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Unmasking hidden disparities: a comparative observational study examining the impact of different rurality classifications for health research in Aotearoa New Zealand

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ABSTRACT

Objectives Examine the impact of two generic—urban–rural experimental profile (UREP) and urban accessibility (UA)—and one purposely built—geographic classification for health (GCH)—rurality classification systems on the identification of rural–urban health disparities in Aotearoa New Zealand (NZ).

Design A comparative observational study.

Setting NZ; the most recent 5 years of available data on mortality events (2013–2017), hospitalisations and non-admitted hospital patient events (both 2015–2019).

Participants Numerator data included deaths (n=156 521), hospitalisations (n=13 020 042) and selected non-admitted patient events (n=44 596 471) for the total NZ population during the study period. Annual denominators, by 5-year age group, sex, ethnicity (Māori, non-Māori) and rurality, were estimated from Census 2013 and Census 2018.

Primary and secondary outcome measures Primary measures were the unadjusted rural incidence rates for 17 health outcome and service utilisation indicators, using each rurality classification. Secondary measures were the age-sex-adjusted rural and urban incidence rate ratios (IRRs) for the same indicators and rurality classifications.

Results Total population rural rates of all indicators examined were substantially higher using the GCH compared with the UREP, and for all except paediatric hospitalisations when the UA was applied. All-cause rural mortality rates using the GCH, UA and UREP were 82, 67 and 50 per 10 000 person-years, respectively. Rural–urban all-cause mortality IRRs were higher using the GCH (1.21, 95% CI 1.19 to 1.22), compared with the UA (0.92, 95% CI 0.91 to 0.94) and UREP (0.67, 95% CI 0.66 to 0.68). Age-sex-adjusted rural and urban IRRs were also higher using the GCH than the UREP for all outcomes, and higher than the UA for 13 of the 17 outcomes. A similar pattern was observed for Māori with higher rural rates for all outcomes using the GCH compared with the UREP, and 11 of the 17 outcomes using the UA. For Māori, rural–urban all-cause mortality IRRs for Māori were higher using the GCH (1.34, 95% CI 1.29 to 1.38), compared with the UA (1.23, 95% CI 1.19 to 1.27) and UREP (1.15, 95% CI 1.10 to 1.19).

Conclusions Substantial variation in rural health outcome and service utilisation rates were identified with different classifications. Rural rates using the GCH are substantially higher than the UREP. Generic classifications substantially underestimated rural–urban mortality IRRs for the total and Māori populations.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The impact of three different rurality classifications across a comprehensive range of population-level health outcome and service utilisation indicators was compared.

⇒ Primary care-specific indicators could not be included due to the (un)availability of such data at a national level in Aotearoa New Zealand.

⇒ To enable comparisons, these analyses are based on rural–urban binaries for each classification, however, researchers often apply different subcategory groupings.

⇒ Differences in the socioeconomic profiles of rural and urban populations are likely to contribute to differences in outcomes and are currently exploring the intersection between rurality, socioeconomic status and ethnicity in further research.

INTRODUCTION

Accurately measuring health disparities is important to rural and other disadvantaged populations because evidence underpins policy to address equitable health resource reallocation. In Australia, Canada and Nordic countries, gradients of worsening health outcomes associated with increasing rurality have been identified.[1–3] Such findings are accepted by the respective governments and underpin targeted rural health policy. Extant research suggests Aotearoa New Zealand (NZ hereafter) is an unexpected outlier in terms of the reported relationship between rurality and health outcomes. The principal

	Urban		Rural		
GCH	**U1**	**U2**	**R1**	**R2**	**R3**
Definition *Smallest geography defined at: SA1*	Major urban areas and places within 25 minutes of major urban areas	Large urban areas and places within 20 minutes of large urban areas	Medium urban areas; 0-25 minutes from medium urban areas; 25-60 minutes from major urban areas; 20-50 minutes from large urban areas	Small urban areas (1,000 - 9,999 residents); 0-25 minutes from small urban areas; 60-90 minutes from major urban areas; 50-80 minutes from large urban areas; 25-60 minutes from medium urban areas	More than 90 minutes from major urban areas; more than 80 minutes from large urban areas; more than 60 minutes from medium urban areas; more than 25 minutes from small urban areas

UA	**Major urban**	**Large urban**	**Medium urban**	**High urban accessibility**	**Medium urban accessibility**	**Low urban accessibility**	**Remote**	**Very remote**
Definition *Smallest geography defined at: SA1*	Communities of 100,000 or more residents	Communities of 30,000 - 99,999 residents	Communities of 10,000 - 29,999 residents	0-15 minutes from major urban areas	15-25 minutes' drive from major urban areas; 0-25 minutes from large urban areas; 0-15 minutes from medium urban areas	25-60 minutes' drive from major urban areas; 25-60 minutes from large urban areas; 15-60 minutes from medium urban areas	60-120 minutes from major, large, or medium urban areas	More than 120 minutes from major, large, or medium urban areas

UREP	**Main urban**	**Satellite urban**	**Independent urban**	**Rural areas with high urban influence**	**Rural areas with moderate urban influence**	**Rural areas with low urban influence**	**Highly rural/remote areas**
Definition *Smallest geography defined at: Meshblock*	Communities of 30,000 or more residents	Communities of 1,0000 - 29,999 residents, where ≥ 20% of the working population works in a main urban area	Communities of 1,0000 - 29,999 residents, where < 20% of the working population works in a main urban area	Communities of less than 1,000 where a significant proportion of the employed population work in a main urban area	Communities of less than 1,000 where a large percentage of the employed population works in a minor or secondary urban area, or a significant percentage work in a main urban area	Communities of less than 1,000 where the majority of the population works in a rural area	Communities of less than 1,000 where there is minimal dependence on urban areas in terms of employment, or there is a very small employed population

Figure 1 Outline of the three rurality classifications used in this analysis, where the rural–urban split occurs, and how each subcategory is defined. GCH, geographic classification for health; SA1, statistical areas 1s; UREP, urban–rural experimental profile.

impact of rurality on health occurs indirectly, by exacerbating other determinants of health.[4] NZ's rural towns have high levels of socioeconomic deprivation and older age structures.[5 6] However, the conclusion drawn in the NZ National Health Committee[7] report on the health of rural NZ was that 'life expectancy and other measures of health status are similar for rural and urban populations overall', reinforcing a previous report[8] and existing health policy settings.[9] The apparent lack of rural–urban health variation in NZ is likely an artefact of inconsistent and inappropriate definitions of rurality that obscure the 'on-the-ground' reality.[10 11] Analytical results can vary according to the size, number and configuration of spatial units that are used.[12 13] Choosing an appropriate rurality classification is an essential component of rural health research, as different classifications aggregate different populations into rural or urban categories resulting in different rural–urban population demographics. International literature, primarily from the USA, indicates that these differences can be substantial.[14–16] The differential aggregation of populations—and their associated health outcomes—into rural or urban categories significantly alters the results of rural–urban analyses.[17–19] Since different classification systems can produce different results, it is incumbent on researchers to be transparent when selecting a rurality classification and to make every effort to ensure the classification system aligns with the purpose of the research.[18]

Until recently, NZ has had no agreed definition of urban and rural for health research and policy and has instead relied on more than 30 generic and ad hoc classification systems.[20] The most frequently used classification has been the seven-level Statistics NZ (Stats NZ) urban–rural experimental profile (UREP)[21] that was based on population size and commuter patterns. The UREP was replaced with the eight-level urban accessibility (UA) classification[22] that classifies statistical area 1s (SA1; median 153 usual residents per SA1) into three urban and five 'rural' (Statistics NZ refers to these categories as 'small urban and rural areas', but for the purposes of this paper we are referring to them as 'rural' areas) categories. Both the UREP and the UA are generic urban–rural classifications that were not specifically designed for health research. A major criticism of the UREP from a health analysis perspective is that it inappropriately classifies several types of communities. Specifically, medium-sized communities (populations between 1000 and 29 999) that have minimal links to larger urban areas and are geographically remote, would be more appropriately classified as rural from a health perspective. Furthermore, the wealthy commuting zones located on the fringes of metropolitan centres would be more appropriately classified as urban.[23] In addition, the different permutations of the UREP found in the NZ health policy and research literature[20] contributes to a lack of consistent evidence about the health needs and outcomes of rural communities in NZ, with contrasting conclusions being drawn from analysis of the same health data.[10] The UA uses updated statistical geographies and considers potential access to urban areas rather than using commuting data that excludes children and unemployed people. However, it remains a generic classification with population and travel time thresholds not specifically designed for health research and policy purposes. While Stats NZ has not specifically designed the UA as a binary rural–urban classification, it will doubtlessly be used to categorise areas as either urban or rural. This means a continued risk of researchers classifying the urban fringe as rural, and medium-sized isolated communities as urban. A novel five-level urban–rural classification, the geographic classification for health (GCH) was recently developed to address these issues.[23] Although the GCH uses the same small geographical areas, population data and drive time formulas as the UA, the 'thresholds' substantially differ. These were developed from a health perspective, in consultation with more than 300 individuals from 20 organisations, and better align with the purpose of the GCH as a classification for health research and policy. The nature of the functional relationships between urban areas and rural surrounds have also been considered through a health lens. The GCH was tested both quantitatively using primary healthcare enrolment data—where it performed better than previous classifications (93%–95% accuracy compared with 66%–70% for the UREP and 81% for the UA)— and qualitatively in partnership with the Ministry of Health's (MoH) National Rural Health Advisory Group.[23]

The aim of this study is to examine the impact of two generic (UREP, UA) and one purposely built (GCH) rurality classification systems on the identification of health disparities in rural NZ. To date, no such analysis has been undertaken in the NZ context. Internationally, comparisons of rurality classifications have only compared generic classifications and focus on specific conditions, rather than a range of health outcome and utilisation indicators.

METHODS

This comparative observational study used routinely collected health data to examine unadjusted rural incidence rates for 17 health indicators (primary measures) and age-sex-adjusted rural and urban incidence rate ratios (IRRs) for the same 17 health indicators (secondary measures). Both primary and secondary outcomes were produced for the total NZ and Māori population using three rurality classifications: the GCH, the UA classification and the UREP. Figure 1 details the three rurality classifications including definitions of their component categories. To calculate comparable IRRs and examine the similarities and differences between the three classifications, classifications were collapsed to a rural–urban binary (see figure 1). The 17 health indicators include common mortality and heath service utilisation outcomes found in previous rural health reports.[7 24]

Numerator data

Extracts of three administrative data collections were obtained from the MoH. This included the most recently available 5 years of data from the mortality collection (2013–2017), the national minimum dataset (NMDS) of hospital discharges (2015–2019) and the national non-admitted patient collection (NNPAC) (2015–2019). Each data set included the person's age at time of event, sex, ethnicity (Māori, the Indigenous people of NZ or non-Māori) and a geographical unit representing the area encompassing their residential address ('meshblock' (median 84 residents) in the mortality collection and 'domicile' (composed of multiple meshblocks, median 2079 residents) for the other collections). SA1s are composed of multiple meshblocks and this geographical information was used to assign 'rurality' according to the UA and GCH which are defined using 2018 SA1s. Meshblock boundaries are updated with each census, and therefore, a forward-mapping approach, using population weights, was applied to older meshblocks to assign the UA and GCH. A similar back-mapping approach was used to assign UREP which is defined using 2006 meshblocks. Both population-weighted forward-mapping and back-mapping of meshblocks were applied to assign rurality to the domicile codes in the NMDS and NNPAC data extracts.

Within the mortality collection, the underlying cause of death, coded to The International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian Modification (ICD-10-AM), was also obtained. This was used to identify deaths resulting from cardiovascular disease (CVD; ICD-10-AM I00-I99), cancer (ICD-10-AM C00-C96, D45-D47) and injury (ICD-10-AM V01-Y36).[25] Amenable mortality defined by the MoH as deaths in those less than 75 years of age 'from conditions for which variation in mortality rates (over time and across populations) reflects variation in the coverage and quality of healthcare (preventive or therapeutic services) delivered to individuals' was also defined using ICD-10-AM codes.[26] In order to account for (often rapid) transfers between hospitals and avoid overcounting, admissions were bundled into episodes of care within the NMDS.[27] Admissions were considered part of the same care episode if there was a discharge followed by an admission to a different facility within 1 day. The primary diagnosis relating to the hospital discharge was used to identify hospitalisations primarily for CVD, cancer and mental and behavioural disorders (ICD-10-AM F00-F99). Ambulatory sensitive hospitalisations (ASH) defined as hospitalisations of people less than 75 years of age 'resulting from diseases sensitive to prophylactic or therapeutic interventions that are deliverable in a primary healthcare setting' were also identified using defined ICD-10-AM codes and age thresholds.[25] Paediatric hospitalisations were classified as those occurring in patients under 15 years of age. All operations and procedures recorded in the clinical code table in the time period were included. NNPAC records for outpatient services were categorised as first and follow-up specialist appointments (using the event type and service type variables) and as first and follow-up subspecialty appointments (using the health specialty code). The services included in the subspecialty outpatient indicators are listed (specialty codes) in online supplemental table 1. NNPAC records for emergency department (ED) attendances were identified using the event type variable.

Statistical analysis

For each rurality classification, annual denominators, by age (5-year age groups and 85+ years), sex and ethnicity (Māori, non-Māori), were estimated from Census 2013 and Census 2018 usually resident population counts using linear interpolation and extrapolation. The denominator used to calculate mortality rates was the sum of the annual denominators for 2013–2017 (ie, rate per 10 000 person-years). For rates using hospitalisations and non-admitted patient events, the denominator used was the sum of the annual denominators for 2015–2019 (ie, rate per 10 000 person-years). Unadjusted incidence rates are presented as they are important indicators of the health status, and therefore, the health needs of the community as a collective whole. Age-sex-adjusted incidence rates, also presented, facilitate the comparison of populations after the potential confounding influence of age and sex has been accounted for. Rural–urban IRRs were calculated by dividing the incidence rate for rural residents by the incidence rate derived for urban residents; a rural–urban IRR less than one indicates that the ‘rural’ incidence rate is smaller than the ‘urban’ incidence rate. To help with interpretation, 95% CIs, obtained from Poisson regression models, are presented for both the unadjusted and adjusted IRRs.

Data were prepared by using SAS software.[28] Stata V.17.0[29] was used for the analysis, and R[30] plus the packages ggplot2[31] and ggh4x[32] to produce the forest plots.

Patient and public involvement

None.

RESULTS

Demography of rural NZ

Overall, the rural population as defined by the GCH is larger (19%) than the UREP rural population (15%) but smaller than the UA rural population (26%) (table 1). A higher proportion of Māori live in rural areas according to the GCH (25%) than the UREP (16%) but not the UA (33%). In all classifications those aged 50–74 years have the largest proportion of rural residents. However, the GCH classifies a similarly high proportion of over 75 years as rural residents. This is not noted under the UREP or UA classifications.

Health outcome indicators

Clear and substantial differences between the classifications can be seen in the mortality indicators, with the GCH defined rural population having poorer outcomes in both absolute terms and when compared with the respective urban population. Aside from injury mortality, unadjusted rural mortality rates are higher for all mortality indicators when the GCH is used to classify rurality for both the total NZ and Māori population (tables 2 and 3). For instance, total NZ all-cause rural mortality rates using the GCH are 65% higher than the UREP-produced rates (82 compared with 50 per 10 000), and 22% higher than rates using the UA (82 compared with 67 per 10 000). For Māori, the differences between the rates produced by each classification are less pronounced. All-cause rural mortality rates using the GCH are 6% higher than the UA, and 9% higher than the UREP, while amenable mortality rates for rural Māori using the GCH are 8% and 10% higher, respectively, than the UA and UREP.

For the total NZ population, rural–urban IRRs indicate that unadjusted mortality rates for rural residents are at least 20% higher than urban residents across all mortality indicators using the GCH, whereas for all-cause and CVD mortality the IRRs for both the UA and UREP suggest that mortality rates are higher for urban residents (table 2). Cancer mortality rates are also higher for urban residents using the UREP. Rural–urban IRRs were most similar across the three classifications for injury deaths. A similar pattern is observed for age-sex-adjusted IRRs, with rural–urban IRRs consistently higher using the GCH (figure 2, online supplemental table 2). Also, in contrast to the UREP and UA, the age-sex-adjusted rural and urban IRRs for the GCH are all above 1 indicating that adjusted rural mortality rates are higher than the urban rates. For Māori, unadjusted rural–urban mortality IRRs range from 1.31 to 1.41 using the GCH, 1.20–1.28 using the UA and 1.13–1.32using the UREP (table 3). Substantial differences are observed between IRRs produced using the GCH compared with both the UA and UREP for all-cause, CVD and amenable mortality. A similar pattern is observed for age-sex-adjusted rural and urban IRRs, with Māori rural–urban IRRs being consistently higher using the GCH (figure 3, online supplemental table 3).

Health service utilisation indicators

The population defined as rural by the GCH has consistently higher rates of health service utilisation (hospitalisations and non-admitted patient events) than the UREP rural population, both in absolute terms and relative to the respective urban population. Similar comparison between the rates and IRRs produced by the GCH and the UA fails to demonstrate such a consistent pattern of difference.

For the total NZ population, unadjusted rural hospitalisation rates were substantially higher when using the GCH compared with the UA and UREP, with the exception of paediatric hospitalisations. Unadjusted rates of all-cause rural hospitalisations (episodes of care) using the GCH were 21% higher than the UREP and 3% higher than the UA (2293, 1904 and 2222 per 10 000, respectively). Unadjusted rural hospitalisation rates for

Table 1 Comparison of 2018 New Zealand (NZ) census usually resident population distribution by ethnicity and age for 3 rurality classifications (N=4 698 795)

Classification		All categories of classifications							
		Total Population		Ethnicity (Col %)		Age in years (Col %)			
Binary	All categories	N	Col %	Māori	Non-Māori	0–24	25–49	50–74	75+
Totals (used as denominator for column %)		4 698 795		775 626	3 922 881	1 542 366	1 569 237	1 284 462	302 442
Urban–rural experimental profile									
Urban	Main urban	3 356 031	71.4	64.5	72.8	73.4	74.6	66.0	68.0
Urban	Satellite urban	159 396	3.4	4.4	3.2	3.4	3.1	3.5	4.2
Urban	Independent urban	498 204	10.6	15.0	9.7	9.6	9.1	12.2	16.7
Rural	Rural high urban influence	174 108	3.7	2.9	3.9	3.5	3.4	4.6	2.5
Rural	Rural medium urban influence	191 463	4.1	4.4	4.0	3.8	3.6	5.3	3.2
Rural	Rural low urban influence	254 994	5.4	7.2	5.1	5.1	4.9	6.7	4.3
Rural	Highly remote/rural	64 311	1.4	1.7	1.3	1.3	1.3	1.6	1.1
Unclassifiable		288							
Urban		4 013 631	85.4	83.9	85.7	86.3	86.9	81.8	89.0
Rural		684 876	14.6	16.1	14.3	13.7	13.1	18.2	11.0
Urban accessibility (UA)*									
Urban	Major urban	2 406 504	51.2	38.6	53.7	53.4	56.1	44.6	42.9
Urban	Large urban	662 406	14.1	20.6	12.8	14.3	13.2	14.2	17.2
Urban	Medium urban	401 292	8.5	8.1	8.6	7.8	7.6	9.2	14.0
Rural	Rural high UA	192 390	4.1	3.4	4.2	4.1	3.8	4.7	2.9
Rural	Rural medium UA	370 488	7.9	9.0	7.7	7.5	7.1	9.5	7.1
Rural	Rural low UA	453 216	9.6	12.5	9.1	8.9	8.4	11.9	10.8
Rural	Remote	178 479	3.8	6.3	3.3	3.5	3.2	4.8	4.3
Rural	Very remote	33 744	0.7	1.5	0.6	0.6	0.6	1.0	0.7
Unclassifiable		276							
Urban		3 470 202	73.9	67.3	75.1	75.5	77.0	68.0	74.2
Rural		1 228 317	26.1	32.7	24.9	24.5	23.0	32.0	25.8
Geographical classification for health									
Urban	U1	2 960 898	63.0	49.1	65.8	65.1	67.2	57.4	55.0
Urban	U2	845 061	18.0	25.5	16.5	17.6	16.2	19.5	22.3
Rural	R1	570 105	12.1	14.0	11.8	11.0	10.8	14.4	15.0
Rural	R2	266 820	5.7	9.0	5.0	5.2	4.8	7.1	6.6
Rural	R3	55 629	1.2	2.3	1.0	1.1	1.0	1.6	1.0
Unclassifiable		282							
Urban		3 805 959	81.0	74.7	82.3	82.7	83.4	76.9	77.3
Rural		892 554	19.0	25.3	17.7	17.3	16.6	23.1	22.7

*In the StatsNZ documentation the binary classification of the UA is 'urban' and 'small urban and rural'; for simplicity, the latter is referred to as 'rural'.

mental and behavioural disorders using the GCH were 50% higher than the UREP and 15% higher than the UA classification (45, 29 and 38 per 10 000, respectively) (online supplemental table 4). A similar pattern was observed for the Māori population with unadjusted rates substantially higher when the GCH was used as opposed to the UREP (table 3). ASH rates for rural Māori were 14% higher using the GCH rather than the UREP (356 compared with 314 per 10 000). Interestingly, unadjusted hospitalisation rates for Māori were highest using the UA for some outcomes. When compared with the UREP, the GCH produces substantially higher rates of hospitalisations for rural residents. For hospitalisations among the total NZ population, the same general pattern is observed for both unadjusted IRRs (table 2) and age-sex-adjusted IRRs (figure 2), with most IRRs having a value of less than one and with the IRRs from the UREP being considerably smaller than those produced using the UA and GCH.

Table 2 Rural:urban incidence rate ratios (IRRs) for a range of outcomes for three rurality classifications; total NZ population

	UREP		UA		GCH	
	Rural:urban IRR		Rural:urban IRR		Rural:urban IRR	
	Est.	95% CI	Est.	95% CI	Est.	95% CI
Mortality (2013–2017)						
All cause	0.67	(0.66 to 0.68)	0.92	(0.91 to 0.94)	1.21	(1.19 to 1.22)
CVD	0.61	(0.60 to 0.63)	0.89	(0.87 to 0.91)	1.22	(1.19 to 1.24)
Cancer	0.84	(0.81 to 0.86)	1.08	(1.06 to 1.10)	1.31	(1.28 to 1.34)
Injury	1.15	(1.09 to 1.22)	1.24	(1.19 to 1.30)	1.40	(1.34 to 1.47)
Amenable (<75 years)	1.04	(1.01 to 1.08)	1.22	(1.19 to 1.25)	1.43	(1.39 to 1.47)
Hospitalisations (2015–2019)						
Episodes of care						
All cause	0.79	(0.79 to 0.79)	0.93	(0.93 to 0.93)	0.97	(0.97 to 0.98)
CVD	0.79	(0.78 to 0.80)	1.00	(0.99 to 1.01)	1.13	(1.13 to 1.14)
Cancer	0.94	(0.93 to 0.95)	1.16	(1.15 to 1.17)	1.25	(1.24 to 1.26)
Mental and behavioural disorders	0.54	(0.53 to 0.55)	0.69	(0.68 to 0.70)	0.85	(0.84 to 0.87)
Paediatric (<15 years)	0.75	(0.74 to 0.75)	0.82	(0.82 to 0.83)	0.83	(0.82 to 0.83)
Ambulatory sensitive hospitalisations (<75 years)	0.73	(0.72 to 0.73)	0.88	(0.87 to 0.88)	0.90	(0.89 to 0.90)
All operations/procedures	0.88	(0.88 to 0.88)	1.02	(1.02 to 1.02)	1.06	(1.05 to 1.06)
Non-admitted patient events (2015–2019)						
Outpatients						
All specialist outpatients						
First	0.88	(0.88 to 0.89)	1.12	(1.12 to 1.12)	1.35	(1.35 to 1.35)
Follow-up	0.78	(0.78 to 0.78)	0.98	(0.98 to 0.98)	1.11	(1.11 to 1.12)
Subspecialty outpatients						
First	0.80	(0.80 to 0.81)	0.93	(0.93 to 0.94)	1.05	(1.04 to 1.05)
Follow-up	0.77	(0.77 to 0.78)	0.90	(0.90 to 0.90)	0.95	(0.95 to 0.95)
Emergency department						
All attendances	0.80	(0.79 to 0.80)	0.93	(0.93 to 0.93)	1.09	(1.09 to 1.09)

CVD, cardiovascular disease; GCH, geographic classification for health; NZ, New Zealand; UA, urban accessibility; UREP, urban rural experimental profile.

For instance the age-sex-adjusted mental and behavioural disorder hospitalisation IRRs for the GCH, UA and UREP are 0.88, 0.73 and 0.58, respectively. A similar pattern was observed for Māori (table 3, figure 3, online supplemental table 3). The relative rates of hospitalisations for rural Māori compared with urban Māori were all substantially closer to one when the GCH was applied instead of the UREP, with an adjusted all-cause hospitalisation IRR of 0.85 for the GCH compared with 0.76 using the UREP.

For the total NZ population, unadjusted rural incidence rates for outpatient and ED events were substantially higher when using the GCH compared with the UA and UREP (online supplemental table 4). Rates of first specialist outpatient events for rural residents were 17% and 41% higher when the GCH was used compared with the UA and UREP, respectively (GCH: 3687, UA: 3156, UREP: 2961; per 10 000). Similar differences between the classifications were also observed for the Māori population (online supplemental table 5). For instance, rates of first specialist outpatient events for rural Māori using the GCH were 11% and 33% higher than the UA and UREP, respectively. Comparing the impact of rurality classifications on unadjusted rural–urban IRRs for non-admitted patient events also showed higher estimates using the GCH compared with both the UA and UREP for the total NZ population. For instance, the GCH shows that rural residents are 35% more likely than urban residents to have a first specialist outpatient event (unadjusted IRR 1.35) while the UREP indicates that rural residents are 12% less likely to have such an event (unadjusted IRR 0.88). A very similar pattern for Māori with regard to unadjusted IRRs was observed, with rural–urban IRRs for non-admitted patient events also showing higher estimates using the GCH compared with both the UA and UREP—with the exception of subspecialty follow-up events for which rural rates were highest using the UA (table 3, online supplemental table 5). The GCH shows that Māori in rural areas are 23% more likely than urban Māori to have a first

Table 3 Rural:urban incidence rate ratios (IRRs) for a range of outcomes for three rurality classifications; Māori population

	UREP		UA		GCH	
	Rural:urban IRR		Rural:urban IRR		Rural:urban IRR	
	Est.	95% CI	Est.	95% CI	Est.	95% CI
Mortality (2013–2017)						
All cause	1.15	(1.10 to 1.19)	1.23	(1.19 to 1.27)	1.34	(1.29 to 1.38)
CVD	1.20	(1.12 to 1.29)	1.28	(1.21 to 1.36)	1.41	(1.33 to 1.49)
Cancer	1.17	(1.10 to 1.26)	1.25	(1.19 to 1.33)	1.34	(1.26 to 1.42)
Injury	1.32	(1.17 to 1.49)	1.22	(1.11 to 1.35)	1.35	(1.22 to 1.50)
Amenable (<75 years)	1.13	(1.06 to 1.21)	1.20	(1.14 to 1.26)	1.31	(1.24 to 1.38)
Hospitalisations (2015–2019)						
Episodes of care						
All-cause	0.78	(0.77 to 0.78)	0.88	(0.88 to 0.89)	0.88	(0.87 to 0.88)
CVD	0.91	(0.89 to 0.93)	1.05	(1.03 to 1.07)	1.03	(1.01 to 1.05)
Cancer	1.07	(1.03 to 1.10)	1.16	(1.13 to 1.20)	1.19	(1.16 to 1.23)
Mental and behavioural disorders	0.55	(0.53 to 0.57)	0.68	(0.66 to 0.70)	0.74	(0.72 to 0.77)
Paediatric (<15 years)	0.75	(0.74 to 0.76)	0.85	(0.84 to 0.85)	0.83	(0.82 to 0.84)
Ambulatory sensitive hospitalisations (<75 years)	0.72	(0.71 to 0.74)	0.84	(0.83 to 0.85)	0.82	(0.81 to 0.83)
All operations/procedures	0.86	(0.85 to 0.86)	0.97	(0.97 to 0.98)	0.98	(0.98 to 0.98)
Non-admitted patient events (2015–2019)						
Outpatients						
All specialist outpatients						
First	0.86	(0.85 to 0.86)	1.07	(1.07 to 1.08)	1.23	(1.22 to 123)
Follow-up	0.82	(0.82 to 0.82)	0.97	(0.97 to 0.97)	0.98	(0.98 to 0.98)
Subspecialty outpatients						
First	0.78	(0.77 to 0.79)	0.95	(0.94 to 0.96)	1.06	(1.05 to 1.07)
Follow-up	0.89	(0.89 to 0.90)	0.98	(0.97 to 0.98)	0.96	(0.96 to 0.97)
Emergency department						
All attendances	0.71	(0.70 to 0.71)	0.87	(0.86 to 0.87)	0.98	(0.98 to 0.99)

CVD, cardiovascular disease; GCH, geographical classification for health; UA, urban accessibility; UREP, urban–rural experimental profile.

specialist outpatient event (unadjusted IRR 1.23) while the UREP indicates that rural Māori are 14% less likely to have such an event (unadjusted IRR 0.86). Interesting patterns in the differences between the age-sex-adjusted IRRs for outpatient events were observed with substantial variation between the three classifications apparent for all first specialist appointments (GCH: 1.22, UA: 1.05, UREP: 0.88) but noticeably less so for follow-up subspecialty appointments (GCH: 0.79, UA: 0.77, UREP: 0.71) (figure 2, online supplemental table 2). This pattern was also observed for Māori (figure 3, online supplemental table 3) Considerable variation between the classifications in the age-sex-adjusted IRRs for ED attendances was also apparent for the total NZ population and for Māori.

DISCUSSION

When compared with both the recently retired (UREP) and the new (UA) Stats NZ generic rurality classifications, the purposively built GCH defines an NZ rural population that has substantially higher rates of mortality and health service utilisation indicators, with the exception of paediatric hospitalisations. For Māori, a similar pattern is observed although some rates produced using the UA were higher than the GCH. For all five mortality indicators, the adjusted rural–urban IRRs produced using the GCH compared with the UREP and UA indicated that rural health outcome disparities are underestimated using the generic classifications. For hospitalisations, the adjusted IRRs produced from the GCH and UA were similar; both indicated that for these measures of health service utilisation rates for rural residents are more similar to rates for urban residents (ie, closer to 1) than when the UREP is used. Adjusted rates of first specialist outpatient appointments and ED attendances were higher for rural residents than urban residents using the GCH whereas the opposite was observed when the UREP was used. For the other three outpatient indicators, the adjusted IRRs indicated that the GCH

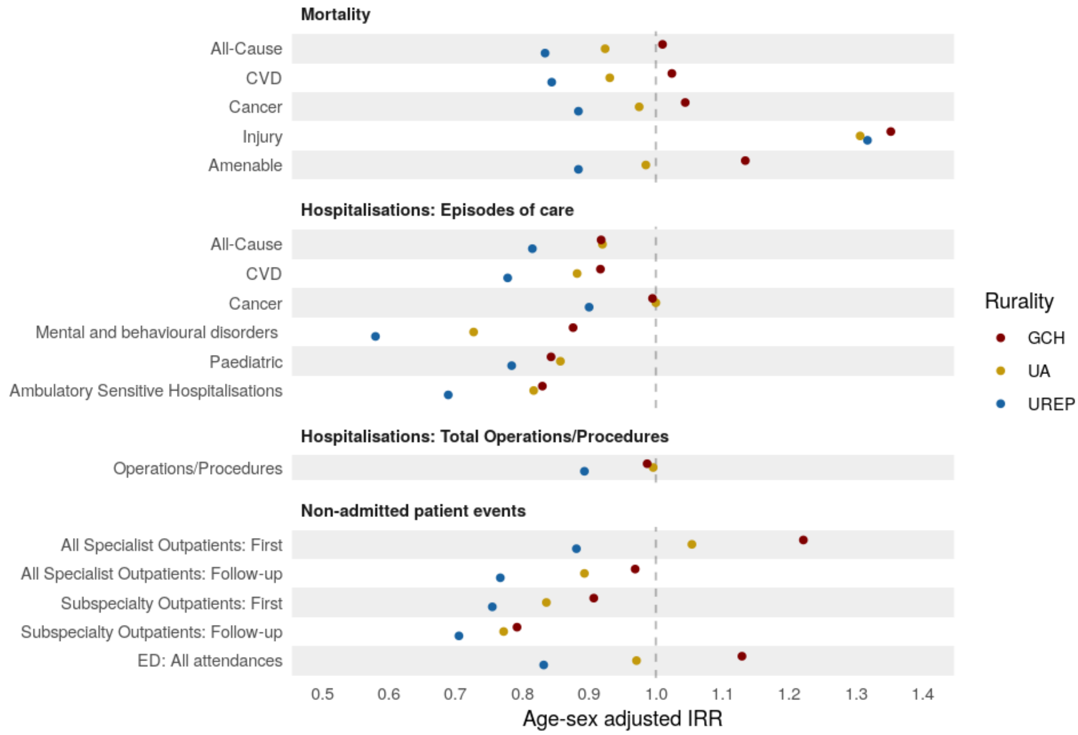

Figure 2 Total NZ population adjusted rural–urban incidence rate ratios (IRRs; urban=reference). CVD, cardiovascular disease; ED, emergency department; NZ, New Zealand; UA, urban accessibility; UREP, urban–rural experimental profile.

estimated rates to be more similar for rural and urban residents than the UA and the UREP.

Similar results were obtained for the Māori population. The differences observed between the unadjusted IRRs are greater than those seen in the age-sex-adjusted IRRs, suggesting that, because of its age profile, the GCH-defined rural population has even higher healthcare needs (relative to their respective urban populations)

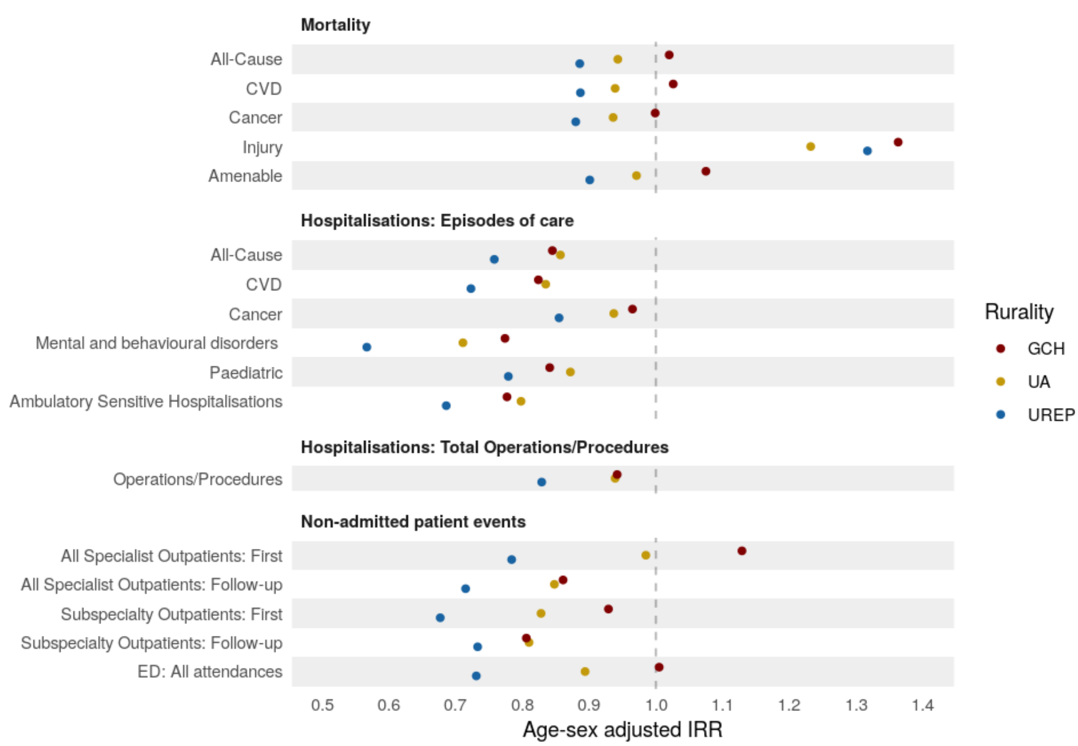

Figure 3 Māori population adjusted rural–urban incidence rate ratios (IRRs; urban=reference). CVD, cardiovascular disease; ED, emergency department; NZ, New Zealand; UA, urban accessibility; UREP, urban–rural experimental profile.

than the UREP-defined or UA-defined rural population. The primary aim of this study was to compare the results generated by different rurality classifications, but it is an important finding that, with the exception of injury, the GCH defines a rural population that has higher mortality rates than the corresponding urban population, whereas the opposite is true when the UREP and the UA are applied to the same datasets. Furthermore, despite having higher mortality rates than their urban peers, the rural populations have lower rates of hospitalisation and operations/procedures than urban populations.

In addition to demonstrating differences between the classification systems, this study has also shown that when using the GCH, rural residents have higher mortality rates yet lower rates of hospitalisation and operations or procedures than urban populations.

These results are important because the majority of health researchers and policy-makers have in the past employed Stats NZ classifications, or permutations thereof, to evaluate the relative health status of urban and rural New Zealanders. The GCH has been purposively designed and validated for health research purposes. Specifically, the population and drive-time thresholds were developed with consideration to the functional dynamics between urban and rural areas, through extensive consultation, and with a strong health lens. These thresholds therefore better align with the reality of health service provision in rural and urban areas of NZ. Therefore, we argue that results produced by the GCH are a more accurate reflection of the state of health in rural NZ and pose a significant challenge to the validity of previous MoH reports using generic classifications, primarily the UREP. The reality of rural health in NZ appears to align more closely with similar international contexts than previously appreciated.[2 3 33] The failure to accurately identify the extent of rural health disparities in NZ has been a disincentive to targeted health policy over several decades. The relative health status of rural and urban populations needs re-evaluated in light of our findings, prior to NZ's newly established national public health system undertaking its legislated requirement to develop a rural health strategy.[34] This paper provides further evidence for the need to carefully and conscientiously select an appropriate rurality classification[18] when undertaking health research and highlights the value of a rurality classification designed with heath and health service delivery in mind. At all levels, the rural–urban disparities identified in this study are considerably smaller than the disparities between Māori and non-Māori, and ethnic health inequities remain the largest and most stark in NZ. The added impact rurality has in exacerbating ethnic health inequities has been described in detail elsewhere.[35]

Strengths and weaknesses of the study

To our knowledge, our paper is the first to examine a comprehensive range of health indicators that encompass both outcomes and service utilisation, in order to compare generic taxonomies with a purposively designed and validated rurality classification for health. To date, most international evidence on the topic comes from the USA, and tends to focus on either specific health outcomes (eg, HIV[19]), specific health services (eg, hospices[36]) or specific populations (eg, veterans[15]), and compares established but generic rurality classifications. To focus on comparing rurality classifications, we have not considered differences in the socioeconomic profile of the different rural populations using the three classifications. We have been unable to include any primary care related indicators, due to the difficulty of accessing comprehensive primary care data at a national level in NZ. To enable comparisons between the different classifications, our analyses are based on a rural–urban binary categorisation for each classification, however, researchers often apply different subcategory groupings.

Unanswered questions and future research

Although the estimates obtained using the GCH in this study provide important new findings that update NZ's rural health evidence, only 17 broad national level indicators were considered. Further investigation is now required into rural health examining a range of health indicators using the GCH. Disentangling the interactions between rurality, ethnicity and socioeconomic deprivation will be essential to establish whether rurality has an influence on health outcomes and service utilisation over-and-above the social determinants of health, and how this may impact Māori, Pacific and other ethnicities differently. The lower relative rates of rural hospitalisation observed in our results are inconsistent with the higher rates of rural mortality in NZ, and the higher rural hospitalisations seen in other contexts[2] raising the possibility of poorer health service access for rural populations in NZ. Finally, considerably higher rural–urban differences were observed in rates for amenable mortality compared with all-cause mortality. One possible explanation is the migration of rural people to cities when they became older and frailer in order to be closer to health services and residential care facilities, an effect that will lower rural mortality rates and further mask rural–urban health outcome disparities. Deaths in those aged 75 years and above are by definition excluded from the amenable mortality indicator. The impact of rural–urban relocation in the later years of life and its effects on rural health statistics and healthcare need has not been examined in NZ to date and will be examined in our further research. In NZ, generic rurality classifications have been underestimating rates of rural health outcomes and service utilisation. These become evident when a rural–urban taxonomy, specifically designed for health research and policy, is applied to the same data. The results of this study mandate a re-evaluation of the health status of rural NZ and emphasise the importance of utilising a classification which is 'fit for purpose' when conducting research into the health of rural populations.

Conclusion

Our analysis has identified substantial variation in rural health outcome and service utilisation rates when different rurality classifications are used to define rural and urban areas of NZ. We have found that generic rurality classifications substantially underestimate rural–urban mortality IRRs for the NZ total and Māori populations.

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