

Mortality outcomes and inequities experienced by rural Māori in Aotearoa New Zealand



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Summary

Background Previous research identified inequities in all-cause mortality between Māori and non-Māori populations. Unlike comparable jurisdictions, mortality rates in rural areas have not been shown to be higher than those in urban areas for either population. This paper uses contemporary mortality data to examine Māori and non-Māori mortality rates in rural and urban areas.

Methods A population-level observational study using deidentified routinely collected all-cause mortality, amenable mortality and census data. For each level of the Geographic Classification for Health (GCH), Māori and non-Māori age-sex standardised all-cause mortality and amenable mortality incident rates, Māori:Non-Māori standardised incident rate ratios and Māori rural:urban standardised incident rate ratios were calculated. Age and deprivation stratified rates and rate ratios were also calculated.

Findings Compared to non-Māori, Māori experience excess all-cause (SIRR 1.87 urban; 1.95 rural) and amenable mortality (SIRR 2.45 urban; 2.34 rural) and in all five levels of the GCH. Rural Māori experience greater all-cause (SIRR 1.07) and amenable (SIRR 1.13) mortality than their urban peers. Māori and non-Māori all-cause and amenable mortality rates increased as rurality increased.

Interpretation The excess Māori all-cause mortality across the rural: urban spectrum is consistent with existing literature documenting other Māori health inequities. A similar but more pronounced pattern of inequities is observed for amenable mortality that reflects ethnic differences in access to, and quality of, health care. The excess all-cause and amenable mortality experienced by rural Māori, compared to their urban counterparts, suggests that there are additional challenges associated with living rurally.

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Introduction

Māori, the Indigenous people of Aotearoa New Zealand were estimated to account for 17.1% of the population in June 2021.¹ The Māori population is significantly younger than the non-Māori population; the median age for

Māori males and females were 25.3 and 27.3 years respectively compared to national median ages of 36.7 for males and 38.8 years for females.¹ Colonisation resulted in the systematic dispossession of Māori from our land, the rights and freedoms associated with it, and the loss of health enhancing Māori knowledges, cultural practices, and language. The historical and contemporary manifestations of colonialism and racism underlie the longstanding inequities in the social determinants of health, access to care, and quality of care experienced by Māori.^{2,3} As a result Māori life

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Research in context

Evidence before this study

Three New Zealand Ministry of Health reports (2007, 2010 and 2012) have previously compared urban and rural mortality rates, and failed to identify consistent urban:rural differences. The most up to date report, *Mātātūhi Tuawhenua: Health of Rural Māori 2012*, is the only report to focus on outcomes for rural Māori at a national level, and included all-cause and amenable mortality. Amenable mortality, a subset of all-cause mortality, is defined as deaths under age 75 years that could potentially be avoided, given effective and timely healthcare. Mortality rates for Māori relative to non-Māori were significantly higher in urban and rural areas. *Mātātūhi Tuawhenua* compared outcomes for large urban areas, independent urban areas (small towns) and rural areas and concluded that all-cause and amenable mortality rates for Māori living in rural areas were lower than those for Māori living in independent urban areas and similar to those for Māori living in urban areas. The higher rural mortality rates seen for Indigenous populations in Australia and the US have not been demonstrated for NZ Māori.

Added value of this study

Analyses in previous reports have been undertaken using generic Statistics NZ urban rural classifications that were not designed with health in mind. It has been suggested that these classifications can mask genuine rural urban differences in health outcomes. This has resulted in the development of a geographic classification for health (GCH) for use in policy and research in New Zealand. This study is the first to use the GCH and up to date mortality data to recalculate Māori and non-Māori mortality rates across the urban rural spectrum.

This study provides the first evidence that living rurally exacerbates the large all-cause and amenable mortality inequities faced by Māori in New Zealand. Rural Māori have all-cause and amenable mortality rates that are considerably higher than those for rural non-Māori and, although the differences are smaller, significantly higher than those of urban Māori.

Although some confidence intervals between categories overlap, a test for trend confirms that the mortality disadvantage faced by rural Māori (and non-Māori) worsens with increasing rurality.

Implications of all the available evidence

The findings have important implications for both rural health and Māori health policy and health services. Targeted interventions to address the health inequities faced by rural Māori and health system and service development to address amenable mortality are required. Further research needs to be undertaken to determine the extent to which relocation in the later years of life may be masking mortality disparities for rural Māori.

expectancy is lower than that of European/other males (6.6 years) and females (6.4 years).⁴ The prevalence, incidence, hospitalisations, and mortality rates for most communicable and non-communicable diseases are greater for Māori compared to the non-Māori population.^{5,6}

The proportion of the population that are considered to reside in rural areas varies according to the urban–rural classification system used to assign rural status. Using Statistics New Zealand's Urban Rural Experimental Profile (UREP; first published in 2004) 18% of Māori and 16% of the European populations were reported to live in rural areas.⁷ In 2020 Statistics New Zealand replaced with UREP with the Urban Accessibility (UA) classification which classifies 31% of European and 33% of the Māori population as residing in rural areas.⁷ UREP is a generic geographic classification that consists of three categories of urban (main urban area, satellite urban community, independent urban community), and four categories of rural (rural area with high urban influence, rural area with moderate urban influence, rural area with low urban influence, highly rural/remote area). Although it is the most frequently used geographic classification in the Aotearoa New Zealand health literature it was not specifically designed for use in the health context and it has been shown to be problematic when used for health analyses.⁸

Defining rurality is an essential component of research exploring rural-urban health inequities. In Aotearoa New Zealand, different definitions of 'rural', including UREP, have been used, resulting in inconsistent categorisation of areas and populations. These inconsistencies have impacted the results of epidemiological studies and health services research, thereby potentially masking inequities between urban and rural areas.^{9,10,12–14}

The Geographic Classification for Health (GCH), a novel classification of rurality for use in health policy and research in Aotearoa New Zealand, was developed and tested in 2021. The GCH uses population size and travel time thresholds to delineate two urban (U1 and U2) and three rural (R1, R2, R3) categories that also align with a heuristic sense of what is understood to be rural in the NZ health context.⁷

To date, the higher mortality rates associated with living rurally that are evident in comparable jurisdictions,^{15,16} have not been demonstrated in Aotearoa New Zealand, for either the total population or for Māori. In 2010 the National Health Committee concluded that health status was similar in rural and urban areas while noting that there were inequities in health outcomes between Māori and non-Māori in all geographic areas.¹⁷

The *Mātātūhi Tuawhenua: Health of Rural Māori 2012* report provided a comprehensive account of rural Māori health. Comparisons were made between Māori in rural and urban areas, and between Māori and non-Māori.¹⁸ Māori mortality rates in each of the seven urban/rural categories within UREP were significantly higher than

non-Māori within the same category. For both the Māori and non-Māori populations, rural all-cause mortality was significantly lower or similar to mortality in urban areas, with the highest rates in independent urban communities and lowest in 'rural areas with high urban influence'. As with all-cause mortality, within each geographic area, Māori experienced significantly higher amenable mortality than their non-Māori peers.¹⁸ There has not been a comprehensive update of rural Māori health outcomes since this report.

The aim of this study is to describe the impact of living rurally on Māori mortality by comparing urban and rural Maori, and to compare Māori mortality with that of non-Māori within each GCH strata.

Methods

This population-level observational study used deidentified routinely collected data from two NZ Government agencies: the Ministry of Health (MoH) and Statistics New Zealand (Stats NZ).

Numerators

Information on all deaths registered in NZ between 2013 and 2017 was extracted from the MoH's Mortality Collection.¹⁹ Two outcomes were considered: all-cause mortality and amenable mortality. Amenable mortality is defined as deaths in people less than 75 years old from conditions for which variation in mortality rates reflects variation in the coverage and quality of health care delivered to individuals.²⁰ Deaths meeting this measure were those with either a primary diagnosis or a first-listed external-cause code within the specified range using the Australian Modification of the International Classification of Diseases 10th Revision (ICD10-AM). Age at death was categorized in 15-year bands (0–14, 15–29, 30–44, 45–59, 60–74, 75+), and for the purposes of this analysis, ethnicity was grouped into 'Māori' and 'Non-Māori'. The Mortality Collection contains the meshblock (smallest geographical area in use by Stats NZ) corresponding to the usual residential address of each fatality. The New Zealand Index of Deprivation 2013 (NZDep2013) is a small area geographic measure of socioeconomic deprivation derived from nine census variables that is produced as an ordinal scale from 1 to 10.²¹ NZDep2013 decile for each residential address was obtained by using meshblock:NZDep concordance tables. For this analysis, quintiles were used with Q1 (NZDep2013 deciles 1–2) representing areas with the lowest deprivation scores and Q5 (NZDep2013 deciles 9–10) representing the most deprived areas. The GCH assigns people to one of 5 levels of rurality according to the Statistical Area 1 (SA1; Statistics NZ's smallest output geography as at 2018) in which their residential address is located. Two versions of GCH were used: the 5-level and a binary urban–rural variable.

Denominators

Census Usually Resident Population counts aggregated, simultaneously, by age, sex, ethnicity, deprivation and rurality were obtained from Statistics NZ for both the 2013 and 2018 Censuses. Age was categorised in 15-year bands. Ethnicity was grouped into 'Māori' and 'Non-Māori'. Person-years for the 5-year period 2013–2017 were calculated from the Census 2013 and Census 2018 counts, combined with annual intercensal estimates obtained using linear interpolation.

Statistical analysis

In order to combine the numerators and denominators, the person-level numerator dataset was collapsed, with all-cause and amenable mortality counts produced for each combination of the age (6), sex (2), ethnicity (2), rurality (5) and deprivation (5) categories ($6 \times 2 \times 2 \times 5 \times 5 = 600$ rows). Crude and age-sex Standardised Incident Rates (SIRs) with 95% Confidence Intervals (CIs) were calculated for Māori and non-Māori for each level of the GCH. SIRs and corresponding 95% CIs were calculated using the Stata Statistical Software command 'dstdize' that produces standardised rates using the direct method.¹¹ Direct standardisation by age and sex was undertaken using the Census 2001 Māori population as the standard population.⁶ For comparisons between ethnic groups, Māori:Non-Māori standardised Incident Rate Ratios (IRRs), i.e. the ratio of the SIR for Māori divided by the SIR for Non-Māori, were produced with 95% CIs. To examine the impact of rurality on Māori, IRRs were calculated that used the population living in U1 as the reference category. SIRs and IRRs were calculated for all-cause and amenable mortality by GCH, as well as stratified by age and deprivation separately. Variance-weighted least square regression was used to test for a linear trend in the age-sex SIRs across the five level GCH for Māori and non-Māori separately. Data were prepared using SAS software version 9.4 for Linux (https://www.sas.com/en_nz/legal/editorial-guidelines.html). Analysis was undertaken using Stata/SE v16.1 (StataCorp. 2019. Stata Statistical Software: Release 16. College Station, TX: StataCorp LLC.). Pyramid plots were produced using the package 'Plotrix' in R.^{22,23}

The University of Otago Human Research Ethics Committee approved the study (reference number HD19/069). Māori consultation was undertaken with the Ngāi Tahu Research Consultation Committee.

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Results

In 2018, 57.0% of the Māori and 36.8% of the non-Māori population were less than 30 years (Table 1). The

	Māori		Non-Māori		Total	
	n	Col %	n	Col %	N	Col %
Age (years)						
0–14	248,763	32.1	674,520	17.2	923,283	19.7
15–29	193,092	24.9	770,298	19.6	963,390	20.5
30–44	133,470	17.2	770,055	19.6	903,525	19.2
45–59	124,458	16.1	808,056	20.6	932,514	19.9
60–74	60,636	7.8	612,684	15.6	673,320	14.3
75+	15,192	2.0	287,289	7.3	302,481	6.4
Gender						
Female	392,757	50.6	1,987,005	50.7	2,379,762	50.7
Male	382,854	49.4	1,935,897	49.3	2,318,751	49.3
NZDep Quintiles						
Q1 (least deprived)	64,869	8.4	837,363	21.4	902,232	19.2
Q2	86,517	11.2	829,419	21.1	915,936	19.5
Q3	115,194	14.9	816,093	20.8	931,287	19.8
Q4	175,464	22.6	780,999	19.9	956,463	20.4
Q5 (most deprived)	333,567	43.0	659,028	16.8	992,595	21.1
GCH						
U1 (most urban)	381,105	49.1	2,579,787	65.8	2,960,892	63.0
U2	198,144	25.6	646,896	16.5	845,040	18.0
R1	108,546	14.0	461,574	11.8	570,120	12.1
R2	69,690	9.0	197,127	5.0	266,817	5.7
R3 (most rural/remote)	18,126	2.3	37,518	1.0	55,644	1.2

Table 1: Demographics of New Zealand Usually Resident Population (Census 2018): Māori, Non-Māori and Total.

age pyramids for Māori and non-Māori in both urban and rural areas are markedly different, clearly demonstrating the greater proportion of Māori under the age of 30 years and non-Māori in the older age groups (Figure 1). Figure 1 also demonstrates that for both ethnic groups, a greater proportion of the population aged 15–44 years reside in urban areas, and a greater proportion of the population 50 years and older reside in rural areas.

There was no difference in the Māori and non-Māori sex distributions. Māori were under-represented in low deprivation quintiles (19.6% in quintiles 1 and 2) compared with non-Māori (42.5%). Conversely, Māori were over-represented in high deprivation quintiles (65.6% compared with 36.7% of non-Māori). One quarter (25.3%) of Māori and 17.8% of non-Māori lived in rural areas (R1, R2 or R3). Relative to non-Māori, the proportion of Māori rises with increasing rurality. Almost 33% (18,126/55,644) of residents in R3 (most remote/rural) report Māori ethnicity (Table 1).

Using the binary version of the GCH, the Māori rural age-sex standardised all-cause mortality rate was significantly higher than that of urban Māori. In comparison the rural non-Māori standardised rate was similar to that of urban non-Māori. Māori all-cause mortality rates were significantly higher than those of non-Māori in both rural (standardised incident rate ratio (SIRR) 1.95; 95%CI 1.88, 2.02) and urban (IRR 1.87; 95%CI

1.84, 1.91) locations. Rural Māori had significantly higher all-cause mortality than urban Māori (IRR 1.07; 95% CI 1.03, 1.10) (Table 2).

Ethnic differences in amenable mortality were more pronounced than those observed for all-cause mortality with Māori:non-Māori SIRRs of 2.45 in urban areas and 2.34 in rural areas. Rural Māori also experienced significantly higher amenable mortality than their urban peers (standardised IRR 1.13, 95%CI 1.07, 1.20) (Table 2).

Using the five level GCH classification provides more detailed information about inequities across the urban–rural spectrum. Age-sex standardised all-cause mortality rates were significantly higher for Māori in all five urban and rural levels. The standardised IRRs range from 1.80 to 2.32, clearly demonstrating Māori excess all-cause mortality. Likewise, Māori amenable mortality rates were significantly higher than non-Māori in all five urban and rural levels with SIRRs ranging from 2.22 to 2.54. Compared with Māori living in U1 areas, Māori in U2 and all three rural levels experienced significantly higher all-cause and amenable mortality. There was strong evidence of a linear trend in increasing standardised incident rates from U1 to R3 for Māori and non-Māori all-cause and amenable mortality with $p < 0.001$ for all four analyses (Supplementary Table 1).

Rural Māori sex standardised all-cause mortality rates were significantly higher than urban Māori rates in the 15–29, 30–44 year age groups and are similar in

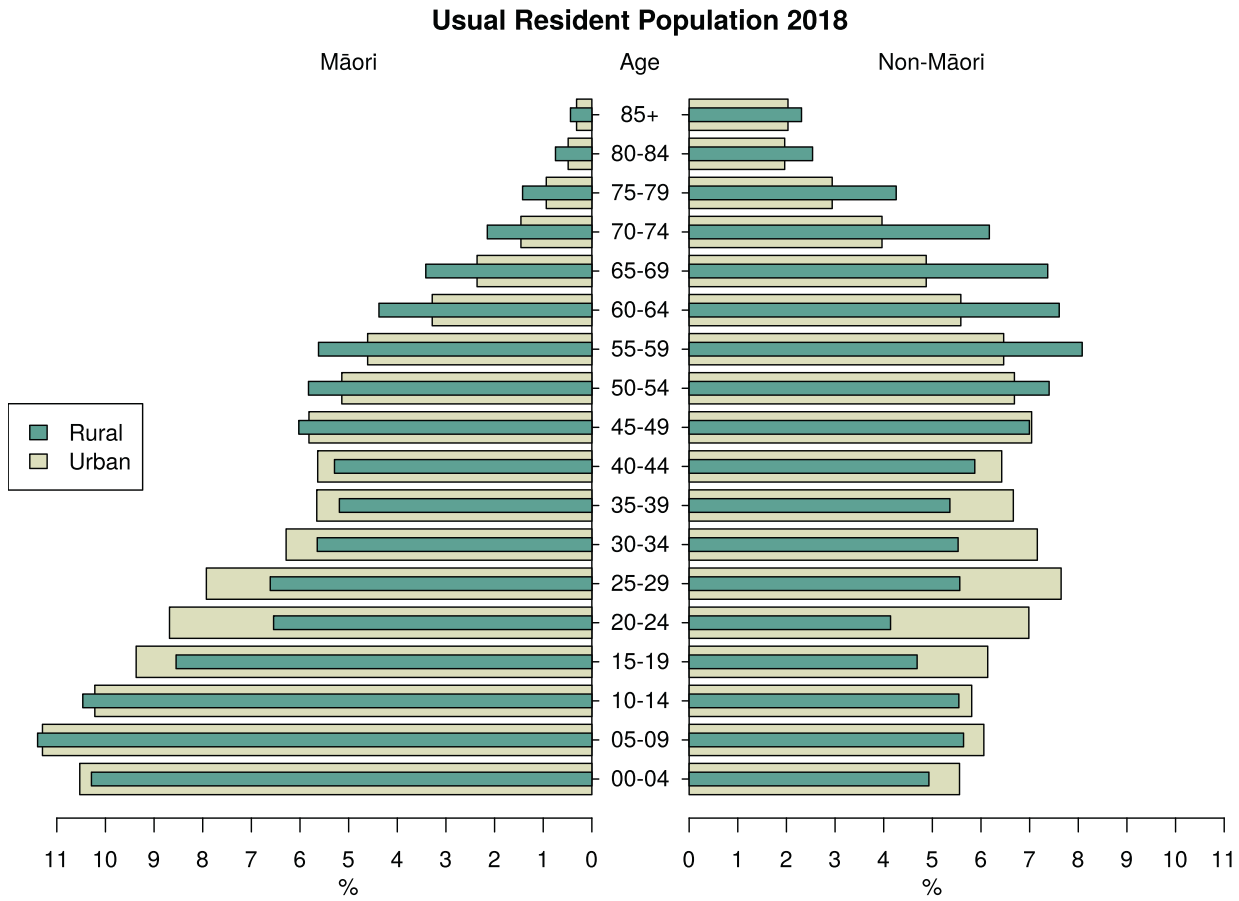


Figure 1. Proportion of the Māori and non-Māori populations living in rural and urban areas, by age.

Mortality	Māori			Non-Māori			Māori:Non-Māori			Māori Rural:Urban		
	Deaths	Incident rate (IR)	Standardised IR ^a	Deaths	Incident rate (IR)	Standardised IR ^a	Standardised IRR ^b	95%CI	Standardised IRR ^b	95%CI	Standardised IRR ^b	95%CI
All-cause												
U	11,625	465.6	339.3	110,476	716.3	181.0	(179.5, 182.6)	1.87	(1.84, 1.91)	ref		
R	5288	622.3	362.0	29,305	875.1	185.7	(182.1, 189.3)	1.95	(1.88, 2.02)	1.07	(1.03, 1.10)	
Amenable												
U	4145	168.7	134.9	15,882	110.4	55.1	(54.1, 56.2)	2.45	(2.36, 2.54)	ref		
R	1832	220.9	152.9	4771	155.9	65.5	(62.9, 160.5)	2.34	(2.19, 2.49)	1.13	(1.07, 1.20)	

Table 2: All-cause and amenable mortality rates (per 100,000 person-years) and standardised incident rate ratios for Māori compared to Non-Māori and within 2-levels of rurality: 2013–2017.

^a Standardised Incident Rate: age-sex standardised to the 2001 Census Māori Population.

^b Incident Rate Ratio (IRR).

the 0–14, 45–59, 60–74 and 75+ age groups with Māori rural: urban SIRRs ranging from 0.97 to 1.45. In the non-Māori population, rural all-cause mortality rates are higher in the 15–29, 30–44 and 45–59 year age groups, similar in the 0–14 and 60–74 year groups and lower in the 75+ year age group. The excess Māori all-cause mortality is clearly demonstrated in all age groups in both rural and urban locations with Māori: non-Māori SIRRs ranging from 1.18 to 2.54. The excess mortality burden is greatest in the 30–44 and 45–59 year old age groups in both rural and urban populations. The standardised all-cause mortality rates for urban Māori and non-Māori under 60 years of age were lower than their rural counterparts, but this pattern was reversed in those aged 60 years and over. Rural non-Māori mortality rates in the 75 year and older group were significantly lower than urban rates. For Māori, the pattern of rural excess mortality observed in the younger age groups, was attenuated in the 60–74 and 75+ year groups with non-significant SIRRs (SIRR 0.98 and 0.97 respectively) (Table 3).

Māori sex standardised rural amenable mortality rates were higher in the 15–29 and 30–44 year age groups (Māori rural: urban SIRRs 1.56 and 1.26, respectively) but were similar in the other age groups. Excess Māori amenable mortality is also demonstrated in all age groups with Māori:non-Māori SIRRs ranging from 1.50 to 2.72 (Table 3).

Using the five level GCH classification Māori all-cause mortality rates in the age groups from 0 to 59 years suggest increasing mortality with increasing rurality, however, the CI overlap. With the exception of R3 in the 0–14 and 15–29 years groups, the excess burden of all-cause mortality experienced by Māori is apparent with Māori:non-Māori SIRRs ranging from 1.14 to 3.57. From 30 years and above, the point estimates suggest that mortality difference is greatest in R3 areas although confidence intervals are wide (Supplementary Table 2).

Inequities in amenable mortality are also evident within all age groups and all GCH levels except for 0–14 year R3 and 15–29 year R2. Sex standardised Māori:non-Māori IRRs range from 1.04 to 3.71 (Supplementary Table 2).

Deprivation quintile specific Māori:non-Māori age-sex standardised IRRs demonstrate that Māori all-cause mortality was significantly higher than non-Māori in both rural and urban regions, with the exception being quintile 1 rural where there were relatively few Māori deaths. Māori rural:urban SIRRs within each deprivation decile varied with lower mortality in quintile 1, excess mortality observed in quintiles 2 and 3, similar mortality in quintiles 4 and 5 (Table 4).

For amenable mortality, deprivation quintile specific Māori:non-Māori standardised IRRs demonstrated that, with the exception of quintile 1 in rural areas, Māori experienced a greater burden of amenable mortality

Mortality	Māori				Non-Māori				Māori:Non-Māori		Māori Rural:Urban	
	Deaths	Incident rate (IR)	Standardised IR ^a		Deaths	Incident rate (IR)	Standardised IR ^a		Standardised IRR ^b		Standardised IRR ^b	
			Est.	95%CI			Est.	95%CI	Est.	95%CI	Est.	95%CI
All-cause												
0–14 years												
U	497	60.4	60.0	(54.7, 65.2)	1056	38.1	38.0	(35.7, 40.3)	1.58	(1.42, 1.76)	ref	
R	195	69.3	69.5	(59.7, 79.3)	227	40.0	39.7	(34.5, 44.8)	1.75	(1.45, 2.12)	1.16	(0.98, 1.37)
15–29 years												
U	561	88.0	88.2	(80.9, 95.5)	1296	40.9	40.4	(38.2, 42.6)	2.18	(1.98, 2.41)	ref	
R	234	129.3	128.3	(111.9, 144.7)	323	68.4	66.3	(59.0, 73.5)	1.94	(1.64, 2.29)	1.45	(1.25, 1.69)
30–44 years												
U	801	178.1	180.5	(168.0, 193.0)	2338	74.8	75.1	(72.0, 78.1)	2.40	(2.22, 2.60)	ref	
R	307	218.0	222.1	(197.3, 247.0)	505	87.2	87.3	(79.7, 94.9)	2.54	(2.21, 2.93)	1.23	(1.08, 1.40)
45–59 years												
U	2518	662.1	665.6	(639.6, 691.5)	8469	268.4	269.0	(263.3, 274.7)	2.47	(2.37, 2.59)	ref	
R	1042	707.0	712.9	(669.8, 756.0)	2169	283.2	282.6	(279.8, 294.5)	2.52	(2.34, 2.72)	1.07	(1.00, 1.15)
60–74 years												
U	3900	2341.2	2352.4	(2279.4, 2425.4)	22,183	1025.8	1028.7	(1015.2, 1042.2)	2.29	(2.21, 2.37)	ref	
R	1801	2285.9	2299.0	(2194.0, 2404.0)	6868	1016.4	1009.0	(985.3, 1032.8)	2.28	(2.16, 2.40)	0.98	(0.92, 1.03)
75+ years												
U	3348	8431.6	8568.1	(8286.8, 8849.4)	75,134	7237.3	7289.4	(7238.8, 7340.1)	1.18	(1.14, 1.22)	ref	
R	1709	8277.6	8321.3	(7941.9, 8700.7)	19,213	6648.7	6662.8	(6571.8, 6753.9)	1.25	(1.19, 1.31)	0.97	(0.92, 1.03)
Amenable												
0–14 years												
U	218	26.5	26.4	(22.9, 29.9)	488	17.6	17.5	(16.0, 19.1)	1.50	(1.28, 1.76)	ref	
R	89	31.6	31.7	(25.1, 38.3)	98	17.3	17.1	(13.7, 20.5)	1.85	(1.39, 2.47)	1.20	(0.94, 1.54)
15–29 years												
U	379	59.5	59.6	(53.6, 65.6)	780	24.6	24.3	(22.6, 26.0)	2.45	(2.17, 2.77)	ref	
R	169	93.4	92.6	(78.7, 106.6)	236	50.0	48.2	(42.1, 54.4)	1.92	(1.58, 2.34)	1.56	(1.30, 1.86)
30–44 years												
U	422	93.9	94.9	(85.9, 104.0)	1179	37.7	37.9	(35.7, 40.0)	2.50	(2.24, 2.80)	ref	
R	165	117.2	119.9	(101.6, 138.2)	284	49.1	49.1	(43.4, 54.8)	2.44	(2.02, 2.96)	1.26	(1.05, 1.51)
45–59 years												
U	1251	329.0	330.8	(312.5, 349.1)	3825	121.2	121.5	(117.6, 125.3)	2.72	(2.55, 2.90)	ref	
R	512	347.4	350.8	(320.5, 381.2)	1064	138.9	138.6	(130.3, 147.0)	2.53	(2.28, 2.81)	1.06	(0.96, 1.18)
60–74 years												
U	1875	1125.6	1131.8	(1080.8, 1182.7)	9610	444.4	446.0	(437.1, 454.9)	2.54	(2.42, 2.67)	ref	
R	897	1138.5	1145.4	(1070.8, 1219.9)	3089	457.2	453.0	(437.0, 468.9)	2.53	(2.35, 2.72)	1.01	(0.94, 1.10)

Table 3: All-cause and amenable mortality rates (per 100,000 person-years) and incident rate ratios for Māori compared to Non-Māori and within 2-level rurality stratified by age; 2013–2017.

^a Standardised Incident Rate: sex standardised to the 2001 Census Māori Population.

^b Incident Rate Ratio (IRR).

Mortality	Māori				Non-Māori				Māori:Non-Māori		Māori Rural:Urban	
	Deaths	Incident rate (IR)	Standardised IR ^a		Deaths	Incident rate (IR)	Standardised IR ^a		Standardised IRR ^b		Standardised IRR ^b	
			Est.	95%CI			Est.	95%CI	Est.	95%CI	Est.	95%CI
All-cause												
NZDep Q1												
U	732	307.0	224.4	(207.9, 240.9)	20,581	605.9	158.0	(155.1, 161.0)	1.42	(1.32, 1.53)	ref	
R	74	237.2	160.5	(122.2, 198.9)	2190	517.7	132.5	(123.7, 141.3)	1.21	(0.95, 1.55)	0.72	(0.56, 0.92)
NZDep Q2												
U	986	329.2	239.3	(224.3, 254.4)	21,233	653.2	150.9	(147.9, 153.9)	1.59	(1.48, 1.69)	ref	
R	301	404.7	274.1	(241.6, 306.6)	4710	665.4	166.5	(158.9, 174.1)	1.65	(1.45, 1.87)	1.15	(1.00, 1.31)
NZDep Q3												
U	1563	411.2	290.6	(276.0, 305.3)	22,223	718.0	168.8	(165.4, 172.2)	1.72	(1.63, 1.82)	ref	
R	745	601.6	387.9	(358.6, 417.3)	7418	879.9	192.5	(185.3, 199.7)	2.02	(1.85, 2.19)	1.33	(1.22, 1.46)
NZDep Q4												
U	2749	485.8	339.3	(326.3, 352.3)	25,813	865.0	204.1	(200.2, 207.9)	1.66	(1.59, 1.74)	ref	
R	1101	535.7	320.7	(300.3, 341.1)	8167	996.6	195.8	(188.1, 203.4)	1.64	(1.52, 1.76)	0.95	(0.88, 1.02)
NZDep Q5												
U	5595	552.5	418.0	(406.9, 429.2)	20,626	765.0	250.2	(245.6, 254.8)	1.67	(1.62, 1.73)	ref	
R	3067	739.3	404.9	(388.7, 421.0)	6820	1228.1	221.9	(212.1, 231.7)	1.82	(1.72, 1.94)	0.97	(0.92, 1.02)
Amenable												
NZDep Q1												
U	232	98.7	78.3	(67.9, 88.7)	2800	87.0	40.6	(38.7, 42.6)	1.93	(1.67, 2.22)	ref	
R	24	78.2	62.8	(36.1, 89.4)	415	104.9	46.4	(40.1, 52.8)	1.35	(0.87, 2.11)	0.80	(0.51, 1.25)
NZDep Q2												
U	321	108.7	85.5	(76.0, 95.0)	2701	89.3	42.3	(40.3, 44.3)	2.02	(1.79, 2.28)	ref	
R	96	131.3	104.7	(82.6, 126.8)	856	129.6	59.4	(53.8, 64.9)	1.76	(1.40, 2.22)	1.22	(0.96, 1.55)
NZDep Q3												
U	512	137.0	110.2	(100.5, 119.9)	2892	101.0	51.2	(48.9, 53.5)	2.15	(1.95, 2.38)	ref	
R	255	209.9	158.2	(137.7, 178.6)	1146	147.7	65.2	(59.9, 70.4)	2.43	(2.08, 2.83)	1.44	(1.23, 1.68)
NZDep Q4												
U	945	170.1	135.8	(127.0, 144.6)	3486	127.1	64.8	(62.2, 67.4)	2.10	(1.94, 2.26)	ref	
R	368	183.1	128.9	(114.9, 142.8)	1235	167.4	70.2	(64.6, 75.8)	1.84	(1.60, 2.10)	0.95	(0.84, 1.08)
NZDep Q5												
U	2135	214.1	173.5	(165.9, 181.0)	4003	157.8	89.3	(86.1, 92.4)	1.94	(1.84, 2.05)	ref	
R	1089	270.3	177.5	(165.9, 189.0)	1119	228.2	82.4	(75.5, 89.4)	2.15	(1.93, 2.40)	1.02	(0.95, 1.11)

Table 4: All-cause and Amenable Mortality Rates (per 100,000 person-years) and Incident Rate Ratios for Māori compared to Non-Māori and within 2-level rurality stratified by deprivation; 2013–2017.

^a Standardised Incident Rate: age-sex standardised to the 2001 Census Māori Population.

^b Incident Rate Ratio (IRR).

than non-Māori in both rural and urban areas. Within each deprivation decile the Māori rural:urban SIRRs showed there was little difference in amenable mortality between urban and rural areas; the exception being quintile 3 for which the SIRR was 1.44 (95%CI 1.23, 1.68) (Table 4).

Discussion

This is the first study in a decade to compare Māori mortality rates across the urban rural spectrum and it is the first study to do so using an urban: rural geographic classification developed for use in health policy and research. The GCH defines a rural Māori population that is older than urban Māori but considerably younger than rural non-Māori. Māori are more likely than non-Māori to live in rural areas and considerably more likely to live in more remote places. Māori also experience much greater socioeconomic deprivation.

The excess Māori all-cause and amenable mortality identified across the rural: urban spectrum reinforces the findings of an extensive body of literature that documents the extent of the health inequities faced by Māori in New Zealand and reflects inequities in the social determinants of health, and inequities in access to, and the quality of, health care. In both rural and urban areas the ethnic inequities are greater for amenable mortality than all-cause mortality, reflecting the impact of ethnic differences in access to, and quality of, health care.^{5,6} The excess all-cause and amenable mortality experienced by rural Māori, compared to their urban counterparts, suggests that there are additional challenges associated with living rurally that are likely to reflect differences in access to care and the different deprivation profile observed in rural Māori communities. A similar trend observed for the non-Māori population also likely reflects differences in access to care.

That living in the most rural areas exacerbates all-cause mortality inequities experienced by Māori has not previously been demonstrated in Aotearoa New Zealand. This finding could also reflect changes in outcomes that have occurred since the previous data were published. It may also be attributable to the use of the GCH, a fit-for-purpose health geographic classification. The GCH classifies many smaller towns as rural or remote unlike older classifications that include these towns in urban categories. Previous reports, using older generic urban rural classifications and older data, identified higher mortality rates for Māori living in smaller towns, and concluded that the rates for those living in more rural and remote areas were similar to those for Māori living in metropolitan centers.^{17,18,24}

This study contributes evidence to the existing literature about Indigenous rural health inequities in other jurisdictions. Most comparable international literature comes from Australia, Canada and the U.S.¹⁶ The findings of this study align with results of Australian and U.

S. research that have also identified an association between rurality and higher mortality rates for adult Indigenous populations.¹⁶ However, this effect has not been unequivocally demonstrated for maternal and infant mortality or adult mortality in Canada and Australia.^{25,26} The gradient of worsening outcomes with increasing rurality/remoteness is an additional finding not previously reported in the New Zealand literature. Studies have identified similar mortality gradients with increasing rurality in Australia and the US,^{27,28} although the Australian evidence for such an effect is conflicting.²⁹

The lower rural all-cause mortality rates in the 75+ non-Māori group and attenuation of excess mortality for Māori over 60 years should not be assumed to provide evidence of healthier older rural populations. It is likely that older rural dwellers relocate to more urban areas in order to access residential care and be closer to health services when they become frail and unwell. Although this effect is evident in the rural Māori population, it is even more pronounced in the equivalent non-Māori population. This raises the possibility that patterns of rural: urban relocation later in life differ for Māori and non-Māori.

Strengths of this study include the use of up-to-date, national data. Use of the GCH, a rural classification system designed specifically for use in health, is an additional strength. The geographic classification that is applied to data can materially alter the results of epidemiological studies. Comparing this paper's findings with previous New Zealand studies reinforces the importance of using a purpose-designed (rather than generic) classification. The analysis of mortality outcomes by age and deprivation is presented for the first time. The small number of deaths in some categories, particularly R3, may have limited the study's power to demonstrate significant differences. A further limitation is that, while it is likely that the availability and accessibility of health services decreases with increasing rurality, this was not quantified in the current paper.

Consistent use of the GCH in research, policy, and health service planning and funding settings will ensure that data accurately represents rural outcomes and will remove inconsistencies in research findings arising from the use of multiple classification systems. This study also provides important baseline evidence for monitoring the impacts of New Zealand's current health system reforms on rural health and rural health inequities. Although not an aim of this study, the results suggest that rural non-Māori also have poorer health outcomes, particularly amenable mortality, than their urban peers. Fully understanding the intersectionality between ethnicity, deprivation and rurality and their interacting impacts on health outcomes is likely to be complex but has the potential to improve the targeting of rural health policy and healthcare delivery. This is the subject of research that is currently being undertaken.

Other future research could investigate the causes of the increasing all-cause and amenable mortality rates with increasing rurality, the patterns of rural: urban relocation in later life, and the relationship between health service availability and models of care, and rural Māori health outcomes.

Stark and persistent Māori health inequities are a product of more than 180 years of colonisation, structural and interpersonal racism, and hindered access to the social determinants of health, despite the guarantees under Te Tiriti o Waitangi and the United Nations Declaration on the Rights of Indigenous Peoples. These chronic inequities underpin the establishment of the Māori Health Authority and Health New Zealand, key elements of New Zealand's current health system reforms. Both agencies are tasked with improving the equitable delivery of healthcare and addressing determinants of health in both rural and urban locations. In addition, inequities between urban and rural Māori highlight the need for strategy, policy and models of healthcare delivery designed for the rural Māori context, coupled with further Māori-led research that includes the ongoing monitoring of Māori health status.

Contributors

Crengle: funding acquisition, conceptualisation, methodology, and writing -original draft.

Davie: funding acquisition, conceptualisation, methodology, formal analysis and writing – review and editing. Associate Professor Davie verifies the data.

Whitehead: funding acquisition, conceptualisation, and writing – review and editing.

De Graaf: funding acquisition, conceptualisation, data curation, methodology, formal analysis, software, validation, and visualisation. Mr de Graaf verifies the data.

Lawrenson: funding acquisition and conceptualisation.

Nixon: funding acquisition, methodology, project administration, conceptualisation, and writing – review and editing.

The corresponding author (Crengle) states that co-authors were not precluded from accessing the data in the study and accept responsibility to submit for publication.

Data sharing statement

The Geographic Classification for Health is freely available. Numerator and denominator data is from publicly available government datasets.

Declaration of interests

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Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.lanwpc.2022.100570.

References

- 1 Statistics New Zealand. Māori population estimates: at 30 June 2021, <https://www.stats.govt.nz/information-releases/maori-population-estimates-at-30-june-2021> 2022. Accessed 13 January 2022.
- 2 Waitangi Tribunal. *HAUORA Report on Stage One of the Health Services and Outcomes Kaupapa Inquiry*. 2019. Wellington.
- 3 Harris R, Cormack D, Tobias M, et al. The pervasive effects of racism: experiences of racial discrimination in New Zealand over time and associations with multiple health domains. *Soc Sci Med*. 2012;74:408–415. <https://doi.org/10.1016/j.socscimed.2011.11.004>.
- 4 Statistics New Zealand. National and subnational period life tables: 2017–2019, <https://www.stats.govt.nz/information-releases/national-and-subnational-period-life-tables-2017-2019>. 2022. Accessed 14 January 2022.
- 5 Aho o Te Kahu Te. *He Pūrongo Mate Pukupuku o Aotearoa 2020, The State of Cancer in New Zealand 2020*. Wellington: Te Aho o Te Kahu, Cancer Control Agency; 2021.
- 6 Ministry of Health. In: Mo Health, ed. *Tatau Kahukura: Māori Health Chart Book 2015*. 3rd edition Wellington: Ministry of Health; 2015. (ed.).
- 7 Whitehead J, Davie G, de Graaf B, et al. Defining rural in Aotearoa New Zealand: a novel geographic classification for health purposes. *N Z Med J*. 2022;135(1559):22–38.
- 8 Fearnley D, Lawrenson R, Nixon G. 'Poorly defined': unknown unknowns in New Zealand rural health. *N Z Med J*. 2016;129:77–81. Accessed 11 August 2016.
- 9 Hawley ST, Chang S, Risser D, et al. Colorectal cancer incidence and mortality in Texas 1990–1992: a comparison of rural classifications. *J Rural Health*. 2002;18:536–546. <https://doi.org/10.1111/j.1748-0361.2002.tb00920.x>. Accessed 17 October 2002.
- 10 Berke EM, West AN, Wallace AE, et al. Practical and policy implications of using different rural-urban classification systems: a case study of inpatient service utilization among veterans administration users. *J Rural Health*. 2009;25:259–266. <https://doi.org/10.1111/j.1748-0361.2009.00228.x>. Accessed 2 July 2009.
- 11 StataCorp. *Stata 16 Base Reference Manual*. College Station, TX: Stata Press; 2019.
- 12 West AN, Lee RE, Shambaugh-Miller MD, et al. Defining "rural" for veterans' health care planning. *J Rural Health*. 2010;26:301–309. <https://doi.org/10.1111/j.1748-0361.2010.00298.x>. Accessed 30 October 2010.
- 13 Weissman S, Duffus WA, Vyavaharkar M, et al. Defining the rural HIV epidemic: correlations of 3 definitions—South Carolina, 2005–2011. *J Rural Health*. 2014;30:275–283. <https://doi.org/10.1111/jrh.12057>. Accessed 18 December 2013.
- 14 Inagami S, Gao S, Karimi H, et al. Adapting the Index of Relative Rurality (IRR) to estimate rurality at the ZIP code level: a rural classification system in health services research. *J Rural Health*. 2016;32:219–227. <https://doi.org/10.1111/jrh.12148>.
- 15 Probst JC, Zahnd WE, Hung P, et al. Rural–urban mortality disparities: variations across causes of death and race/ethnicity, 2013–2017. *Am J Public Health*. 2020;110:1325–1327. <https://doi.org/10.2105/ajph.2020.305703>.
- 16 Carson E, Sharmin S, Maier AB, et al. Comparing indigenous mortality across urban, rural and very remote areas: a systematic review and meta-analysis. *Int Health*. 2018;10:219–227. <https://doi.org/10.1093/inthealth/ihy021>.
- 17 National Health Committee. *Rural Health: Challenges of Distance, Opportunities for Innovation*. Wellington: National Health Committee; 2010.
- 18 Ministry of Health. *Mātātuhi Tuawhenua: Health of Rural Māori 2012*. Wellington: Ministry of Health; 2012.
- 19 Ministry of Health. Mortality Collection, <https://www.health.govt.nz/nz-health-statistics/national-collections-and-surveys/collections/mortality-collection>.
- 20 Ministry of Health. *Saving Lives: Amenable Mortality in New Zealand, 1996–2006*. 2010.
- 21 Atkinson J, Salmond C, Crampton P. *NZDep2013 Index of Deprivation*. Wellington: University of Otago; 2014. May 2014.

- 22 R Core Team. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing; 2018.
- 23 Lemon J. Plotrix: a package in the red light district of R. *R-News*. 2006;6:8–12.
- 24 Ministry of Health. *Urban–Rural Health Comparisons: Key Results of the 2002/03 New Zealand Health Survey*. Wellington: Ministry of Health; 2007.
- 25 Coory M. Can a mortality excess in remote areas of Australia be explained by indigenous status? A case study using neonatal mortality in Queensland. *Aust N Z J Public Health*. 2003;27:425–427. Comparative Study.
- 26 Simonet F, Wilkins R, Heaman M, et al. Urban living is not associated with better birth and infant outcomes among inuit and first nations in Quebec. *Open Womens Health J*. 2010;4:25–31. <https://doi.org/10.2174/1874291201004020025>. Accessed 1 January 2010.
- 27 Banham D, Jury H, Woollacott T, et al. Aboriginal premature mortality within South Australia 1999–2006: a cross-sectional analysis of small area results. *BMC Public Health*. 2011;11:286. <https://doi.org/10.1186/1471-2458-11-286>.
- 28 Singh GK, Siahpush M. Widening rural-urban disparities in all-cause mortality and mortality from major causes of death in the USA, 1969–2009. *J Urban Health: Bull N Y Acad Med*. 2014;91:272–292. <https://doi.org/10.1007/s11524-013-9847-2>.
- 29 Andreasyan K, Hoy WE. Recent patterns in chronic disease mortality in remote living indigenous Australians. *BMC Public Health*. 2010;10:483. <https://doi.org/10.1186/1471-2458-10-483>.