

Defining catchment boundaries and their populations for Aotearoa New Zealand's rural hospitals

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ABSTRACT

Introduction. There is considerable variation in the structure and resources of New Zealand (NZ) rural hospitals; however, these have not been recently quantified and their effects on healthcare outcomes are poorly understood. Importantly, there is no standardised description of each rural hospital's catchment boundary and the characteristics of the population living within this area. **Aim.** To define and describe a catchment population for each of New Zealand's rural hospitals. **Methods.** An exploratory approach to developing catchments was employed. Geographic Information Systems were used to develop drive-time-based geographic catchments, and administrative health data (National Minimum Data Set and Primary Health Organisation Data Set) informed service utilisation-based catchments. Catchments were defined at both the Statistical Area 2 (SA2) and domicile levels, and linked to census-based population data, the Geographic Classification for Health, and the area-level New Zealand Index of Socioeconomic Deprivation (NZDep2018). **Results.** Our results highlight considerable heterogeneity in the size (max: 57 564, min: 5226) and characteristics of populations served by rural hospitals. Substantial differences in the age structure, ethnic composition, socio-economic profile, 'remoteness' and projected future populations, are noted. **Discussion.** In providing a standardised description of each rural hospital's catchment boundary and its population characteristics, the considerable heterogeneity of the communities served by rural hospitals, both in size, rurality and socio-demographic characteristics, is highlighted. The findings provide a platform on which to build further research regarding NZ's rural hospitals and inform the delivery of high-quality, cost-effective and equitable health care for people living in rural NZ.

Keywords: catchment populations, Geographic classification for health, geography, health services, rural communities, rural health, rural health inequities, rural hospitals.

Introduction

In New Zealand (NZ), people living in rural areas have poorer health outcomes than residents living in urban areas, and this is accentuated for Māori.¹ An estimated 10–15% of New Zealanders rely on rural hospitals for health care.²

International studies have found rural hospitals can benefit the health of rural communities by enhancing access to, and integration of, services; however, definitions of rural hospitals are varied and highly country-contingent.^{3–5} Even within NZ, there is considerable variation in the size, structure and resources of rural hospitals (including access and integration within the wider healthcare system, governance, workforce models and level and range of diagnostic services offered).⁶ The working definition of rural hospitals accepted by the Medical Council of New Zealand and the Royal New Zealand College of General Practitioners' Division of Rural Hospital Medicine (DRHMNZ) includes geographical distance from specialist services; acute in-patient bed capacity; 24/7 acute care; and a predominantly generalist workforce. The DRHMNZ list of rural hospitals currently sits at 24.² The extent to which NZ rural hospitals improve access to health care, improve health outcomes and improve health equity for rural communities, particularly for Māori and

WHAT GAP THIS FILLS

What is already known: New Zealand's rural hospitals do not fit a homogenous concept. There is no standardised description of each rural hospital's catchment boundary and its population characteristics.

What this study adds: Our study findings provide, for the first time for Aotearoa New Zealand, a standardised description of each rural hospital's catchment boundary and the socio-demographic characteristics of the population living within this area. NZ's rural hospitals serve very different communities.

Key geographic units: This research refers to several geographic units, defined by the Statistics New Zealand, Statistical Standard for Geographic Areas, and often used in health research, which may be unfamiliar to readers. *Meshblocks* are the smallest statistical geography at which census data are collected in Aotearoa New Zealand, and are the building blocks of all other statistical geographies. *Meshblocks* usually contain between 30 and 60 dwellings (60–120 residents) and there are 53 589 *meshblocks* in Aotearoa. *Statistical Area 1 (SA1)* are the smallest geography at which data are released by Statistics New Zealand. *SA1s* are made up of *meshblocks* and have an ideal range of 100–200 residents, with a maximum population of approximately 500. There are 29 889 *SA1s* in Aotearoa New Zealand. *Statistical Area 2 (SA2)* is a larger statistical geography that is formed by grouping *SA1s*. These are usually socially homogenous areas that are geographically similar. *SA2s* often approximate a suburb in urban areas where they usually contain between 2000 and 4000 residents, and generally contain 1000–3000 residents in rural areas. There are 2253 *SA2s* in Aotearoa New Zealand. *Area Units* (also called *Census Area Units*) are no longer officially defined in the Statistical Standard for Geographic Areas. *Area Units* were last used for the reporting of data relating to the 2013 Census. The boundaries of *Area Units* do not align with *SA1s* or *SA2s*, but are the equivalent of the *Domiciles* used by the Ministry of Health as a geographic unit in some of their important health datasets (eg National Minimum Dataset [NMDS]). *Area Units* and *Domiciles* are also 'built up' from *meshblocks*. There are 2004 *Area Units* in Aotearoa. The differences between *SA1s*, *SA2s*, and *Domiciles/Area Units* and how these geographic units relate to *meshblocks* are visualised in Supplementary Figs S1, S2.

Pacific peoples, is currently unknown.^{6,7} Importantly, there is no standardised description of each rural hospital's catchment boundary and its population characteristics.⁶

Internationally, various approaches have been used to define health service catchments, including distance or travel time measures, and mapping utilisation patterns.^{8,9} In NZ, general practice catchments have been developed using patient enrolment records,¹⁰ however, this approach may not be directly transferable to the development of rural hospital catchments. Actual patterns of rural hospital

utilisation likely differ from general practice, and from assumed geographic catchments. Research indicates that patients often bypass their closest health services for a variety of reasons.^{11,12} Differences in rural hospital utilisation patterns reflect multiple factors, including patient preferences, their relationships with providers, and the rural hospital variations mentioned above.

Recently, a novel Geographic Classification for Health (GCH) for use in NZ health research has been developed to more accurately monitor urban–rural variation in health outcomes and access to health services in NZ.¹³ Defining rural hospital catchments will improve the ability of hospitals and funders to understand the socio-demographic characteristics of the population that is served by, and is likely to use, rural hospitals. This would include developing a better understanding of the age structure, ethnic profile, and socio-economic position of populations served by rural hospitals, as well as using the GCH to understand the rurality (and/or remoteness) of such populations.

This exploratory study aims to explore methodologies to define and describe a catchment population for each of New Zealand's rural hospitals.

Methods

Data

This research used several health, population, and geographic datasets. The NZ Ministry of Health provided two datasets: (1) the National Minimum Dataset (NMDS), which included anonymised information on all public and private hospital discharges between 1 January 2017 and 29 October 2019; and (2) anonymised Primary Health Organisation (PHO) datasets for 2019, 2020 and 2021, which includes information on all people registered with a PHO.

The NMDS and the PHO dataset were linked using a unique encrypted identifier based on the National Health Index (NHI) for each patient. The NMDS contained the domicile code for each patient and the facility code of the hospital of presentation, whereas the PHO dataset provided residential information at a small geographic unit – the *meshblock*.

Census-based population data were downloaded from the Statistics New Zealand data service, 'NZ.Stat', and included age and sex by ethnic group (Usually Resident Population 2018)¹⁴ and population projections to 2043 (2018 base, medium projection).¹⁵ The Geographic Classification for Health¹ and the New Zealand Index of Socioeconomic Deprivation¹⁶ provided information on rurality and area-level socioeconomic deprivation respectively. Finally, several datasets with geographic information supported this analysis: (1) all hospital locations, defined as rural hospitals using the DRHMNZ definition and list of rural hospitals ($n = 24$),² from the Ministry of Health Facility code table, which also noted

the ‘facility code’ of each hospital;¹⁷ (2) geographic units (SA1, SA2, Area Unit 2017) from Statistics New Zealand (2022);¹⁸ (3) the Geographic Areas file 2020, a concordance file allowing various geographic units to be linked (Statistics New Zealand 2020);¹⁹ (4) the Land Information New Zealand (2022) NZ Street address dataset,²⁰ which allowed address-weighted SA1s to be created; and (5) a road network layer that allows for drive times between locations to be estimated.²¹

Data cleaning and linkage

Fig. 1 outlines the data cleaning and linkage process. Discharges related to a unique identifier, with an admission occurring within 24 h of each other, were identified and combined into ‘episodes of care’, as these are more likely to represent hospital (intra- or inter-) transfers than novel hospitalisations. Duplicate NHI records in each of the three PHO datasets were removed. To assign a *meshblock* to each hospital discharge, encrypted NHI data were used to iteratively link NMDS with the three PHO datasets, beginning with the most recent 2021 dataset. Any NMDS records that were unable to be linked to a *meshblock* were then linked to the 2020 PHO dataset, and then finally the 2019 PHO dataset. In this way, a total of 2 649 546 hospital discharge records were assigned a *meshblock* to represent the individual’s residential location. The final stage of linking involved using the Geographic Areas concordance file to link *meshblocks* to other administrative

geographies such as SA1s and SA2s. As domiciles align with Area Units (AU), discharge records were able to be directly linked using the same concordance file. The completeness of this linking varied by geographic unit and resulted in different levels of ‘missingness’, with SA2s being the most complete.

Analytic approach

Two exploratory approaches to developing rural hospital catchments were tested: (1) catchments based on the drive-time from each SA1 to the nearest hospital; and (2) catchments based on the number of hospital discharges in an area. The second approach was applied to both SA2s and domiciles.

Drive-time approach

Based on an assumption that people will use the hospital closest to their residential address, Geographic Information Systems (GIS) were used to estimate the drive time from each address-weighted SA1 to the nearest hospital. SA1s, which had a rural hospital as the closest hospital, were identified, and these areas thereby defined the ‘drive-time’ catchments of each rural hospital.

Hospital discharge approach

People do not always use their closest health service^{12,22} and administrative health data can be used to develop health

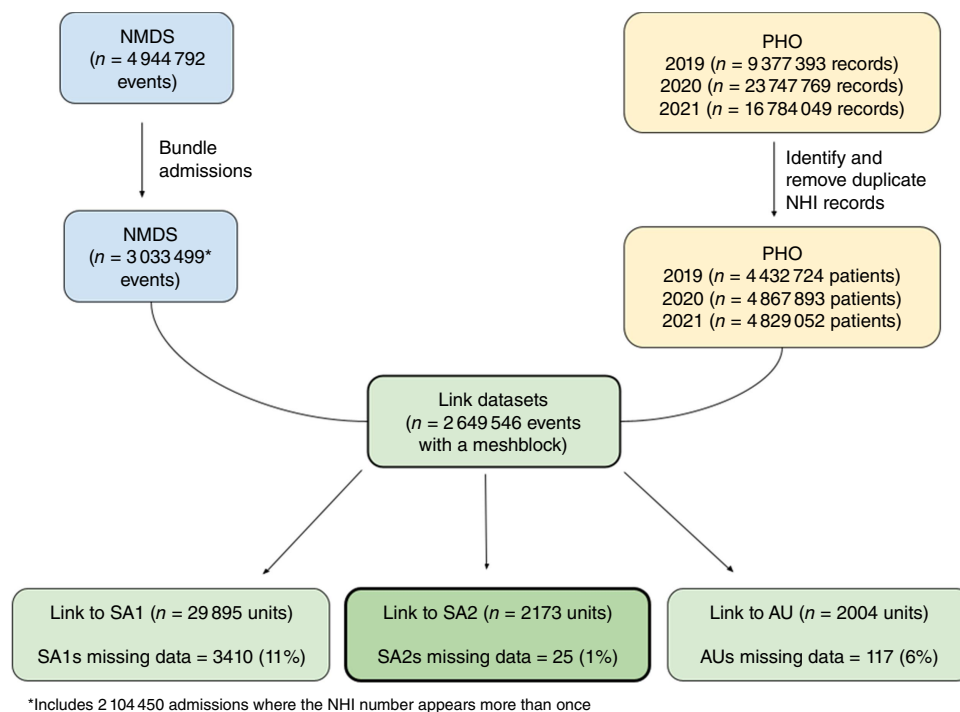


Fig. 1. Process of cleaning data, linking National Minimum Data Set (NMDS) to Primary Health Organisation (PHO) data, and linking to Statistical Area 1 (SA1), Statistical Area 2 (SA2) and Area Unit (AU) geographies.

service catchments that better reflect actual patterns of service use.^{10,23,24} Data completeness and the ability to link to census-based population datasets meant that SA2s were the preferred geographic unit for mapping and defining hospital discharge-based rural hospital catchments; however, many health datasets are still only available at the domicile level, so catchments were also defined at the domicile level.

Hospital discharges were filtered by hospital and separately aggregated to SA2 and domicile. Each rural hospital was grouped into one of three categories based on the total volume of hospital discharges across the study period: Large (>10 000), Medium (100–10 000), and Small (<100). A sensitivity analysis was used to test different potential thresholds – the minimum number of discharges for an area to be included within a rural hospital catchment – for each of the categories. It was determined that the most stable, consistent, and robust thresholds would be 10 for hospitals with <100 discharges, 50 for hospitals with <10 000 discharges, and 100 for hospitals with ≥10 000 discharges across the period. Next, these thresholds were applied to SA2s and domiciles to identify areas within each rural hospital catchment. The priority

was to identify the ‘external’ boundary of a catchment. In some cases, areas within the centre of a catchment did not meet the threshold, but were still included, as they were surrounded by other areas above the hospitalisation threshold. Finally, census-based population data were linked to the SA2 catchments of each rural hospital. This was combined with a SA2-level GCH rurality category, and NZDep2018 area-based socioeconomic deprivation to develop socio-demographic profiles of the population within each rural hospital catchment.

Ethics approval for this study was granted by the Human Research Ethics Committee of the University of Otago (HD21/065).

Results

Two exploratory approaches to developing rural hospital catchments were investigated. It was determined that a drive-time-based approach (based on an assumption that people would use their closest hospital) would not accurately reflect the reality of rural hospital service utilisation.

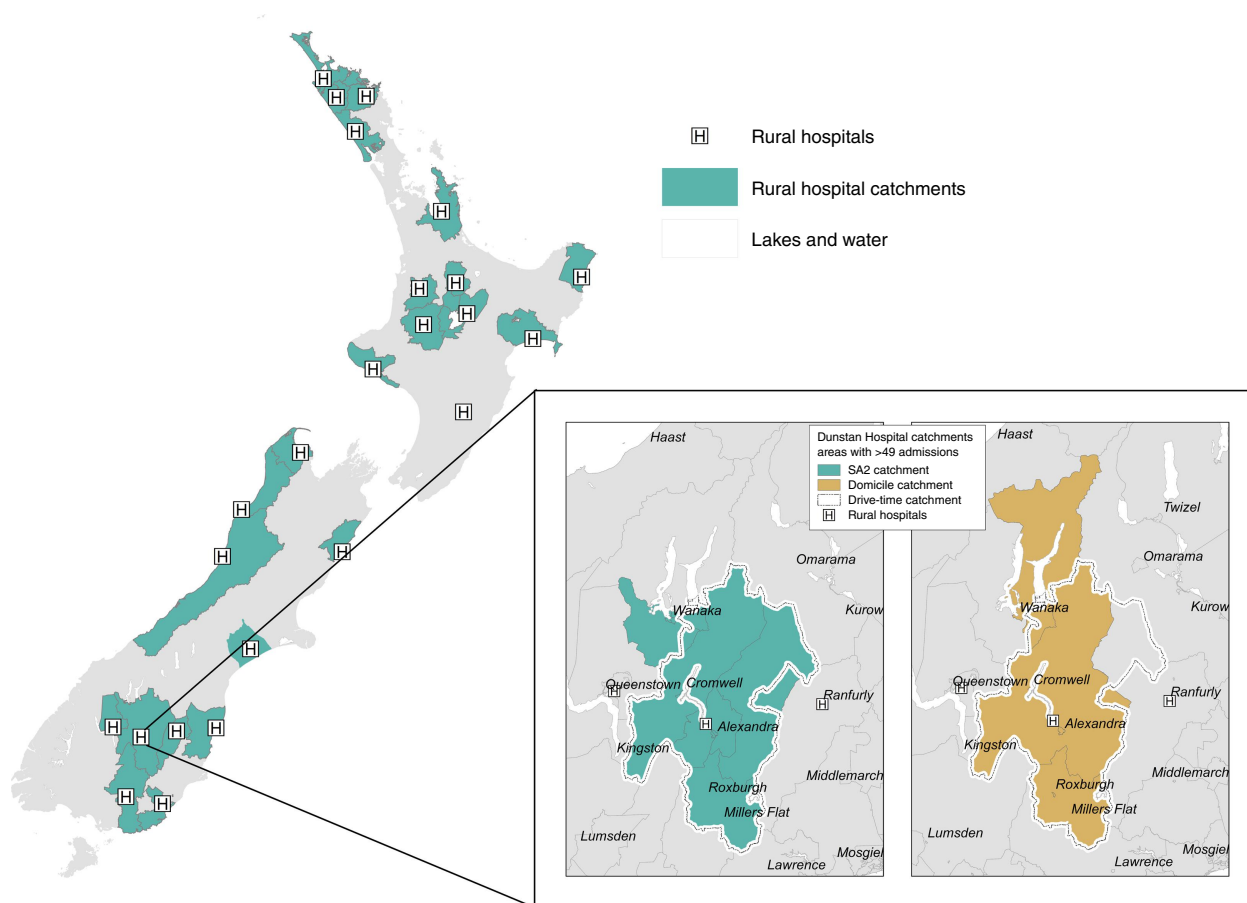


Fig. 2. Exploratory rural hospital catchments for all of Aotearoa New Zealand, with an insert indicating differences between the drive-time-based catchment and hospital discharged-based catchments at the SA2 and domicile level for Dunstan Hospital.

Therefore, the hospital discharge approach was used to develop catchments at the SA2 level. Fig. 2 displays areas that fall within a rural hospital catchment identified in this study. Fig. 2 indicates that several rural hospital catchments in Northland, the Central North Island, the West Coast, and the Southern region of New Zealand overlap and/or border onto each other.

Fig. 2 displays the hospital discharge catchments developed at the SA2 and domicile levels for Dunstan hospital, with drive-time catchments overlaid. It is apparent that hospitalisation patterns differ from that which might be expected using a drive-time approach alone. The differences between catchments defined at the SA2 and domicile level are also noticeable. The domicile-based catchment includes a substantial area to the north of Wanaka, which is not present in the SA2 catchment, whereas the SA2-based catchment extends further to the east of Alexandra and west of Wanaka.

Tables 1 and 2 below display key information about the population residing within each of the 24 rural hospital catchments defined at the SA2 level. This data are visualised in Supplementary Figs S3, S4. Table 1 includes the total number of admissions for each hospital during the study period. It also uses the Census 2018 usual resident population to show the estimated total population residing within each catchment, which is disaggregated by ethnicity and broad age groups. Ethnicity data from the census are not prioritised, meaning that individuals can identify with multiple ethnicities, and therefore the combination of total responses can exceed the total catchment population. Table 2 displays additional socio-economic information about each catchment population using NZDep2018 grouped into quintiles. Q1 reflects the least deprived 20% of all neighbourhoods in NZ. Conversely, Q5 represents neighbourhoods that are among the 20% most socioeconomically deprived of all neighbourhoods in NZ. Table 2 highlights substantial differences in the socio-economic profiles of different catchment populations. Table 2 also incorporates the GCH to display the number of people within each rural hospital catchment that live within each of the five GCH categories. U1 and U2 refer to 'urban' areas of NZ. None of the 24 catchments incorporated any urban populations. R1, R2, and R3 are rural areas of NZ, with R3 being the most remote and R1 reflecting rural areas that are closer to cities. Supplementary Table S1 shows the Māori and Pacific Peoples populations of each rural hospital catchment, further disaggregated by broad age groups (< 15 years, 15–29 years, 30–64 years, ≥ 65 years). Supplementary Table S2 outlines selected population projections ('medium' Statistics New Zealand subnational estimates at the SA2 level) for each rural hospital catchment, including the projected 2033 total catchment population, the size and proportion of the projected population aged ≥ 65 years in 2033, and the size and proportion of the population projected to be living in areas of high socioeconomic deprivation by 2033 (assuming that the spatial distribution of socioeconomic deprivation remains constant). Additional socio-demographic

information, including broad age groups for each ethnicity, is available on request.

Discussion

Summary of principal findings

Our study findings provide, for the first time for Aotearoa New Zealand, a standardised method for describing each rural hospital's catchment boundary using the 'hospital discharge' approach. This approach can be applied at the domicile level when using other health data, or at the SA2 level to utilise census population data and describe the socio-demographic characteristics and rurality profile of the population living within each catchment. Our results highlight the considerable heterogeneity in the populations served by rural hospitals, both in size, socio-demographic characteristics and rurality. It is clear that NZ's rural hospitals serve very different communities. For instance, Te Puia Springs (90%), Hokianga (68%) and Wairoa (66%) serve a high proportion of Māori, whereas Tokoroa (9.5%), Hokianga (6.1%), and Kaitiāia (5.1%) serve a high proportion of Pacific peoples.

Strengths and weaknesses of the study

The catchments produced are shaped and constrained by the available geographic units, and it is important for analysts to clarify whether catchments are defined at SA2 or domiciles levels. However, our detailed methodology improves the transparency of determining catchments through an exploratory method that tests both drive-time and hospital-admission approaches to developing catchments. Although these have their own strengths and weaknesses, our consideration of both approaches means that our results are less likely to be systematically biased in a particular direction. Furthermore, research team members contributed considerable broad expertise, including detailed knowledge of the rural hospital context; therefore, this helped to make our results more meaningful. However, patient movement and high levels of residential mobility are more likely to affect Māori and Pacific peoples,²⁵ and may have influenced the extent of some catchments. Furthermore, people who are not enrolled with a PHO, may have different healthcare-related mobility patterns. Census data uses non-prioritised ethnicity, and individuals can identify with multiple ethnic groups. This is particularly common for Māori and Pacific peoples, and for younger people.²⁶ Furthermore, Pacific peoples are a heterogeneous population with similar values, but different cultures, languages, and ethnic differences.

It is important to develop consistent catchments using an agreed and standardised methodology. This will require additional work in partnership with the sector, including qualitative input. Our novel catchments are exploratory and preliminary catchments only, and we do not suggest that these should be used for funding or resource allocation purposes.

Table 1. Demographic data (Census 2018 usual resident population) for each rural hospital catchment.

Name	Number of admissions	Total catchment population	Māori	Pacific Peoples	European	Asian	Other	<15 years	15–29 years	30–64 years	≥65 years
Thames Hospital	26 417	57 564	11 562 (20.1)	1515 (2.6)	49 467 (85.9)	2133 (3.7)	975 (1.7)	9807 (17.0)	7683 (13.3)	24 474 (42.5)	15 588 (27.1)
Te Nikau Grey Hospital	18 012	31 308	3657 (11.7)	468 (1.5)	28 353 (90.6)	1053 (3.4)	744 (2.4)	5577 (17.8)	4893 (15.6)	14 709 (47.0)	6141 (19.6)
Kaitaia Hospital	12 549	28 299	14 817 (52.4)	1440 (5.1)	17 955 (63.4)	768 (2.7)	438 (1.5)	6267 (22.1)	4392 (15.5)	12 288 (43.4)	5337 (18.9)
Taupo Hospital	11 253	38 613	11 520 (29.8)	1239 (3.2)	29 571 (76.6)	1878 (4.9)	693 (1.8)	8088 (20.9)	6363 (16.5)	16 992 (44.0)	7167 (18.6)
Ashburton Hospital	8466	33 330	2727 (8.2)	1716 (5.1)	27 927 (83.8)	2457 (7.4)	768 (2.3)	6804 (20.4)	5919 (17.8)	14 649 (44.0)	5970 (17.9)
Bay of Islands Hospital	8315	39 087	16 743 (42.8)	1680 (4.3)	26 205 (67.0)	1215 (3.1)	609 (1.6)	8265 (21.1)	6258 (16.0)	16 980 (43.4)	7584 (19.4)
Hawera Hospital	7418	34 137	8646 (25.3)	690 (2.0)	28 161 (82.5)	1119 (3.3)	588 (1.7)	7560 (22.1)	5907 (17.3)	14 988 (43.9)	5661 (16.6)
Oamaru Hospital	7051	22 641	1878 (8.3)	855 (3.8)	19 809 (87.5)	1323 (5.8)	405 (1.8)	4194 (18.5)	3423 (15.1)	9993 (44.1)	5025 (22.2)
Tokoroa Hospital	6740	26 436	8343 (31.6)	2523 (9.5)	16 947 (64.1)	1086 (4.1)	372 (1.4)	5523 (23.0)	4458 (18.6)	10 200 (42.4)	3849 (16.0)
Dunstan Hospital	5839	32 568	2373 (7.3)	546 (1.7)	30 114 (92.5)	996 (3.1)	708 (2.2)	5709 (17.5)	4782 (14.7)	15 504 (47.6)	6591 (20.2)
Lakes District Hospital	4871	25 308	1287 (5.1)	327 (1.3)	19 842 (78.4)	3333 (13.2)	1986 (7.8)	3990 (15.8)	6969 (27.5)	12 396 (49.0)	1944 (7.7)
Dargaville Hospital	3366	14 433	4146 (28.7)	621 (4.3)	11 607 (80.4)	396 (2.7)	222 (1.5)	2832 (19.6)	2289 (15.9)	6240 (43.2)	3072 (21.3)
Te Kuiti Community Hospital	3062	13 128	5394 (41.1)	435 (3.3)	8793 (67.0)	582 (4.4)	177 (1.3)	2982 (22.7)	2502 (19.1)	5577 (42.5)	2076 (15.8)

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Table 1. (Continued)

Name	Number of admissions	Total catchment population	Māori	Pacific Peoples	European	Asian	Other	<15 years	15–29 years	30–64 years	≥65 years
Taumarunui Community Hospital	2830	8040	3486 (43.4)	213 (2.6)	5547 (69.0)	240 (3.0)	114 (1.4)	1719 (21.4)	1341 (16.7)	3513 (43.7)	1473 (18.3)
Gore Hospital	2624	17 454	2142 (12.3)	192 (1.1)	15 708 (90.0)	522 (3.0)	267 (1.5)	3513 (20.1)	2910 (16.7)	7800 (44.7)	3222 (18.5)
Buller Health	2578	7272	825 (11.3)	120 (1.7)	6696 (92.1)	159 (2.2)	156 (2.1)	1212 (16.7)	891 (12.3)	3381 (46.5)	1779 (24.5)
Hokianga Health – Rawene Clinic	2052	6123	4137 (67.6)	375 (6.1)	2901 (47.4)	120 (2.0)	51 (0.8)	1377 (22.5)	903 (14.7)	2622 (42.8)	1218 (19.9)
Wairoa Hospital & Health Centre	1959	8370	5499 (65.7)	279 (3.3)	3972 (47.5)	189 (2.3)	90 (1.1)	1962 (23.4)	1503 (18.0)	3465 (41.4)	1431 (17.1)
Clutha Health First	1394	10 743	1344 (12.5)	255 (2.4)	9432 (87.8)	453 (4.2)	189 (1.8)	2001 (18.6)	1827 (17.0)	4884 (45.5)	2034 (18.9)
Kaikoura Hospital	1147	3912	723 (18.5)	30 (0.8)	3363 (86.0)	162 (4.1)	108 (2.8)	633 (16.2)	600 (15.3)	1851 (47.3)	834 (21.3)
Dannevirke Community Hospital	434	5508	1824 (33.1)	129 (2.3)	4140 (75.2)	216 (3.9)	39 (0.7)	1137 (20.6)	978 (17.8)	2166 (39.3)	1233 (22.4)
Maniototo Health Services	344	1635	156 (9.5)	12 (0.7)	1485 (90.8)	81 (5.0)	18 (1.1)	279 (17.7)	228 (14.5)	726 (46.2)	339 (21.6)
Te Whare Hauora O Ngati Porou – Te Puia Springs	232	3576	3216 (89.9)	123 (3.4)	918 (25.7)	36 (1.0)	30 (0.8)	903 (25.3)	612 (17.1)	1518 (42.4)	540 (15.1)
Golden Bay Community Health	54	5226	420 (8.0)	45 (0.9)	4962 (94.9)	108 (2.1)	117 (2.2)	882 (16.9)	624 (11.9)	2556 (48.9)	1167 (22.3)

Data are presented as *n* (%).

Table 2. Socioeconomic and rurality data for each rural hospital catchment.

Name	NZDep Q1	NZDep Q2	NZDep Q3	NZDep Q4	NZDep Q5	GCH U1/U2	GCH R1	GCH R2	GCH R3
Thames Hospital	1464 (2.5)	4170 (7.2)	15 882 (27.6)	14 631 (25.4)	21 417 (37.2)		16 365 (28.4)	40 740 (70.8)	459 (0.8)
Te Nikau Grey Hospital	1332 (4.3)	2457 (7.8)	7719 (24.7)	9072 (29.0)	10 728 (34.3)		15 732 (50.2)	13 146 (42.0)	2430 (7.8)
Kaitaia Hospital		2133 (7.5)		4380 (15.5)	21 786 (77.0)			14 577 (51.5)	13 722 (48.5)
Taupo Hospital	4533 (11.7)	8142 (21.1)	7491 (19.4)	7575 (19.6)	10 872 (28.2)		31 212 (80.8)	7401 (19.2)	
Ashburton Hospital	7512 (22.5)	11 997 (36.0)	6891 (20.7)	6930 (20.8)			27 888 (83.7)	5442 (16.3)	
Bay of Islands Hospital		8472 (21.7)	4710 (12.1)	5625 (14.4)	20 280 (51.9)		7047 (18.0)	28 449 (72.8)	3591 (9.2)
Hawera Hospital		1734 (5.1)	7131 (20.9)	11 319 (33.2)	13 953 (40.9)		17 994 (52.7)	16 143 (47.3)	
Oamaru Hospital	1050 (4.6)	4689 (20.7)	8937 (39.5)	7671 (33.9)	294 (1.3)		21 654 (95.6)	987 (4.4)	
Tokoroa Hospital			6153 (23.3)		20 283 (76.7)		24 045 (91.0)	2391 (9.0)	
Dunstan Hospital	18 546 (56.9)	12 243 (37.6)	1779 (5.5)					29 670 (91.1)	2898 (8.9)
Lakes District Hospital	13 647 (53.9)	9159 (36.2)	1485 (5.9)				25 308 (100)		
Dargaville Hospital				3513 (24.3)	10 920 (75.7)		6594 (45.7)	7839 (54.3)	
Te Kuiti Community Hospital			1833 (14.0)	3696 (28.2)	7599 (57.9)		3027 (23.1)	8880 (67.6)	1221 (9.3)
Taumarunui Community Hospital			1050 (13.1)	2283 (28.4)	4707 (58.5)			5970 (74.3)	2070 (25.7)
Gore Hospital		8238 (47.2)	6144 (35.2)	1443 (8.3)	1629 (9.3)		3825 (21.9)	13 629 (78.1)	
Buller Health			1260 (17.3)		6012 (82.7)			6558 (90.2)	714 (9.8)
Hokianga Health – Rawene Clinic					6123 (100)			1095 (17.9)	5028 (82.1)
Wairoa Hospital & Health Centre				861 (10.3)	7509 (89.7)			8370 (100)	
Clutha Health First		1608 (15.0)	3363 (31.3)	5772 (53.7)			6738 (62.7)	4005 (37.3)	
Kaikoura Hospital		1689	2223					3912	

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Table 2. (Continued)

Name	NZDep Q1	NZDep Q2	NZDep Q3	NZDep Q4	NZDep Q5	GCH U1/U2	GCH R1	GCH R2	GCH R3
		(43.2)	(56.8)					(100)	
Dannevirke Community Hospital				2148 (39.0)	3360 (61.0)			5508 (100)	
Maniototo Health Services		1635 (100)							1635 (100)
Te Whare Hauora O Ngati Porou – Te Puia Springs					3576 (100)			954 (26.7)	2622 (73.3)
Golden Bay Community Health			5226 (100)					5226 (100)	

Data are presented as *n* (%).

Meaning of the study: possible mechanisms and implications for clinicians, service managers and policymakers

Our results concur with previous findings indicating substantial variation in the size of facilities defined as a ‘rural hospital’ in Aotearoa New Zealand.⁶ Researchers and policymakers may now proceed to more meaningfully quantify variation in the structure and resources of rural hospitals. This may include access to rural hospitals, examinations of their integration within the wider healthcare system, governance models, workforce models, and the relationship between diagnostic services offered and community need. Previously researchers have been unable to definitively identify particular communities served by rural hospitals. Our study findings will help to further define the role delineation between different types of facilities and develop targets for access to services for rural communities. Standardised rural hospital catchments also mean that routinely collected health data can now be used to examine outcomes for the populations served by rural hospitals in NZ. Study findings will also permit an improved comparison between NZ and international literature or international definitions.

Our findings highlight that Māori and Pacific peoples are structurally younger than the total New Zealand population and are located throughout rural New Zealand, despite nearly 65% of Pacific people living in the Auckland region.^{27,28} It is important that we train a culturally safe rural health workforce,²⁹ and invest in Māori and Pacific rural workforce development and opportunities for Māori and Pacific rural health leadership.

Unanswered questions and future research

Before our findings are adopted as ‘definitive’ catchments for funding and planning purposes, further work is required to refine these results with a particular focus on qualitative input. Using this platform, further research can then be undertaken

to address questions such as: what is the extent to which NZ rural hospitals improve access to healthcare, improve health outcomes and improve health equity for rural communities, particularly for Māori and Pacific people?; how, why and when do patients bypass rural hospitals?; and how do visitors to rural areas interact with or use rural hospitals?

Key conclusions

We have developed an initial standardised approach to defining the boundaries of rural hospital catchments using routinely collected hospital discharge data. When combined with census population data, this reveals that the populations living in rural hospital catchments are diverse and are therefore likely to have varied healthcare needs and aspirations. Further work is required to refine these catchments, with qualitative input from major stakeholders, before conclusive catchments can be determined.

Supplementary material

Supplementary material is available [online](#).

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Data availability. The raw data used to generate these results are confidential and are therefore unable to be shared. However, upon request, we are able to make available maps and concordance files for each of the rural hospital catchments.

Conflicts of interest. Several authors (KB, RM, SR, and GN) work in rural hospitals. The authors declare no additional conflicts of interest.

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