Comparison of urban and rural mortality rates across the lifespan in Aotearoa/New Zealand: a population-level study

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ABSTRACT

Background Previous studies undertaken in New Zealand using generic rurality classifications have concluded that life expectancy and age-standardised mortality rates are similar for urban and rural populations.

Methods Administrative mortality (2014–2018) and census data (2013 and 2018) were used to estimate age-stratified sex-adjusted mortality rate ratios (aMRRs) for a range of mortality outcomes across the rural-urban spectrum (using major urban centres as the reference) for the total population and separately for Māori and non-Māori. Rural was defined according to the recently developed Geographic Classification for Health.

Results Mortality rates were higher overall in rural areas. This was most pronounced in the youngest age group (<30 years) in the most remote communities (eg, all-cause, amenable and injury-related aMRRs (95% CIs) were 2.1 (1.7 to 2.6), 2.5 (1.9 to 3.2) and 3.0 (2.3 to 3.9) respectively. The rural:urban differences attenuated markedly with increasing age; for some outcomes in those aged 75 years or more, estimated aMRRs were <1.0. Similar patterns were observed for Māori and non-Māori.

Conclusion This is the first time that a consistent pattern of higher mortality rates for rural populations has been observed in New Zealand. A purpose-built urban-rural classification and age stratification were important factors in unmasking these disparities.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Existing published evidence suggests that rural and urban New Zealanders have similar life expectancies and age standardised mortality rates.

WHAT THIS STUDY ADDS

⇒ Among younger age groups mortality rates, for a range of causes, are considerably higher for people living in rural compared with urban areas.
⇒ This rural:urban difference attenuates markedly later in life.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study provides the strongest evidence to date of poorer health outcomes for New Zealanders who live in rural areas.
⇒ The results reinforce the importance of using a geographic classification that is fit-for-purpose and of age stratification when comparing health outcomes for rural and urban populations.

INTRODUCTION

Populations living in rural areas of Australia, Canada, the USA and most Nordic countries have higher mortality rates and lower life expectancies than their urban peers.[1–4] Despite its similarities, extant research suggests that this is not the case in Aotearoa/New Zealand (NZ hereafter). The three reports[5–7] that have compared mortality outcomes across the urban-rural spectrum in NZ identified large and consistent inequities between Māori, the Indigenous population of NZ, and non-Māori, but little difference between urban and rural populations.

Reports prepared for the Minister of Health in 1999 (1995–1997 mortality data) and the National Health Committee in 2010 (2005–2007 mortality data) included life expectancies at birth that were very similar for urban and rural populations.[5 6] More comprehensive mortality data for both Māori and non-Māori, covering the same 2005–2007 period, are contained in Mātātuhi Tuawhenua:Health of Rural Māori, published by the Ministry of Health (MoH) in 2012.[7] As well as life expectancy, mortality rates were provided for a range of conditions, including cardiovascular disease, cancer, injury, avoidable and amenable mortality[8]; and separately for cities, rural towns and rural areas (outside the towns). Mātātuhi Tuawhenua again identified large Māori:non-Māori inequities across the urban rural spectrum. The gap between Māori and non-Māori life expectancy at birth was at its greatest in rural areas for both males (9.6 years) and females (9.8 years). Life expectancy for residents of rural towns was slightly less (eg, Māori males 1.3 years, non-Māori males 1.5 years) than that of cities and rural areas. Life expectancy for those living in cities and rural areas were very similar. The same pattern of poorer outcomes in rural towns relative to both cities and rural areas was demonstrated for all-cause and amenable mortality.

Until recently, New Zealand has had no agreed definition of urban and rural for consideration of health issues. Research and policy documents, including the aforementioned, have relied on generic rurality classification systems, most often different permutations of the Statistics New Zealand (Stats NZ) Urban Rural Experimental Profile (UREP).[7] The appropriateness of the UREP as a tool for use in health research and policy and the resultant mortality data trends have been questioned by experienced clinicians and public health experts.[9] Acknowledging that the geographic classification that is applied to data can materially alter the results of epidemiological studies and that urban:rural classifications used in health analyses need to be fit-for-purpose,[10] a novel 5-level urban-rural classification, the Geographic Classification for Health (GCH) was recently developed in NZ to overcome this problem.[11 12] 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 when the UREP was retired), the 'thresholds' differ substantially and align better with the purpose of the GCH as a classification for health research and policy.[12]

Results to date have demonstrated that the GCH defines a rural population characterised by higher mortality rates than the population defined as rural by the UREP and the UA.[13] This provides the first substantive evidence to support the earlier concerns that generic classifications may have been masking rural:urban disparities in NZ. An additional important early finding was that rural:urban mortality differences derived using the GCH are considerably larger for amenable mortality than for all-cause mortality.[13] Since amenable mortality is confined to those <75 years of age, this raises the possibility that rural:urban mortality differs by age. None of the previous reports included age-stratified all-cause or amenable mortality data.

The advent of a new purpose-built rurality classification, the elapsed time since similar data were published and the imminent development of NZ's first national rural health strategy are all reasons to review the health status of rural NZ populations. The aim of this study is to provide accurate and recent, age-stratified rates for urban and rural, Māori and non-Māori, populations in NZ across a range of mortality outcomes.

METHODS

This population-level observational study used deidentified routinely collected data from two NZ Government agencies: the MoH and Stats NZ.

Geographic classification for health

The GCH and the protocol for its development have been published in detail elsewhere.[11 12] The GCH was developed for the NZ context and uses population and drive-time thresholds to classify small areas into one of five categories, two of which are urban (U1, U2) and three rural (R1, R2, R3) (see online supplemental figure 1 for the classification matrix). U1 includes all five of NZ's major urban centres with populations over 100 000 and their immediate surrounds. Smaller regional cities and their surrounds make up U2. R1 to R3 categorise increasingly smaller and more remote rural towns and communities. The GCH does not use access to specific services, or health statistics to define rurality.

Numerators

Information on all deaths registered in NZ between 2014 and 2018 was extracted from the MoH's Mortality Collection. Five outcomes were considered: (1) all-cause, (2) deaths considered to be 'amenable' (were those with an underlying cause of death within the specified range using the Australian Modification of the International Classification of Diseases 10th revision (ICD10-AM)),[8] (3) cardiovascular deaths (ICD10-AM range: I00-I99), (4) cancer deaths (ICD10-AM range: C00-C96 or D45-D47) and (5) injury deaths (ICD10-AM range V01-Y36).

The meshblock (the smallest geographical area in use by Stats NZ) corresponding to the usual residential address of each death is recorded in the Mortality Collection. Using the statistical area 1 (Stats NZ's smallest output geography as at 2018) of the meshblock recorded, one of five GCH categories pertinent for each death was obtained.

Age at death was categorised as follows: 0–29, 30–44, 45–59, 60–74 or 75+ years, Sex was categorised as male and female. In line with Te Tiriti o Waitangi, 'Māori' and 'non-Māori' analyses were produced. If Māori was listed in any of the ethnicity fields recorded in the Mortality Collection, the individual was considered Māori.

Denominators

Census Usually Resident Population counts aggregated, simultaneously, by age, sex, ethnicity and rurality were obtained from Stats NZ for both the 2013 and 2018 censuses. Age was categorised in 15-year bands. Ethnicity was grouped into 'Māori' and 'non-Māori'. Annual estimates for each of the combinations of these variables (age (5), sex (2), ethnicity (2) and rurality (5)) were obtained from linear interpolation of the census 2013 and census 2018 counts. The average population for the 5-year period 2014–2018 for each of the combinations was obtained from these annual estimates.

Statistical analysis

In order to combine the numerator and denominator datasets, the person-level numerator dataset was collapsed, with counts of each outcome produced for each combination of the age (5), sex (2), ethnicity (2) and rurality (5) categories ($5\times2\times2\times5=100$ rows).

Crude mortality rates per 100 000 population were calculated for the age-strata within each of the five outcome variables. Sex-adjusted mortality rate ratios (aMRRs) per age group and outcome were calculated using Poisson regression and represent the ratio of the sex-adjusted incidence rate in one of the GCH categories (U2, R1, R2, R3) divided by the sex-adjusted incidence rate in U1 (reference category); 95% CIs are presented for the aMRRs.

The above statistics were produced for the total population, Māori and non-Māori.

Data were prepared using SAS software V.9.4 for Linux (SAS Institute). Analysis was undertaken using Stata/SE V.17.0.[14] Figures were produced using R.[15]

RESULTS

Of 160 180 deaths registered in 2014–2018, GCH was not available for one person hence 160 179 are included in this analysis. Over the same 5-year period, NZ had an average population of 4 516 093.

Unadjusted age-stratified mortality rates (per 100 000 population) for the NZ population, Māori and non-Māori are presented in tables 1–3, respectively. More detailed results including these as well as frequencies and aMRRs (using U1 as reference) by GCH category for the total population are presented in online supplemental table 1. Online supplemental tables 2 and 3 present results for Māori and for non-Māori, respectively in the

Table 1 New Zealand population: overall and age-stratified unadjusted mortality rates per 100 000 by cause of death and rurality (see online supplemental table 1 for more detailed results)

	Geographic classification for health				
	U1	U2	R1	R2	R3
Cause of death	(most urban)				(most rural)
All cause					
All ages (years)	3081	4573	4143	4213	3353
<30	210	299	296	353	436
30–44	402	573	507	692	636
45–59	1457	1841	1649	1900	2033
60–74	5352	6158	5595	5748	5726
75+	35 496	38 238	33 433	33 949	28 502
Amenable					
All ages (years)	534	792	793	906	949
<30	116	171	182	206	291
30–44	197	314	294	375	406
45–59	666	856	794	950	996
60–74	2317	2742	2505	2638	2552
Cardiovascular disease					
All ages (years)	964	1504	1320	1323	1038
<30	7	12	5	11	16
30–44	63	105	69	99	110
45–59	332	399	398	444	542
60–74	1306	1540	1414	1521	1554
75+	13 034	14 692	12 464	12 604	11 088
Injury					
All ages (years)	175	270	266	295	344
<30	93	153	159	204	280
30–44	134	205	233	328	373
45–59	161	224	208	264	359
60–74	172	192	221	221	264
75+	1000	1260	1089	950	904
Cancer					
All ages (years)	903	1323	1289	1373	1128
<30	15	24	23	25	16
30–44	120	150	133	168	88
45–59	639	814	744	805	797
60–74	2432	2779	2617	2720	2609
75+	8088	8669	8142	8880	7855

Table 2 Māori population: overall and age-stratified unadjusted mortality rates per 100 000 by cause of death and rurality (see online supplemental table 2 for more detailed results)

	Geographic classification for health				
	U1	U2	R1	R2	R3
Cause of death	(most urban)				(most rural)
All cause					
All ages (years)	2094	2724	2680	3380	4018
<30	341	386	397	495	532
30–44	858	1001	1009	1177	1190
45–59	3080	3433	3243	3657	3971
60–74	11 016	11 754	10 605	11 443	11 111
75+	39 080	43 891	37 523	42 982	37 162
Amenable					
All ages (years)	761	935	967	1158	1458
<30	191	223	254	273	384
30–44	459	497	574	623	674
45–59	1481	1619	1522	1806	2219
60–74	5141	5841	5209	5729	5063
Cardiovascular disease					
All ages (years)	596	804	789	1059	1330
<30	12	17	7	21	25
30–44	188	234	157	243	278
45–59	925	964	1033	953	1401
60–74	3300	3478	3153	3788	3539
75+	14 055	16 566	14 187	17 427	14 865
Injury					
All ages (years)	219	257	272	339	410
<30	168	210	217	273	334
30–44	308	340	423	467	595
45–59	256	256	217	368	496
60–74	225	255	304	289	269
75+	776	881	786	877	676
Cancer					
All ages (years)	639	822	861	1016	1140
<30	21	22	29	32	12
30–44	187	212	242	253	159
45–59	1126	1334	1347	1393	1285
60–74	4362	4484	4286	4478	4077
75+	9855	10 842	9381	10 175	8784

same format. The aMMRs by GCH category are compared in figures 1 and 2 for a range of mortality outcomes.

Mortality rates for Māori are considerably higher than those for non-Māori across all GCH categories, all age groups and for all causes.

In those under 30 years of age, the rate of all-cause mortality was 210 per 100 000 population in U1; this was substantially lower than that observed for the other four GCH categories. The all-cause aMRR indicated the mortality rate for those <30 years in R3 was 2.06 times higher (95% CI 1.66 to 2.56) that of those living in U1. All-cause aMRRs were also significantly higher for all regional and rural GCH categories (U2, R1, R2, R3) for the 30–44 and 45–59 years age groups.

The opposite is seen in those aged 75 years or older where rural mortality rates are less than major urban (U1) rates, reflected in aMRRs <1. Although CIs overlap, for all regional and rural GCH categories there is a consistent trend for higher aMRRs in younger age groups that reduce in magnitude as age groups increases. This is most marked for those living in R3, where the aMRR is 2.06 in those <30 years compared with 0.79 for those 75 years or older. All-cause mortality rates are overall lower for R1 than for regional centres (U2) in the >45 years age groups. In the <60 years age groups, there is a trend towards higher rates again for those living in the more remote R2 and R3 categories but large overlaps in the CIs are present.

The same pattern of higher all-cause mortality rates for younger age groups in regional and rural areas is evident for both Māori and non-Māori, although the aMRRs for Māori in U2 and R1 and R3 are smaller than those observed in the non-Māori population. The attenuation in the aMRRs with increasing age, while still present, is less marked for Māori, with all-cause mortality rates similar to, but generally not significantly less than, for those living in major urban centres.

Cardiovascular mortality follows a similar pattern to all-cause mortality, although CIs are wider and often overlapping. For

Table 3 Non-Māori population: overall and age-stratified unadjusted mortality rates per 100 000 by cause of death and rurality (see online supplemental table 3 for more detailed results)

	Geographic classification for health				
	U1	U2	R1	R2	R3
Cause of death	(most urban)				(most rural)
All cause					
All ages (years)	3219	5093	4464	4489	3055
<30	183	256	257	268	367
30–44	348	454	400	536	424
45–59	1286	1516	1389	1454	1305
60–74	4968	5495	5111	4907	4293
75+	35378	37899	33214	33036	26258
Amenable					
All ages (years)	501	748	752	817	714
<30	101	145	154	166	224
30–44	165	263	234	296	303
45–59	580	700	676	733	537
60–74	2125	2375	2244	2181	1884
Cardiovascular disease					
All ages (years)	1015	1701	1437	1410	907
<30	6	10	4	5	9
30–44	48	69	50	53	45
45–59	269	284	295	315	219
60–74	1171	1310	1246	1187	1026
75+	13000	14579	12371	12117	10109
Injury					
All ages (years)	169	273	264	280	314
<30	77	125	136	163	241
30–44	114	167	192	284	288
45–59	151	217	206	237	307
60–74	168	184	213	211	262
75+	1008	1283	1105	957	963
Cancer					
All ages (years)	940	1464	1383	1490	1123
<30	14	25	21	21	18
30–44	112	133	110	140	61
45–59	588	708	646	655	614
60–74	2301	2577	2456	2461	2218
75+	8029	8538	8075	8749	7615

the total population, all-cause cardiovascular mortality rates are higher for those living in U2 compared with U1 for all age strata and similarly for those aged under 75 years in R1, R2 and R3.

The largest urban-rural disparities are seen for injury deaths and most evident in the younger age groups. In those aged <60 years, injury-related mortality rates are significantly and consistently higher for those in R1, R2 and R3 than they are in the reference U1 population for the total population. At times the differences are large; for example, for non-Māori <30 years of age, the aMRR for those living in R3 compared with U1 is 3.07 (95% CI 2.09 to 4.51).

Total population cancer mortality rates are significantly higher for all age groups living in U2 and R2 areas compared with rates for those living in U1 areas. This is also evident for Māori aged 45–59 years living in U2, R1 and R2 compared with U1 and for non-Māori aged 45–74 years living in U2 and R1 compared with U1.

Total NZ amenable aMRRs are consistently higher in regional/rural areas, and typically higher for those in more remote areas, with differences more pronounced in younger population groups. For example, in those under 30 years of age the aMRRs for U2, R1, R2 and R3, respectively compared with U1 are 1.47, 1.56, 1.76 and 2.48. Within R3, the aMRRs decrease accordingly as the age groups increase from 2.48 to 2.05, 1.48 then 1.07. A similar pattern is seen in the results for Māori and non-Māori.

DISCUSSION

This is the first study in a decade to compare population-level mortality rates across the urban rural spectrum in NZ and the first to do so for a range of mortality outcomes stratified by age. Clear patterns emerge when the results are considered together. In those under 60 years of age, mortality rates are higher in rural areas (R1, R2 and R3) than in major urban centres (U1). This is evident for the total population, for Māori and for non-Māori. The largest disparities were apparent among the youngest age groups (<30 years of age) in the most remote communities where the sex-standardised mortality rates were more than double that of the major urban centres. Age-stratified mortality rates in regional cities (U2) are higher and more similar to those in rural areas than to those observed in major urban centres. For non-Māori, the rural:urban differences attenuated as the age strata increased in years; for those 75 years and older, sex-adjusted rural all-cause mortality rates were lower than those observed for U1. This same pattern of attenuation with age was observed for U2, and for Māori across rural categories, but not

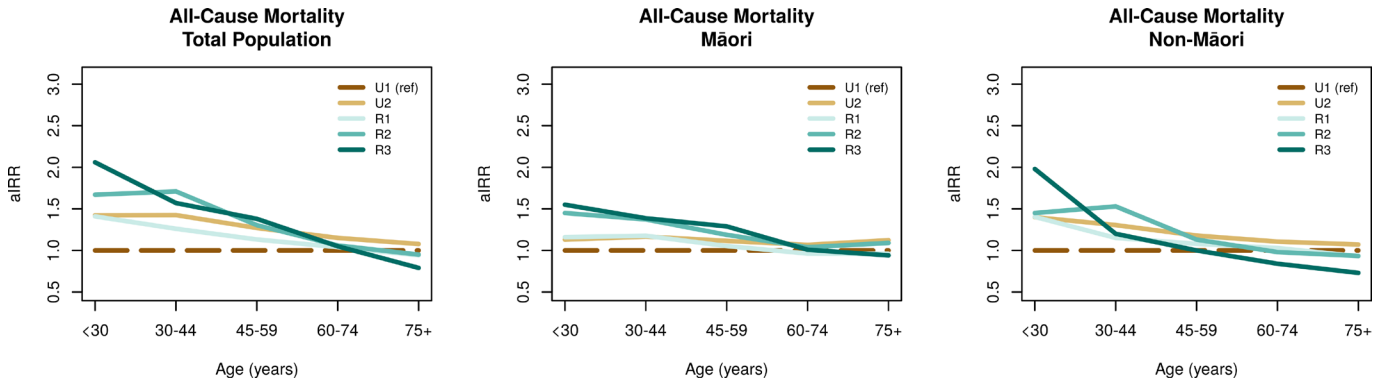

Figure 1 New Zealand total population, Māori and non-Māori sex-adjusted all-cause mortality rate ratios (aMRRs; using U1 as reference) by Geographic Classification for Health category and age group for 2014–2018.

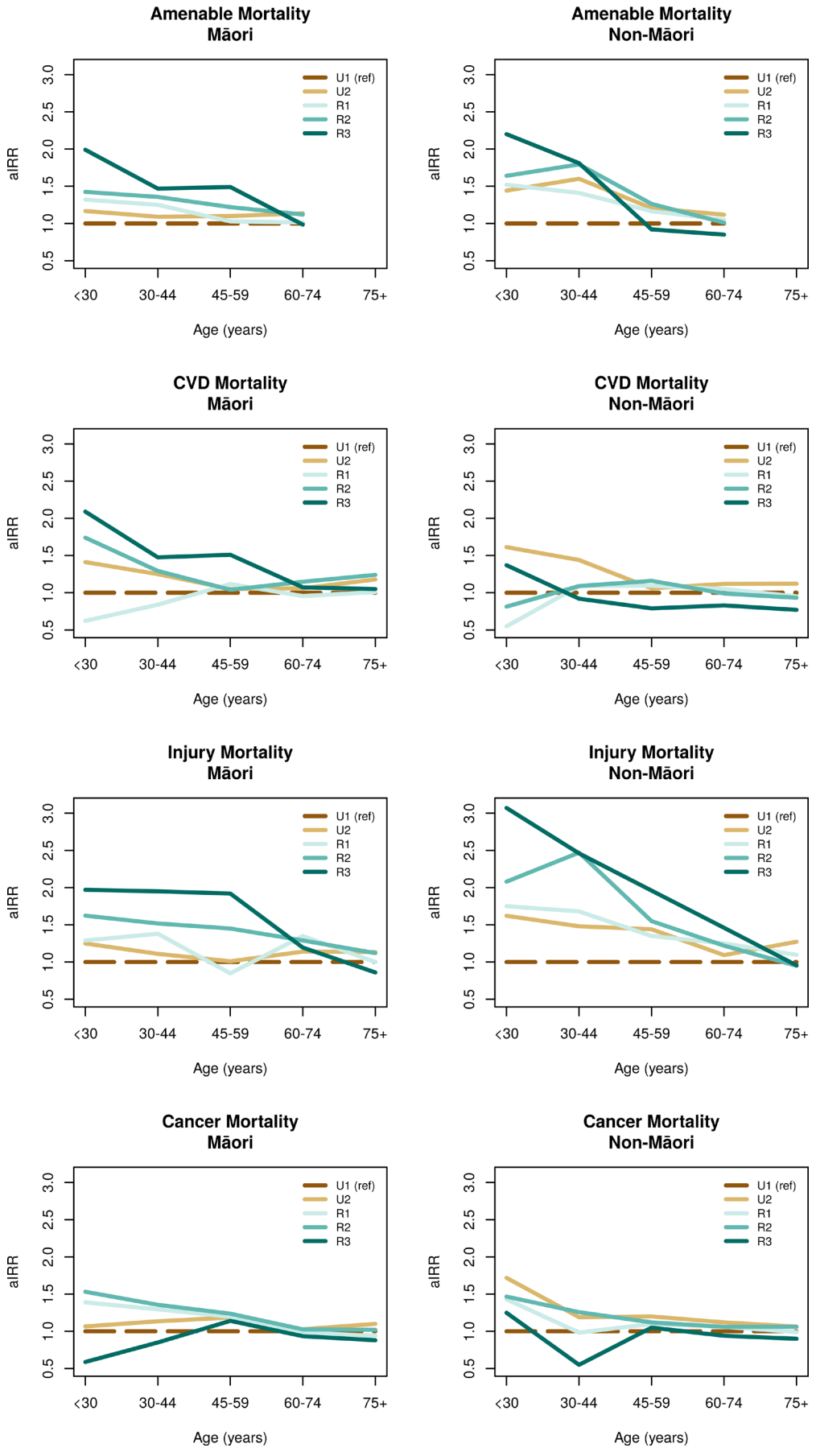

Figure 2 New Zealand Māori and non-Māori population sex-adjusted mortality rate ratios (aMRRs; using U1 as reference) by Geographic Classification for Health category and age group for 2014–2018. CVD, cardiovascular death.

to the same extent, and did not lead to the reversal observed for non-Māori in R1, R2 and R3. Rural:urban disparities by age are most evident for injury and amenable mortality, but still present for cardiovascular disease. For cancer deaths, rural:urban disparities are overall smaller and evident in only some age categories.

Higher mortality rates in rural areas are frequently observed in high-income countries with low population densities and Indigenous populations. These include Australia, Canada, the USA and the Nordic countries with the exception of Denmark.[1–4] The converse, or little difference, is observed in those with higher population densities including the UK and Continental Western Europe.[16 17] The clear pattern of higher age-stratified rural mortality rates in this study suggests that NZ aligns more closely with the former group than was previously demonstrable. This has important health policy implications in a country where rural health outcomes have been assumed to be as good, if not better, than those in urban areas. Because amenable mortality is an indicator for the 'coverage and quality of healthcare', the presence of rural:urban disparities in amenable mortality that exceed those seen in all-cause mortality for those under 75 years of age, has implications for the delivery of equitable healthcare to rural populations, in terms of both primary and secondary health services.

Higher amenable mortality rates are present for all total population GCH categories relative to major urban centres (U1), including regional cities (U2). As such, the results have relevance for the 37% of NZers who live outside of major urban centres (ie, live in communities of 100 000 or less). The results for those that live in U2 highlight the risk of underestimating the healthcare needs of residents of regional cities if their health data are combined with those for residents of major urban centres in binary urban:rural analyses as has frequently occurred in the past.[5–7]

The gradient of higher relative mortality rates for regional and rural areas that gradually attenuate with age is an important finding that appears to have been only rarely described in the existing literature.[18] It should not be assumed that this finding provides evidence of a healthier older rural population; the migration of rural people when they become elderly and frail, often to access residential care and be closer to health services, might be a more plausible explanation. Relocation from rural to urban areas would explain the high proportion of the R3 population in the 45–59 years age group (highest of any of the GCH categories), but the much lower proportion aged 75 years or older (lowest of any of the GCH categories).[19] Although this is evident for rural Māori, it is even more pronounced for non-Māori. This raises the possibility that patterns of rural:urban migration later in life differ for Māori and non-Māori. These findings have implications for the age-standardised/age-adjusted rates and life expectancies commonly used as measures of the relative health status of urban and rural populations in older studies and reports.[5–7] The majority of deaths occur in older age groups and any lowering of mortality rates as a consequence of migration, as opposed to genuine differences in health status, will reduce the usefulness of mortality rates, and the life expectancies calculated from them, as valid measures of the relative health status of urban and rural populations. Migration may also be impacting the higher rural mortality rates observed in younger age groups. The movement of rural school leavers to urban areas, often for study or training, is reflected in population profiles of rural areas that exhibit the lowest proportion of those aged 15–29 years.[19] It is conceivable that those aged 15–29 years who remain in rural areas experience greater risks to health and well-being. The extent to which the rural context or composition are responsible for rural:urban differences in health outcomes continues to be debated.[16] Migration between rural and urban areas in the later years of life will be considered in our future research.[20]

Since Māori are more likely than non-Māori to live in rural areas, accurate comparisons of rural:urban health outcomes is of particular importance to Māori. Thirteen per cent of residents of U1 communities report Māori ethnicity, a proportion that rises to 32% in the most remote (R3) areas.[19] A recent study of ours comparing Māori and non-Māori mortality rates confirmed the persistence of the large inequities for all-cause and amenable mortality rates demonstrated in Mātātuhi Tuawhenua; these Māori:non-Māori inequities were apparent across all GCH categories and for all age groups.[7 19] The age-sex standardised amenable mortality rate for Māori compared with non-Māori was 2.4 times higher for those that were living in urban areas, and 2.3 times higher for those that were living in rural areas. The rural Māori population is younger than the rural non-Māori population and as a consequence more adversely impacted by the higher rural:urban aMRRs observed in younger age groups.

Strengths of this study include the use of recently available national data, a purpose-built geographic classification and the age stratification of results. There are a number of limitations. The mortality rates were based on the address at the time of death which may not reflect where a person has lived for the majority of their lives. The small number of deaths in some categories, particularly R3, may have limited the study's power to demonstrate statistically significant differences. NZ's rural communities are diverse and results may differ between regions. Deprivation was not considered and may go some way to explaining the variation in mortality that was observed. Further research is underway that explores the intersecting impacts of rurality, ethnicity and socioeconomic deprivation on mortality and other health outcomes, including at a regional level.[20]

CONCLUSION

By adopting a new rurality classification system designed specifically for use in health, age-stratifying the results and considering Māori and non-Māori independently, it has been possible to demonstrate more clearly the nature and extent of the early mortality faced by NZers living outside major urban centres. The study has wider implications. Rather than proving an exception, these NZ data reinforce the pattern of higher mortality rates for rural populations observed in other high-income countries with low population densities. The findings highlight the risks of underestimating rural:urban differences in mortality rates should researchers fail to adopt a rurality classification that is fit-for-purpose or to age stratify their results.

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Contributors GN's contribution included conception of the study design, leading the writing of the first draft and revision of the paper, and is the author responsible for the overall content as guarantor . GD acquired the data and undertook the statistical analysis as well as writing sections of the initial and revised manuscript. JWi helped design the study and the underlying geographic classification. He contributed to the writing of the initial and revised manuscripts. RM contributed to the conception of the study, helped with the analysis and reviewed drafts of the manuscript. BdG prepared the data, undertook the initial analysis and prepared the figures. RL contributed to the study design, advised on the analysis and reviewed versions of the manuscript. MS helped organise the study and the research team and reviewed the manuscript. JWa contributed to the conception of the study design, reviewed drafts of the paper and provided the international commentary. JH contributed to the conception of the study design, advised on the geographic analysis and reviewed early drafts of the paper. SC helped with the conception of the study, led the ethnic-specific analyses and contributed to the writing of the initial and revised manuscripts.

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