the high cost of travel, supplies, and utilities for remote RHAs (Alberta Health and Wellness, 2002, 2007). The Assured Access adjuster compensate regions where they receive an additional percentage (25 percent for remote population and 50 percent for very remote population) of the per capita funding rate for each resident living outside of population circles (50-kilometer radius) with a population concentration of at least 5,000 (Alberta Health and Wellness, 2002, 2007). The Cost of Doing Business adjuster compensate regions located more than 300 kilometers from a major city, where they receive additional funding equal to 25 percent of the region's estimated supplied budget (Alberta Health and Wellness, 2002).

Scotland accounts for the impact of remoteness on the cost of delivering health services by including separate remoteness adjustments for community and hospital services. These adjustments compensate Health Boards for 'unavoidable factors' that influence the costs of delivering services to meet those needs (NHS Scotland Resource Allocation Committee, 2007). The remoteness adjustment for hospital services is based on analysis of Board level information on unit costs and road kilometres per 1,000 population as a single indicator of remoteness (NHS Scotland Resource Allocation Committee, 2007). The remoteness adjustment for community services has two components; (i) adjustment for travel-intensive services is based on a simulation model of the additional travel associated with the delivery of services by district nurses and health visitors in rural areas, and (ii) clinical-based services are based on an analysis of the cost of providing General Medical Services in remote areas (NHS Scotland Resource Allocation Committee, 2007).

In England, adjustment is made for unavoidable higher costs of delivering healthcare due to location, referred to as the 'Market Forces Factor', reflecting that staff, land and building input costs are higher in certain areas of the country (for example London) (NHS England Analytical Services Finance, 2016).

[17] A standardised mortality ratio (SMR) describes whether a specific population (e.g., patients in a certain area) are more, less, or equally as likely to die than a standard/ reference population (e.g., patients across the entire country).

[18] The purpose is to incorporate factors known to influence or reflect population morbidity due to lack of systems for generating direct measures of population morbidity.

In addition, adjustments are made for the higher costs of providing emergency ambulance services in sparsely populated areas, and for the higher costs of unavoidably small hospitals with 24-hour accident and emergency services in remote areas (NHS England Analytical Services Finance, 2016).

New Zealand include a rural adjuster for the unavoidable extra costs associated with providing health services to rural communities (Ministry of Health, 2016). The model is based on seven separate service areas where DHBs have indicated they face additional costs relating to rurality; offshore islands, rural GP/PHO payments (comprising a rural bonus/remote rural practice area funding payment; a rural workforce retention premium; a reasonable roster amount; and a rural after-hours payment), travel and accommodation (reimbursement of eligible patients for travel and accommodation), inter-hospital transfers (the cost of transporting patients between facilities), community services (the extra cost of providing community services to small and/or sparse populations – either services in the home, integrated family clinics or small rural hospitals), facilities (the diseconomy cost of providing a full role delineation model three service to a small population), governance (diseconomies related to governance costs due to small size rather than rurality) (Ministry of Health, 2016). In the 2015 review of the New Zealand PBRA funding formula, it was recommended that the governance component of the rural adjuster be dropped, reflecting unanimous feedback from District Health Boards (Ministry of Health, 2016).

New South Wales, Australia includes a 'Dispersion Factor', a measure of the distance from hospital and distance from nearest capital city and is applied across three of the programme components (Ministry of Health, 2016). New South Wales also adjust their model to account for 'unavoidable costs', including the rurality of the AHS. This is in recognition that rural residents have higher levels of premature mortality, higher hospitalisation rates, lower life expectancy, and lower survival rates for cardiovascular diseases and cancer (Kirigia, 2009). Additionally, rural residents report significantly higher rates of facing difficulties in accessing care. This rurality factor is measured using the Accessibility and Remoteness Index of Australia (ARIA). This index is calculated using 'road distance from centres of populations greater than 5,000 persons to four categories of 'service centres'[19]. A score is calculated as a ratio of the road distance to the mean road distance for each category (NSW Health, 2006).

Northern Ireland includes a rurality adjustment to compensate areas for unavoidable costs due to excess time spent on travel when undertaking home care visits in rural areas (Health and Social Care Board, 2015). The rurality adjustment is based on staff time and travel costs, modelled using an operational research model: Simplified Modelling of Spatial Systems, where areas are compensated for additional travel over the Northern Ireland average (Department of Health, 2014). An economies of scale adjuster was introduced in 2004, based on a research report by MSA-Ferndale Secta[20], which compensate Local Commissioning Groups for hospitals or community services that are of a size that do not promote optimal unit costs, but need to meet a given level of demand (Department of Health, 2014; Health and Social Care Board, 2015).

Ethnicity

Ethnicity is adjusted for in some formulae. Alberta, Canada, and New Zealand include an indicator for ethnicity and New South Wales, Australia applies an indigenous weight in their PBRA formula (Radinmanesh et al., 2021). Alberta, Canada includes an aboriginal population group alongside the other socioeconomic groups' welfare and subsidy (see socioeconomic section for more detail on

[19] The service categories are based on resident populations as follow: A. 250,000 or more, B. 48,000 - 249,000. C. 18,000 to 47,999, D. 5,000 – 17,999.

[20] https://www.health-ni.gov.uk/sites/default/files/publications/dhssps/differential-costs.pdf

these) (Alberta Health and Wellness, 2007). Where an individual belongs to more than one of these groups, a decision hierarchy is applied where welfare is first, followed by aboriginal, followed by subsidy, and with all other individuals grouped into 'other' applied last (Alberta Health and Wellness, 2007).

New Zealand applies an additional cost weight for Maori and Pacific populations to account for unmet need in these groups (Ministry of Health, 2016). The cost weighting applied in the New Zealand PBRA model for ethnicity is derived by comparing expected expenditure with actual expenditure in each ethnic group, and an adjustment factor is calculated based on the identified difference which is then applied as a single adjustment across all cells in the particular ethnic group (Penno et al., 2012).

In New South Wales, the Resource Distribution Formula (RDF) takes into consideration the Aboriginal and Torres Strait Islander Populations in each AHS. It is well established that these indigenous communities have poorer health status, and as such have additional healthcare needs. As of 2011, there was inadequate data to accurately capture the future indigenous populations at a local level (NSW Health, 2006). As a result, the RDF assumes that the percentage of indigenous population within an AHS remains constant. To reflect their additional needs, an effective weight of 2.5 is applied per indigenous person (NSW Health, 2006). Alongside the indigenous weighting, the Health Need Index also captures the proportion of the population that is indigenous. Whilst the latter variable reflects current need, the former 'reflects a judgement that additional resources (in addition to those currently provided) are required (NSW Health, 2006).

Unmet need

Unmet need indicators are included in PBRA models to allocate additional funding towards healthcare organisations with population groups experiencing poorer health outcomes than the rest of the population and that utilise health services to a lesser extent than other groups with the same level of need, called 'specific' unmet need[21] (Rice & Smith, 2001). Specific unmet need reflects that certain population groups may have greater issues accessing health services due to various barriers (for example cost, health literacy, distance) (Ministry of Health, 2016). PBRA models using a utilisation-based approach to model future healthcare needs (expenditure), where needs are modelled on existing utilisation patterns, will not capture specific unmet need, indicating the need to include additional adjustments to the models to address this, if present.

England adjusts for unmet need to address health inequalities by using the standardised mortality ratio for those aged under 75 (Advisory Committee on Resource Allocation (ACRA), 2015; NHS England, 2019). The unmet need weight is 10% in the core formula (CCG allocation), 15% for primary care (Advisory Committee on Resource Allocation (ACRA), 2015) and 5% within the specialised services formula (NHS England, 2019).

New Zealand include an unmet need adjuster to target funding for population groups having issues accessing health services; those that identify as Maori or Pacific peoples and those living in areas of high deprivation[22] (Ministry of Health, 2016).

[21] Unmet need for health services can be general or specific. General unmet need describes a situation when there are insufficient resources to meet the entire needs of the population and is not an issue for a PBRA model. Specific unmet need occurs when a population group does not use the same level of resources as other population groups with the same level of need and become an issue for PBRA models using an utilisation approach where the relative healthcare needs are measured from patterns of health care use.

[22] Maori, Pacific people and residents in the most deprived areas (NZDep quintiles 4 and 5) experience poorer health outcomes than others suggesting that these groups have healthcare needs that are not being met. Survey findings confirm that more individuals from these population groups report unmet need for primary care than the rest of the population.

In New South Wales, Australia, indigenous (Aboriginal and Torres Strait Islanders) and homeless populations are given additional weightings in the population count to reflect unmet need in these population groups (Ministry of Health, 2016; Rice & Smith, 1999). Aboriginal and Torres Strait Islanders are also given additional weighting in the Health Need Index, to reflect their higher need for acute care hospital admissions (Ministry of Health, 2016).

Scotland adjusts for unmet need for circulatory disease (heart diagnostic group), as there is evidence of a shortfall in use of these services due to deprivation levels (Ministry of Health, 2016), and unmet need is an issue under continuous consideration, where analysis into shortfall in use of other acute services has been undertaken (Technical Advisory Group on Resource Allocation Morbidity and Life Circumstances Subgroup, 2016).

Cross-boundary flows/Unpredictability in uptake population

New Zealand include an overseas eligible and refugees adjuster to compensate District Health Boards for unavoidable costs of providing services to eligible overseas visitors[23] (derived from recent costs) and an allowance for new refugees to New Zealand (to meet the high health costs of this group). Adjustments for cross-boundary flows are also made in Alberta, Canada; New South Wales, Australia; and Spain (Radinmanesh et al., 2021; Rice & Smith, 1999). The cross-boundary flow adjustment in Alberta, Canada, referred to as 'import-export activity', is calculated based on identification of inter-regional activity from the activity data sets used for calculating the PBRA funding formula, and after the activity has been translated into expenditure value, adjustments are made where the region providing the service (import) is assigned the expenditure value and the region where the expenditure value is deducted from the region where the patient comes from (export) (Alberta Health and Wellness, 2007).

Data Availability

As highlighted by Diderichsen (2004) the most limiting factor with regard to a choice of a resource allocation model is normally data availability. Data is required on:

- Health care costs at the individual or ecological level in order to facilitate the selection and weighting of need factors.
- The distribution of need factors for each area or purchaser population.
- Supply data to in order to control for any confounding effect.
- Morbidity to test variations in utilisation for equal morbidity across need factors (Diderichsen, 2004).

Some developed countries maintain individual-level databases covering nearly all health care costs for the whole population. Using personal identification numbers, these databases can be linked to other databases which include individual or contextual sociodemographic characteristics (Diderichsen, et al. 1997 in Diderichsen, 2004). However, many other countries need to rely on non-administrative data with regard to selecting and weighting need factors at the regional level. Household surveys on Health and Living standards may prove useful in this regard (Diderichsen, 2004). Furthermore, data on health care utilisation may have to be roughly translated into costs (Diderichsen, 2004).

Reviewing and Updating PBRA Models

Developing a system of robust governance and evaluation mechanisms is important to monitor and assess if the PBRA model is delivering on stated policy objectives and to enable adjustments to the

[23] Covering New Zealand citizens domiciled overseas who return to New Zealand for treatment, those patients for whom there is a reciprocal arrangement (UK, Australia, and some Pacific Islands).

model be made (Johnston et al., 2021; Smith, 2008). New South Wales, Australia; Alberta, Canada; England; New Zealand; and Scotland have expert advisory groups that review the formulae and resource allocation estimates (Johnston et al., 2021). A few jurisdictions publish external audits and reviews of formulae on a regular basis. New Zealand publishes information through the Ministry for Health website, Scotland makes information available through the Technical Advisory Group on Resource Allocation (TAGRA)[24] and England publish information through the Advisory Committee on Resource Allocation (ACRA)[25]. New South Wales' Resource Distribution Formula (RDF) is reviewed annually by an RDF Advisory Committee which consists of members with academic, clinical, and health administrative expertise. Using a wide consultation process, they make recommendations with regard to any improvements in the RDF (Kirigia, 2009). The New Zealand Ministry of Health (2016) argues that as variables are to be regularly reviewed and new potential variables considered, it is important that clear criteria for inclusion are set out.

Relevant Data in an Irish Context

When considering the findings of the previous section and the potentially relevant indicators identified with regard to applying a PBRA in an Irish context, the following data sources present themselves as the most appropriate.

CSO Census of Population

In order to examine population data for the new RHAs, Small Area Population Statistics (SAPS) are required.[26] The population census provides data at the 'Small Area' (SA) level (18,641 observations in 2016 Census). These SAs have been matched to their relevant RHA by Department of Health statisticians, enabling the analysis of Census 2016 data by RHA. Census data provides a rich source of demographic information in terms of age and gender while also providing the required data on the rurality of RHAs. In terms of potential socioeconomic, ethnicity, and health status variables, the census enables the examination by RHA with regard to:

- Principal Economic Status.
- Social Class.
- Highest level of education completed.
- Occupation.
- Occupancy Type.
- Household Type.

In terms of Ethnicity:

- Nationality.
- Ethnic or Cultural Background.

[24] https://www.tagra.scot.nhs.uk/

[25] https://www.england.nhs.uk/publication/advisory-committee-on-resource-allocation-acra-terms-of-reference/

[26] Health Service Executive geographies, including the RHA, don't follow the standard Central Statistics Office or Public Sector Boundaries, so Small Area Population Statistics are the most appropriate observations.

Health Status Indicators:

- Self-Reported Health Status.
- Persons with a disability.

A significant disadvantage with the Census for the purposes of this work, is that it takes place every five years and estimates of population in the intercensal period may not be reliable. As the Census was not carried out in 2021 due to Covid-19, we are currently at the end of a particularly long intercensal period. Furthermore, while population estimates are estimated by the CSO for the intercensal period, many of the variables of interest highlighted above are not.

With regard to socioeconomic data from the Census, the lack of income as well as measures of deprivation and consistent poverty is a significant drawback. While this data is collected at the survey level annually through the Survey on Income and Living Conditions (SILC), it is not currently able to be analysed by RHA geography. The Pobal HP Deprivation Index is presented in this paper as a proxy for Deprivation across the RHAs. It uses census data on 10 key indicators including: the proportion of skilled professionals, education levels, employment levels, and single-parent households found in an area to estimate the likely rate of deprivation.[27]

Healthy Ireland Survey

The limited health information in the census has led the Department to trial the use of the 'Healthy Ireland' Survey for the purposes of developing a PBRA. The 'Healthy Ireland' Survey is an interviewer-administered survey of health and health behaviours of people living in Ireland,[28] commissioned by the Department of Health and carried out by Ipsos MRBI. The Survey was conducted annually since its inception in 2015. Five waves, from 2015-2019, were completed using face-to-face interviews with approximately 7,500 people per annum and are available on the 'Healthy Ireland' website.

Presented in this paper are results from analysis carried out by DoH Statisticians which pools the five waves of the Survey in order to present statistically robust health indicators by RHA.

As previously stated, the ability of Ireland to pursue a best practice approach is constrained by the lack of a fit for purpose unique health identifier and the inability to match utilisation and cost to other characteristics of people or groups (e.g., socioeconomic status). Work is currently underway on the Health Information Bill which will legislate for the use of a fit for purpose unique health identifier. This would enable more robust patient-level data and assist in the development of the PBRA.

[27] However, the Pobal HP Index is calculated at SA level, not the individual level. Ecological inference issues need to be accounted for when combining with individual level data.

[28] In non-residential settings.

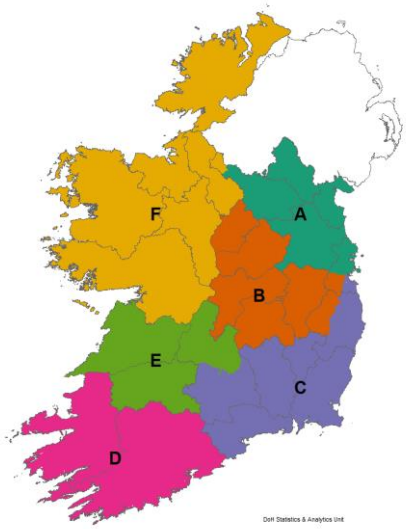
Statistical Profiles of the RHAs

This section of the paper presents relevant variables as identified in the evidence review part of the paper, largely from the relevant data sources identified, namely the CSO Census of Population and 'Healthy Ireland' Survey. We begin by showing data on what has been shown to be the core building blocks of PBRA models internationally, namely, population size and age and sex distribution of the RHAs. This is followed by a look at some health status and utilisation data from the 'Healthy Ireland' Surveys, before looking at socioeconomic variables and ethnicity from the census. We then conclude by taking a look at the rurality measure of the RHAs. Figure one below, provides a visual of the geographies of the RHAs as per the Government decision of 2019. Finally, it is important to highlight, that further work will seek to estimate the relationship between the variables presented here on need and expenditure in order to inform PBRA design. Data here will just be presented, showing how RHAs compare relative to each other without comment on the significance differences may have on resources allocation.

Table 2: Geographies of the Regional Health Areas

RHA	HSE Local Health Offices
A	Dublin North Central, Dublin North West, Dublin North, Meath, Louth, Cavan/Monaghan.
B	Dublin South City, Dublin South West, Dublin West, Kildare/West Wicklow, Laois/Offaly Longford/Westmeath.
C	Dublin South East, Dun Laoghaire, Wicklow, Wexford, Carlow/Kilkenny, Waterford, Tipperary South.
D	Cork West, Cork South Lee, Cork North Lee, Cork North, Kerry.
E	Limerick, Clare, Tipperary North/East Limerick.
F	Galway, Roscommon, Mayo, Sligo/Leitrim[29], Donegal.

Figure 1: Geographies of the Regional Health Areas

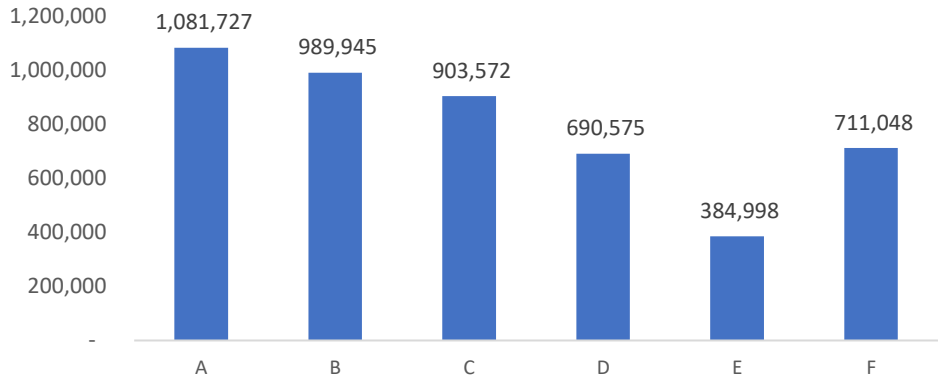


[29] West county Cavan: A small portion of west county Cavan continues to be aligned with Sligo/Leitrim for health services.

Total Population

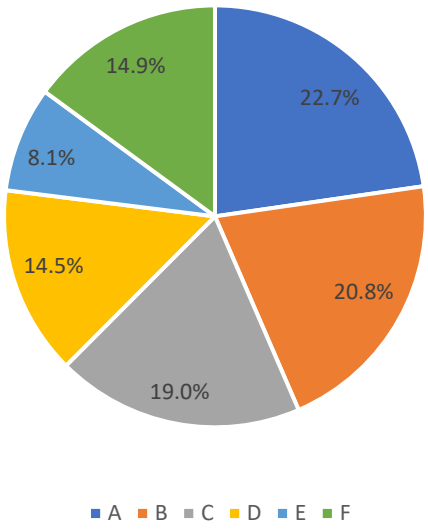
In terms of resource allocation by needs adjusted capitation, the size of the population of an RHA will likely have the largest impact on the relative size of allocation to a region. As shown in figure two, RHA A has the largest population in 2016 at 1,081,727 or 22.7% of the total population as shown in Figure 3. RHA E is the smallest RHA with a population of 384,998, representing 8.1% of the total population.

Figure 2: Total Population by RHA 2016



Source: CSO Census 2016

Figure 3: RHA % of the Total Population

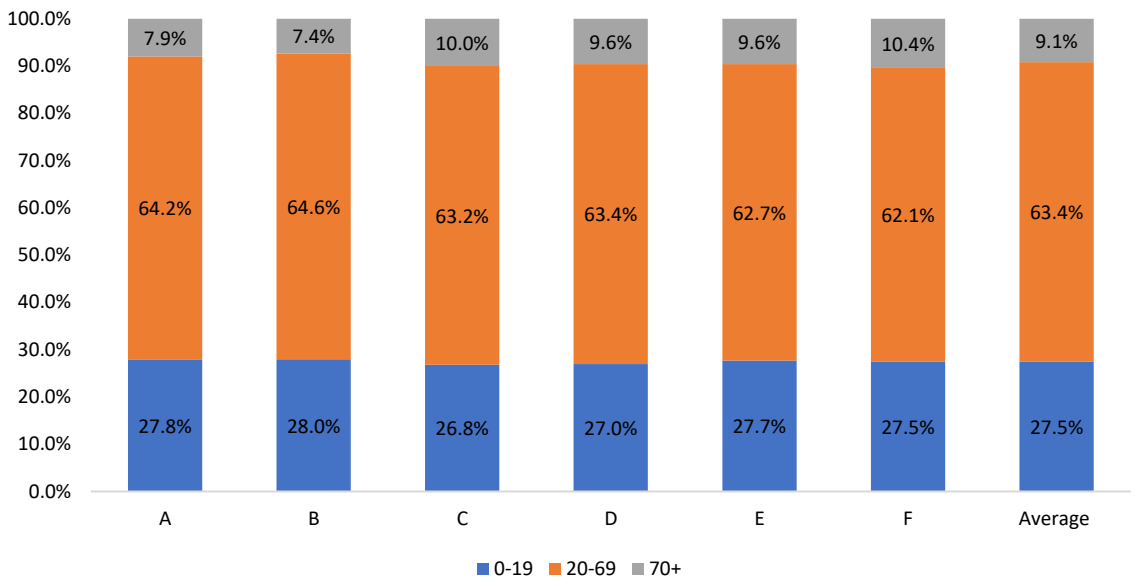


Source: CSO Census 2016

Age and Gender by RHAs

As highlighted in the literature review, age and gender are the fundamental starting point in any needs adjusted capitation funding formula. Figure four shows the difference in the population age distributions by RHA. As measured by the rate of the population aged 70+, RHA F has the 'oldest' population with those 70+ making up 10.4% of the population while the average across all RHAs is 9.1%. RHA B on the other hand has the smallest share of the population aged 70+ at 7.4%. Population Pyramids showing differences by sex and five-year age band for each RHA are available in the appendix.

Figure 4: Age Across the RHAS

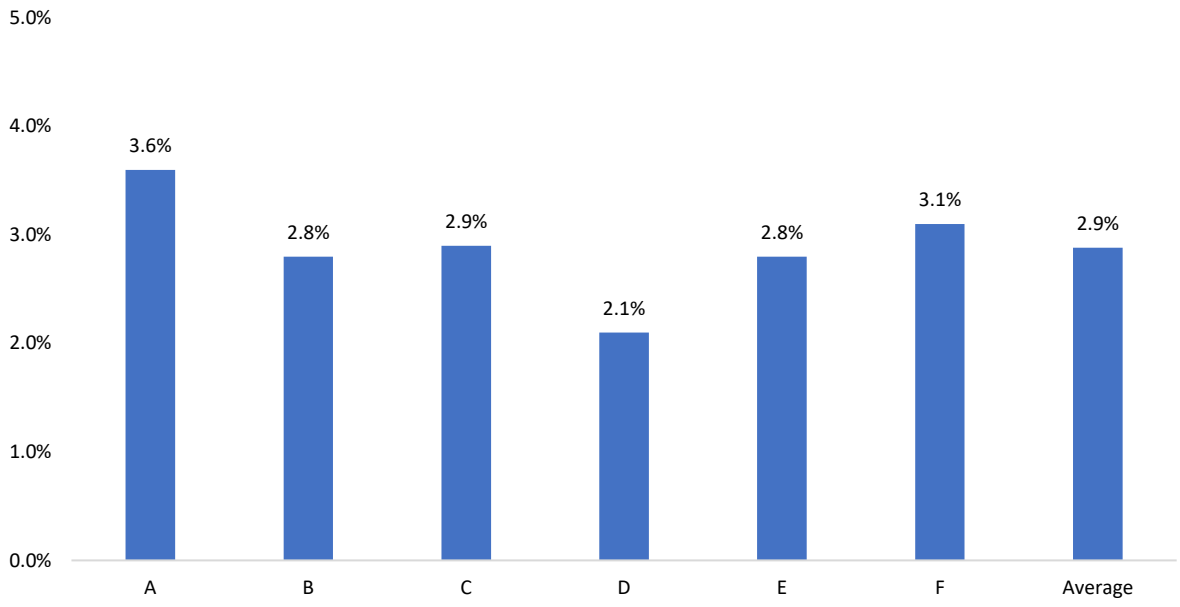


Source: CSO Census 2016

Health Status Indicators

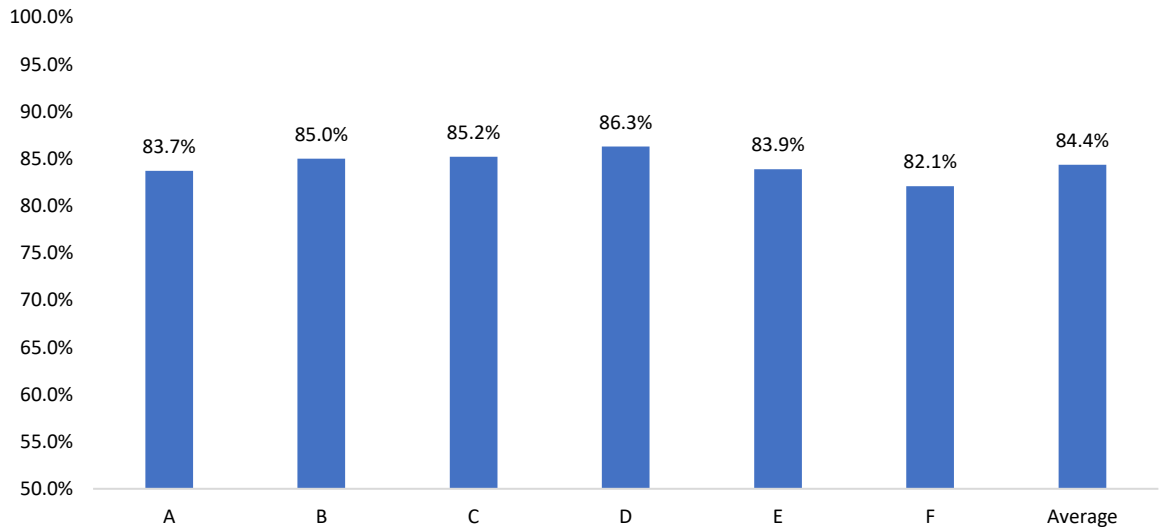
Figures five to nine show results from the pooling of the five waves of the 'Healthy Ireland' Survey 2015-2019 with regard to key health status indicators. Figure five shows the percentage of the population in each RHA that has self-reported 'Bad' or 'Very Bad' health as well as the average rate between RHAs. RHA A has the highest rate at 3.6% while RHA D has the lowest at 2.1%, and the average rate is 2.9%. Figure six shows the percentage of the population in each RHA that has self-reported 'Good' or 'Very Good' health as well as the average rate. Here, RHA F has the lowest rate at 82.1%, while RHA D, has the highest at 86.3% with the average rate between RHAs being 84.4%.

Figure 5: % of RHA Population in Bad/Very Bad Health



Source: Healthy Ireland Survey (waves 1-5)

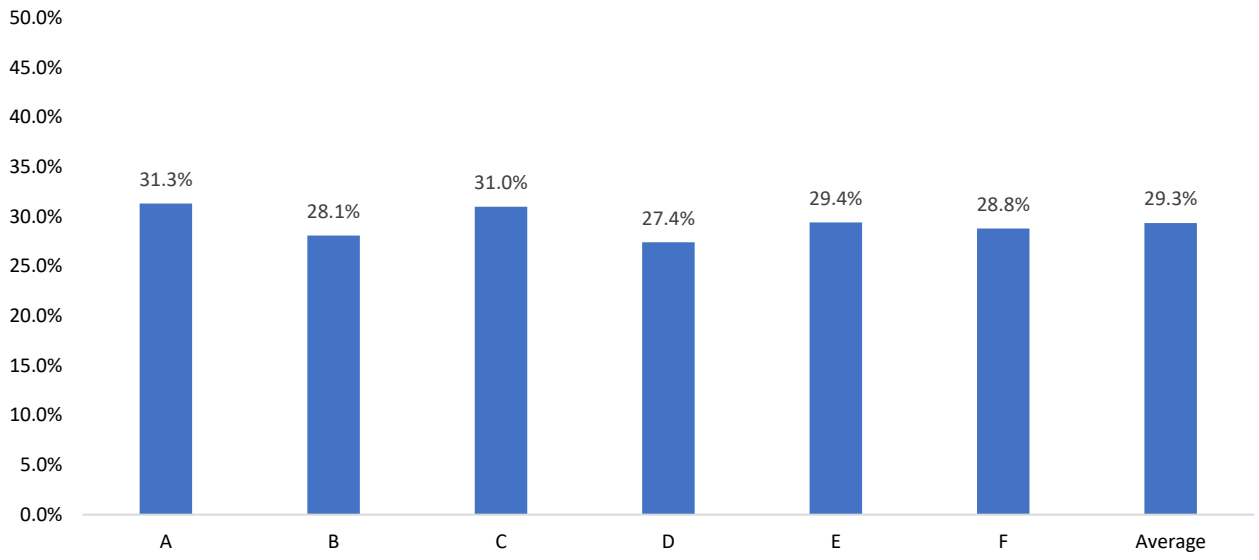
Figure 6: % of RHA Population in Good/Very Good Health



Source: Healthy Ireland Survey (waves 1-5)

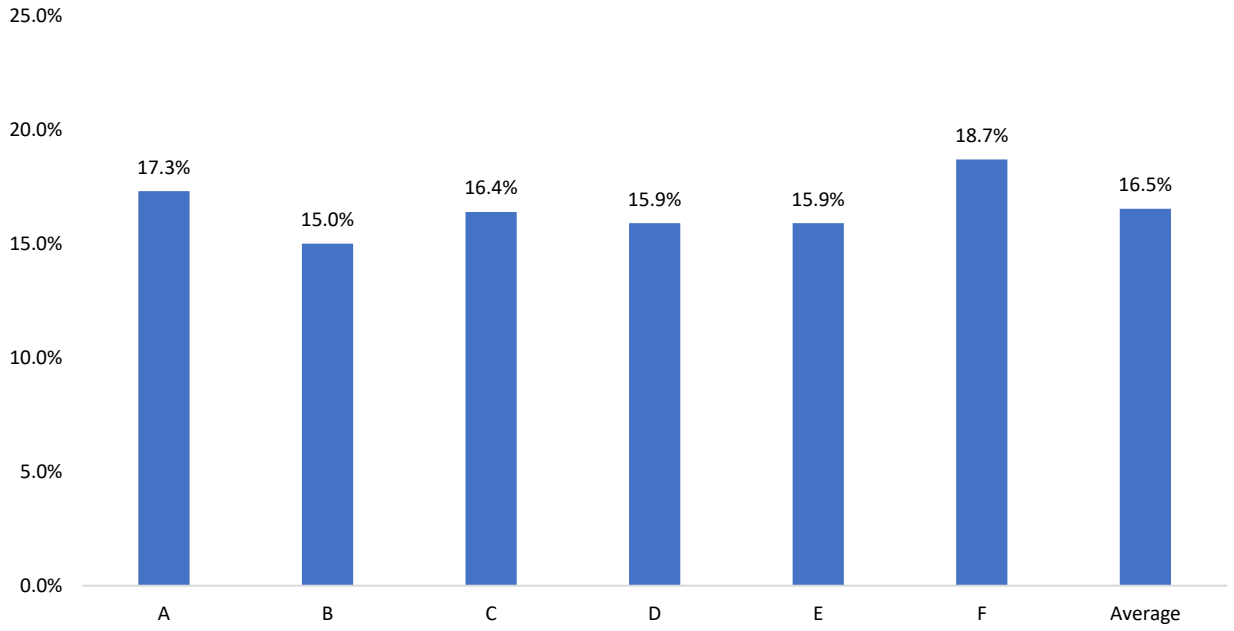
Figure seven shows the percentage of each RHA that has a long-term illness as well as the average rate between RHAs. Here we see that RHA A has the highest rate at 31.3%, while D has the lowest at 27.4%. The average rate between RHAs is 29.3%. With regard to the percentage of each RHA that is defined as being 'limited but not severely' by a long-term illness, Figure eight shows that RHA F is the highest at 18.7%, with RHA B the lowest at 15%. The average rate is 16.5%. Figure nine shows the percentage of each RHA Population that are severely limited by a long-term illness. Here we see that RHA F is the highest at 4.4% with RHA B the lowest at 3.2%. The overall average rate is 3.8%.

Figure 7: % of RHA Population that have a long-term illness



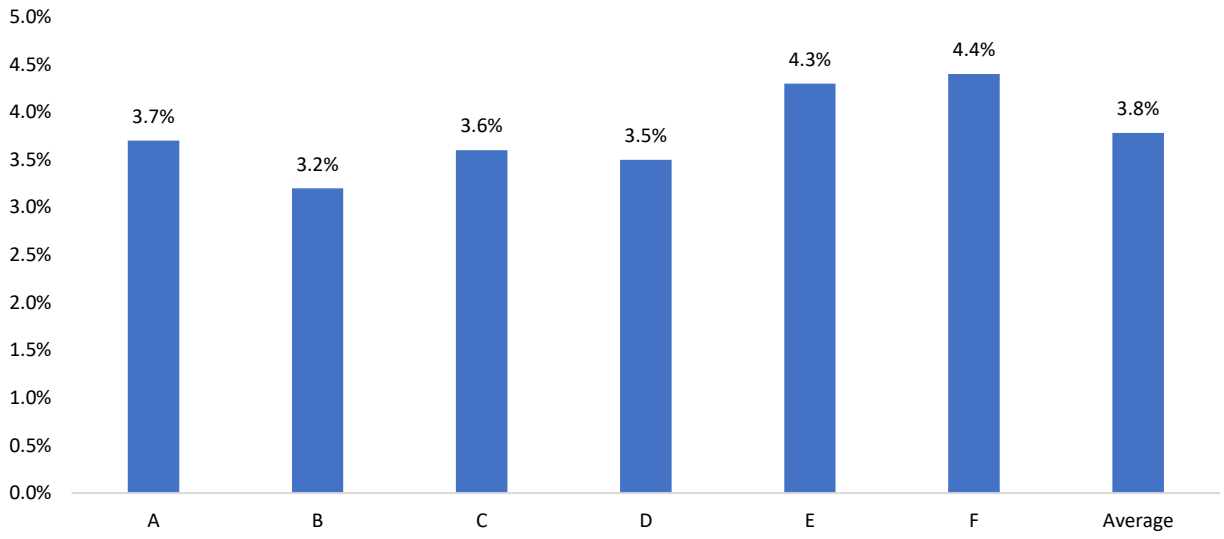
Source: Healthy Ireland Survey (waves 1-5)

Figure 8: % of RHA Population that are limited but not severely by a long-term illness



Source: Healthy Ireland Survey (waves 1-5)

Figure 9: % of RHA Population that are severely limited by a long-term illness

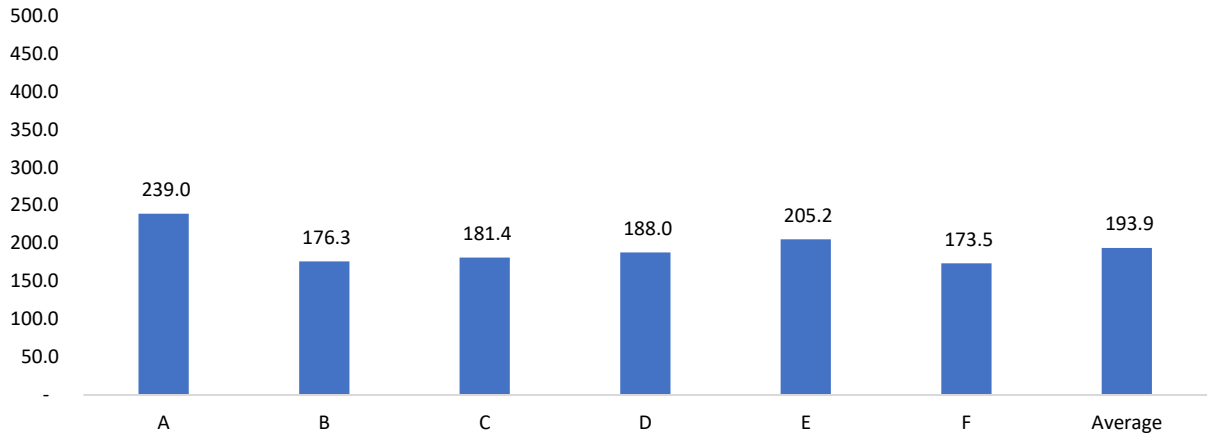


Source: Healthy Ireland Survey (waves 1-5)

Figures 10 to 12 show the age standardised mortality rate per 100,000 by RHA for respiratory diseases, circulatory diseases, and cancer. The age-standardised mortality rate is a weighted average of the age-specific mortality rates per 100,000 persons, where the weights are the proportions of persons in the corresponding age groups of the WHO standard population.[30] Figure 10 shows that with regard to respiratory diseases, RHA A had the highest age standardised rate in 2017 at 239 per 100,000, with RHA F having the lowest at 173.5. The average of all RHAs was 193.9 per 100,000. When looking at the age-standardised mortality rate for diseases of the circulatory system, figure 11 shows that RHA D had the highest rate per 100,000 at 322.8, while RHA B had the lowest at 261.1. The average rate across all RHAs was 293.6 per 100,000. Figure 12 shows the Age-Standardised Mortality Rate with regard to cancers. Here we see that RHA A has the highest rate at 257.4 per 100,000 with RHA B having the lowest at 178.4. The average across all RHAs is 214.8.

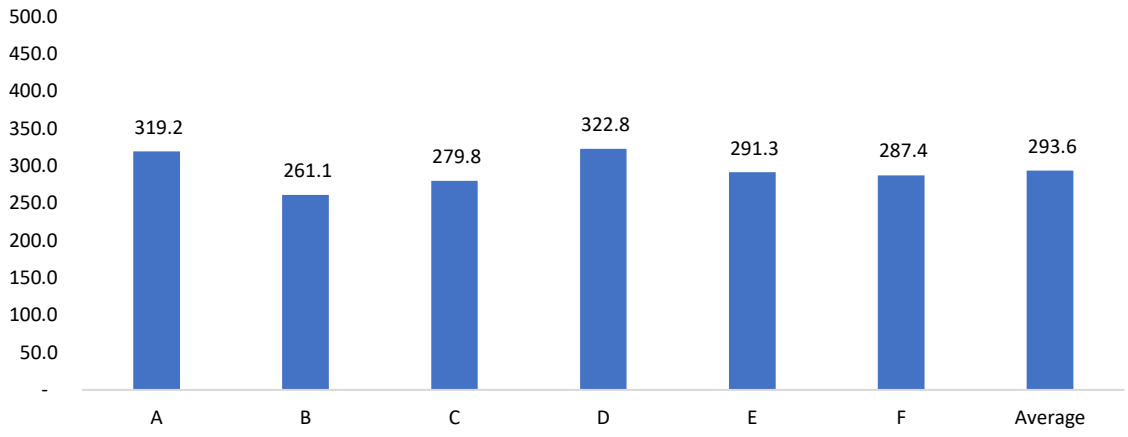
[30] The numbers of deaths per 100,000 population are influenced by the age distribution of the population. Two populations with the same age-specific mortality rates for a particular cause of death will have different overall death rates if the age distributions of their populations are different. Age-standardised mortality rates adjust for differences in the age distribution of the population by applying the observed age-specific mortality rates for each population to a standard population. **https://www.who.int/data/gho/indicator-metadata-registry/imr-details/78#:~:text=The%20age%2Dstandardized%20mortality%20rate,of%20the%20WHO%20standard%20population.**

Figure 10: Age-standardised Mortality Rate Per 100,000 - Respiratory Diseases by RHA, 2017



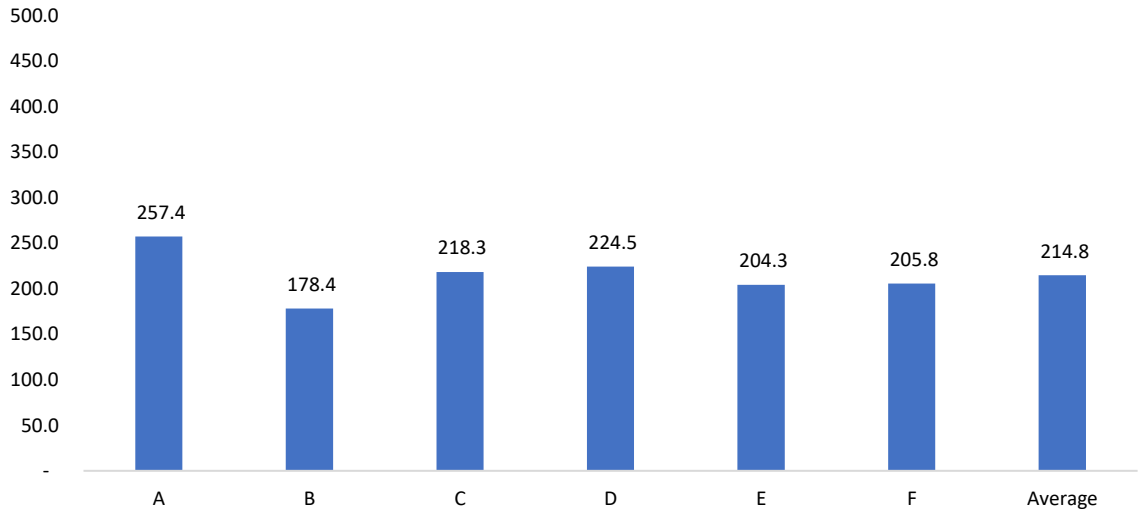
Source: Department of Health

Figure 11 Age-Standardised Mortality Rate per 100,000 - Diseases of the Circulatory System by RHA, 2017



Source: Department of Health

Figure 12: Age-Standardised Mortality Rate per 100,000 - Cancers by RHA, 2017

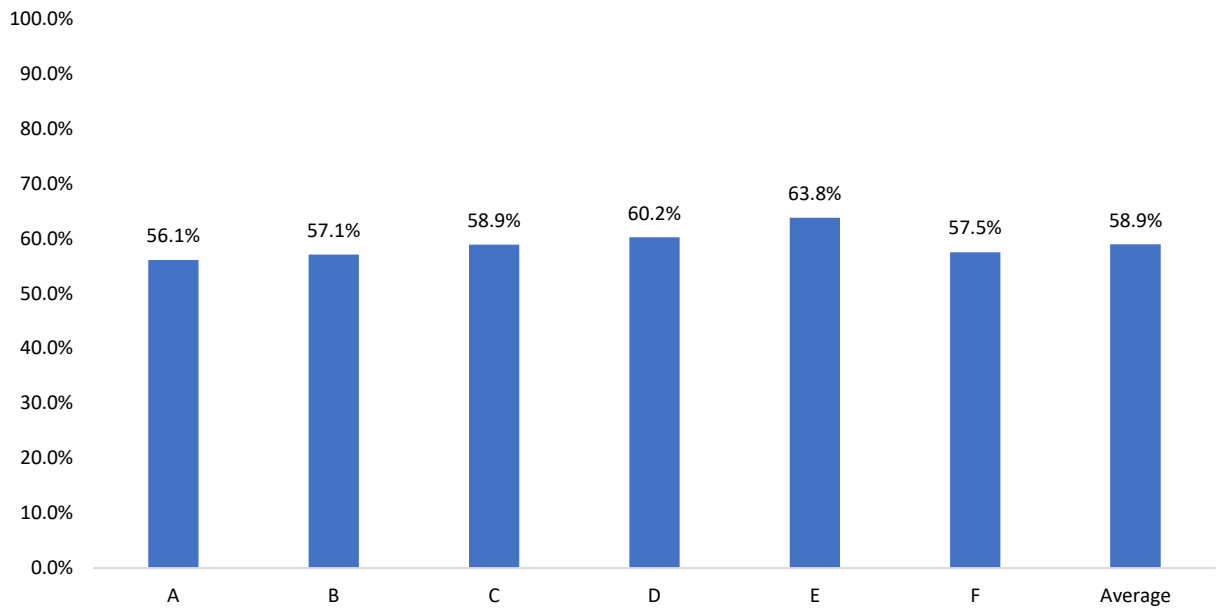


Source: Department of Health

Healthcare Utilisation Indicators

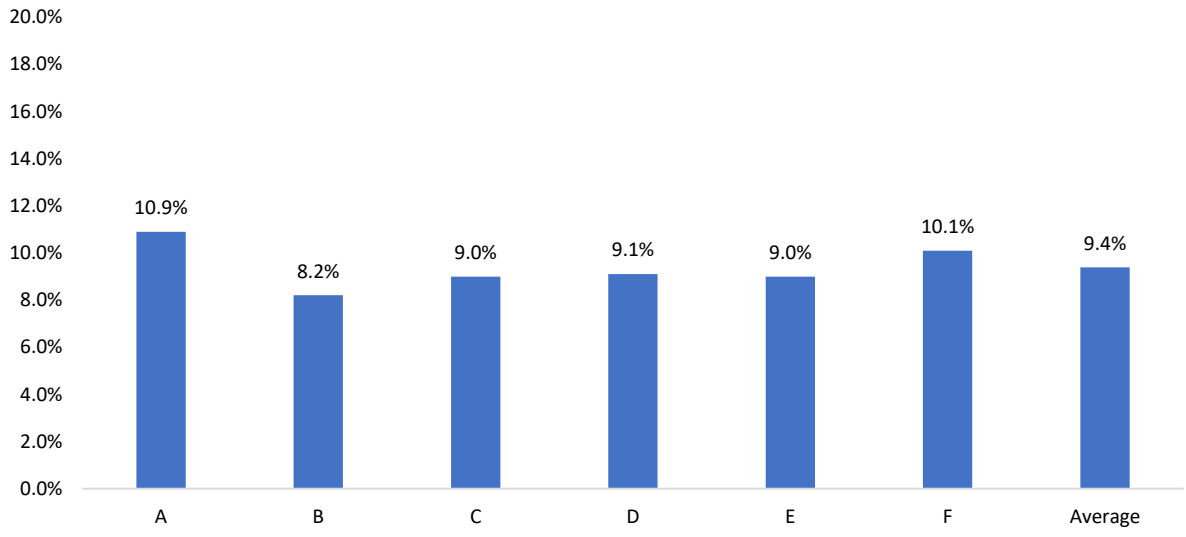
Figures 13 to 16 show results from the pooling of the five waves of the 'Healthy Ireland' Survey 2015 - 2019 with regard to key health care utilisation indicators. Figure 13 shows the percentage of each RHA that has visited a GP in the last 12 months, as well as the average rate between RHAs. As can be seen, RHA E is the highest at 63.8% of the population while RHA A is the lowest at 56.1%. The average rate for RHAs is 58.9%. Figure 14 shows the percentage of each RHA that were admitted to hospital in the last 12 months. RHA A has the highest rate at 10.9%, with RHA B having he lowest at 8.2%. The average rate between RHAs is 9.4%.

Figure 13: % of RHA Population that visited GP in last 12 months



Source: Healthy Ireland Survey (waves 1-5)

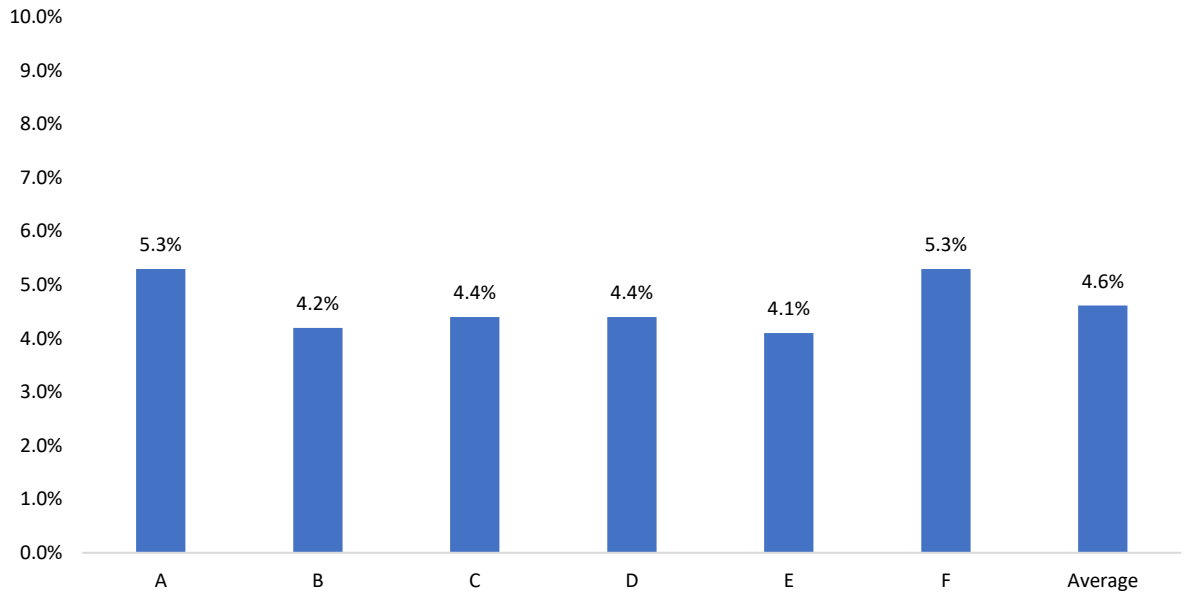
Figure 14: % of RHA Population that were admitted to hospital in the last 12 months



Source: Healthy Ireland Survey (waves 1-5)

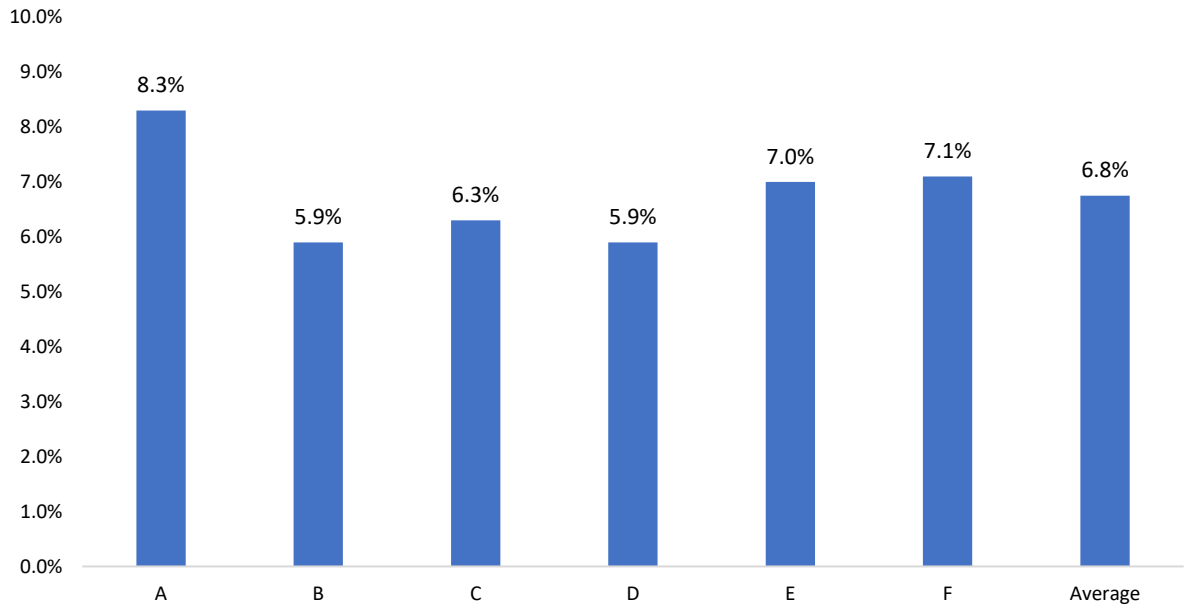
Figure 15 shows the percentage of each RHA Population that were admitted as an inpatient in the last 12 months as well as the average between RHAs. As can be seen, RHA A and RHA F, both have the highest rates of population admitted at 5.3%., with RHA E having the lowest at 4.1%. The average rate is 4.6%. Figure 16 shows the percentage rate of each RHA Population that was admitted as a day patient in the last 12 months. Here we see that RHA A has the highest rate at 8.3% while RHA B and D have the lowest rate at 5.9%. The average rate is 6.8%.

Figure 15: % of RHA Population that were admitted as an inpatient in last 12 months



Source: Healthy Ireland Survey (waves 1-5)

Figure 16: % of RHA Population that were admitted as a day patient in last 12 months

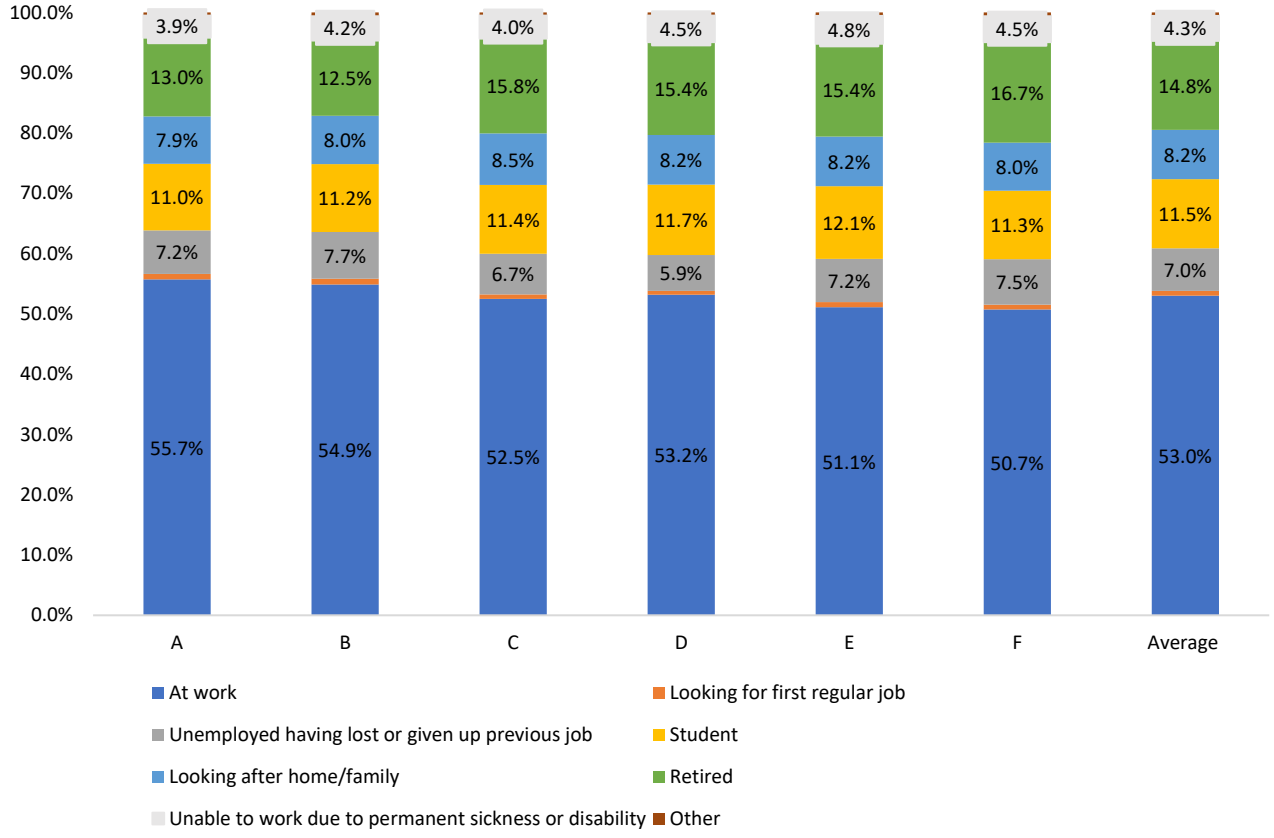


Source: Healthy Ireland Survey (waves 1-5)

Socioeconomic Profiles

Figure 17 shows the principal economic status of those aged 15 and over in each RHA as categorised in the 2016 Census. The average rate of those 'at work' across all RHAs is 53%. This rate is highest in RHA A at 55.7% and lowest in RHA F at 50.7%. The average rate for those 'unemployed having lost or given up their previous job' across all RHAs is 7%. This rate is highest in RHA B at 7.7% and lowest in RHA D at 5.9%. When looking at the rate of those retired across RHAs the average is 14.8%. This rate is highest in RHA F at 16.7% and lowest in RHA B at 12.5%. The average rate of those unable to work due to permanent sickness or disability is 4.3%. This rate is lowest in RHA A at 3.9% and highest in RHA E at 4.8%.

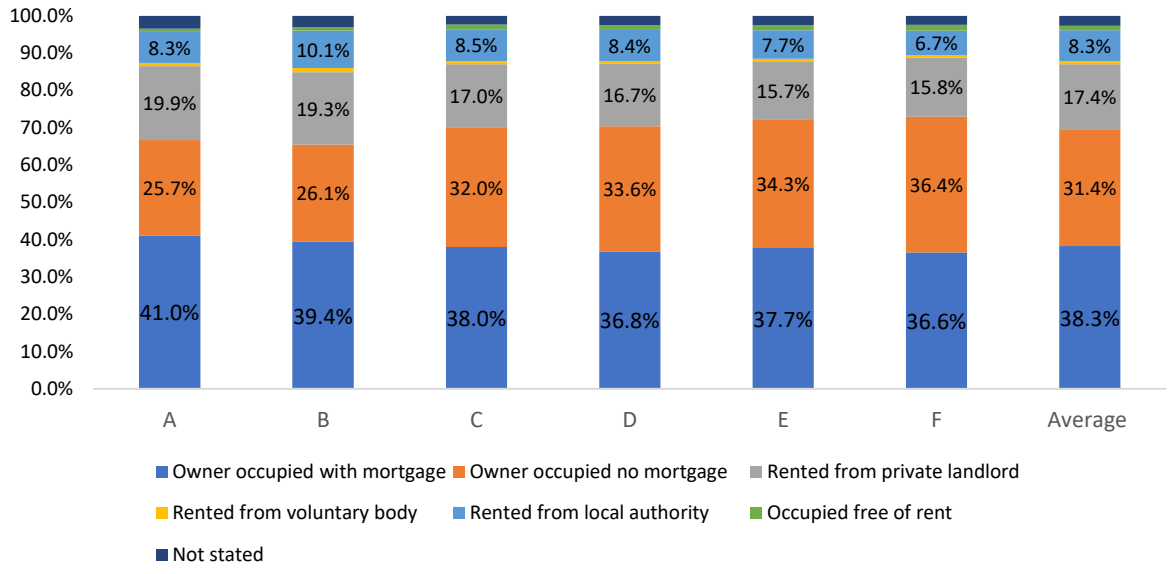
Figure 17: Population aged 15+ years by principal economic status



Source: CSO Census 2016

Figure 18 shows persons by permanent private household by type of occupancy in each RHA. The average rate across all RHAs of those renting from a local authority is 8.3%. This rate is highest in RHA B at 10.1% and lowest in RHA F at 6.7%. With regard to those renting from a private landlord, the average rate across all RHAs is 17.4%. This rate is highest in RHA A at 19.9% and lowest in RHA E at 15.7%. The average rate across all RHAs for those persons who are owner occupiers without a mortgage is 31.4%. This rate is highest in RHA F at 36.4% and lowest in Area A at 25.7%. With regard to those who are owner occupiers with a mortgage, the average rate across all RHAs is 38.3%, with the highest rate seen in Area A at 41% and lowest in Area F at 36.6%.

Figure 18: Persons by permanent private household by type of occupancy

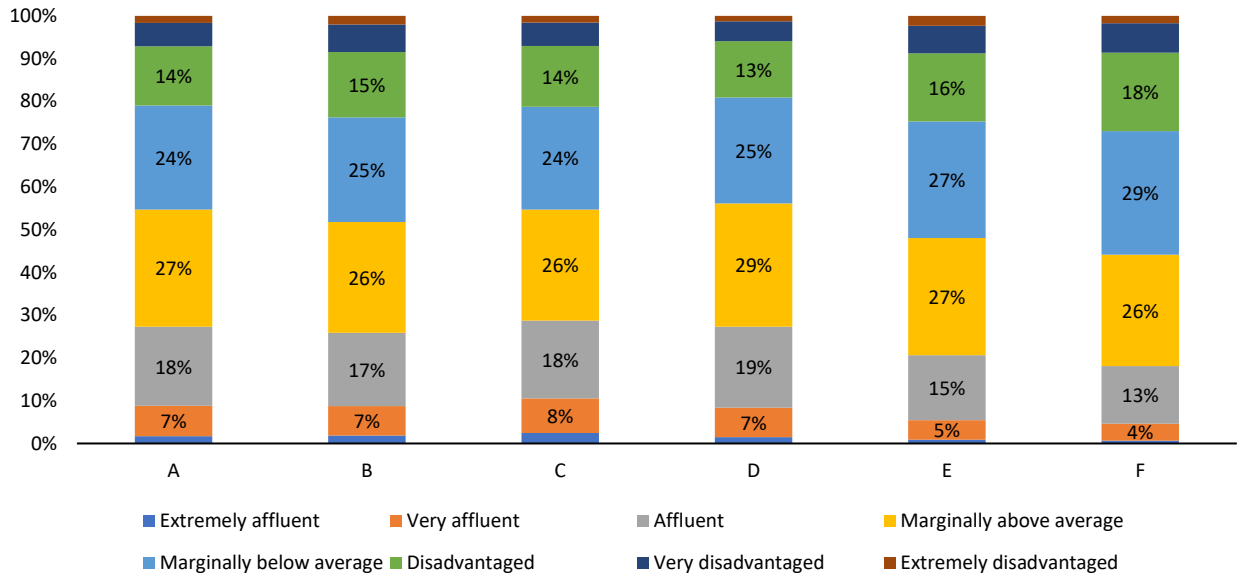


Source: CSO Census 2016

The Pobal HP Deprivation Index was developed by Trutz Haase and Jonathan Pratschke and funded by Pobal. Based on the 'Small Area' statistics in the 2016 Census, the HP Deprivation Index shows the level of overall affluence and deprivation. It uses three dimensions of affluence/disadvantage: Demographic Profile, Social Class Composition, and Labour Market Situation.[31] Figure 19 shows the HP Deprivation Index by RHA using Census 2016. In terms of the rate of the RHA measured as 'Disadvantaged', we see that RHA F has the highest rate at 18%, while RHA D has the lowest at 13%. When looking at the rate of those considered to be 'Affluent', RHA D has the highest rate at 19%, with RHA F having the lowest at 13%.

[31] For detail on the construction of the HP Deprivation Index see Haase & Pratschke (2017) https://www.pobal.ie/app/uploads/2018/06/The-2016-Pobal-HP-Deprivation-Index-Introduction-07.pdf

Figure 19: Deprivation Level HP Index

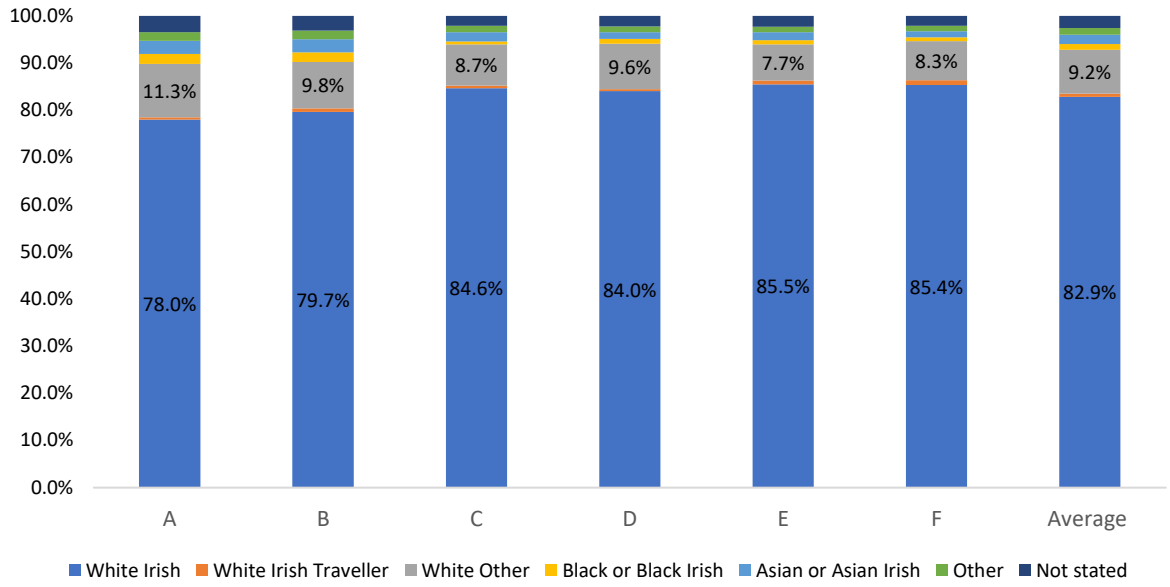


Source: Derived from CSO Census 2016

Ethnicity

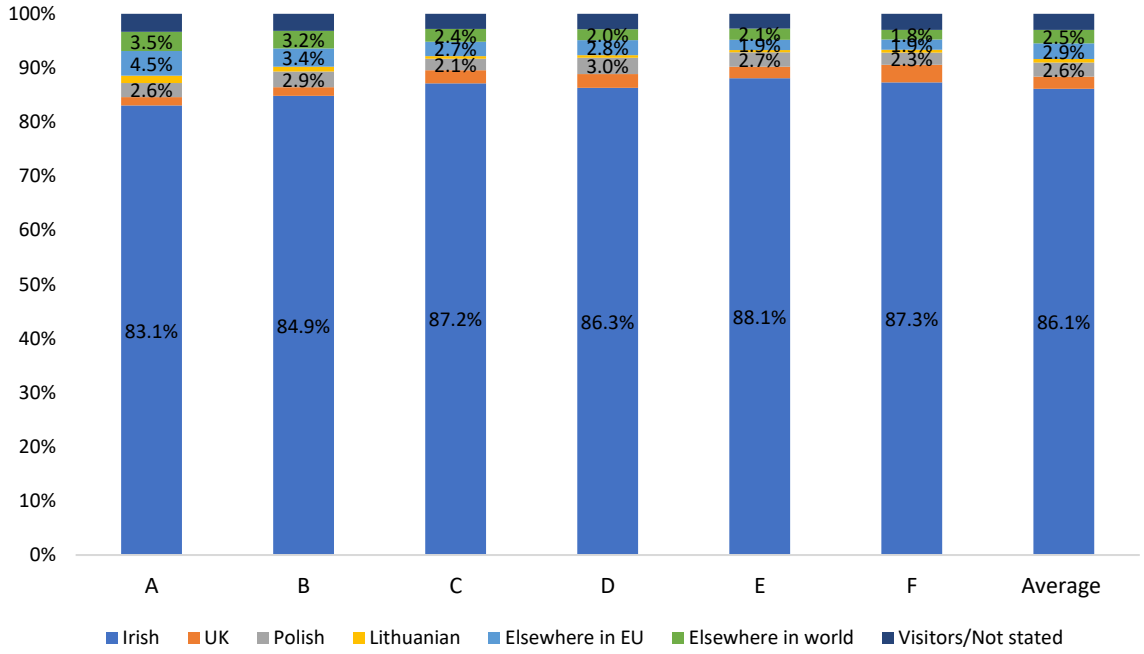
Figure 20 shows the Ethnic and cultural background by RHA in the 2016 Census as well as the average between RHAs. As can be seen, those who identify as 'White Irish' make up the majority of the population of each RHA, averaging 82.9%. RHA E has the highest rate at 85.5%, marginally higher than RHA F at 85.4%, while RHA A has the lowest rate at 78%. The next largest category across RHAs is 'White Other' with an average between the RHAs of 9.2%. RHA A has the highest rate at 11.3% while RHA E have the lowest 7.7%. Those who identify as 'White Irish Traveller' make up 0.7% when averaged across the RHAs, with the highest rate seen in RHA F at 1% and the lowest in RHA D and RHA A, both at 0.5%. Figure 21 shows RHA by Nationality. Here see that those of an Irish nationality make up the majority with an average across RHAs is of 86.1%. RHA E has the highest rate of population in this category at 88.1%, while RHA A has the lowest at 83.1%. The second biggest nationality (as opposed to 'Elsewhere in the EU') is Polish averaging 2.6% across the RHA, with the highest rate in RHA D at 3% and the lowest being RHA C at 2.1%.

Figure 20: Ethnic or cultural background



Source: CSO Census 2016

Figure 21: Nationality

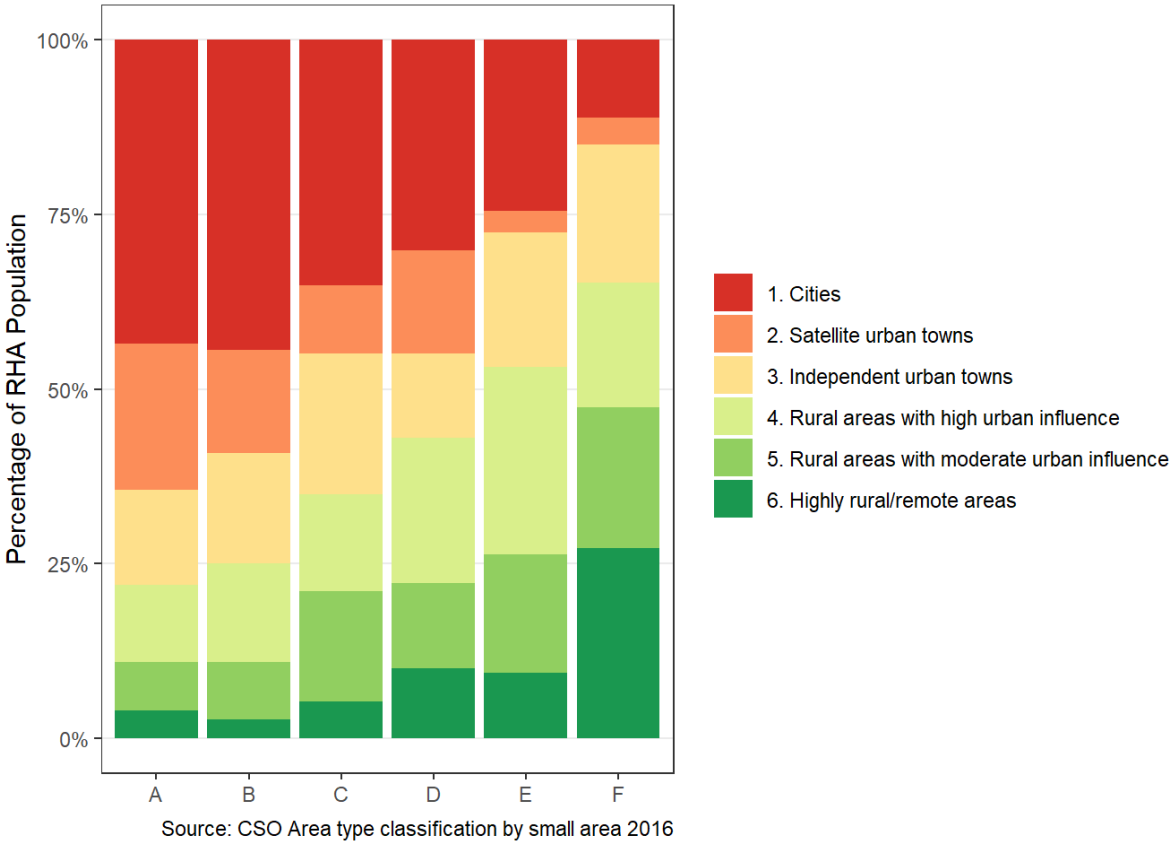


Source: CSO Census 2016

Rurality/ Population Density

As discussed in the paper, rurality is often factored into PBRA models, with funding being provided to cover 'unavoidable excess costs' of providing services in remote/rural areas. Figure 22 shows the rurality and population density of the Regional Health Areas. This is measured as a percentage of the population that live in each Small Area classification type within each Regional Health Area. Overall, rurality is one of the most apparent characteristics in which the RHAs diverge. The graph shows that RHA A and B are the most urbanised regions, with 64% and 59% living in cities or satellite urban towns respectively. This reflects the fact that both RHAs include parts of Dublin and the surrounding commuter belt. In contrast, RHA F is the most rural, with 65% living in 'rural areas' with 27% living in highly rural/remote areas.

Figure 22: % of Each RHA Population That Live in Each Area Type



Conclusion

Population-Based Resource Allocation is a funding model for health planning that seeks to distribute healthcare resources according to population need to promote efficiency and equity in both health outcomes and distribution of resources. The Irish healthcare system is undergoing substantial reform with a commitment to regionalisation and implementation of a PBRA funding model by 2024. This work has sought to build upon the review carried out by Johnston et al., (2021) by focussing more on the practical nature of implementing PRBAs in an Irish context, with consideration given to methodology and data used.

As highlighted in the review, no two PBRA models are the same. However, some common variables, methodology and data were observed. Informed by the findings of the literature review, potential Irish data sources were considered. The CSO Census of Population and the Department of Health's 'Healthy Ireland' Surveys were found to be the most useful and reliable data sources for the purposes of designing a PBRA.

The ability of Ireland to pursue a best practice approach is constrained by the lack of a fit for purpose unique health identifier and the inability to match utilisation and cost to other characteristics of people or groups (e.g., socioeconomic status). However, this paper provides data on the likely drivers of healthcare need in the Irish context. Work is ongoing with regard to estimating relationships between need variables and utilisation/expenditure, given data constraints, in order to inform the development of a PBRA model.

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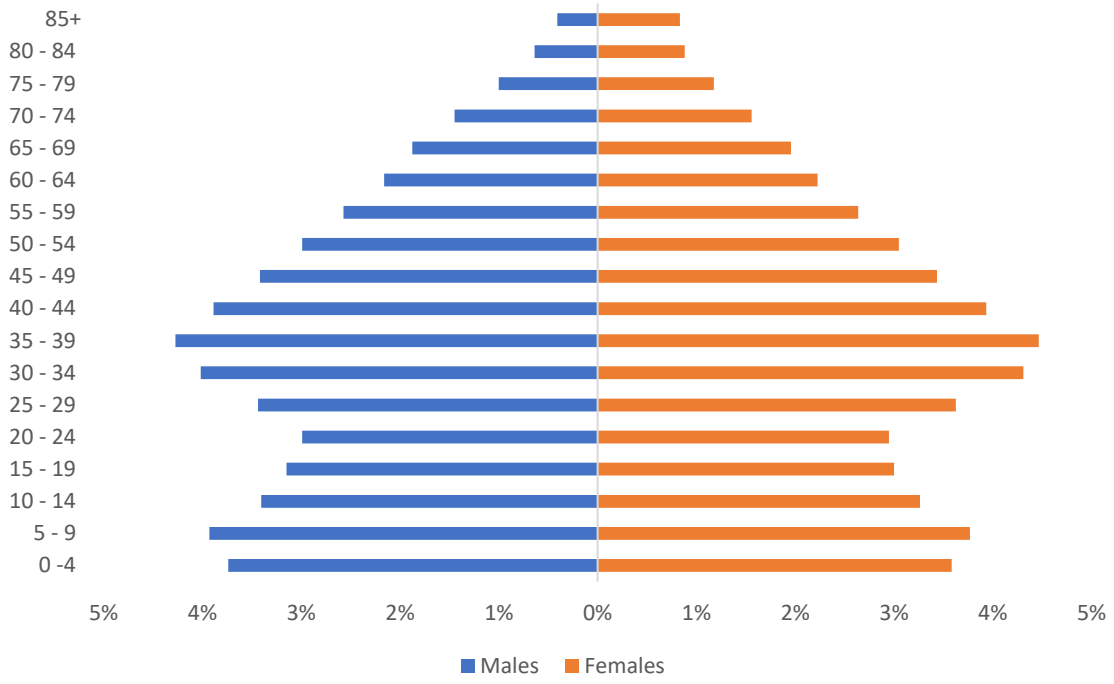
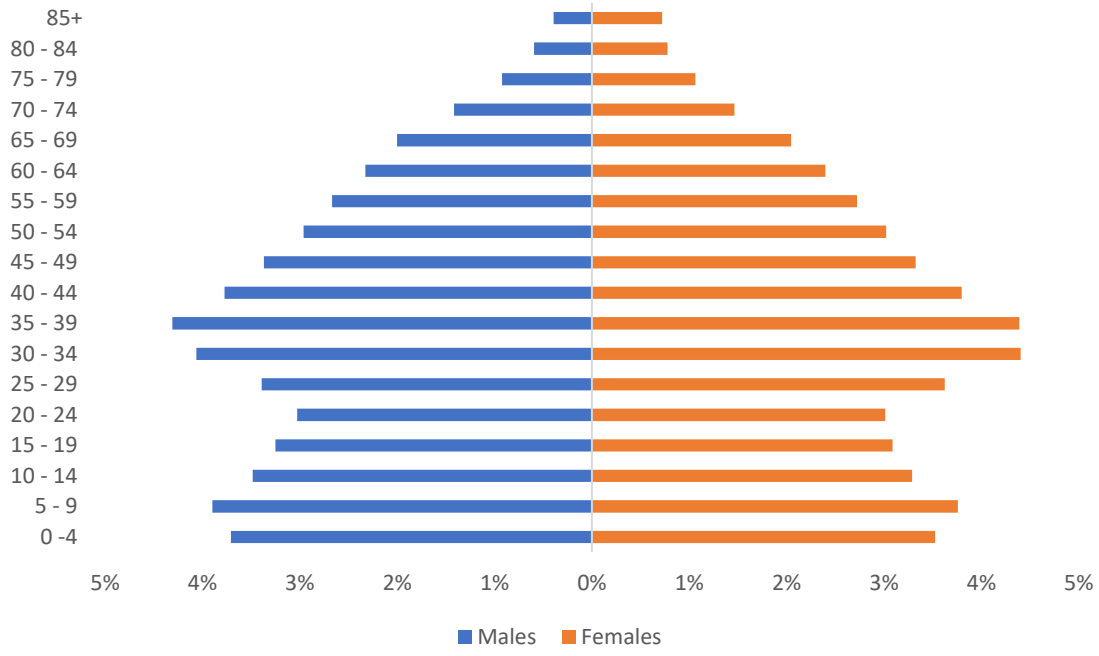
Appendix - Population Pyramids by RHA

Figure 23: Age and Gender - RHA A



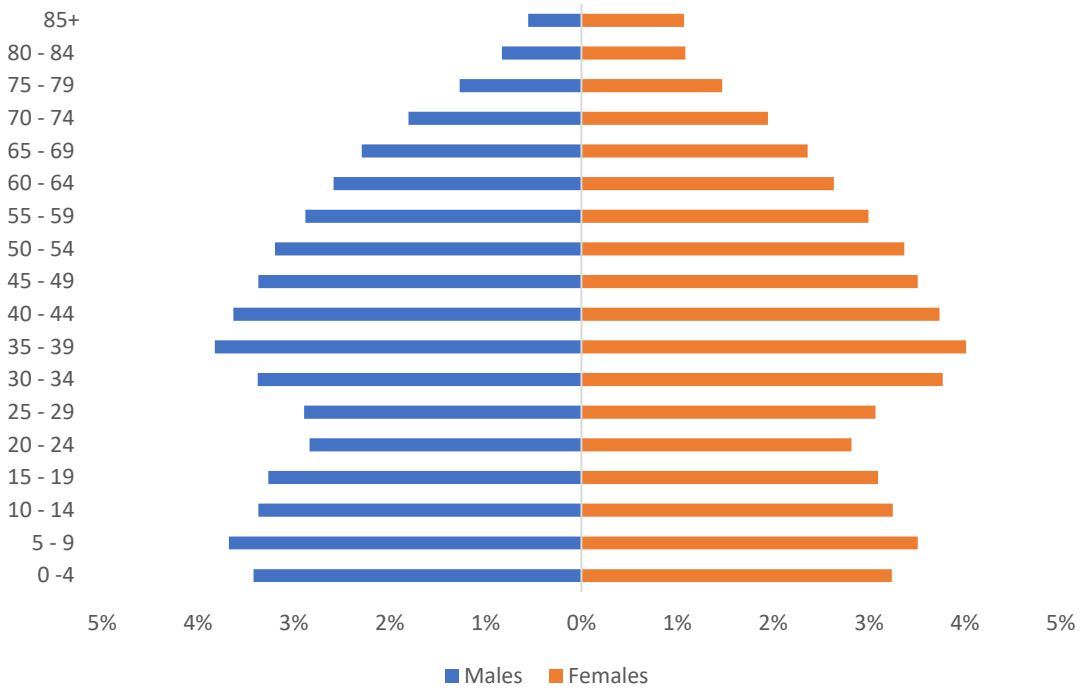
Source: CSO Census 2016

Figure 24: Age and Gender - RHA B



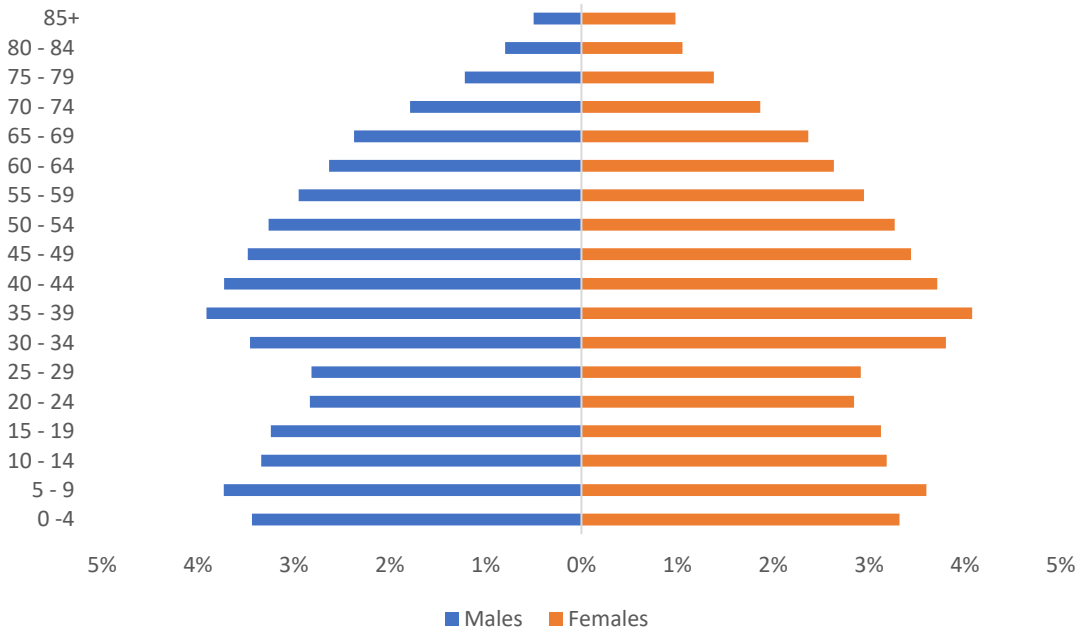
Source: CSO Census 2016

Figure 25: Age and Gender - RHA C



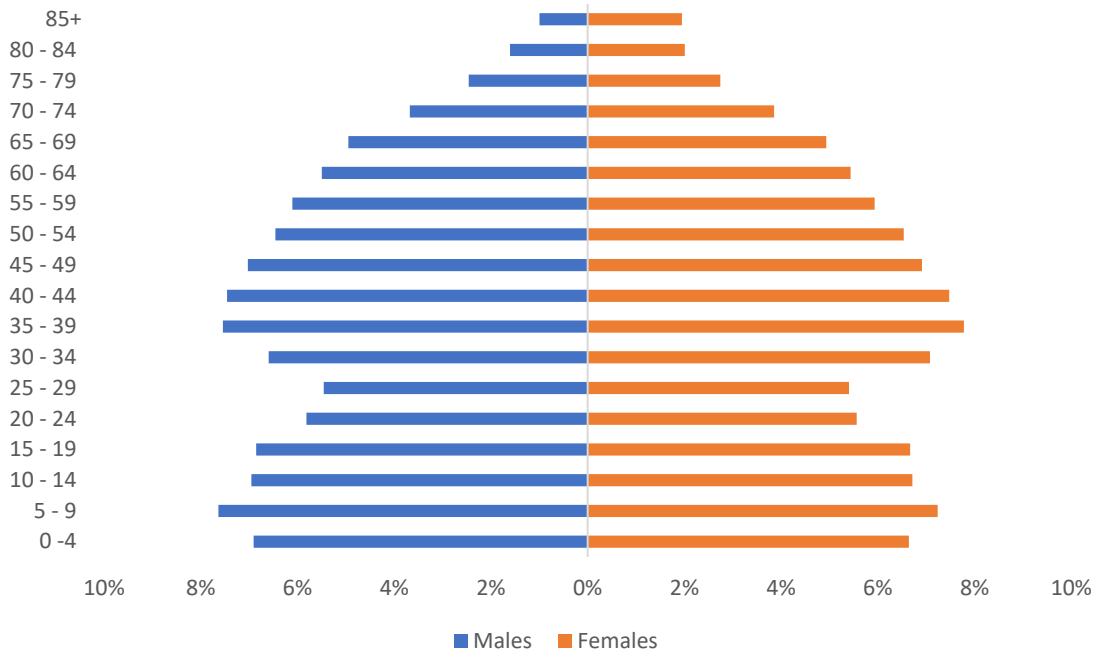
Source: CSO Census 2016

Figure 26: Age and Gender - RHA D



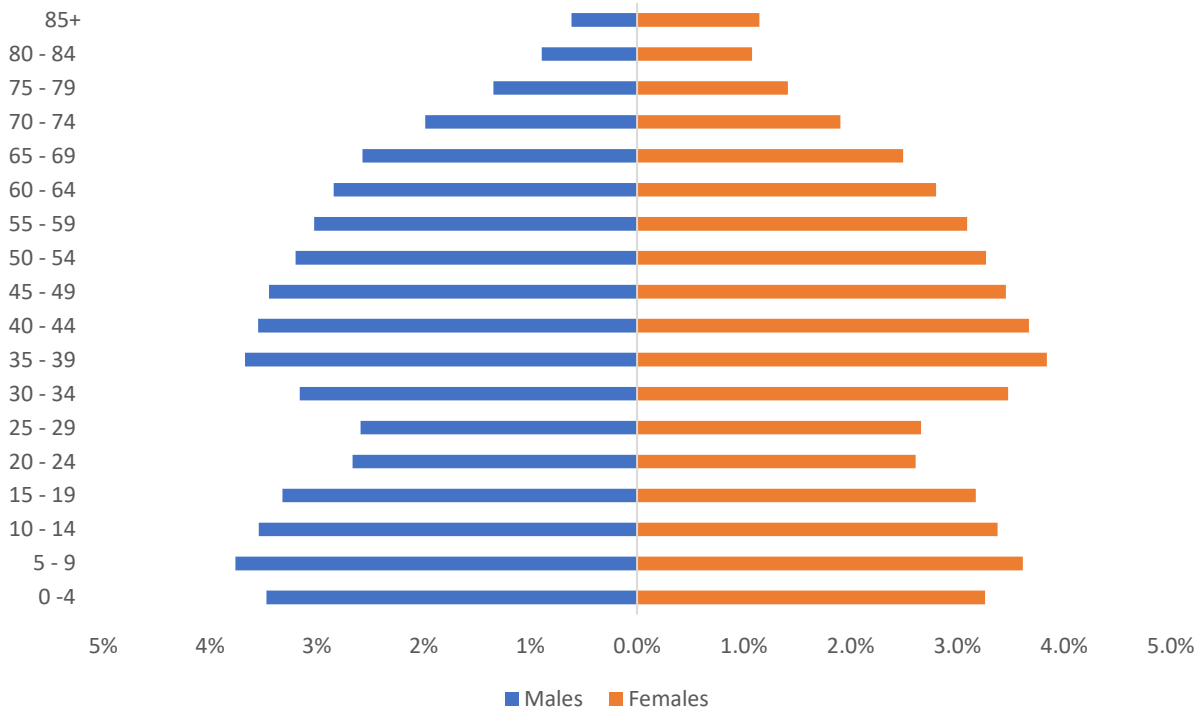
Source: CSO Census 2016

Figure 27: Age and Gender - RHA E



Source: CSO Census 2016

Figure 28: Age and Gender - RHA F



Source: CSO Census 2016

Quality Assurance process

To ensure accuracy and methodological rigour, the author engaged in the following quality assurance process.

- ☑ Internal/Departmental
  - ☑ Line management
  - ☑ Spending Review Steering group
  - ☑ Other divisions/sections

- ☑ External
  - ☑ Other Government Department
  - ☑ Quality Assurance Group (QAG)
  - ☑ External experts