Comparison of the Sociodemographic Composition of Rural and Urban Aotearoa New Zealand: Insights from Applying the Geographic Classification for Health to the 2018 Census

JESSE WHITEHEAD,[*, 1] JUNE ATKINSON,[2] GABRIELLE DAVIE,[3]
BRANDON DE GRAAF,[3] KYLE EGGLETON,[4] SUE CRENGLE,[5]
RORY MILLER,[6, 7] KATHARINA BLATTNER,[6, 8] PETER CRAMPTON,[9]
AND GARRY NIXON[6, 10]

Abstract

Generic rurality classifications in Aotearoa New Zealand lack adequacy for health research and policy, hindering understanding of rural-urban sociodemographic differences. To address this, we utilise the fit-for-purpose and novel Geographic Classification for Health. Responses to the 2018 Census are analysed at the SA2 level to describe and compare sociodemographic characteristics of rural and urban residents at national and regional scales. The rural-urban distribution of socio-economic deprivation is also examined using NZDep2018. This research establishes a baseline for understanding health care needs and sociodemographic changes

---

[*] Jesse Whitehead is a researcher at Te Ngira, Te Whare Wananga o Waikato |University of Waikato. Corresponding author: jesse.whitehead@waikato.ac.nz
Author affiliations:

1. Te Ngira: Institute for Population Research, Te Whare Wananga o Waikato |University of Waikato, Hamilton, New Zealand.
2. Department of Public Health, Te Whare Wānanga o Ōtākou | University of Otago, Wellington, New Zealand
3. Department of Preventive and Social Medicine, Te Whare Wānanga o Ōtākou | University of Otago, Dunedin, New Zealand
4. Department of General Practice and Primary Health Care, Waipapa Taumata Rau | University of Auckland, Auckland, New Zealand.
5. Ngai Tahu Māori Health Research Unit, Division of Health Sciences, Te Whare Wānanga o Ōtākou | University of Otago, Dunedin, New Zealand.
6. Department of General Practice and Rural Health, Te Whare Wānanga o Ōtākou | University of Otago, Dunedin, New Zealand.
7. Thames Hospital, Te Whatu Ora Health New Zealand, Waikato, New Zealand.
8. Rawene Hospital, Hauora Hokianga, Northland, New Zealand.
9. Kōhatu, Centre for Hauora Māori, Te Whare Wānanga o Ōtākou | University of Otago, Dunedin, New Zealand
10. Dunstan Hospital, Clyde, New Zealand.

in Aotearoa's rural and urban communities, including disparities by ethnicity and Te Whatu Ora Health region.

Whakarāpopotonga

He takarepa ngā whakarōpūtanga tuawhenua arowhānui kei Aotearoa mō te rangahau me ngā kaupapahere hauora, ka mutu ka ārai i te māramatanga ki ngā rerekētanga hangapori-pāpori tuawhenua-tāone. Hei whakatika i tēnei, e whakamahi ana mātou i te Whakarōpūtanga Matawhenua hou, tino hāngai hoki mō te Hauora. E tātaritia ana ngā urupare ki te Tatauranga 2018 i te taumata SA2 hei whakaahua me te whakataurite i ngā āhuatanga hangapori-pāpori o ngā kainoho tuawhenua me ngā kainoho tāone i te taumata ā-motu me te taumata ā-rohe. E ārohia ana anō hoki te horahanga tuawhenua-tāone o te pakukore ohapori mā te whakamahi i te NZDep2018. Ko tā te rangahau nei he whakapūmau i te paerewa e mārama ai te tangata ki ngā hiahia tiaki hauora me ngā panoni hangapori-pāpori i ngā hapori tuawhenua me te tāone o Aotearoa, taea noatia ngā manarite-kore ā-mātāwaka me te rohe o Te Whatu Ora.

Ngā kupu matua tuawhenuatanga, tokoingoa pāpori o te hauora, whakarōpūtanga matawhenua mō te hauora

R ural health research, planning and advocacy in Aotearoa New Zealand (hereafter, New Zealand) has been hindered by the lack of a rurality classification that is suitable for health research purposes (Fearnley et al., 2016; Whitehead, Davie, et al., 2022). This means that different definitions of rurality have been used across multiple contexts, making it very difficult to compare and contrast data and resulting in contradictory evidence being produced, even when using the same data (Fearnley et al., 2016; Whitehead, Davie, et al., 2022). The geographic classification that is applied to data can materially alter the results of epidemiological studies and rurality classifications used in health analyses need to be appropriate (Weissman et al., 2014). The lack of an appropriate classification can mask disparities, hinder health service planning, and slow the development of meaningful health promotion initiatives and public health action needed to address the social determinants of health (SDH) in rural areas (Nelson et al., 2021).

This issue has recently been addressed in New Zealand with the development of a novel and fit-for-purpose rurality classification: the

Geographic Classification for Health (GCH) (Nixon et al., 2021; Whitehead, Davie, et al., 2022). Although the GCH uses the same small geographic areas, population data and drive-time formulas as the Stats NZ Urban Accessibility Classification (UA; released in 2021) (Stats NZ, 2020), the thresholds differ substantially and align better with the purpose of the GCH as a classification for health research and policy. The thresholds used by the GCH were developed from a health perspective, in consultation with more than 300 individuals from 20 organisations across New Zealand. The GCH was also tested quantitatively using primary health care enrolment data, where it performed better than previous or alternative classifications (93 per cent to 95 per cent accuracy compared with 66 per cent to 70 per cent for Stat NZ's Urban-Rural Experimental Profile and 81 per cent for the UA) (Whitehead, Davie, et al., 2022). Importantly, we have recently demonstrated that, compared with the GCH, previous rurality definitions systematically underestimate poor rural health outcomes in New Zealand across a range of measures including mortality, hospitalisation and specialist appointments (Whitehead, Davie, de Graaf, Crengle, Lawrenson, et al., 2023).

The GCH is available for a range of geographic units, including meshblock, Statistical Area 1 (SA1), Statistical Area 2 (SA2) and Health Domicile, making it possible to apply it to a range of routinely collected national data sets such as the Mortality Collection, hospital discharges and census. The GCH can thus be used to develop profiles of rural populations at the national and large-regional level and contribute to the development of rural health policy and planning, including both local-level rural health plans and national-level rural health strategies. People living in rural areas of New Zealand have recently been recognised as a priority population in Pae Ora (Healthy Futures) legislation passed into law in June 2022 (Parliamentary Counsel Office, 2022). As such, a rural health strategy has now been developed by the Ministry of Health (MoH) (2023) and this will help to guide strategic planning to improve the health outcomes of people living in rural New Zealand. The GCH has been adopted in Te Pae Tata |Interim New Zealand Health Plan 2022 as part of the nationally consistent system of data capture and analytics (Te Whatu Ora, 2022).

An association between rurality and poorer health outcomes, including higher mortality rates, is well recognised in high-income countries with low population densities, including New Zealand (Australian Institute

of Health and Welfare, 2022; Bremberg, 2020; Cross et al., 2021; Nixon et al., 2023; Subedi et al., 2019). It is, however, unclear to what extent rurality has a direct effect on health outcomes and it may instead exert its greatest impact by exacerbating the effects of socio-economic disadvantage and ethnicity (Smith et al., 2008). Access to health care is widely recognised as the major rural health issue (Ministry of Health, 2023), the consequence of a number of factors including small low-density populations geographically distant from urban centres where specialist health services are concentrated, lack of investment in local health services, and chronic rural health professional workforce shortages (Wakerman & Humphreys, 2002). Some aspects of rural lifestyle may exert a positive impact on health, for example community connectedness (Blattner et al., 2020); others, including some rural occupations and behaviours, have a negative impact (Smith et al., 2008).

When the now-retired Stats NZ Urban Rural Experimental Profile was applied to the 2006 Census data, higher levels of several 'negative' SDH were noted among residents of rural towns (at that time termed 'independent urban areas' with populations between 1000 and 29,999) than in both larger urban and more remote rural areas (National Health Committee, 2010). These SDH included lower mean incomes, poorer access to transport and communication, and lower educational attainment, all of which have the potential to create additional barriers to accessing distant health services.

Research gap

As noted above, rural health research in New Zealand has been hindered by the lack of a suitable classification. In addition, there has been no work, to our knowledge, systematically exploring rural-urban differences in SDH. SDH are social, economic and political mechanisms leading to health stratification inequity (World Health Organization, 2010). The World Health Organization's conceptual model, the Commission of Social Determinants of Health, describes structural determinants and intermediary determinants. *Structural determinants* directly affect socio-economic position and include gender (sexism), ethnicity (racism), education, occupation and income. *Intermediary determinants* include material circumstances such as housing, food availability and water supply; health behaviours such as alcohol intake, exercise and smoking; psychosocial

factors; and the health system itself, such as poor access. The limited research that has been carried out on rural-urban differences in SDH in New Zealand has suggested some variation in a number of structural and intermediary determinants. Gender differences, with a higher proportion of males in rural areas, might account for more risk-taking behaviour, occupational differences and traumatic brain injuries (Feigin et al., 2013). Higher socio-economic deprivation has been noted in rural areas (Hider et al., 2007). Smoking (Barnett et al., 2009) and alcohol consumption (Ministry of Health, 2012) may also be more prevalent in rural areas. Educational achievement is reportedly lower in rural areas with lower school completion rates and higher rates of no educational qualifications (National Health Committee, 2010). Some environmental risk factors are possibly greater in rural areas with higher rates of drinking water contamination (Jaksons et al., 2019).

There is a larger body of work on rural-urban differences in the health system. Important differences include lower rates of screening (Cameron et al., 2012; Obertova et al., 2016) in rural areas, greater health workforce pressures (Hider et al., 2007), poorer geographic access to preventative health care (Whitehead, Atatoa Carr, et al., 2022), and fewer disability and aged-care services (National Health Committee, 2010). However, while individual SDH and socio-economic characteristics of rural populations in New Zealand have been examined, there has not been, to our knowledge, any recent analysis using an appropriate rurality classification that accurately describes rural and urban populations. The recent development of the GCH and its adoption by the health sector means that it is important to use the GCH to understand the sociodemographic characteristics of rural and urban populations, Māori and non-Māori, and the geographic distribution of the SDH.

While providing a detailed examination of all SDH is beyond the scope of this paper, we have focused on using publicly available data to explore the sociodemographic characteristics of rural and urban New Zealand. We have paid particular attention to factors that are relevant to health, and this inevitably overlaps with several SDH. This research, therefore, aims to use available data sets, including data from the New Zealand Census, in conjunction with the GCH and the NZDep index of socio-economic deprivation to develop a high-level understanding of: (1) the distribution of selected SDH across rural and urban populations, (2) the

distribution of socio-economic deprivation across rural and urban populations nationally, and (3) how these two distributions differ for Māori and non-Māori. These analyses will be carried out at both the national level and for the four regions of Te Whatu Ora.

These analyses will help New Zealand researchers, policymakers and health service providers with insights into the sociodemographic characteristics of rural and urban populations as defined by the GCH. This is important as the GCH has been adopted as the preferred tool for monitoring urban-rural variation in health outcomes and health care in New Zealand. Understanding the sociodemographic characteristics of rural and urban populations is a crucial step in understanding their health status and health needs, and therefore better address inequities and disparities in service utilisation (Whitehead, Davie, de Graaf, Crengle, Lawrenson, et al., 2023). Many of the sociodemographic variables we have examined are recognised SDH (World Health Organization, 2010), as a key part of understanding – and therefore being able to act upon – health inequities is to examine the inequitable distribution of the SDH (Marmot & Wilkinson, 2006).

Methods

Data sets

The following were used to complete this analysis, all at Statistical Area 2 (SA2) levels: data from the 2018 Census (Stats NZ, 2022), the GCH2018-SA22018 concordance file (Whitehead, Davie, de Graaf, Crengle, Fearnley, et al., 2023), and the NZDep2018-SA22018 concordance file (Atkinson et al., 2020). The GCH applied population and drive-time thresholds to classify SA1s into one of five categories, two of which are urban (U1, U2) and the remaining three rural (R1, R2, R3) (see Supplementary Figure 1 for the classification matrix).[1, 4] U1 includes all five of New Zealand's major urban centres with populations over 100,000 and their immediate surrounds, while smaller regional cities and their surrounds make up U2. R1 to R3 categorise increasingly smaller and more remote rural towns and communities. A binary GCH classification is created by combining U1 and U2 into 'urban' and R1–R3 into 'rural'. The GCH does not use access to specific services or health statistics to define rurality. The GCH was originally developed using SA1-level geography, with concordance files

to other geographic units subsequently developed. NZDep is an index of socio-economic deprivation that is derived for small geographical areas throughout New Zealand; it is based on nine census variables related to socio-economic deprivation and has a value from 1 (low deprivation) to 10 (high deprivation) (Salmond & Crampton, 2012). In this study, NZDep quintiles have been used that combine deprivation values 1–2 into Q1, 3–4 into Q2, and so on up to 9–10 into Q5. NZDep is used in research and social epidemiology to explore health variations, allocate central government funds, and for advocacy.

Census variables

We have limited our analysis to selected 2018 Census variables which were chosen because of their relevance to established SDH (World Health Organization, 2010), health inequities observed in New Zealand, and some of the challenges and issues related to living in rural areas. Although issues with the 2018 Census are well documented (2018 Census External Data Quality Panel, 2020; Kukutai & Cormack, 2018), Stats NZ have remedied some concerns by using data from other administrative sources, where possible, to improve both coverage and quality. For some variables (e.g., mould in the home), imputation was not possible; variables such as this have been included anyway since the census is often the only source of this data. We analysed variables relating to three areas: (1) population demographics – including age, sex, ethnicity and birthplace (New Zealand versus overseas); (2) socio-economic variables – including employment status, income, highest qualification, homeownership, occupation and telecommunications access; and (3) the health-related variables of smoking status and presence of mould in the home. It should be noted that our analysis uses total response ethnicity, meaning that individuals are able to identify with more than one ethnic identity, and therefore ethnicity totals add to more than 100 per cent of the usually resident population. Our analysis uses Level 1 ethnicity groupings which tend to underestimate ethnic diversity especially within Pacific, Asian and MELAA (Middle Eastern, Latin American and African) and Other groupings. In addition, income is self-reported and, therefore, may not always reflect actual income levels.

Analysis

All data sets were analysed in SAS ((SAS 9.4 TS Level 1M6), © 2016 by SAS Institute Inc., Cary, NC, USA) to group data by GCH category at both the national level and for each of the four Te Whatu Ora health regions. Data are presented in tables and figures. The population pyramids in Figure 1 were produced in R (R Core Team, 2018), while the heatmaps in Figure 2 were produced in SAS.

Results

Rural-urban distribution of demographic variables

Table 1 displays the distribution of demographic variables from the 2018 Census across the five GCH categories, as well as across a binary urban-rural split.[2] While most people lived in U1 areas, 19 per cent of the population lived rurally. Young people aged 15–29 years were proportionally more likely to live in urban areas, while older people (aged 65+) were proportionally more likely to live rurally. Only 54 per cent of older people lived in U1 areas. The sex distribution across rural and urban areas is relatively even, although females make up a decreasing proportion of the population in more rural areas, and comprise 50.1 per cent, 49.6 per cent and 48.0 per cent of the population in R1, R2 and R3, respectively. Ethnic differences in urban-rural population distribution are also evident in Table 1, with a very high proportion of Pacific, Asian and MELAA and Other responses from people living in U1 areas. Few Pacific (2.8 per cent) and Asian (3.6 per cent) people lived in rural areas. On the other hand, a higher proportion of Māori lived in rural areas (19.5 per cent) and just under half of Māori (49.1 per cent) lived in U1 areas. Table 1 also indicates that when examining the rural-urban distribution of different ethnicities by broad age groups and examining row percentages, it is apparent that older Māori (aged 65+ years) were substantially less likely than the 'total population' to live in U1 areas (39.9 per cent). Approximately one-third of older Māori lived in rural areas (R1–R3) while an additional 27.0 per cent lived in provincial centres (U2). Substantial rural-urban differences in birthplace were also noted (see Table 2). The proportion of New Zealand-born residents is substantially higher in rural (83.6 per cent) than urban (70.1 per cent) areas, and generally increases with increasing rurality. More than one-third of the

most-urban (U1) residents were born overseas, compared with just 13.4 per cent of the most-rural (R3) residents. A high proportion of Māori were born in New Zealand, with little difference between rural and urban areas (97.8 per cent in U1 to 98.5 per cent in R3).

Table 1: Comparison of 2018 Census demographic variables by GCH category ($N = 4,698,795$)

2018 Census variables		Classification							
		Urban		Rural			All urban	All rural
		U1	U2	R1	R2	R3		
Total Population	*N*	2,961,138	845,169	570,147	266,931	55,806	3,806,307	892,884
	Row %	63.0	18.0	12.1	5.7	1.2	81.0	19.0
Population density	Land area (km2)	10,176	12,873	58,992	78,924	103,923	23,049	241,839
	Land area (%)	3.8	4.9	22.3	29.8	39.2	8.7	91.3
	Population per km^2	291.0	65.7	9.7	3.4	0.5	165.1	3.7
Age in yrs (N)	< 15	576,951	171,309	111,231	53,067	11,031	748,260	175,329
	15–29	667,296	153,336	92,628	41,691	8,667	820,632	142,986
	30–64	1,329,204	366,780	255,459	119,187	26,088	1,695,984	400,734
	65+	387,645	153,768	110,766	52,977	9,981	541,413	173,724

2018 Census variables		Urban		Rural			All urban	All rural
		U1	U2	R1	R2	R3		
Age in yrs (col%)	< 15	19.5	20.3	19.5	19.9	19.8	19.7	19.6
	15–29	22.5	18.1	16.2	15.6	15.5	21.6	16.0
	30–64	44.9	43.4	44.8	44.7	46.8	44.6	44.9
	65+	13.1	18.2	19.4	19.8	17.9	14.2	19.5
Sex	Female	1,502,031	432,753	285,861	132,438	26,790	1,934,784	445,089
	Male	1,458,852	412,338	284,274	134,490	29,016	1,871,190	447,780
Sex (col%)	Female	50.7	51.2	50.1	49.6	48.0	50.8	49.8
	Male	49.3	48.8	49.9	50.4	52.0	49.2	50.2
Ethnicity total responses (N)	European	1,900,419	665,817	475,659	213,984	41,304	2,566,236	730,947
	Māori	380,967	198,129	108,588	69,813	18,129	579,096	196,530
	Pacific	319,773	34,005	19,803	6,429	1,608	353,778	27,840
	Asian	620,808	50,529	25,095	9,381	1,797	671,337	36,273
	MELAA & Other	93,411	16,707	12,570	4,779	1,116	110,118	18,465

(Table continued over the page)

2018 Census variables		Urban		Rural			All urban	All rural
		U1	U2	R1	R2	R3		
Ethnicity total responses (col%)	European	64.2	78.8	83.4	80.2	74.0	67.4	81.9
	Māori	12.9	23.4	19.0	26.2	32.5	15.2	22.0
	Pacific	10.8	4.0	3.5	2.4	2.9	9.3	3.1
	Asian	21.0	6.0	4.4	3.5	3.2	17.6	4.1
	MELAA & Other	3.2	2.0	2.2	1.8	2.0	2.9	2.1
European (N)	< 15	355,464	128,646	90,951	40,755	5,760	484,110	137,466
	15–29	387,852	111,225	72,066	30,909	4,200	499,077	107,175
	30-–64	843,312	289,104	214,158	95,187	14,868	1,132,416	324,213
	65+	313,977	140,706	103,995	47,616	6,783	454,683	158,394
European (col%)	< 15	18.7	19.3	19.1	19.0	13.9	18.9	18.8
	15–29	20.4	16.7	15.2	14.4	10.2	19.4	14.7
	30–64	44.4	43.4	45.0	44.5	36.0	44.1	44.4
	65+	16.5	21.1	21.9	22.3	16.4	17.7	21.7

(Table continued over the page)

2018 Census variables		Urban		Rural			All urban	All rural
		U1	U2	R1	R2	R3		
Māori (N)	< 15	120,624	65,256	35,997	22,308	4,620	185,880	62,925
	15–29	102,669	48,078	24,450	15,048	2,943	150,747	42,441
	30–64	138,117	73,104	41,082	26,778	6,513	211,221	74,373
	65+	19,215	13,023	7,974	6,030	1,968	32,238	15,972
Māori (col%)	< 15	31.7	32.9	33.2	32.0	25.5	32.1	32.0
	15–29	26.9	24.3	22.5	21.6	16.2	26.0	21.6
	30–64	36.3	36.9	37.8	38.4	35.9	36.5	37.8
	65+	5.0	6.6	7.3	8.6	10.9	5.6	8.1
Pacific (N)	<15	104,145	13,095	7,758	2,550	552	117,240	10,860
	15-29	88,200	8,928	4,719	1,545	336	97,128	6,600
	30-64	109,776	10,740	6,495	2,001	465	120,516	8,961
	65+	17,586	1,377	912	318	60	18,963	1,290

(Table continued over the page)

2018 Census variables		Urban		Rural			All urban	All rural
		U1	U2	R1	R2	R3		
Pacific (col%)	<15	32.6	38.5	39.2	39.7	34.3	33.1	39.0
	15–29	27.6	26.3	23.8	24.0	20.9	27.5	23.7
	30–64	34.3	31.6	32.8	31.1	28.9	34.1	32.2
	65+	5.5	4.0	4.6	4.9	3.7	5.4	4.6
Asian (N)	< 15	123,492	11,982	5,712	2,322	231	135,474	8,265
	15–29	166,125	13,431	6,096	2,145	405	179,556	8,646
	30–64	289,806	22,734	12,240	4,662	678	312,540	17,580
	65+	41,421	2,502	1,140	405	45	43,923	1,590
Asian (col%)	< 15	19.9	23.7	22.8	24.8	12.9	20.2	22.8
	15–29	26.8	26.6	24.3	22.9	22.5	26.7	23.8
	30–64	46.7	45.0	48.8	49.7	37.7	46.6	48.5
	65+	6.7	5.0	4.5	4.3	2.5	6.5	4.4

2018 Census variables		Urban		Rural			All urban	All rural
		U1	U2	R1	R2	R3		
MELAA & Other (N)	<15	21,516	3,756	2,574	996	96	25,272	3,666
	15–29	21,699	2,751	2,256	738	135	24,450	3,129
	30–64	44,811	8,559	6,630	2,655	468	53,370	9,753
	65+	5,211	1,647	1,182	495	114	6,858	1,791
MELAA & Other (col%)	< 15	23.0	22.5	20.5	20.8	8.6	22.9	19.9
	15-–29	23.2	16.5	17.9	15.4	12.1	22.2	16.9
	30–64	48.0	51.2	52.7	55.6	41.9	48.5	52.8
	65+	5.6	9.9	9.4	10.4	10.2	6.2	9.7

Figures 1a and 1b display population pyramids indicating the different age structures of urban and rural areas, displayed by sex. Three population pyramids are presented, outlining the differing rural-urban age structures for the total 2018 New Zealand Census population as well as for Māori and non-Māori. For the total New Zealand population (Figure 1a), a higher proportion of rural residents were aged 50 years and older for both males and females, while a higher proportion of urban residents were aged 40 years and younger. This pattern is reflected in the non-Māori population (Figure 1b). The substantially different age structure of the Māori population is apparent in Figure 1b, with a proportionately much larger population of young people aged 19 years and under in both rural and urban areas. Despite the overall much younger age structure in the Māori population, a similar rural-urban distribution by age group is observed, with those aged 50 years and older more likely to live in rural areas, and people aged 15–44 years more likely to live in urban areas.

## *Rural-urban distribution of socio-economic and other variables*

Table 2 displays socio-economic and additional health-related variables from the 2018 Census by GCH category for the New Zealand total population, as well as for Māori and non-Māori.

Socio-economic variables

Employment. Table 2 indicates that while rural areas had slightly lower total population unemployment rates (3.5 per cent compared with 4.1 per cent), rural areas also had a slightly higher proportion of people not in the labour force (32.9 per cent compared with 30.9 per cent). Compared with non-Māori, unemployment rates were substantially higher for Māori in both urban (8.1 per cent compared with 3.5 per cent) and rural areas (8.0 per cent compared with 2.5 per cent), but with little difference observed between urban and rural Māori. For non-Māori however, unemployment rates declined with increasing rurality, from 3.7 per cent in the most-urban areas (U1) to 2.2 per cent in the most-rural R3 areas.

Figure 1a: Population pyramid for the 2018 Census Usually Resident Population by rural-urban residence, sex and 5-year age group for the total New Zealand population
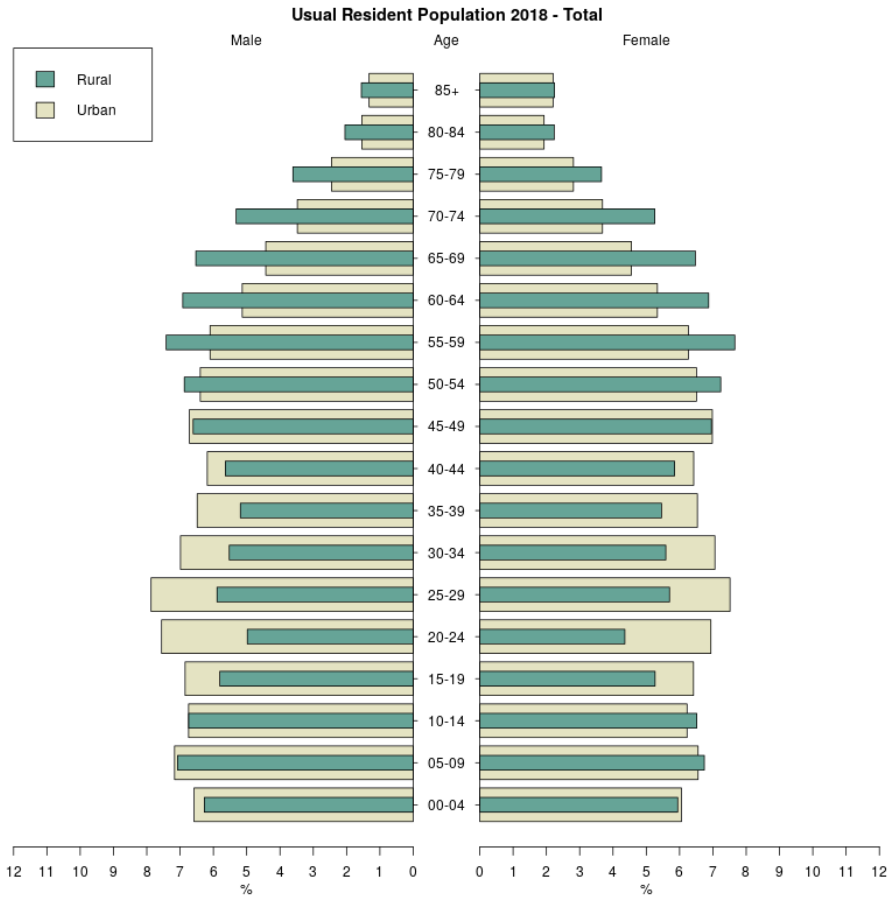
Figure 2b: Population pyramid for the 2018 Census Usually Resident Population by rural-urban residence, sex and 5-year age group for Māori and non-Māori
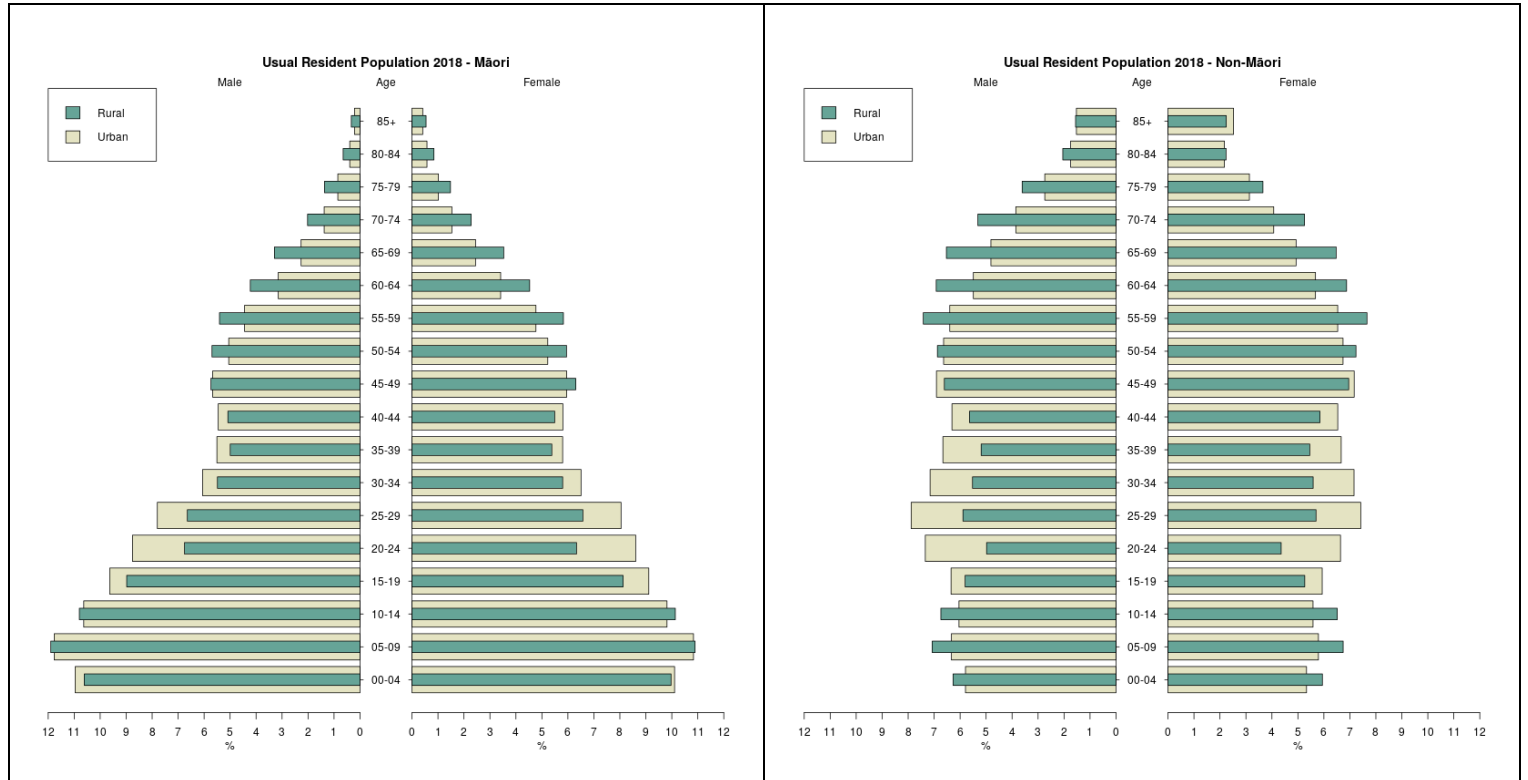
Table 2a: Additional sociodemographic variables by GCH category, for the New Zealand total population

Aotearoa New Zealand		Total Population (col%)							
	Ages		*Urban*		*Rural*			*All urban*	*All rural*
	(yrs)	U1	U2	R1	R2	R3			
Socio-economic variables									
* *Employment Status*									
Employed	≥ 15	65.6	62.8	63.8	63.3	62.5		65	63.6
Unemployed	≥ 15	4.1	4.0	3.4	3.7	4.2		4.1	3.5
Not in the labour force	≥ 15	30.2	33.2	32.8	33.1	33.3		30.9	32.9
Occupation									
Managers	≥ 15	17.2	15.6	22.5	24.4	28.5		16.8	23.4
Professionals	≥ 15	26.1	20.0	15.8	13.9	12.1		24.8	15.0
Technicians and Trades Workers	≥ 15	11.8	12.8	12.4	11.9	9.5		12.0	12.1
Community and Personal Service Workers	≥ 15	9.3	10.6	9.2	9.2	10.2		9.6	9.2

(Table continued over the page)

	Ages	Urban		Rural			All urban	All rural
	(yrs)	U1	U2	R1	R2	R3		
Clerical and Admin. Workers	≥ 15	11.6	10.3	9.1	8.6	7.3	11.3	8.9
Sales Workers	≥ 15	9.7	8.9	7.8	7.6	5.5	9.5	7.6
Machinery Operators, Drivers	≥ 15	5.6	6.6	7.0	6.6	6.3	5.8	6.9
Labourers	≥ 15	8.6	15.2	16.2	17.8	20.6	10.0	16.9
* Total personal income								
< 20k	≥ 15	34.2	35.0	34.2	36.2	40.9	34.4	35.1
20–50k	≥ 15	31.7	37.8	37.1	38.3	38.1	33.1	37.5
50–70k	≥ 15	14.8	13.6	14.2	13.6	11.6	14.5	13.9
>70k	≥ 15	19.3	13.6	14.5	12.0	9.3	18	13.5

	Ages	Urban		Rural			All urban	All rural
	(yrs)	U1	U2	R1	R2	R3		
* *Highest Qualification*								
No qualifications	≥ 15	15.4	22.2	23.4	24.7	24.3	16.9	23.9
Secondary school	≥ 15	45.6	49.3	50.0	50.6	50.7	46.5	50.2
Diploma	≥ 15	9.6	10.2	10.1	10.0	10.1	9.8	10
Bachelor's	≥ 15	17.1	11.0	10.0	9.3	9.2	15.8	9.8
Higher degree	≥ 15	12.3	7.2	6.5	5.5	5.6	11.1	6.1
* *Home ownership*								
Held in trust or own	≥ 15	48.3	56.9	59.3	57.5	55.3	50.2	58.5
Not held in trust or owned	≥ 15	51.7	43.1	40.7	42.5	44.7	49.8	41.5
* *Telecommunications (households)*								
No access to telecommunication systems	All	1.0	1.0	1.0	1.3	2.5	1.0	1.2
Access to a cellphone	All	85.7	84.9	84.3	80.8	64.6	85.5	82.0
Access to a telephone	All	55.7	61.1	60.7	58.6	59.0	57.0	60.0
Access to the internet	All	81.9	77.1	76.1	72.2	64.9	80.7	74.2

	Ages	Urban		Rural			*All urban*	*All rural*
	(yrs)	U1	U2	R1	R2	R3		
Other variables								
Smoking status								
Regular smoker	≥ 15	11.6	15.4	15.7	17.6	20.1	12.4	16.5
Ex-smoker	≥ 15	19.6	25.5	26.8	27.1	28.5	20.9	27.0
Never smoked regularly	≥ 15	68.8	59.1	57.5	55.4	51.4	66.7	56.5
Dwelling mould indicator								
Always mould over A4 size	All	5.5	4.8	4.4	5.1	7.2	5.3	4.8
Sometime mould over A4 size	All	15.0	13.8	12.9	13.5	15.8	14.8	13.2
No mould / mould smaller than A4 size	All	79.5	81.4	82.6	81.4	77.1	79.9	82.0
Birthplace								
New Zealand	All	66.2	83.6	82.3	85.7	86.6	70.1	83.6
Overseas	All	33.8	16.4	17.7	14.3	13.4	29.9	16.4

Note: * These variables are similar to those included in NZDep2018.

Table 2b. Additional sociodemographic variables by GCH category, for Māori population

Aotearoa New Zealand		Māori (col%)							
	Ages	Urban			Rural			All urban	All rural
	(yrs)	U1	U2	R1	R2	R3			
Socio-economic variables									
* *Employment Status*									
Employed	≥ 15	63.5	62.0	62.4	59.6	54.3		63.0	60.7
Unemployed	≥ 15	8.1	8.3	7.7	8.5	8.5		8.1	8.0
Not in the labour force	≥ 15	28.4	29.7	29.9	31.9	37.2		28.8	31.3
Occupation									
Managers	≥ 15	13.4	10.6	14.5	14.5	16.1		12.4	14.6
Professionals	≥ 15	18.6	15.4	12.6	12.3	13.8		17.6	12.6
Technicians and Trades Workers	≥ 15	12.0	11.0	11.4	11.2	8.9		11.7	11.1
Community and Personal Service Workers	≥ 15	11.6	12.8	11.7	12.2	12.1		12.0	11.9

(Table continued over the page)

	Ages (yrs)	Urban		Rural			All urban	All rural
		U1	U2	R1	R2	R3		
Clerical and Admin. Workers	≥ 15	11.3	8.6	7.8	7.8	6.8	10.4	7.7
Sales Workers	≥ 15	9.9	8.5	7.5	7.1	5.2	9.4	7.2
Machinery Operators, Drivers	≥ 15	9.3	8.9	9.5	7.8	8.9	9.2	8.9
Labourers	≥ 15	13.9	24.2	25.2	26.9	28.0	17.3	26.0
* Total personal income								
< 20k	≥ 15	41.5	43.9	43.4	46.4	51.0	42.3	45.2
20–50k	≥ 15	32.5	36.5	35.6	36.4	34.6	33.9	35.8
50–70k	≥ 15	13.4	11.4	12.1	10.7	8.3	12.7	11.3
>70k	≥ 15	12.6	8.1	8.8	6.5	6.1	11.1	7.7

	Ages (yrs)	Urban		Rural			All urban	All rural
		U1	U2	R1	R2	R3		
* Highest Qualification								
No qualifications	≥ 15	23.0	25.8	28.4	30.3	30.0	24.0	29.2
Secondary school	≥ 15	53.9	54.3	54.0	53.6	52.2	54.0	53.7
Diploma	≥ 15	8.2	8.7	8.0	7.7	8.0	8.4	7.9
Bachelor's	≥ 15	9.8	7.9	6.5	5.9	6.4	9.2	6.3
Higher degree	≥ 15	5.0	3.4	3.0	2.4	3.3	4.5	2.8
* Home ownership								
Held in trust or own	≥ 15	27.4	32.5	36.9	35.8	39.9	29.1	36.7
Not held in trust or owned	≥ 15	72.6	67.5	63.1	64.2	60.1	70.9	63.3
* Telecommunications (households)								
No access to telecommunication systems	All							
Access to a cellphone	All			This household data is not available by ethnic identity				
Access to a telephone	All							
Access to the internet	All							

(Table continued over the page)

	Ages	Urban			Rural		All urban	All rural
	(yrs)	U1	U2	R1	R2	R3		
Other variables								
Smoking status								
Regular smoker	≥ 15	26.2	29.4	30.1	32.7	32.9	27.2	31.3
Ex-smoker	≥ 15	22.1	24.0	24.8	24.3	27.1	22.7	24.8
Never smoked regularly	≥ 15	51.8	46.7	45.1	43.0	40.0	50.0	43.9
Dwelling mould indicator								
Always mould over A4 size	All	10.9	10.1	10.2	11.9	12.9	10.6	11.0
Sometime mould over A4 size	All	22.3	22.2	21.3	23.4	23.9	22.3	22.3
No mould / mould smaller than A4 size	All	66.9	67.7	68.4	64.7	63.2	67.1	66.7
Birthplace								
New Zealand	All	97.8	98.2	98.1	98.2	98.5	98.0	98.2
Overseas	All	2.2	1.8	1.9	1.8	1.5	2.0	1.8

Note: * These variables are similar to those included in NZDep2018.

Table 2c. Additional sociodemographic variables by GCH category, for non-Māori population

Aotearoa New Zealand							Non-Māori (col%)	
	Ages	Urban			Rural		All urban	All rural
	(yrs)	U1	U2	R1	R2	R3		
Socio-economic variables								
* *Employment Status*								
Employed	≥ 15	65.9	63.0	64.1	64.3	66.4	65.3	64.3
Unemployed	≥ 15	3.7	3.0	2.6	2.3	2.2	3.5	2.5
Not in the labour force	≥ 15	30.4	34.0	33.3	33.4	31.4	31.2	33.3
Occupation								
Managers	≥ 15	17.6	16.8	23.9	27.1	33.2	17.5	25.2
Professionals	≥ 15	27.0	21.2	16.4	14.3	11.4	25.8	15.6
Technicians and Trades Workers	≥ 15	11.8	13.3	12.6	12.1	9.8	12.1	12.3
Community and Personal Service Workers	≥ 15	9.1	10.0	8.7	8.4	9.4	9.3	8.7

(Table continued over the page)

	Ages (yrs)	Urban		Rural			All urban	All rural
		U1	U2	R1	R2	R3		
Clerical and Admin. Workers	≥ 15	11.7	10.7	9.4	8.8	7.5	11.5	9.1
Sales Workers	≥ 15	9.7	8.9	7.9	7.7	5.6	9.5	7.7
Machinery Operators, Drivers	≥ 15	5.2	6.0	6.6	6.3	5.4	5.4	6.5
Labourers	≥ 15	8.0	13.1	14.5	15.4	17.7	9.0	14.9
* Total personal income								
< 20k	≥ 15	33.3	32.8	32.5	33.2	36.2	33.2	32.8
20–50k	≥ 15	31.6	38.1	37.4	38.8	39.8	32.9	37.9
50–70k	≥ 15	15.0	14.1	14.6	14.4	13.2	14.8	14.5
>70k	≥ 15	20.1	15.0	15.6	13.5	10.8	19.1	14.8

	Ages	Urban		Rural			All urban	All rural
	(yrs)	U1	U2	R1	R2	R3		
* *Highest Qualification*								
No qualifications	≥ 15	14.4	21.3	22.5	23.2	21.8	15.9	22.7
Secondary school	≥ 15	44.6	48.2	49.3	49.7	50.0	45.4	49.4
Diploma	≥ 15	9.8	10.6	10.5	10.6	11.1	10.0	10.5
Bachelor's	≥ 15	18.0	11.8	10.7	10.2	10.4	16.7	10.5
Higher degree	≥ 15	13.1	8.1	7.1	6.3	6.7	12.1	6.8
* *Home ownership*								
Held in trust or own	≥ 15	50.5	61.9	62.9	62.7	61.3	52.9	62.8
Not held in trust or owned	≥ 15	49.5	38.1	37.1	37.3	38.7	47.1	37.2
* *Telecommunications (households)*								
No access to telecommunication systems	All							
Access to a cellphone	All			This household data is not available by ethnic identity				
Access to a telephone	All							
Access to the internet	All							

(Table continued over the page)

	Ages (yrs)	Urban		Rural			All urban	All rural
		U1	U2	R1	R2	R3		
Other variables								
Smoking status								
Regular smoker	≥ 15	9.8	11.9	13.0	13.2	14.1	10.3	13.1
Ex-smoker	≥ 15	19.3	25.9	27.2	27.8	29.2	20.6	27.5
Never smoked regularly	≥ 15	70.9	62.2	59.8	58.9	56.7	69.1	59.4
Dwelling mould indicator								
Always mould over A4 size	All	4.8	3.4	3.3	3.1	4.5	4.5	3.3
Sometime mould over A4 size	All	14.1	11.7	11.2	10.5	12.0	13.6	11.1
No mould / mould smaller than A4 size	All	81.1	84.9	85.5	86.3	83.5	81.8	85.6
Birthplace								
New Zealand	All	61.5	79.1	78.6	81.3	79.8	65.1	79.4
Overseas	All	38.5	20.9	21.4	18.7	20.2	34.9	20.6

Note: * These variables are similar to those included in NZDep2018.

Occupation. The proportion of 'managers' and 'labourers' was substantially higher in rural areas (23.5 per cent and 16.9 per cent, respectively) than in urban areas (16.8 per cent and 10.0 per cent, respectively). In addition, these two occupations were most common in R3 areas (32.3 per cent for managers, and 21.8 per cent for labourers); and both were higher than in urban areas (17.2 per cent and 8.6 per cent, respectively). On the other hand, a higher proportion of 'professionals' lived in urban areas (24.8 per cent), and in particular in U1 (26.1 per cent), when compared with rural areas (15.0 per cent). Smaller differences were noted between the rural-urban distribution of other occupational groups. For Māori, while the rural-urban differences were less marked for managers (rural = 14.6 per cent, urban = 12.4 per cent) and professionals (rural = 12.6 per cent, urban = 17.6 per cent), notable differences in the distribution of labourers were identified (rural = 26.0 per cent, urban = 17.3 per cent).

Income. The proportion of people who reported earning less than $20,000 was similar in urban and rural areas (35.1 per cent and 34.4 per cent, respectively). When broken down by ethnicity, the proportion of non-Māori who reported earning less than $20,000 was still similar (32.8 per cent in urban areas compared with 33.8 per cent in rural areas), but was slightly higher for Māori in rural areas (45.2 per cent) than for Māori in urban areas (42.3 per cent). The proportion of people reporting low incomes was high in R3 (40.9 per cent), and particularly for Māori (51.0 per cent). More than half of Māori aged 15 years and over in the most-rural areas reported an income of less than $20,000, compared with 36.2 per cent for non-Māori in the most-rural areas. On the other hand, higher incomes of more than $70,000 were more commonly reported in the most-urban (U1) areas (19.3 per cent), and less commonly in the most-rural (R3) parts of New Zealand (9.3 per cent). Māori were substantially less likely to report incomes over more than $70,000, particularly in R1 areas (8.8 per cent), and especially in the most-rural (R3) areas (6.1 per cent) Overall, people living in the most-rural areas (R3) were approximately half as likely to report a high income as people living in the most-urban areas (U1). This is true for both Māori (6.1 per cent compared with 12.6 per cent) and non-Māori (10.8 per cent compared with 20.1 per cent).

Highest qualification. Rural residents were substantially more likely to have no formal qualifications (23.9 per cent compared with 16.9 per cent for urban residents). This is true for both Māori (29.2 per cent compared

with 24.0 per cent) and non-Māori (22.7 per cent compared with 15.9 per cent). Compared with non-Māori, there was a higher proportion of Māori who had no formal qualifications across all five GCH categories. For the total population, bachelor's and higher degrees were less common in rural areas (9.8 per cent and 6.1 per cent, respectively), including for both Māori (6.3 per cent and 2.8 per cent) and non-Māori (10.5 per cent and 6.8 per cent).

Home ownership. Rural residents were more likely to own their home or hold it in a trust. Overall, about 59 per cent of rural residents were homeowners, compared with just over half of urban residents. Slightly over a third (36.7 per cent) of rural Māori were homeowners, compared with 62.8 per cent of rural non-Māori. Homeownership rates for Māori were highest in the most-rural areas (R3), at 39.9 per cent, but were lower than for non-Māori across all five GCH categories.

Telecommunications. Almost all New Zealand households had access to at least one form of telecommunication (cell phone, internet or telephone). However, it was more common for rural, and particularly the most-rural (R3) households (2.5 per cent), to have no telecommunications access. The proportion of households with access to a cellphone decreased as rurality increased, from 85.7 per cent in U1 to 80.8 per cent in R2, with a noticeable decline to 64.6 per cent in R3 areas. Households in rural areas were also less likely to have access to the internet (74.2 per cent) compared with urban households (80.7 per cent) On the other hand, rural households were more likely to have access to a telephone than urban households (60.0 per cent and 57.0 per cent, respectively).

Other health-related census variables

Smoking status. Compared with urban residents, people living in rural areas were more likely to be regular (16.5 per cent compared with 12.4 per cent) or ex-smokers (27.0 per cent compared with 20.9 per cent). A similar pattern was observed for both Māori and non-Māori.

Mould. Substantial differences between the presence of mould in rural and urban households were not identified. However, it appears it was more common in urban areas for households to sometimes (14.8 per cent) or always (5.3 per cent) have mould larger than an A4 piece of paper compared with rural areas (13.2 per cent and 4.8 per cent, respectively). It must be noted that missing data were high overall for this census variable (22.1 per

cent) and highest among the most-rural (R3) residents (28.6 per cent). For Māori, always having mould in a dwelling was similarly reported in rural (11.0 per cent) and urban (10.6 per cent) areas, while for non-Māori, slightly higher rates of reporting were noted for urban areas (4.5 per cent compared with 3.3 per cent).
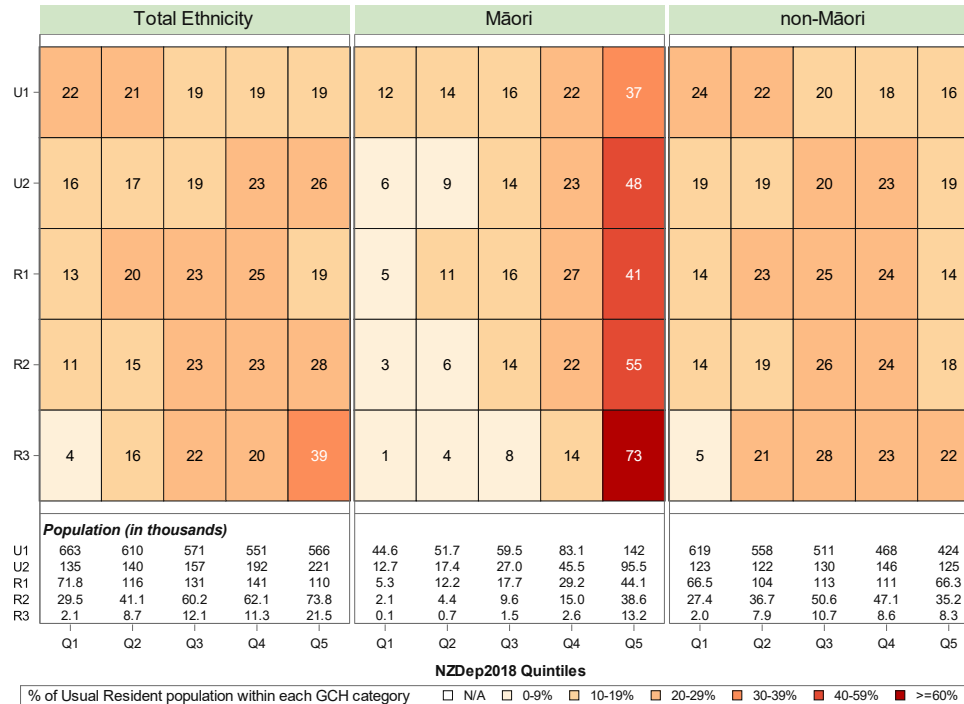
We also identified regional variation across many of these variables. These differences are presented in detail in four supplementary tables which have the same structure as Tables 1 and 2 but present data for each of the four Te Whatu Ora health regions.[3] For instance, the Te Whatu Ora Northern Region has just 9.1 per cent of its population living in rural areas compared with 29.1 per cent in Te Manawa Taki Midland Region. Also, as an example of differences between regions, the highest proportion of rural residents who were regular smokers was also in Te Manawa Taki (18.9 per cent), with the lowest proportion in Te Waipounamu (14.2 per cent).

Figure 2 displays the population distribution by NZDep quintile for each GCH category for the total New Zealand population, and for Māori and non-Māori. Figure 2 shows that in 2018, just over 60 per cent of the population lived in the most-urban areas (U1) and that this group was relatively evenly distributed across the five quintiles of socio-economic deprivation. In contrast, of the almost 50 per cent of Māori who lived in U1, more than three times as many people lived in the most socio-economically deprived areas (Q5, 37 per cent) compared with the least-deprived areas (Q1, 12 per cent). For non-Māori, two-thirds lived in U1; of these people, the percentage that lived in the least-deprived area (Q1, 24 per cent) was 1.5 times higher than the number that lived in Q5 (16 per cent). Of the 197,000 Māori who lived rurally, half lived in areas of high socio-economic deprivation (Q5). In contrast, rural non-Māori were more likely to live in areas of medium to high socio-economic deprivation, and less likely to live in areas of low socio-economic deprivation.

Supplementary Figures 2 and 3 provide the same information by Te Whatu Ora health region and district,[4] again highlighting substantial geographic variation in the intersection between rurality and socio-economic deprivation, and how this also varies by ethnicity. There was clear evidence of geographical variation in the intersections of ethnicity, socio-economic deprivation and rurality. For example, of the 1.8 million people in the health region considered 'Northern' by Te Whatu Ora, 86 per cent lived in U1 areas; 70 per cent of the 250,000 Māori and 89 per cent of non-Māori. Almost one

in three (30 per cent) Northern Māori lived in the most-urban and most-deprived areas (U1–Q5) with another 17 per cent in the most-deprived areas (Q5) across U2 to R3. In comparison, 17 per cent of Northern non-Māori lived in the most-urban and most-deprived areas (U1–Q5) with only another 2 per cent in the most-deprived areas (Q5) across U2 to R3. In the Southern District Health Board (DHB) region, 38 per cent of the 325,000 residents lived in U1, 18 per cent in U2 and 44 per cent in rural areas (R1–R3). For the 34,000 Māori in the Southern DHB, 33 per cent lived in U1, 29 per cent in U2 and 37 per cent lived rurally (R1–R3). Although a similar percentage of Māori and non-Māori in Southern DHB lived in U1–Q5 areas (8 per cent and 7 per cent, respectively), 23 per cent of Māori in this region lived in the most-deprived areas (Q5) compared with 14 per cent of non-Māori.

Figure 2: Distribution (percentage and counts) of the 2018 Census New Zealand population by rurality and deprivation

	Total Ethnicity					Māori					non-Māori				
U1	22	21	19	19	19	12	14	16	22	37	24	22	20	18	16
U2	16	17	19	23	26	6	9	14	23	48	19	19	20	23	19
R1	13	20	23	25	19	5	11	16	27	41	14	23	25	24	14
R2	11	15	23	23	28	3	6	14	22	55	14	19	26	24	18
R3	4	16	22	20	39	1	4	8	14	73	5	21	28	23	22

Population (in thousands)

	Total Ethnicity					Māori					non-Māori				
U1	663	610	571	551	566	44.6	51.7	59.5	83.1	142	619	558	511	468	424
U2	135	140	157	192	221	12.7	17.4	27.0	45.5	95.5	123	122	130	146	125
R1	71.8	116	131	141	110	5.3	12.2	17.7	29.2	44.1	66.5	104	113	111	66.3
R2	29.5	41.1	60.2	62.1	73.8	2.1	4.4	9.6	15.0	38.6	27.4	36.7	50.6	47.1	35.2
R3	2.1	8.7	12.1	11.3	21.5	0.1	0.7	1.5	2.6	13.2	2.0	7.9	10.7	8.6	8.3
	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5	Q1	Q2	Q3	Q4	Q5

NZDep2018 Quintiles

% of Usual Resident population within each GCH category   ☐ N/A   ☐ 0-9%   ☐ 10-19%   ☐ 20-29%   ☐ 30-39%   ☐ 40-59%   ☐ >=60%

Notes: 1. Rurality measured by the GCH, with U1 = most urban and R3 = most rural.

2. Deprivation measured by the NZDep Index of Social Deprivation, where Q1 = the least-deprived 20 per cent and Q5 = the most-deprived 20 per cent.

Discussion

Statement of principal findings

This research provides the first detailed description of the distribution of the New Zealand population across rural and urban areas, using a rurality classification specifically developed for health research purposes. It also explores variation in important sociodemographic and health-related variables by rurality, ethnicity and region. This paper highlights the occurrence of socio-economic and related inequities across the rural-urban spectrum. The inequitable distribution of examined SDH is likely exacerbated by the tyranny of distance in rural communities. This combination is likely to contribute to inequitable health outcomes for rural Māori, as observed and reported elsewhere (Crengle et al., 2022).

Overall, the socio-economic profile of the most-urban (U1) areas appeared to differ from other parts of New Zealand. For instance, compared with residents of other GCH categories, residents of the most-urban areas were more likely to report being employed, earning more than $70,000 in personal income, having a bachelor's or higher degree, having access to the internet, and never having smoked regularly. Although U1 residents did report lower rates of homeownership and were less likely to report having no household mould, it appears that many positive socio-economic characteristics are associated with residence in the most-urban areas of New Zealand. This is corroborated by the heatmaps in Figure 2 that display the distribution of the New Zealand population across GCH categories and NZDep quintiles. Residents of the most-urban areas were more likely to live in areas of lower socio-economic deprivation (i.e., wealthier areas) than were residents in U2 and rural areas (R1–R3). In fact, as rurality increased, smaller and smaller proportions of residents in each GCH category lived in areas of high socio-economic deprivation – suggesting some evidence for an urban-rural socio-economic gradient. When examining the proportion of residents living in areas of high socio-economic deprivation (Q5), this gradient is less linear. However, the proportion of residents living in NZDep Q5 was lowest in U1 and generally increased with rurality, with very high proportions of residents in the most-rural (R3) areas living in areas of high socio-economic deprivation. The heat maps in Figure 2 also help to visualise the ethnic differences in the rural-urban socio-economic gradient. Compared with non-Māori, a higher proportion of Māori live in areas of high socio-

economic deprivation within each GCH category. Similarly, as rurality increases from U1 through to R3, an increasing proportion of Māori live in areas of high socio-economic deprivation – although this proportion does decrease slightly from U2 to R1. For Māori who lived in the most-rural areas (R3), a much higher proportion of the population lived in NZDep Q5 (73 per cent) compared with Māori who lived in the most-urban areas (37 per cent).

Persistent inequity

This research confirms the continued presence of socio-economic inequities for Māori who, compared with non-Māori, were more likely to report being unemployed, having lower personal income, having no qualifications, being regular smokers, and living in dwellings with persistent mould. Māori were also less likely than non-Māori to own their homes or work as managers or professionals. Previous research has highlighted many of these inequities, underpinned by the historical and contemporary manifestations of colonialism and racism and their relationships to access to health care, quality of care and health outcomes (Crengle et al., 2022; Ministry of Health, 2017; Reid et al., 2019; Reid & Robson, 2007; Ryks et al., 2019; Talamaivao et al., 2020). However, these have not often been examined for both rural and urban areas of New Zealand using a suitable rurality classification (see Ministry of Health (2012) for the most recent comprehensive analysis). For instance, urban Māori were 2.3 times more likely to be unemployed than urban non-Māori. This increased to 3.2 times for rural Māori when compared with rural non-Māori. Similar patterns were observed for reported low (< $20k) personal income (1.3 times and 1.4 times higher for urban and rural Māori, respectively, than for urban and rural non-Māori), and presence of mould over A4 size (2.4 times and 3.3 times higher for urban and rural Māori, respectively, compared with urban and rural non-Māori).

The data provided in this paper will assist researchers, policymakers and health planners to 'make sense' of the results they obtain when analysing health data using the GCH. We have provided a detailed summary of important variables that are related to the SDH and are therefore likely to relate to the health profiles of rural and urban communities. This is particularly relevant to health policy and planning, and our findings could be used to inform more equitable configurations of health care services.

Some strengths of this research include that it is the first recent attempt to systematically analyse rural-urban variation in sociodemographic and health-related census variables. This study synthesises a large population data set, combines it with a fit-for-purpose rurality classification and measure of area-level socio-economic deprivation, and provides this information at the national and regional levels. There are also some weaknesses, however, that should be noted. These include the need to complete all analyses at SA2 level – to obtain census variables by ethnicity – despite both the GCH and NZDep2018 being designed at the SA1 level. This may have also exacerbated issues relating to heterogeneity within small areas (Salmond & Crampton, 2002), which may be more substantial in rural areas where SA2s are generally larger. In addition, there were a limited number of variables relating to the SDH available within census data sets that could be analysed. Important missing variables include food availability, physical activity, measures of psychological distress, and access to and the quality of health care. Furthermore, we were unable to include measures of the structural drivers of the SDH, or indicators that better align to Māori and hauora models. For instance, the Meihana Model (Pitama et al., 2014) highlights the importance of factors such as colonisation, racism and marginalisation as historical and societal influences on wellbeing. However, these factors can be difficult to quantify, and are not readily available in national data sets. Finally, it is important to note that this analysis is based on data from the 2018 Census and thus is a snapshot of rural-urban sociodemographic variation at only one point in time. New Zealand's high levels of residential mobility (Robertson et al., 2021) means that rural:urban variation is likely to change over time. Furthermore, people who resided in rural areas in 2018 may have recently moved from urban areas or vice versa, and thus these populations should not be considered to be static. Further research is currently underway to examine rural-urban mobility in the later years of life.

Nevertheless, with the 2023 Census data soon to be available, this research provides a baseline which will allow researchers and policymakers to track sociodemographic trends over time for rural and urban areas.

Notes

1   See Whitehead, Davie, et al. (2022) for a detailed description of the GCH's development which aligns with international approaches to defining rurality that use the core concepts of population size and proximity to metropolitan areas. Different jurisdictions take various approaches to defining rurality, but generally use a combination of these variables. In the United States of America, there are five key measures of rurality that are used in epidemiological studies, all based on a combination of population size, density and distance or commuting patterns. Canada has at least four different rurality classifications used in health research – all based on a combination of population size, density and distance. While exact thresholds cannot be universally applied, factors of population size, density and distance are key considerations in international geographic classifications of rurality.

2   A very small proportion of respondents (n = 465, < 0.01 per cent) were unable to be assigned to a GCH category and are excluded from this analysis.

3   The four supplementary tables are available from the corresponding author on request.

4   The two supplementary figures are available from the corresponding author on request.

References

2018 Census External Data Quality Panel. (2020). *Final report of the 2018 Census External Data Quality Panel*. Stats NZ. https://www.stats.govt.nz/reports/final-report-of-the-2018-census-external-data-quality-panel

Atkinson, J., Salmond, C. E., & Crampton, P. (2020). *NZDep2018 Index of Deprivation*. https://www.otago.ac.nz/wellington/otago823833.pdf

Australian Institute of Health and Welfare. (2022). *Rural and remote health – Health status and outcomes*. https://www.aihw.gov.au/reports/rural-remote-australians/rural-and-remote-health#Heath%20status

Barnett, R., Pearce, J., & Moon, G. (2009). Community inequality and smoking cessation in New Zealand, 1981–2006. *Social Science & Medicine*, *68*(5), 876–884. https://doi.org/10.1016/j.socscimed.2008.12.012

Blattner, K., Stokes, T., Rogers-Koroheke, M., Nixon, G., & Dovey, S. M. (2020). Good care close to home: Local health professional perspectives on how a rural hospital can contribute to the healthcare of its community. *The New Zealand Medical Journal (Online)*, *133*(1509), 39–34. https://pubmed.ncbi.nlm.nih.gov/32027637/

Bremberg, S. (2020). Rural-urban mortality inequalities in four Nordic welfare states. *Scandinavian Journal of Public Health*, *48*(8), 791–793. https://doi.org/10.1177/1403494820921684

Cameron, V. A., Faatoese, A. F., Gillies, M. W., Robertson, P. J., Huria, T. M., Doughty, R. N., Whalley, G. A., Richards, M. A., Troughton, R. W., & Tikao-Mason, K. N. (2012). A cohort study comparing cardiovascular risk factors in rural Māori, urban Māori and non-Māori communities in New Zealand. *BMJ Open*, *2*(3), e000799. https://doi.org/10.1136/bmjopen-2011-000799

Crengle, S., Davie, G., Whitehead, J., de Graaf, B., Lawrenson, R., & Nixon, G. (2022). Mortality outcomes and inequities experienced by rural Māori in Aotearoa New Zealand. *The Lancet – Western Pacific*. https://doi.org/10.1016/j.lanwpc.2022.100570

Cross, S. H., Califf, R. M., & Warraich, H. J. (2021). Rural-urban disparity in mortality in the US from 1999 to 2019. *JAMA*, *325*(22), 2312–2314. https://doi.org/10.1001/jama.2021.5334

Fearnley, D., Lawrenson, R., & Nixon, G. (2016). 'Poorly defined': Unknown unknowns in New Zealand rural health. *The New Zealand Medical Journal (Online)*, *129*(1439), 77. https://pubmed.ncbi.nlm.nih.gov/27507724/

Feigin, V. L., Theadom, A., Barker-Collo, S., Starkey, N. J., McPherson, K., Kahan, M., Dowell, A., Brown, P., Parag, V., & Kydd, R. (2013). Incidence of traumatic brain injury in New Zealand: A population-based study. *The Lancet Neurology*, *12*(1), 53–64. https://doi.org/10.1016/S1474-4422(12)70262-4

Hider, P., Lay-Yee, R., & Davis, P. (2007). Doctors, practices, patients, and their problems during usual hours: A description of rural and non-rural primary care in New Zealand in 2001–2002. *The New Zealand Medical Journal* [Online], *120*(1253). https://pubmed.ncbi.nlm.nih.gov/17514220/

Jaksons, R., Horn, B., Moriarty, E., & Moltchanova, E. (2019). Spatio-temporal analysis of differences in campylobacteriosis incidence between urban and rural areas in the Southern District Health Board, New Zealand. *Spatial and Spatio-temporal Epidemiology*, *31*, 100304. https://doi.org/10.1016/j.sste.2019.100304

Kukutai, T., & Cormack, D. (2018). Census 2018 and implications for Māori. *New Zealand Population Review, 44,* 131–151. https://population.org.nz/wp-content/uploads/2019/02/NZPR-Vol-44_final.pdf

Marmot, M., & Wilkinson, R. (2006). *Social determinants of health* (2nd ed.). Oxford University Press.

Ministry of Health (2012). *Mātātuhi Tuawhenua: Health of Rural Māori 2012*. https://www.health.govt.nz/publication/matatuhi-tuawhenua-health-rural-maori-2012

————— (2017). *Ministry of Health reports on Māori health outcomes and disparity in outcomes between Māori and non-Māori from 1992 to 2016*. https://www.health.govt.nz/system/files/documents/pages/ministry_of_health_reports_on_maori_health_outcomes.pdf

———————— (2023). *Rural Health Strategy*.
https://www.health.govt.nz/publication/rural-health-strategy

National Health Committee. (2010). *Rural Health: Challenges of distance, opportunities for innovation.* Available from https://thehub.swa.govt.nz/resources/rural-health-challenges-of-distance-opportunities-for-innovation/

Nelson, K. S., Nguyen, T. D., Brownstein, N. A., Garcia, D., Walker, H. C., Watson, J. T., & Xin, A. (2021). Definitions, measures, and uses of rurality: A systematic review of the empirical and quantitative literature. *Journal of Rural Studies*, *82*, 351–365. http://dx.doi.org/10.1016/j.jrurstud.2021.01.035

Nixon, G., Davie, G., Whitehead, J., Miller, R., de Graaf, B., Lawrenson, R., Smith, M., Wakerman, J., Humphreys, J., & Crengle, S. (2023). Comparison of urban and rural mortality rates across the lifespan in Aotearoa/New Zealand: A population-level study. *Journal of Epidemiology and Community Health*, 77*(9).* https://doi.org/10.1136/jech-2023-220337

Nixon, G., Whitehead, J., Davie, G., Fearnley, D., Crengle, S., de Graaf, B., Smith, M., Wakerman, J., & Lawrenson, R. (2021). Developing the geographic classification for health, a rural-urban classification for New Zealand health research and policy: A research protocol. *Australian Journal of Rural Health, 29*(6), 939–946. https://doi.org/10.1111/ajr.12778

Obertova, Z., Hodgson, F., Scott-Jones, J., Brown, C., & Lawrenson, R. (2016). Rural-urban differences in prostate-specific antigen (PSA) screening and its outcomes in New Zealand. *The Journal of Rural Health*, *32*(1), 56–62. https://doi.org/10.1111/jrh.12127

Parliamentary Counsel Office. (2022). *Pae Ora (Healthy Futures) Bill. Section 40B Rural Health Strategy*. https://legislation.govt.nz/bill/government/2021/0085/latest/LMS701298.html?search=sw_096be8ed81c2a073_rural_25_se&p=1&sr=5

Pitama, S., Huria, T., & Lacey, C. (2014). Improving Maori health through clinical assessment: Waikare o te Waka o Meihana. *The New Zealand Medical Journal* [Online], *127*(1393). https://pubmed.ncbi.nlm.nih.gov/24816961/

R Core Team. (2018). *A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.R-project.org/

Reid, P., Cormack, D., & Paine, S.-J. (2019). Colonial histories, racism and health—The experience of Māori and Indigenous peoples. *Public Health*, *172*, 119–124. https://doi.org/10.1016/j.puhe.2019.03.027

Reid, P., & Robson, B. (2007). Understanding health inequities. In B. Robson & R. Harris (Eds.), *Hauora: Māori Standards of Health IV. A study of the years 2000–2005* (pp. 3–10). Te Ropu Rangahau Hauora a Eru Pomare.

Robertson, O., Nathan, K., Howden-Chapman, P., Baker, M. G., Carr, P. A., & Pierse, N. (2021). Residential mobility for a national cohort of New Zealand-born children by area socioeconomic deprivation level and ethnic group. *BMJOpen*, *11*(1), e039706. https://bmjopen.bmj.com/content/11/1/e039706

Ryks, J., Simmonds, N., & Whitehead, J. (2019). The health and wellbeing of urban Māori in Aotearoa New Zealand. In I. Vojnovic, A. L. Pearson, A. Gershim, G. Deverteuil, & A. Allen (Eds.), *Handbook of global urban health* (pp. 283–296). Routledge. https://doi.org/10.4324/9781315465456

Salmond, C. E., & Crampton, P. (2002). Heterogeneity of deprivation within very small areas. *Journal of Epidemiology & Community Health*, *56*(9), 669–670. http://dx.doi.org/10.1136/jech.56.9.669

Salmond, C. E., & Crampton, P. (2012). Development of New Zealand's deprivation index (NZDep) and its uptake as a national policy tool. *Canadian Journal of Public Health/Revue Canadienne de sante'e publique*, *103*(8 Suppl 2) S7–S11. https://pubmed.ncbi.nlm.nih.gov/23618071/

Smith, K. B., Humphreys, J. S., & Wilson, M. G. (2008). Addressing the health disadvantage of rural populations: How does epidemiological evidence inform rural health policies and research? *Australian Journal of Rural Health*, *16*(2), 56–66. https://doi.org/10.1111/j.1440-1584.2008.00953.x

Stats NZ. (2020). *Urban accessibility – methodology and classification*. https://www.stats.govt.nz/methods/urban-accessibility-methodology-and-classification

————— (2022). https://nzdotstat.stats.govt.nz/wbos/Index.aspx

Subedi, R., Greenberg, T. L., & Roshanafshar, S. (2019). Does geography matter in mortality? An analysis of potentially avoidable mortality by remoteness index in Canada. *Health Reports*, *30*(5), 3–15. https://doi.org/10.25318/82-003-x201900500001-eng

Talamaivao, N., Harris, R., Cormack, D., Paine, S.-J., & King, P. (2020). Racism and health in Aotearoa New Zealand: A systematic review of quantitative studies. *The New Zealand Medical Journal* [Online], *133*(1521), 55–68. https://journal.nzma.org.nz/journal-articles/racism-and-health-in-aotearoa-new-zealand-a-systematic-review-of-quantitative-studies

Te Whatu Ora. (2022). *Te Pae Tata Interim New Zealand Health Plan 2022*. https://www.tewhatuora.govt.nz/publications/te-pae-tata-interim-new-zealand-health-plan-2022/

Wakerman, J., & Humphreys, J. S. (2002). Rural health: Why it matters. *Medical Journal of Australia*, *176*(10), 457–458. https://doi.org/10.5694/j.1326-5377.2002.tb04514.x

Weissman, S., Duffus, W. A., Vyavaharkar, M., Samantapudi, A. V., Shull, K. A., Stephens, T. G., & Chakraborty, H. (2014). Defining the rural HIV epidemic: Correlations of 3 definitions—South Carolina, 2005–2011. *The Journal of Rural Health*, *30*(3), 275–283. https://doi.org/10.1111/jrh.12057

Whitehead, J., Atatoa Carr, P., Scott, N., & Lawrenson, R. (2022). Structural disadvantage for priority populations: The spatial inequity of COVID-19 vaccination services in Aotearoa. *The New Zealand Medical Journal*, *135*(1551), 54–67. https://journal.nzma.org.nz/journal-articles/structural-disadvantage-for-priority-populations-the-spatial-inequity-of-covid-19-vaccination-services-in-aotearoa-open-access

Whitehead, J., Davie, G., de Graaf, B., Crengle, S., Fearnley, D., Smith, M., Lawrenson, R., & Nixon, G. (2022). Defining rural in Aotearoa New Zealand: A novel geographic classification for health purposes. *The New Zealand Medical Journal 135*(1559), 22–38. https://journal.nzma.org.nz/journal-articles/defining-rural-in-aotearoa-new-zealand-a-novel-geographic-classification-for-health-purposes

Whitehead, J., Davie, G., de Graaf, B., Crengle, S., Fearnley, D., Smith, M., Lawrenson, R., & Nixon, G. (2023). *Geographic classification for health – Concordance files*. https://doi.org/10.6084/m9.figshare.22728851

Whitehead, J., Davie, G., de Graaf, B., Crengle, S., Lawrenson, R., Miller, R., & Nixon, G. (2023). Unmasking hidden disparities: A comparative observational study examining the impact of different rurality classifications for health research in Aotearoa New Zealand. *BMJ Open*, *13*(4), e067927. https://doi.org/10.1136/bmjopen-2022-067927

World Health Organization. (2010). *A conceptual framework for action on the social determinants of health* (Social Determinants of Health Discussion Paper 2). https://www.who.int/publications/i/item/9789241500852