



RESEARCH ARTICLE

Geographic inequalities in non-acute healthcare supply: evidence from Ireland [version 1; peer review: 1 approved, 2 approved with reservations]

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V1 First published: 04 Oct 2021, 4:111
<https://doi.org/10.12688/hrbopenres.13412.1>

Latest published: 04 Oct 2021, 4:111
<https://doi.org/10.12688/hrbopenres.13412.1>

Abstract

Background: Recent reforms in Ireland, as outlined in Sláintecare, the report of the cross-party parliamentary committee on health, are focused on shifting from a hospital-centric system to one where non-acute care plays a more central role. However, these reforms were embarked on in the absence of timely and accurate information about the capacity of non-acute care to take on a more central role in the system. To help address this gap, this paper outlines the most comprehensive analysis to date of geographic inequalities in non-acute care supply in Ireland.

Methods: Data on the supply of 10 non-acute services including primary care, allied health, and care for older people, were collated. Per capita supply for each service is described for 28 counties in Ireland (Tipperary and Dublin divided into North and South), using 2014 supply and population data. To examine inequity in the geographic distribution of services, raw population in each county was adjusted for a range of needs indicators.

Results: The findings show considerable geographic inequalities across counties in the supply of non-acute care. Some counties had low levels of supply of several types of non-acute care. The findings remain largely unchanged after adjusting for need, suggesting that the unequal patterns of supply are also inequitable.

Conclusions: In the context of population changes and the influence of non-need factors, the persistence of historical budgeting in Ireland has led to considerable geographic inequities in non-acute supply, with important lessons for Ireland and for other countries. Such inequities come into sharp relief in the context of COVID-19, where

Open Peer Review

Approval Status

	1	2	3
version 1			
04 Oct 2021	view	view	view

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Any reports and responses or comments on the article can be found at the end of the article.

non-acute supply plays a crucial role in ensuring that acute services are preserved for treating acutely ill patients.

Keywords

geographic inequalities, geographic inequity, non-acute care, primary & community care, historical budgeting, Ireland

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Author roles: **Smith S:** Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Project Administration, Supervision, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing; **Walsh B:** Conceptualization, Formal Analysis, Investigation, Methodology, Project Administration, Supervision, Writing – Review & Editing; **Wren MA:** Conceptualization, Methodology, Project Administration, Supervision, Writing – Review & Editing; **Barron S:** Data Curation, Formal Analysis, Methodology, Writing – Review & Editing; **Morgenroth E:** Data Curation, Writing – Review & Editing; **Eighan J:** Data Curation, Formal Analysis, Methodology, Writing – Review & Editing; **Lyons S:** Methodology, Visualization, Writing – Review & Editing

Competing interests: No competing interests were disclosed.

Grant information: Health Research Board Ireland [HRA-HSR-2014-659].

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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How to cite this article: Smith S, Walsh B, Wren MA *et al.* **Geographic inequalities in non-acute healthcare supply: evidence from Ireland [version 1; peer review: 1 approved, 2 approved with reservations]** HRB Open Research 2021, 4:111 <https://doi.org/10.12688/hrbopenres.13412.1>

First published: 04 Oct 2021, 4:111 <https://doi.org/10.12688/hrbopenres.13412.1>

Introduction

Integration is at the centre of global health strategies to achieve people-centred health services^{1,2}. One of the key goals outlined in global and European strategies to improve integration is the need to move away from hospital- and disease-based curative care models, towards services that prioritise primary and community care services and the ‘co-production’ of health^{1, p7,3}. In Ireland, integration forms a central part of recent reforms endorsed by the cross-party parliamentary committee on health⁴. Burke *et al.*⁵ summarise the key aims of the “Sláintecare” strategy: to establish a universal, single-tier health service where patients are treated solely on the basis of need, and a “reorienting of the health system ‘towards integrated primary and community care consistent with the highest quality of patient safety’”^{5: p1278}. However, these reforms have been embarked on in the absence of timely and accurate information about the capacity of primary and community care (summarised as ‘non-acute care’) to take on a more central role in the system. While Sláintecare acknowledges the importance of increasing non-acute workforce capacity, up to now there has been no systematic analysis of the patterns of supply of these services across the country. To help address this gap, this paper outlines the most comprehensive analysis to date of geographic inequalities (and inequities) in non-acute care supply in Ireland.

The Irish healthcare system provides an important example of a system that was traditionally ‘hospital-centric’⁶, and the lower priority paid to non-acute services is evidenced by the absence of any national dataset detailing the number, location and catchment areas for non-acute services. Rather, several disparate data sources provide some information on the supply of publicly provided, and very limited information on the supply of private, non-acute services. This has made it difficult to characterise the current supply of non-acute care and to undertake the research needed to help improve health policy.

Ireland also provides an example of a healthcare system where widespread historical budgeting persists. The absence of data has hindered the development of a formal population-based resource allocation formula for non-acute care⁷, another goal in the current reforms⁸. Many countries have adopted population-based resource allocation models to allocate supply in line with population health need characteristics (e.g., England⁹). There are examples of resource allocation formulae in Ireland for specific services (e.g., activity-based funding in acute care). However, historical budgeting persists in non-acute care⁸, and resource allocations are unlikely to have kept pace with changing population needs and demographic patterns across the country, and there is anecdotal evidence of geographic inequalities in supply⁴.

Background: measuring geographic equity in healthcare supply

Access to healthcare is a broad concept that encompasses availability and accessibility, affordability, and acceptability of services, and the degree of fit between individuals and these different dimensions^{10–12}. Many empirical studies on access focus on one aspect of this multifaceted concept, and there is a large

body of work that interprets access as a supply concept (the focus of this paper), concentrating on geographic availability of services using provider–population ratios^{11,13–16}. For example, UK researchers used this approach to examine the geographic distribution of general practitioners (GPs) from the mid-1970s to the 2000s, with modifications to the supply ratios to take account of geographic variations in healthcare needs^{14–17}. We use supply ratios to examine geographic patterns of supply of non-acute services in Ireland, drawing on the methods used in the UK to adjust for healthcare needs.

Simple comparisons of supply-to-population ratios across different geographic regions provide a good indication of patterns of geographic inequality. This is the most common way in which geography is used in assessing equality and/or equity in healthcare access¹⁸, allowing international organisations (e.g., Eurostat) to undertake cross-country comparisons of health and social care supply. Supply ratios are useful for broad comparisons of supply across large areas, and are used by policymakers to set minimal standards of supply and to identify underserved areas¹⁹.

Other studies have focused on what has been referred to as spatial accessibility¹⁹. These studies involve models (e.g., Two-step floating catchment area, 2SFCA) that move beyond simple provider–population ratios to incorporate both healthcare availability (i.e., level of supply) and accessibility (i.e., distance/time between patient location and healthcare facility). The 2SFCA method and other related techniques have been applied to a wide range of countries and healthcare services: for example, variations in geographic accessibility of different aspects of primary care in Wales²⁰, Texas, US²¹, Ontario, Canada²², and ambulatory and inpatient services in Germany²³. Analysis of spatial accessibility in healthcare in Ireland has been focused on GPs and long-term residential care (LTRC)^{24–27} but extending this type of analysis to other non-acute healthcare services is hindered by the absence of adequately geocoded data.

This paper makes four core contributions to the literature for healthcare policymakers. First, the analysis demonstrates how the persistence of historic budgeting can lead to considerable inequities in supply of non-acute care. Second, in the absence of detailed geocoded data, simple provider-to-population ratios, with adjustments for healthcare need factors, can be used to give a comprehensive description of non-acute care in a country, and identify notable regional patterns. Third, while localised decision-making facilitates better matching of supply with local demand, the Irish experience underlines the importance of appropriate data and guidance from the national level to help address any geographic imbalances in supply. Fourth, the analysis highlights important regions requiring attention from Irish policymakers undertaking comprehensive healthcare reforms.

Institutional context

Healthcare organisation in Ireland has undergone several changes in the past 15 years, with implications for how local

non-acute care services are allocated. The nationally based Health Service Executive (HSE) replaced (in 2005) 11 former regional Health Boards that had considerable autonomy in developing local services, with local political representation on the boards. The HSE replaced an older system comprised of local services that had developed in different ways²⁸. Since 2005, the HSE has overseen numerous changes in the organisation of local non-acute services from 32 Local Health Offices (LHOs), to 17 Integrated Service Areas (never fully implemented), to nine Community Health Organisations (CHOs), comprising 96 Community Health Networks (CHNs). CHNs cover an average population of 50,000 and provide the structure for integrating primary and social care. In 2019, six Regional Health Areas (RHAs) were proposed, merging hospital groups with CHOs to ensure integration across acute and non-acute care, with each RHA having its own budget and greater autonomy at local level²⁹. We examined the 10 most central non-acute healthcare services in Ireland³⁰, representative of the key professions that make up CHNs.

The extent of healthcare affordability for patients is an important element in facilitating access to healthcare. Ireland is unusual amongst other high-income European countries because it does not offer universal access to primary care⁵ and there is a lack of clarity around entitlement to other non-acute care⁴. For GP care, approximately 33% of the population have a Medical Card (MC) which covers free GP visits (and cover for other primary care and acute care including prescription medicines³¹). A further 11% have a GP Visit Card (GPVC) that covers free GP care only³². MCs are granted mainly on the basis of an income-based means test but some are also granted on a discretionary basis to patients with health needs for whom paying for healthcare would cause 'undue financial hardship'³¹. Since 2015, GPVCs are available for children under six years of age and adults aged 70+. The rest of the population pays out-of-pocket for GP care (average €52.50 per visit³³). More than 40% of the population have supplementary private health insurance which mainly covers acute care³⁴. For other non-acute care, it is acknowledged that there is 'huge variety' in access 'depending on geographic location and existing supply in that area', and in practice priority is often given to MC holders⁴: p45,35. This paper provides a more rigorous analysis of available data to move beyond this anecdotal understanding of variable access to non-acute care services in Ireland.

Methods

Geographic setting

There are 26 administrative counties in the Republic of Ireland, ranging in population size from 0.32m (Leitrim) to 1.35m (Dublin), with a total population of 4.8 million people³⁶. Ireland has a low population density, with a large dispersed rural population. Per capita non-acute supply is described for 28 counties (Tipperary and Dublin are divided into North and South) using 2014 ESRI population estimates (described in detail in previous applications^{37,38}). This level of aggregation has the advantage that counties are stable across time (aligning well with, but independent of, potentially changing HSE administrative structures) and reflect definitions of catchment areas for non-acute services, which are designed to be community-based services serving clients in their immediate locality.

Supply and needs data

This paper draws on several data sources on the supply of 10 mainly publicly employed non-acute services, including private supply where available:

General practitioners: GPs in Ireland are self-employed private practitioners. A large proportion hold a state General Medical Services (GMS) contract to provide GP care that is free at the point of use to MC and GPVC holders^{39,40}. Data on GP supply are based on extracts from the Irish College of General Practitioners database and the Irish Medical Directory in September 2014^{24,41}. GPs in training (668) were not included due to a lack of information on location and whole-time equivalent (WTE) activity⁴². Headcounts were converted to WTEs using recent survey data on self-reported full-time/part-time practices, disaggregated by sex, by a representative sample of GPs in Ireland⁴³.

Community nurses (CNs) and allied health professionals: the HSE employs community nurses (Public Health Nurses (PHNs) and community Registered General Nurses) to provide a wide range of non-acute services to individuals within a geographic area^{44,45} in health centres and in individuals' homes. Allied health professionals including physiotherapists, occupational therapists, speech and language therapists and others (podiatrists & chiropodists, counsellors & psychologists, social workers) deliver services in health centres or individuals' homes. These can include private as well as publicly employed professionals. Data on the WTE supply (by grade, LHO, agency) of publicly employed community nurses and allied health professionals were obtained from the Health Service Personnel Census (HSPC), December 2014⁴⁶.

Private physiotherapists: data on private and state-subsidised voluntary physiotherapists were taken from the register of members of the Irish Society of Chartered Physiotherapists (ISCP). WTEs were estimated using data from an online survey of ISCP members, as previously described⁴⁷.

Care for older people: home carers provide domestic support and more intensive care where needed, to older people in their own home. Approximately 75% of formal home care is publicly financed and provided by a mix of state-run, not-for-profit, and for-profit organisations³⁰. LTRC is mainly provided in private nursing homes although the majority of care is publicly financed³⁰. Data on the number of publicly financed home care hours provided under the two home care schemes running in 2014 (Home Help and Home Care Package schemes) were obtained from the HSE. The 2015 data on the supply of LTRC beds were based on combined datasets maintained by the Health Information and Quality Authority (HIQA) (responsible for regulation in long-term care), and the Department of Health (DOH).

Needs data: To adjust county populations for need, data on the population aged 65+ and 85+ were available in the 2014 ESRI population estimates; data from the Central Statistics Office (CSO) were used to estimate mortality and disability rates by county; data on the number of people with MCs and GPVCs

by LHO were provided by the Primary Care Reimbursement Service (PCRS); and data from the PCRS and the Department of Pharmacology and Therapeutics, Trinity Centre for Health Sciences in St. James's Hospital, Dublin were used to estimate chronic illness levels amongst MC holders.

Methods

Supply data were assigned to counties based on address (e.g., a GP surgery, a nursing home), using boundary files for counties provided by the CSO. Where the address was unavailable and the supply data were assigned to aggregate areas that cross county borders (e.g., some LHOs), the supply data (e.g., number of nurses) were redistributed from the aggregate areas to counties based on share of population. The population in each LHO disaggregated by county was received from the Health Intelligence Unit of the HSE. Data on MC and GPVC numbers by LHO were assigned to counties in the same way.

Metrics presented: supply per capita, location quotients (ratio of area supply per capita to national supply per capita^{17,18}), and Gini coefficients were estimated. Supply was measured in terms of WTEs for personnel (GPs, community nurses, etc), beds for LTRC, and hours for home care supply.

Needs adjustment: to examine potential sources of inequity in the geographic distribution of non-acute services, the raw population in each county was adjusted for each of the following needs indicators independently: age (65+ and 85+), mortality, disability, MC status and a measure of morbidity among MC holders. The choice of indicators can be categorised using Andersen's Behavioural Model of Health Services Use¹² and

include predisposing characteristics (i.e., age), need (i.e., mortality, disability, chronic illness levels) and enabling factors (i.e., MC coverage). For ease of presentation these are collectively referred to as 'needs' indicators. The needs adjustment methods are based on analysis of GP distribution in the UK¹⁴⁻¹⁶. The general approach involved adjusting the population in each study area by a specific need indicator, and then re-calculating the ratios of supply per capita on the basis of the adjusted population (e.g., number of GPs per person with disability in each area). A range of needs adjustments were applied, reflecting the complexity of, and the challenges in measuring healthcare need⁴⁸.

Results

Inequality in supply

Table 1 shows national average supply per capita, together with the Gini coefficient, for each of the 10 non-acute services in Ireland in 2014, prior to adjustment for need. The Gini coefficient ranges from 0.091 for LTRC to 0.615 for publicly employed podiatrists and chiropodists, indicating substantial geographic inequality in non-acute supply, but also that the degree of inequality varies across the services.

Figure 1 presents the distribution of each of the non-acute services by county, detailing the variability in supply across counties and the variability in the shape of the distributions across services.

Figure 1a also shows that there are some counties with consistently low levels of per capita supply for many of the services. Table 2 provides further detail on this aspect. For each non-acute

Table 1. Supply of non-acute care, Ireland, 2014.

	Non-Acute Primary and Community Care (WTEs)							Care for Older People		
	GP	PHN/CN	PT ¹	OT	SLT	P&C	CO&PSY	SW	LTRC ² Beds	Home Care Hours ²
Ireland: national supply:										
Supply per 10,000 population	5.7	5.4	3.6	2.2	1.5	0.1	1.8	1.5	49.8	24.1
Gini coefficient	0.096	0.125	0.116	0.171	0.12	0.615	0.168	0.214	0.091	0.101

Key: GP: General Practitioner (private practitioners)
 PHN/CN: Public Health Nurse/Community Registered General Nurse (publicly employed)
 PT: Physiotherapist (publicly employed and private practitioners)
 OT: Occupational Therapist (publicly employed)
 SLT: Speech & Language Therapist (publicly employed)
 P&C: Podiatrists & Chiropodists (publicly employed)
 CO&PSY: Counsellors & Psychologists (publicly employed)
 SW: Social Worker (publicly employed)
 LTRC: Long-term Residential Care (public and private)

Sources: Secondary data collated by the authors, see Data & Methods

Notes: 1. Physiotherapy supply includes public and private supply

2. Supply of long-term residential care beds per 1,000 population aged 65+; supply of home care hours per population aged 65+

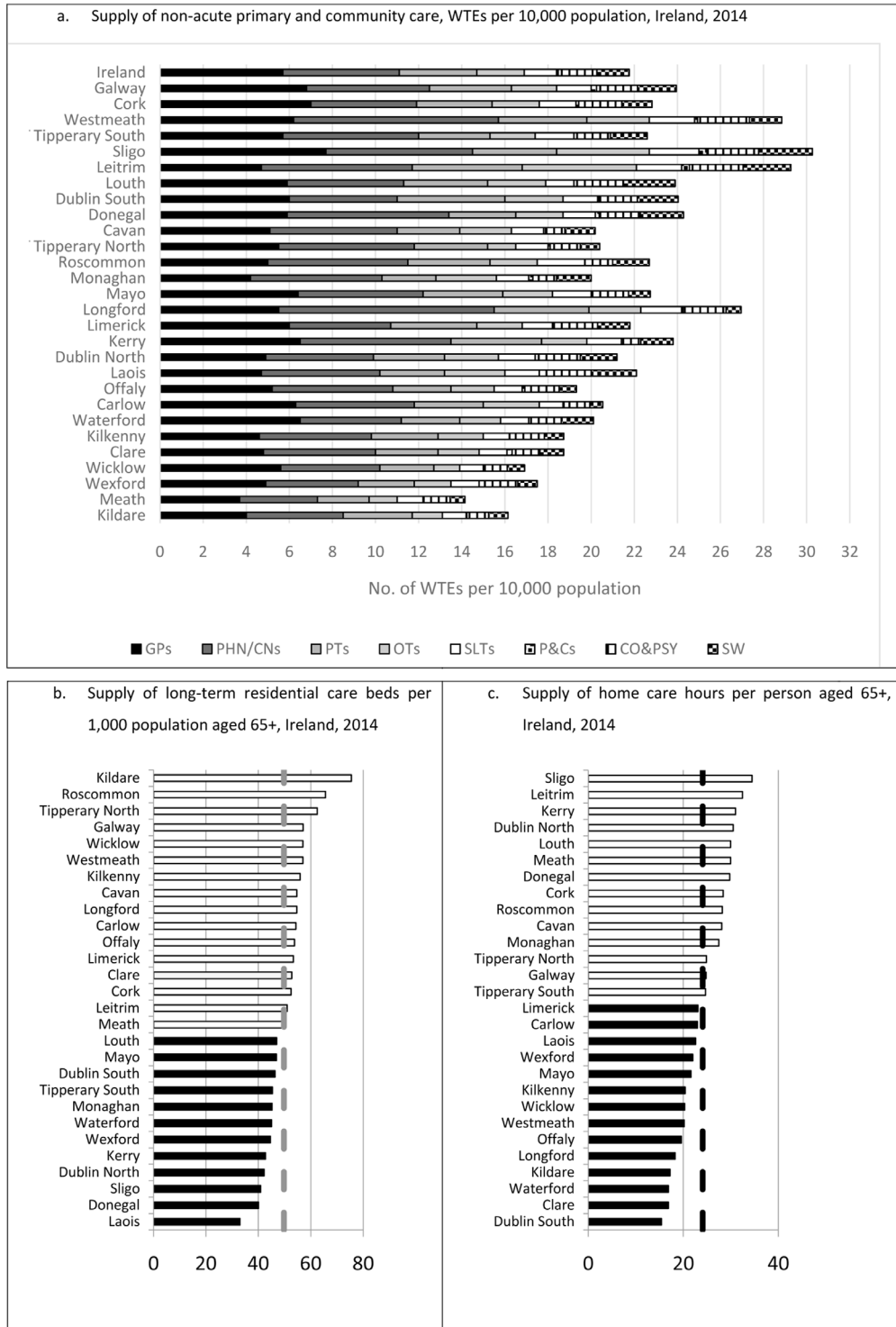


Figure 1. Estimated supply of non-acute care, Ireland, 2014.

Table 2. Supply of non-acute healthcare services, relative to the national average per capita supply (unadjusted population) in Ireland by county, 2014.

	Non-Acute Primary and Community Care								Care for Older People		Number of Services >10 per cent below
	GP	PHN/CN	PT ¹	OT	SLT	P&C	CO&PSY	SW	LTRC ²	HCH ²	
Kildare	●	●	●	●	●	●	●	●	○	●	9
Meath	●	●	●	●	●	●	●	●	●	○	8
Wexford	●	●	●	●	●	●	●	●	●	●	8
Wicklow	●	●	●	●	●	●	●	●	○	●	8
Clare	●	●	●	●	●	○	●	●	●	●	7
Kilkenny	●	●	●	●	●	●	●	●	○	●	7
Waterford	○	●	●	●	●	●	●	●	●	●	7
Offaly	●	●	●	●	●	○	●	●	●	●	5
Carlow	○	●	●	○	●	●	●	●	●	●	5
Laois	●	●	●	○	●	●	○	○	●	●	4
Limerick	●	●	○	●	●	●	○	●	●	●	3
Mayo	○	●	●	●	○	●	●	●	●	●	3
Tipperary North	●	○	●	●	●	○	●	●	○	●	3
Dublin North	●	●	●	○	●	●	○	○	●	○	3
Kerry	○	○	○	●	●	●	●	●	●	○	3
Monaghan	●	○	●	○	●	○	●	●	●	○	3
Longford	●	○	○	●	○	●	○	●	○	●	3
Roscommon	●	○	●	●	○	●	●	○	○	○	3
Dublin South	●	●	○	○	●	●	●	○	●	●	2
Cavan	●	○	●	●	●	○	●	●	○	○	2
Louth	●	●	●	○	●	●	○	○	●	○	2
Donegal	●	○	●	●	●	○	○	○	●	○	2
Tipperary South	●	○	●	●	○	●	●	○	●	●	1
Westmeath	●	○	○	○	○	○	○	●	○	●	1
Leitrim	●	○	○	○	○	○	○	○	●	○	1
Sligo	○	○	●	○	○	○	○	○	●	○	1
Cork	○	●	●	●	●	○	○	●	●	○	0
Galway	○	●	●	●	●	○	○	○	○	●	0

Sources: Secondary data collated by the authors

○ County has supply at least 10 per cent *higher* than national average

● County has supply at least 10 per cent *lower* than national average

● County has supply approximately equal to the national average

1. Physiotherapy supply includes public and private supply

2. Supply of long-term residential care beds per 1,000 population aged 65+; supply of home care hours per population aged 65+

service, [Table 2](#) presents the counties where per capita supply is at least 10% higher than the national average (white circles), counties where per capita supply is at least 10% lower than the national average (black circles), and counties where per capita supply is within 10% of the national average (grey circles). Focusing on those areas with a location quotient that is lower than 0.90, a number of counties had low levels of supply relative to the national value for nearly all of the 10 non-acute services. These counties are mainly located in the East of the country, including: Kildare, Wicklow and Meath, which are the three main commuter counties around the capital city (Dublin); Wexford, Kilkenny and Waterford in the Southeast. As an exception to this eastern trend, the western county of Clare had seven non-acute services with a location quotient lower than 0.90. There was also consistency across services in terms of the areas that have high levels of supply relative to the national value. Sligo, Leitrim, Westmeath all have seven or more non-acute services, with location quotients greater than 1.10. Sligo and Leitrim are located in the north west of the country, while Westmeath is in the midlands.

The main exception to this regional pattern is the supply of LTRC. Areas with the lowest levels of supply for most of the non-acute services had relatively high levels of supply of long-term care (e.g., Kildare, Kilkenny, and Wicklow) and vice versa (e.g., Sligo).

Inequity in supply

Following adjustment for need, the geographic distribution of each non-acute service remained unequal and overall, there was very little change in the distributions following adjustment.

The scatterplots in [Figure 2](#) summarise how the geographic distribution of the supply of publicly employed CNs changes after adjustment for each need indicator. The graphs plot each county's location quotient before adjustment (y axis), and after adjustment for the need indicator (e.g., MCs) (x axis). For example, a data point in the upper left quadrant indicates a county where per capita supply is higher than the national value based on the unadjusted population, and lower than the national value based on the needs-adjusted population. If needs-adjustment does not change a county's location quotient (i.e., ratio of county to national supply), then the data point will lie on the diagonal 'line of no change'.

For the supply of publicly employed CNs, the location quotients for the majority of counties lie close to the line of no change for each need indicator. There are exceptions to this pattern. For example, in [Figure 2e](#), Kildare, Dublin North and Dublin South are located inside the bottom right quadrant where the location quotient was below the national average prior to adjustment for MCs (used as a proxy for healthcare need as well as socioeconomic status) (0.83, 0.93, 0.93) and higher than

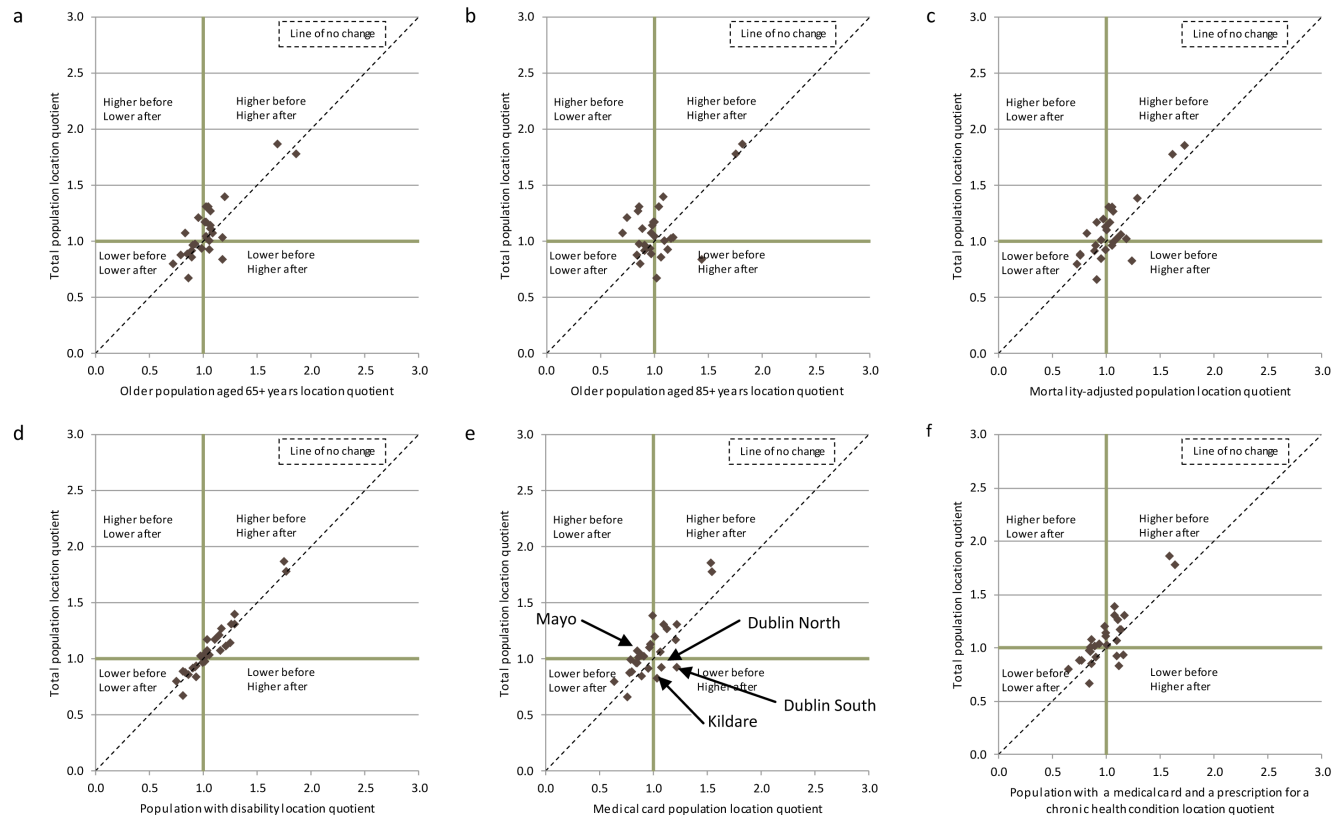


Figure 2. Scatter plot of location quotients of the number of WTE community nurses per 10,000 total population, and per 10,000 needs-adjusted populations by county, Ireland 2014.

the national average after adjusting for the MC population (1.04, 1.08, 1.21). Conversely, Mayo is located in the top left quadrant where the location quotient fell from 1.07 prior to adjustment to 0.85 after adjustment, for the MC population. However, the analysis adopts a conservative approach of assuming that location quotients that fall within 10% of the national value are similar to the national average. Thus, these exceptions, while notable, are not considered very significant changes given that the values did not all fall outside the 10% interval.

When comparing across the different adjustment factors, for each type of supply, controlling for the population aged 85+ is most likely to influence rankings, illustrated in Figure 2 for community nursing (and Figure 3 and Figure 4 for GPs and LTRC). For each type of supply, the majority of the counties did not move from their respective quadrants following adjustment for the need indicators (although they may move within that quadrant). Kildare, Mayo and Roscommon were the most frequent exceptions to these patterns, mainly after adjustment for age 85+, but the changes in quadrants were only significant in a limited number of instances. These findings indicate that the analysis is picking up on genuine geographic inequities in supply that cannot be explained by needs.

Discussion

Core findings

This paper provides the most comprehensive picture of the geographic distribution of non-acute care in Ireland to date.

Despite Ireland being a small country with a mainly centralised health system, the findings show considerable geographic inequalities in the supply of non-acute care across Irish counties. There are some counties that have low levels of supply of not only one, but several types of non-acute care, which include publicly employed, but also some privately provided services (GPs and private PTs). Similarly, some areas have high levels of relative supply of multiple types of non-acute care. The findings remain largely unchanged after adjusting for different needs indicators, suggesting that the unequal patterns of supply are also inequitable and have been determined by non-need factors.

With the exception of LTRC, the supply of non-acute services in Ireland is consistently lower in the east of the country compared with other regions. This pattern holds after needs adjustment. In contrast, there is more regional variation in the areas that have consistently high levels of supply (before and after needs adjustment).

While explaining the reasons behind the observed inequalities is beyond the scope of this paper, population change provides some explanation for the observed 'eastern' effect. There have been sizeable changes in the distribution of the population by county over the past 30 years. In particular, there have been increases in population in Dublin and the greater Dublin commuter counties. Kildare and Meath populations increased, as a proportion of national population, by more than 40% from 1986

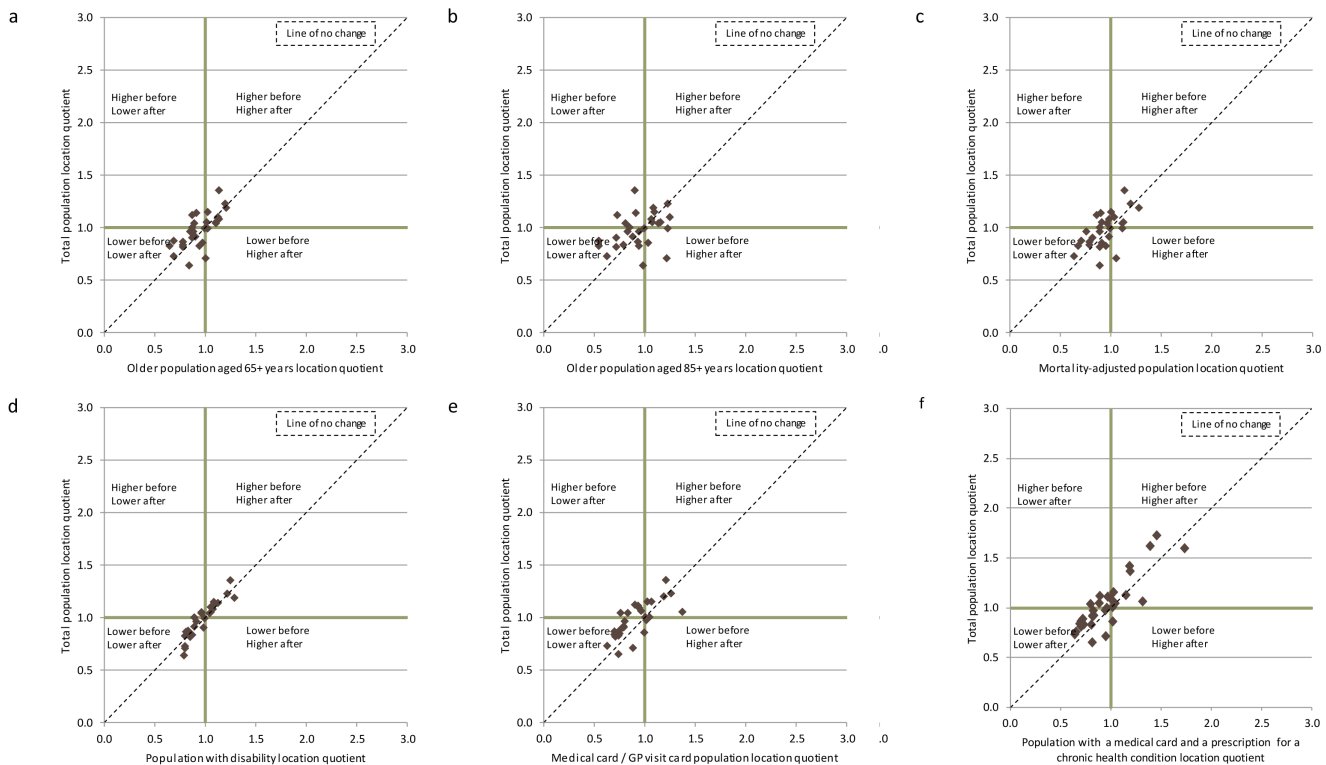


Figure 3. Scatter plot of location quotients of the estimated number of WTE GPs per 10,000 total population, and per 10,000 needs-adjusted populations by county, Ireland 2014.

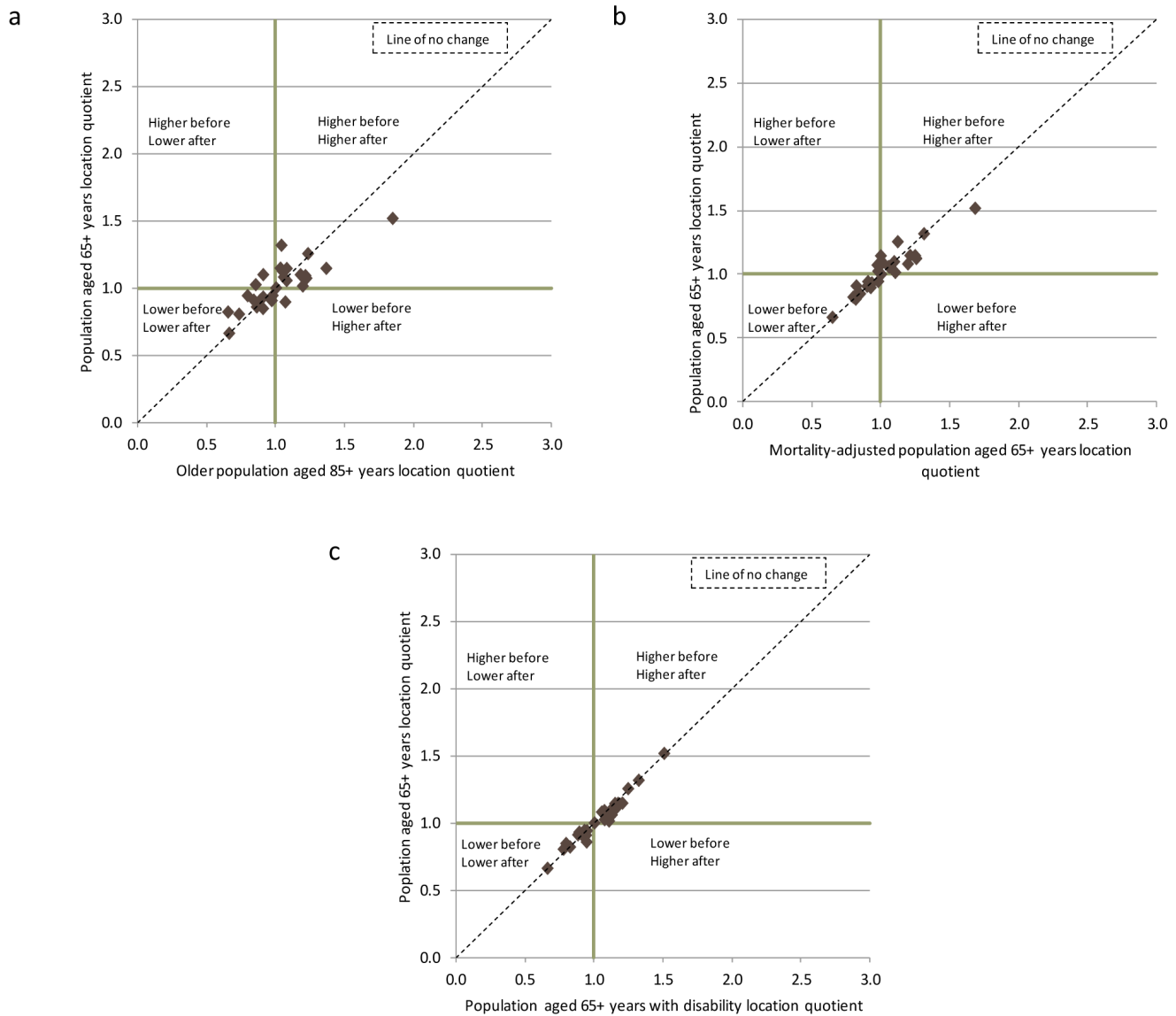


Figure 4. Scatter plot of location quotients of the number of long-term residential care beds per 1,000 population aged 65+ years, and per 1,000 needs-adjusted populations by geographic area, Ireland 2014.

to 2016⁴⁹. Wicklow (12%) and Wexford (9%), in the east, also experienced large increases in population. The relatively low levels of per capita supply in these counties could be explained, at least in part, by supply distribution not keeping up with changes in population distribution. Over the same time period, some of the largest declines in population, as a proportion of national population, occurred in Sligo and Leitrim (12–13% reduction) which may explain why per capita non-acute supply is consistently higher than in other counties.

However, there are exceptions to these general patterns, with other factors also likely to be at play, and because of the persistence of historical budgeting it is important to keep in mind influences from former administrative structures.

The difference in the geographic distribution of LTRC compared with the other non-acute services is assumed to be influenced by location decision factors. More than 75% of LTRC beds in Ireland are now privately provided^{50,51}. This may make equal distribution of these services more difficult because supply is likely to be influenced by market factors such as land prices, profit margins, and availability of staff.

Limitations

Equity in access to healthcare is a core objective in many healthcare systems including Ireland⁴, and it is acknowledged that supply is just one element within the broad concept of ‘access’¹¹. The focus on supply in this paper is a feature of the data available for non-acute services in Ireland. In contrast,

data collection on acute care and lifestyle survey data^{52,53} has been more extensive. For some non-acute services such as GPs and LTRC, where data can be geocoded, more detailed analysis of spatial accessibility has been undertaken^{24,25,27,41}. The need for timely access to information to support an integrated health-care system has been underlined in international policy³. The emphasis in this paper has been on collating and cleaning data from disparate sources, using simple provider-to-population ratios (raw and needs-adjusted) for a broad spectrum of services to give a comprehensive picture of regional inequity in non-acute supply in Ireland.

Supply in each county is assessed against national average supply but the latter is not equivalent to adequate supply. Analysis was focused on those counties that are more than 10% different from the national average, ensuring a conservative approach is adopted to measuring variations across counties. To judge whether or not a given level of supply is adequate would require assessment against a set of agreed criteria. International supply benchmarks are challenging to determine, given the varying roles and definitions of care providers in different countries. Alternative benchmarks could include clinical standards outlining optimal care levels. For example, Wren *et al.*⁵⁴ examined the quality of rehabilitation care for stroke survivors in Ireland against international best practice protocols. Optimal supply may be higher than the national average for some of the non-acute services examined here, given clear evidence of unmet need and long waiting times for public community therapy services and home care³⁰.

Data gaps remain, including on the supply of private health professionals (e.g., SLTs, P&Cs, HCHs) and GP practice nurses. New data sources are coming on stream, which could be used for future analysis (e.g., the multi-profession regulator (CORU) responsible for the registration of health and social care professionals⁵⁵). There may also be local variations in non-acute service delivery that are not apparent in WTE data. For example, in some areas the delivery of selected non-acute services is contracted out to private providers, or there can be differing degrees of role substitution/overlapping (e.g., overlapping roles of community nurses, PTs and OTs) across counties.

Finally, the needs adjustment methods do not control for collinearity across needs indicators. However, the MC can be considered a multi-dimensional need indicator because, as well as being a key enabling factor for receiving publicly funded healthcare, the MC is also frequently considered a control for socio-economic status (since eligibility is largely based on income means-testing)^{56,57} and a proxy for healthcare need, given the well-established link between lower socio-economic status and poorer health⁵⁸⁻⁶⁰.

Conclusions

Lessons for Ireland and other countries

Formal resource allocation models for healthcare have been in use for decades⁹, yet in Ireland, historical budgeting in

non-acute care persists. The analysis in this paper shows that in the context of important population changes and the influence of non-need factors (e.g., hangovers from previous administrative structures), persistence of historical budgeting can lead to considerable geographic inequities in non-acute healthcare supply. In the Irish case, there are notable regional patterns to the observed inequities, with supply in the east consistently lower relative to the rest of the country. While such inequities can remain under the radar under normal conditions of demand (particularly in the absence of systematic analysis of supply), they come into sharp relief in the context of a crisis such as the COVID-19 pandemic where non-acute supply plays a crucial role in ensuring that acute services can be preserved for treating COVID-19 and other patients with acute care needs. A key objective in Ireland's current health reform programme, Sláintecare⁴, is the development of a community-costing programme for non-acute care. This, together with building capacity in non-acute care in the areas where it is most needed, is now more important than ever.

For Ireland, keeping pace with population change is critical. Future migration within and into Ireland, as well as population growth patterns, may exacerbate the regional disparities in non-acute supply, especially because projected population increases are for those areas with already relatively low levels of non-acute supply⁶¹.

The Irish case also has lessons for policymakers seeking to find the appropriate balance between local autonomy and national oversight in healthcare planning. With the persistence of historical budgeting, there remains an institutional legacy with regard to the regional-based Health Boards that were in place prior to the HSE. In addition to the factors already discussed, some of the geographic differences in supply may be a consequence of the historical regional Health Board structures. Local autonomy for service planning led to divergences in non-acute supply, with some of these divergences persisting and underpinning the inequities in supply across Ireland. As part of Sláintecare, the proposed establishment of RHAs means that aspects of localised decision-making will remain. This should facilitate better matching of supply with local patient demand, but it is important that there is national oversight to ensure that data infrastructure, data analysis and resource allocation mechanisms are systematic and consistent across regional structures.

Data availability statement

Underlying data

This paper is based on the analysis of secondary datasets, and no other data were collected as part of this research. Details on those datasets and their host institutions are outlined below:

- Population: 2014 population estimates developed at the Economic and Social Research Institute^{37,38}
- Supply of GPs: registers hosted and managed by the Irish College of General Practitioners and Irish Medical Directory^{24,41}

- Supply of publicly employed Public Health Nurses, community Registered General Nurses, physiotherapists, occupational therapists, speech and language therapists, podiatrists & chiropodists, counsellors & psychologists, and social workers: Health Service Personnel Census (HSPC). Data extract provided to the authors by the HSE⁴⁶
 - Supply of private physiotherapists: register of members of the Irish Society of Chartered Physiotherapists (ISCP). Data extract provided to the authors by the ISCP (<https://www.iscp.ie/>)
 - Supply of care for older people: Data on the number of publicly financed home care hours provided to the authors by the HSE. Data on the supply of LTRC beds were provided to the authors by the HSE based on combined datasets maintained by the Health Information and Quality Authority (HIQA) (responsible for regulation in long-term care), and the Department of Health (DOH).
- For access contact Social Care Division, Department of Health (<https://www.gov.ie/en/organisation-information/7137c8-social-care-division/>).
 - Mortality and disability rates: Central Statistics Office (CSO), <https://www.cso.ie/en/census/census2011reports/census2011profile8ourbillofhealth-healthdisabilityandcarsinireland/>; <https://www.cso.ie/en/releasesandpublications/ep/p-vs/vitalstatisticsyearlysummary2014/>
 - Medical cards and GP Visit card numbers: Primary Care Reimbursement Service (PCRS), <https://www.sspcrs.ie/portal/annual-reporting>
 - Chronic illness levels: data analysed at the Department of Pharmacology and Therapeutics, Trinity Centre for Health Sciences in St. James's Hospital, Dublin and provided to the authors for this study. Access to the analysed and anonymised tables that were provided to the authors were restricted to the purposes of this study.

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Version 1

Reviewer Report 16 March 2022

<https://doi.org/10.21956/hrbopenres.14612.r31576>

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Karyn Morrissey 

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Major comments:

- I think it would be good to explain the regional imbalance in Ireland somewhere. The economic dominance of the greater Dublin area. The aging population in the NW and West of Ireland. Higher rates of poverty outside of Dublin, etc.
- My main concern comment is that looking at needs in terms of age only is too limited. Data on current reported long term illness is available at the small area level for Ireland. This should be used as a needs indicator as well as the age profile.
- Similarly, given the role of socioeconomic status and deprivation on health outcomes it is completely remiss not to include an indicator of need based on some sort of proxy for deprivation. The Irish index of deprivation would be ideal.
- As need should be the only driver of actual supply, I'm not sure why the authors present the non adjusted needs analysis. Or if they feel it is necessary, why the scatterplots with the line of no change? What does this dimension actually add? I really think this scatterplots are unnecessary and actually distracting. Instead I would spend more time articulating need based on a wider range of variables as I note.

Minor comments:

- Make it clear in the abstract that needs are based on age profile of units of analysis.
- Provide a table displaying the 10 services of interest and high level data - number per county/
- Provide an overview of each county in terms of the Irish Index of Multiple deprivation, not just age and population.
- I really think you need to add a map of the 26 admin countries for international readers.

- Where was data on addresses obtained? Is there finally a database or was it via web scraping?

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Population health, access to health services, Non communicable Diseases

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 11 March 2022

<https://doi.org/10.21956/hrbopenres.14612.r31578>

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Andres Garchitorena 

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The article by Smith and collaborators presents an interesting analysis of geographic inequalities in the distribution of primary care (termed “non-acute healthcare” because it goes beyond GPs and community health) in Ireland. The article is clearly presented, the methods are well described and appropriate, and the results are interesting, given the lack of literature on the subject. The manuscript has been thoroughly reviewed by a previous researcher and it seems that some of the

recommendations have been taken into account in the current version. I will not go into too much detail or repeat things that were already said, because I feel the article is strong and does not need major revisions. I only have a few minor comments that could help clarify further some remaining elements and improve the presentation of the paper. These are summarized below:

Methods:

- Since ESRI can be interpreted as the company that owns ArcGIS, especially when talking about GIS data, I would use the full name of the institute to avoid confusion. You only use it twice anyway, so it is not worth the risk.
- The adjustment for morbidity is not explained in enough detail that one can know exactly how it was done. If I understand it, the authors use data on people with a MC card going to one hospital in the capital to get the % of people with chronic conditions, and from there, extrapolate to other areas based on the % of people with MC cards. Is that right? If so, couldn't this approach overestimate or in any case bias their estimates as it comes from a hospital setting (not the general population) and from the capital city (may not be representative of rural areas)? It is worth adding some more details about the methods and rationale for this choice.
- Even though the use of Gini coefficients is common in the literature on inequalities, it would be useful for the reader to briefly describe how to interpret values of these coefficients.
- A small formatting issue: "Methods" is used both as the headline of the section and the headline of a subsection within the "Methods" section, which is confusing.

Results:

- In figures 2, 3 and 4, the range in the axes is too large. The authors could improve visualisation and interpretation if the ranges were reduced to 0.5-1.5 (or up to 2 for some). In addition, to facilitate interpretation of results and give more information, dots in the graph could be color-coded or numbered, so that patterns seen in Fig1 and Table 1, can also have an equivalent in terms of this adjusted information in figures 2, 3 and 4.
- As the authors explain, some of the geographic inequalities are "spatial": consistently, areas in the east of Ireland have lower supply of services, as well as commuters around the capital. It would be really nice to see these results in a map of Ireland, as non-Irish readers do not necessarily know the location of those different counties and cannot otherwise make those conclusions just by looking at the names of counties.

Discussion/Conclusion:

- A main hypothesis for the inequalities observed, which is highlighted from introduction to conclusion, is that historical budgeting has not kept up with changes in population growth. Even if this is not the main goal of the paper, it could be relevant to include a very basic analysis showing this relationship (e.g. a plot of population growth by county against supply of non-acute care in 2014).
- I expected to see some comparisons of the work presented here for Ireland with similar work done in other countries, in order to put the study in the broader context of the literature on the subject. Is Ireland unique in its approach to non-acute care? Have other

studies in European countries found similar/different results as observed here? Have they approached the topic of inequalities in non-acute care similarly, or in different ways, or not at all?

- In terms of health policy, do the authors have some specific recommendations based on the results observed and the specific context of the Irish health system? I wonder particularly how governments (local or national) can help reduce existing gaps given that a large part of the medical workforce seems either private or at least not subject to allocation by centralized planning.

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Global health, health systems strengthening

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 09 February 2022

<https://doi.org/10.21956/hrbopenres.14612.r31331>

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GENERAL:

This is a very interesting paper that collates and visualizes very effectively an assemblage of data from across non-acute healthcare supply and draws from it some important insights on spatial variations from within that data. The context of the work is clear, especially in relation to how it might inform the development of reform within the current system. While there is some good literature cited around spatial accessibility, many of the GIS-driven spatial analytical approaches of that work are not used with the authors preferring a more spatial economics approach; but perhaps it would be good to make more explicit in the text a loss of nuance in using tools such as location quotients; even though the latter are visualized in interesting if complex form. It is also the case that that wider literature cited was working with better geo-spatial data in more constrained service settings so completely understand that choice. The data collection seems pretty sound within the constraints of what the authors have to work with, and the analysis of the spatial variation, again very acceptable given similar methodological constraints.

I have a number of broad observations and reflections and some specific questions about the geographical decisions made on the development of the data and some wider conclusions but I will detail these below. Some of the comments might seem to argue for a reworking of the data analysis but I am not minded to ask the authors to do this, rather maybe incorporate a bit more meaningful geographical thinking into the paper as a whole. In addition I think there is a real potential, especially given the authorship of this paper, to push a wider agenda around more creative thinking on geographical data scales, collection techniques and coding. This is, as the authors note, beyond the scope of this paper, yet the paper makes a subtle but powerful case for a deeper examination of same in the future and why not include that as a statement in the final section at least.

SPECIFIC COMMENTS:

A first comment is that while it is sensible to focus on a single year, 2014, its choice as the year of study is not clearly justified in the paper. A year that might align with a census, say 2016, might make more sense, but if the data collected does not align, then that's fine but maybe clarify a little. Indeed the need to coalesce the analysis around data that is 7-8 years old is in itself a rather telling comment on the availability of meaningful spatial data across the primary/community sector.

- **Introduction:**

- Introduction is very efficient and presents the investigation clearly and within good health care politics and data contexts. While the paper does code up the data sets as public and private later on, I wonder whether some sort of sense of where Slaintecare is coming from in being a response to the current complex braided tiers (depending on service) of service supply, might help for a wider readership beyond Ireland, who might be less familiar with the complexities of our public/private model; something that is perhaps even more deeply embedded in the PCCC side as it is on the hospitals side.
- On the data, I think there is a very valuable point to make, and you do so in an almost over-subtle way, on the lack of availability of private service supply data. This remains a real structural barrier to meaningful integrated planning and that affects both availability and analysis in this type of modelling.
- I like the mention of the impact of historical budgeting, which might even be broadened out to the sort of long-run historical development of primary and

community services more generally. That slow geographical development of services over time also shapes something you pick up on later in terms of spatial inequalities, namely the low ranking of new commuter geographies on terms of service supply compared to places with more established histories and this is a very nice finding that links the two together.

- **Background:** As noted in the general comments, there's a nice efficient summary here of the different ways in which accessibility and service supply emerge in both spatial and aspatial ways and nice to see some of the GIS specific literature mentioned here as well. Central to that literature is work around travel time, catchments and indeed cross-boundary mobilities in service accessibility and utilization. The paper does not really use any of that literature, focusing instead on slightly older measures but I do agree that the data constraints you are working with make these more contemporary geospatial methods hard to apply and you note they also do not fit exactly to your aims and good to see. In terms of the paper's listed aims, the first two make sense, the third one mostly so but not quite sure what exactly the last one is saying?
- **Institutional context:** Nice efficient summary here of the complex history of health service boundaries and also the core structures that shape access good to see but given paper is built around services in 2014, might be useful to clarify which boundaries were extant then, and what is indeed the current state of play in 2022, even if that is still pretty up in the air. Just a clarity around how the dates line up.
- **Geographic setting:**
 - This is one area I have a little difficulty with – the use of what one might argue are a mix of out-of-date and also randomly allocated counties feels odd to me. Why not use Local Authorities, especially in Dublin, where the old county had not been a meaningful entity for several decades now? The creation of a random South and North Dublin also splits Dublin City, one of the core new local authorities, in two parts. Equally prior to 2014, most of the other Irish cities were separate local authorities to their associated counties – by loosely amalgamating them, you arguably may lose some important urban/rural nuance beyond the Great Dublin area. But perhaps this is another rationale for your choice of 2014 as the core date for analysis? I can see you needed to use counties to probably reflect in part how data is still, fairly lazily recorded in the system but would like to see you make a stronger case for the specific geography you use. I do appreciate that later in the document you do also note that LHO boundaries are not coterminous with the old counties, and indeed that some sort of spatial retro fitting was needed. This is presented as something slightly trivial, but given the complexity of LHOs in Dublin and Cork and the double-counties in some cases, this was I suspect quite a task for the Health Intelligence Unit to develop. So I do get you end up with a slightly unsatisfactory compromise between service and admin boundaries and I think I would like you to just say that, given how the data forces you to work.
 - The listing of 'ten' supply variables is slightly confusingly listed in the text, though much clearer in Table 1 on the next page. It might be a little pedantic, but could you maybe number/code them in the text as they are listed in turn in page 4 as well.

- **Methods:** The use of GINI coefficients for a general service variation measure is very interesting, and while challenging to interpret at times, the location quotients are used in interesting ways. I also like the weighting variables and I think I can see the sense in showing the raw and weighted versions in the graphs on pages 8, 9, and 10. I wonder why you don't just present the weighted version as a stand alone visualisation but I do get that you want to provide some nuance to what can otherwise be a fairly blunt instrument in its raw form.
- **Results:**
 - I really like the graphics on pages 6 and 7 and think these are really clever visualisations. While the geographer in me would like to see at least one map in the paper, if only to provide a non-Irish (and indeed many Irish) readers with the actual geographical boundaries and what they look like, I can see from a data perspective, Figure 1 and Table 1 work really well. There's a lot of complex data crammed in here and if anything I might have liked a bit more discussion on these findings, but very clever visualisation work here and nice to get that sense of an accumulation/assemblage of spatial inequalities across services you get from both. The analysis of this data seems to me something I would like to see develop a little – what's nice about the data is that it picks up the specific under-supply in the commuter counties of the east, but think this is also a pattern evident in many of the other bigger cities as well, especially Cork and Galway and that's got a little lost in the amalgamated counties mix. More importantly, in that first paragraph on page 8 you actually talk about geography and why it might matter or explain/shape the observed results.
 - With the different analysis of the LQs, it very nice to see that on Figure 2e at least the counties are given names and are not mere dots on a graph. I wonder if the same might be applied to some of the other outliers in other sub-charts, though I do get that you suggest all the data is within an acceptable level of variation. Also just in terms of the variables used in weighting, I don't think you mention deprivation much in the paper at all. I completely understand the impossibility of applying any sort of 'average' dep score from smaller units to a county scale, but given the literature on the impacts of COVID-19 on these areas, it might be worth a mention in passing, if only to explain why it was not used because of geo-spatial modelling difficulties. This would also bring in a sense of how post-COVID inequalities may become further embedded in terms of the services you discuss.
- **Discussion:** I do think there is quite a difference between the different measures you use, though I do appreciate that both long-term residential and home care are listed as 'services'. From that point of view, its good to see you note that the geographical variations with these two measures are differently aligned than most of the others. Other readers might argue for the exclusion of these two which might make the other results hold together but I think its precisely the invisibility of these strands of non-acute care that argue for their inclusion and well done for building them in.
- **Limitations:** You do mention some data as being geocoded, but I think it would be a lost opportunity for the paper in looking forward, to make no mention of Eircodes. Given these are point based, a better integration of these into data records would make for much more

open amalgamation of data into newer service geographies, such as the 96 new Community Health Networks. This in turn speaks to a wider potential for more nuanced analysis at a sub-county level in future work. While its clear from your work that even pulling together disparate data sets at a county scale is hard enough, the geospatial modelling potential of aggregating records collected at Eircode level to any new geographical reporting unit is actually one of the genuine values of the Eircode design. Some mention of the potential and need for new spatial coding and modelling to finer geographical scales seems an implicit finding from the paper; why not make it more explicit to get people who develop data in the non-acute sector to consider this more seriously

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Medical/Health Geography; GIS and Health

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.
