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Rurality, Deprivation and Ethnicity in New Zealand: Population Distributions and Intersecting Impacts on Mortality

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ABSTRACT

Objective: To understand how rurality and socioeconomic deprivation intersect to influence health outcomes for Māori (Indigenous population) and non-Māori in Aotearoa New Zealand (NZ).

Methods: Firstly, Census 2018 was used to describe population-level distributions of NZ's 4.7 million residents by rurality [measured using the Geographic Classification for Health (GCH)], socioeconomic deprivation [using NZ's Deprivation Index (NZDep)], and ethnicity (Māori and non-Māori). Secondly, using the national Mortality Collection as the numerator and Census-based population estimates as the denominator, rural: urban mortality rate ratios (MRRs) for Māori and non-Māori, adjusted for NZDep, were estimated from multivariate Poisson regression models.

Results: For the NZ population, rurality and socioeconomic deprivation were found to intersect differently for Māori and non-Māori. Of the 160 170 all-cause deaths in 2014–2018, 64% were 75 years or older. Almost half (46%) of the deaths in those under 75 years were considered amenable. For Māori and non-Māori aged 45–59 years, higher rates of mortality (all-cause and amenable) for rural residents, compared to urban, were attenuated when adjusted for socioeconomic deprivation. In those under 45 years, rural: urban disparities in mortality (all-cause and amenable) remained; for example, for Māori the crude amenable MRR was 1.31 (95% CI 1.17, 1.47) and the adjusted, 1.26 (95% CI 1.13, 1.41); for non-Māori, the respective estimates were 1.45 (95% CI 1.33, 1.58) and 1.46 (95% CI 1.33, 1.59).

Conclusions: Māori ethnicity, living in rural areas and socioeconomic deprivation frequently co-exist. Rural–urban disparities in all-cause and amenable mortality evident in younger age groups, particularly those under 45 years of age, cannot be explained by ethnicity or socioeconomic deprivation.

1 | Introduction

Higher mortality rates and shorter life expectancies have individually been associated with indigeneity, socioeconomic deprivation and to a lesser extent rurality, both in Aotearoa New Zealand (NZ hereafter) and comparable countries, including Australia [1–6]. Few studies have considered the intersecting impact of these variables on mortality and many rural health

Summary

What is already known on this subject?

- Rural–urban disparity in mortality rates differs by age in Aotearoa New Zealand (NZ).
- Socioeconomic deprivation is typically higher in rural areas compared to urban areas and Indigenous people are more likely to live in socioeconomically deprived areas.
- Relatively little is known about the extent to which socioeconomic deprivation contributes to rural–urban variation in health outcomes, including how this varies by ethnicity.

What this paper adds?

- Nearly half of rural Māori (Indigenous population of NZ) live in areas of high socioeconomic deprivation; for rural non-Māori, it is less than one in six.
- Socioeconomic deprivation and ethnicity do not explain excess rural mortality in younger people in NZ.
- Identifying other drivers of higher rural–urban all-cause and amenable mortality is crucial to inform effective health policy.

reports fail to present Indigenous and non-Indigenous outcomes separately, despite the large differences between them [7]. It has been suggested that rural–urban differences in life expectancy can be explained by ethnicity and socioeconomic status [8].

In NZ, age-standardised mortality rates for those that live in the most remote communities are 20% higher than for residents of major cities; this is largely driven by the rural–urban disparities present in the younger age groups [9]. Rural communities typically include a higher proportion of Māori. Using Census 2018, 25% of Māori lived in rural areas compared to 18% of non-Māori [10]. The gap between Indigenous Māori and non-Māori life expectancy at birth is 7.5 years for males and 7.3 years for females [2]. Māori are disproportionately impacted by poorer access to the social determinants of health such as housing, quality healthcare [11], and by racism in the health system as well as wider society [12–14]. In rural areas, a higher proportion of residents live in areas of high socioeconomic deprivation than in large urban cities [10, 15]. Life expectancy for males and females living in the least socioeconomically deprived areas is longer than it is for male and female residents in the most deprived areas, by 10.7 and 9.0 years, respectively [2]. As a result of these associations, rural–urban differences in health outcomes often intersect with ethnic inequities and differences in health due to socioeconomic position.

International evidence suggests that the principal impact of rurality on health occurs indirectly, through other determinants [8, 16]. Some rural residents have the financial and social capital to overcome health disadvantages associated with rurality, such as distance from specialist health services, while for others the inequities in the social determinants of health are exacerbated by challenges of living rurally. Determining whether this is the case in NZ is crucial for informing the development of interventions that will effectively address the rural–urban differences in health outcomes that have been identified, particularly for rural Māori [1].

Progress to address historically inconsistent findings around health outcomes for those living rurally in NZ has recently been made through the development of the Geographic Classification for Health (GCH). The GCH was designed as a tool for use in health research and policy, to help accurately monitor rural–urban variation in health outcomes and access to health services in NZ [10]. Based on the Census 2018 population distribution and drive time thresholds that are meaningful in a health context, the GCH assigns one of five categories on the rural–urban spectrum to small geographical areas [10]. The GCH differs from comparable Australian rurality classifications in that, in NZ, regional cities (populations between ~30000 and ~100000) are considered urban ('U2' category). The GCH thus classifies 19% of NZ's population as living in rural or remote areas, in comparison with 27% of the Australian population as defined by the Modified Monash Model [7]. Variation in the social determinants of health (e.g., qualifications, employment status, smoking status, home ownership) has been observed between residents living in different GCH categories [15].

Previous research has separately highlighted ethnic differences in the distribution of socioeconomic deprivation, rurality, and health outcomes for New Zealanders [1, 17]. However, relatively little is known about the extent to which socioeconomic deprivation contributes to rural–urban variation in health outcomes, including how this varies by ethnicity.

Creating essential knowledge about the intersection between rurality, socioeconomic deprivation, and ethnicity, and the extent to which each factor influences health outcomes in NZ is critical. As a first step, this study examines mortality, all-cause and amenable. Amenable mortality encompasses all deaths considered to be premature and avoidable; this makes it a valuable rural health outcome and indicator of health system performance. In addition, because it excludes all deaths in those 75 years of age and older (unlike age-standardised all-cause mortality and estimated life expectancy), amenable mortality rates will be less affected by the rural to urban migration that is presumed to occur in older age groups in response to increasing frailty [9].

As such, this study addresses the following research questions (RQ):

1. How is the NZ population distributed by rurality and socioeconomic deprivation, and are there differences in this distribution by ethnicity (Māori, non-Māori)?
2. To what extent are rural–urban differences in mortality rates (all-cause and amenable) explained by socioeconomic deprivation and ethnicity?

2 | Methods

This quantitative research project involved a cross-sectional analysis of the NZ population. De-identified routinely collected data available from Statistics New Zealand (Stats NZ; Census) and the Ministry of Health—Manatū Hauora (MoH; Mortality Collection) were used.

Census 2018 Usually Resident Population counts that include those who usually live in and were present in NZ on census night were obtained from Stats NZ [18]. These were aggregated simultaneously by age, sex, ethnicity, socioeconomic deprivation and rurality [10, 19]. Age was categorised in 15-year bands and sex as Male and Female using the two response categories provided in Census 2018 (information on gender and sexual identity was not collected until Census 2023). Ethnicity was grouped into 'Māori' and 'non-Māori'; if Māori was listed in any of the ethnicity fields recorded, the individual was considered Māori, otherwise as 'non-Māori'. This approach, focused on achieving equity for Māori, aligns with NZ Ethnicity Data Protocols and acknowledges the importance of Te Tiriti o Waitangi as a foundational document of NZ [20, 21]. Te Tiriti o Waitangi, signed in 1840 between representatives of the British Crown and Māori, is an agreement that includes three articles. The last article gives Māori the rights and privileges of British subjects and is often interpreted in today's context as an obligation to ensure equitable outcomes for Māori [21].

Although the smallest geographical unit used by StatsNZ is the meshblock, the smallest output geography used in Census 2018 is Statistical Area 1s (SA1s; each SA1 contains roughly 100–200 people). Thus, the SA1 of usual residence and available concordance files were used to obtain rurality (GCH) and socioeconomic deprivation (New Zealand Index of Socioeconomic Deprivation; NZDep) [22–24].

The GCH contains five categories: two urban (U1 representing major metropolitan centres and U2 provincial cities) and three rural categories (R1–R3, with the latter the most remote). The binary version of the GCH was also utilised (urban = U1–U2, rural = R1–R3). Given the absence of a consistently used individual-level indicator of socioeconomic status in NZ, use of an area-based measure, NZDep, is common [19]. NZDep is an index of socioeconomic deprivation that is applied to small geographical areas throughout NZ and is used in research and social epidemiology to explore variations in health, allocate central government funds, and for advocacy. It is based on nine Census variables and has a value from 1 to 10 [25]. The deprivation-related variables from Census 2018 were household income, receipt of means-tested benefit, no qualifications, unemployment, single-parent families, dwelling not owner-occupied, severe damp and/or mould in the dwelling, overcrowding and access to the internet [19]. For this study, deciles of NZDep2018 (derived from the 2018 Census) were combined into quintiles with Q1 representing the 20% of small areas considered to be the least socioeconomically deprived and Q5, the 20% of small areas with the highest levels of socioeconomic deprivation.

2.1 | Methods Specific for RQ1

The distribution of rurality, deprivation, and ethnicity for the total NZ population, and separately for Māori and non-Māori, was examined using counts and percentages. Variations in distributions are displayed in tables and in heatmaps. Since Māori are a considerably younger population than non-Māori, and given rural: urban differences in mortality have been shown to differ by age, population age-pyramids, stratified by socioeconomic deprivation, ethnicity and rurality, were constructed [9]. Population pyramids are used to graphically illustrate the distribution of a population by age; the width of the bars represents the relative size of the population in that age group.

2.2 | Methods Specific for RQ2

To examine the combined effect of rurality, socioeconomic deprivation and ethnicity on all-cause and amenable mortality, 5 years of data from the Mortality Collection (2014–2018) were used as the numerator and aggregated Census usually resident population counts as the denominator. Amenable mortality is defined as premature deaths (under age 75) that could potentially be avoided given effective and timely healthcare [26, 27]. 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 (ICD-10-AM); see Table [27, 28]. Age at death was categorised in 15-year bands (0–14, 15–29, 30–44, 45–59, 60–74, 75+). The Mortality Collection contains the meshblock corresponding to the usual residential address of each fatality; this was used to obtain GCH and NZDep2018 for each fatality.

Person-years (the denominator) for the 5-year period (2014–2018) were based on population-level Census counts, disaggregated simultaneously by age group, sex, ethnicity, socioeconomic deprivation, and rurality. More specifically, counts of usual residents for each combination of age group (6 categories), sex (Male, Female), ethnicity (Māori, non-Māori), NZDep (5 quintiles), and GCH (5 categories) in Census 2013 and Census 2018 were obtained, with linear interpolation then used to obtain annual intercensal estimates for 2014–2017. Estimated counts for each combination of age group, sex, ethnicity, NZDep, and GCH by year for 2014–2018 were summed to obtain person-years over the 5 years. Stratification by age and age-sex standardisation using Census 2018 Māori as the standard population were used to account for different age structures in the Māori and non-Māori population.

To better understand how rurality, deprivation and ethnicity are associated with mortality (all-cause and amenable), age-stratified crude rural: urban Mortality Rate Ratios (MRRs) and adjusted MRRs (aMRRs) were obtained using multivariate Poisson regression. Adjustment was undertaken iteratively to enable changes in the age-stratified rural: urban MRRs to be compared. For each age-group, the adjusted models included: (1) sex; (2) sex and ethnicity; (3) sex and NZDep2018; and (4) sex, ethnicity and NZDep2018. A similar process was undertaken to estimate crude and adjusted rural: urban MRRs for Māori and non-Māori separately.

For both RQs, SAS software was used for data management and Stata 18 software for the analysis. With data extracts from Census 2018 and the Mortality Collection, individuals were excluded if GCH or NZDep2018 could not be obtained. This can occur for meshblocks that very few people live in (e.g., marinas).

3 | Results

This section presents the results relevant to the first research question (RQ1) followed by the results for the second research

question (RQ2). RQ1 examines the population distribution by rurality and socioeconomic deprivation for NZ overall and for Māori and non-Māori. RQ2 focuses on rural–urban differences in all-cause and amenable mortality rates and examines the extent to which these differences are explained by socioeconomic deprivation and ethnicity.

For RQ1, the SA1-level usually resident population of New Zealand, as enumerated in the 2018 Census, was used. This included 4 699 191 people, although 786 (180 Māori) people who lived in areas that couldn't be assigned an NZDep value were excluded leaving 4 698 405.

Area-level socioeconomic deprivation is variably distributed across the 5 levels of the GCH (Table 1). Since the majority (63%) of New Zealanders live in major urban areas (U1), it is not surprising that U1 includes the largest number of people living in areas considered to be the most socioeconomically deprived (Q5). The 565 842 that live in U1-Q5 (i.e., those living in the most urban areas and the highest quintile of socioeconomic deprivation) represent 12% of all New Zealanders; 18% of Māori live in U1-Q5 (142 035/775 446) compared to 11% of non-Māori (423 807/3 922 959). Those living in the most urban areas (U1) are distributed relatively evenly across the quintiles of socioeconomic deprivation with 22% in Q1, the least deprived quintile, and 19% in Q5. In comparison, in all the other GCH categories (U2, R1-R3), a much lower percentage of residents were living in Q1 and a higher percentage of residents in Q5. Of the 18% of New Zealanders living in U2 areas, 16% were in Q1 and 26% in Q5. Almost 900 000 New Zealanders live in rural areas; 12% in R1, 6% in R2 and 1% in R3. Of those living in R2 areas, 11% were in Q1 and 28% in Q5; for R3 residents there were only 4% in Q1 compared to 39% in Q5. Of note is that U2 areas had a higher proportion of residents living in areas of highest socioeconomic deprivation than either U1 or R1 areas (26% of people in U2 were in Q5 compared to 19% of those living in U1 and R1). The proportion of Māori living in each of the levels of the GCH also varies with Māori representing 13% of U1 residents, 23% of U2 residents, 19% of R1 residents, 26% of R2 residents and 33% of R3 residents.

The distribution of rurality and deprivation is different for Māori, with an exacerbated pattern of very high socioeconomic deprivation in rural areas. Overall, more Māori live in areas of high socioeconomic deprivation than non-Māori (43% in Q5 compared to 17% respectively). About half of Māori living in U2 and R2 areas, 48% and 55% respectively, were in high-deprivation neighbourhoods (Q5) while in R3 areas, 73% of Māori were in Q5. For non-Māori living in U2 and R2 areas, less than 20% lived in Q5 areas and only 14% of non-Māori in R1 lived in Q5. In R3 areas, 22% of non-Māori were in Q5. At the other end of the spectrum, stark differences are also apparent between urban and rural Māori and non-Māori in terms of the proportion of the population living in areas with low socioeconomic deprivation (Q1). For Māori, 12% of urban residents lived in Q1 areas compared to < 1% of R3 residents; for non-Māori, the respective percentages are 24% and 5%.

Differences in the distribution of the NZ population by rurality, socioeconomic deprivation and ethnicity are apparent within and between age-strata (Figure 1). Within each quintile, the proportion of Māori in the youngest age group was almost double that of non-Māori. In rural (R1-R3) areas, the proportion of both Māori and non-Māori aged 60–74 years was higher in rural areas compared to urban areas across all levels of socioeconomic deprivation. This was particularly apparent for non-Māori in areas of higher socioeconomic deprivation (Q4 and Q5) and extended to those aged 75 years and older.

To address RQ2, all-cause fatalities that occurred in 2014–2018 were examined. Of the 160 180 all-cause fatalities in this 5-year period, 10 could not be assigned to a GCH category. Of the remaining 160 170, 64% ($n = 101\,847$) were 75 years or older at the time of death and 22% ($n = 35\,531$) were 60–74 years (Table 2). Almost one-quarter ($n = 35\,281$) were rural residents (i.e., meshblock of usual residence as recorded in the Mortality Collection was R1-R3), with the remaining 78% ($n = 124\,889$) classified as urban. Regardless of rurality, both all-cause and amenable mortality rates increased with age and were higher for Māori than non-Māori. For those under 60 years of age, crude rates of all-cause mortality in rural areas were higher than for those living in urban areas. For those aged 75 years or older, the opposite was observed with all-cause mortality rates higher in urban than rural areas (7258 and 6672 per 100 000 person-years (PY) respectively). The same pattern of higher rural all-cause mortality in the two younger age groups and higher urban all-cause mortality in the oldest age group was apparent for Māori and non-Māori.

Amenable mortality accounts for almost half (26 922/58323, 46%) of the fatalities in those under 75 years of age, although variation by ethnicity is apparent (Māori: 6 122/12279, 50%; non-Māori: 20 800/46044, 45%). In those under 45 years of age, 59% (1 072/1813) of the deaths of those living in rural areas was considered amenable compared to 53% (3 525/6625) of those in urban areas. For the total population, rates of amenable mortality markedly increase with age from around 50 per 100 000 PY in those under 45 years of age to around 500 per 100 000 PY in those aged 60–74 years; in comparison, differences between those living in urban and rural areas are less obvious. That said, in those aged under 45 years, the amenable mortality rate for rural residents is noticeably higher than for urban residents (47 per 100 000 PY compared to 31 per 100 000 PY, respectively). Amenable mortality rates are considerably higher for Māori than non-Māori. For example, in those aged 60–74 years, the amenable mortality rate for rural Māori is 1076 per 100 000 PY compared to 441 per 100 000 PY for rural non-Māori. For Māori, rural–urban disparities in amenable mortality rates are apparent in those under 45 years (70 and 53 per 100 000 PY, respectively). For non-Māori, amenable mortality rates are higher for rural residents compared to urban in both the under 45 years age group (39 and 27 per 100 000 PY respectively) and those 45–59 years (137 and 121 per 100 000 PY respectively).

Table 3 examines the association between area-level socioeconomic deprivation and rural and urban age-stratified mortality rates for the NZ population and for Māori and non-Māori separately. For both all-cause and amenable mortality, unadjusted rural: urban mortality rate ratios vary considerably by age group, with rural residents having higher mortality rates in the youngest age group; the reverse pattern was observed in the oldest age group. For example, in those under 45 years of age unadjusted

TABLE 1 | New Zealand usually resident census population 2018 by rurality (GCH; 5-level) and socioeconomic deprivation (NZDep quintiles); overall and for Māori and non-Māori.

	Geographic Classification for Health (GCH)											
	U1 (most urban)		U2		R1		R2		R3 (most rural)		Total[a]	
	n	col %	*n*	col %	*n*	col %	*n*	col %	*n*	col %	*n*	col %
NZ population												
Overall (row %)	2 960 793	63.0	84 5127	18.0	570 111	12.1	266 727	5.7	55 647	1.2	4 698 405	100.0
NZDep quintiles												
Q1 (least deprived)	663 402	22.4	135 387	16.0	71 799	12.6	29 544	11.1	2079	3.7	902 211	19.2
Q2	610 098	20.6	139 656	16.5	116 403	20.4	41 082	15.4	8655	15.6	915 894	19.5
Q3	570 858	19.3	157 263	18.6	130 809	22.9	60 189	22.6	12 108	21.8	931 227	19.8
Q4	550 593	18.6	191 817	22.7	140 736	24.7	62 073	23.3	11 259	20.2	956 478	20.4
Q5 (most deprived)	565 842	19.1	221 004	26.2	110 364	19.4	73 839	27.7	21 546	38.7	992 595	21.1
Māori												
Overall (row %)	380 928	49.1	198 123	25.5	108 567	14.0	69 711	9.0	18 117	2.3	775 446	100.0
NZDep quintiles												
Q1 (least deprived)	44 583	11.7	12 687	6.4	5340	4.9	2139	3.1	120	0.7	64 869	8.4
Q2	51 747	13.6	17 418	8.8	12 207	11.2	4350	6.2	714	3.9	86 436	11.1
Q3	59 505	15.6	27 009	13.6	17 667	16.3	9567	13.7	1455	8.0	115 203	14.9
Q4	83 058	21.8	45 498	23.0	29 247	26.9	15 012	21.5	2625	14.5	175 440	22.6
Q5 (most deprived)	142 035	37.3	95 511	48.2	44 106	40.6	38 643	55.4	13 203	72.9	333 498	43.0
Non-Māori												
Overall (row %)	257 9865	65.8	647 004	16.5	461 544	11.8	197 016	5.0	37 530	1.0	3 922 959	100.0
NZDep quintiles												
Q1 (least deprived)	618 819	24.0	122 700	19.0	66 459	14.4	27 405	13.9	1959	5.2	837 342	21.3
Q2	558 351	21.6	122 238	18.9	104 196	22.6	36 732	18.6	7941	21.2	829 458	21.1
Q3	511 353	19.8	130 254	20.1	113 142	24.5	50 622	25.7	10 653	28.4	816 024	20.8
Q4	467 535	18.1	146 319	22.6	111 489	24.2	47 061	23.9	8634	23.0	781 038	19.9
Q5 (most deprived)	423 807	16.4	125 493	19.4	66 258	14.4	35 196	17.9	8343	22.2	659 097	16.8

[a]786 (180 Māori) that were unable to be classified by NZDep are not included.

all-cause mortality rates are 36% (95% CI 29%, 43%) higher for those living in rural areas compared to urban areas whereas in those 75 years and older, all-cause mortality rates are 8% (95% CI 7%, 9%) lower for those living in rural areas compared to urban areas. For all age-groups and outcomes, adjustment for sex made minimal difference to the rural: urban MRRs. In those under 45 years of age, adjustment for ethnicity resulted in a relatively large change to the rural: urban mortality rate ratio. In contrast, the additional adjustment for socioeconomic deprivation resulted in minimal change (all-cause mortality: crude MRR

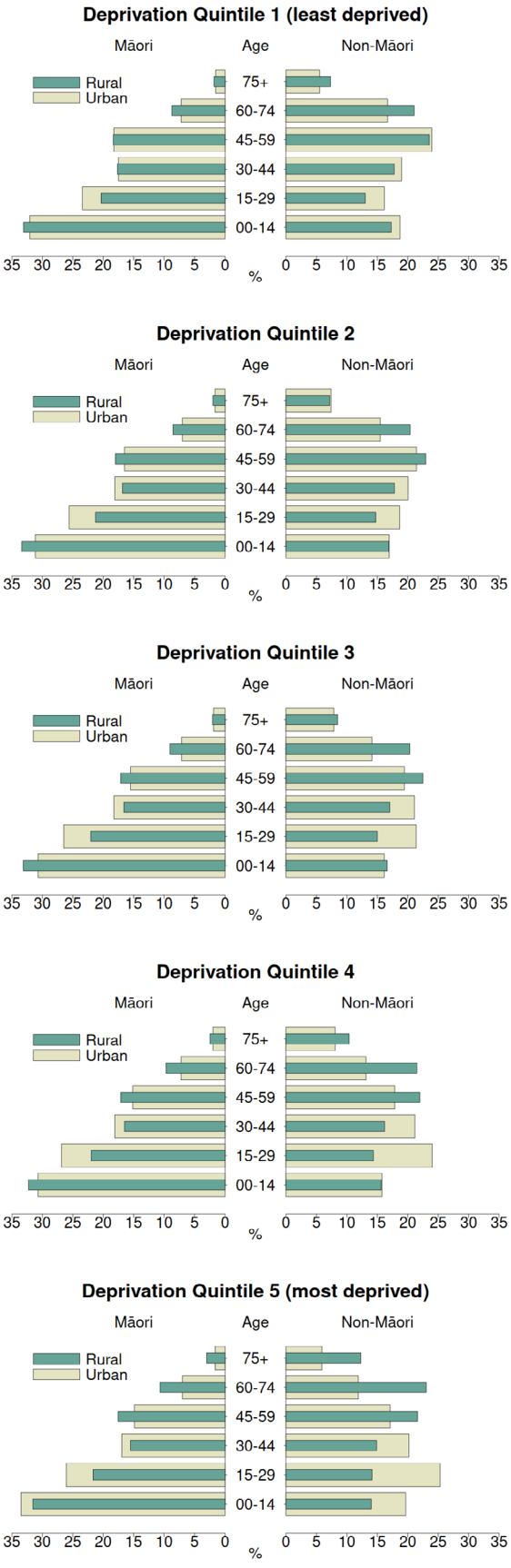

FIGURE 1 | Population age-pyramids of New Zealand's 2018 Census Usually Resident by socioeconomic deprivation (NZDep; Q = Quintile), ethnicity (Māori and non-Māori) and rurality (Geographic Classification for Health (GCH); 2-level).

1.36, sex-ethnicity aMRR 1.26, sex-ethnicity-NZDep aMRR 1.24; amenable mortality: crude MRR 1.51, sex-ethnicity aMRR 1.39, sex-ethnicity-NZDep aMRR 1.37). Interestingly, a different pattern was observed with those aged 45–59 and 60–74 years where the association between socioeconomic deprivation and mortality was more apparent in explaining differences between mortality rates of urban and rural residents. In those aged 45–59 years, the sex-ethnicity adjusted MRR was similar to the sex-NZDep adjusted estimate, with attenuation observed in the all-adjusted model (all-cause mortality—1.13, 1.06, 1.04, 0.99; amenable mortality—1.20, 1.12, 1.10, 1.05: crude MRR and sex-ethnicity, sex-NZDep, sex-ethnicity-NZDep aMRRs, respectively). For those aged 75 years and older, adjustment for sex, ethnicity and socioeconomic deprivation made minimal impact on the rural–urban difference (aMRR 0.90 compared to the crude estimate of 0.92).

To help interpret the key estimates in Table 3, the crude and sex-deprivation-adjusted Rural:Urban MRRs for Māori and non-Māori by age group are presented in Figure 2. For Māori under 45 years, the unadjusted all-cause mortality rate is 22% higher (95% CI 12%, 33%) for rural residents compared to urban residents. Adjustment for sex did not change this estimate, whereas adjustment for NZDep reduced this estimate to 16% (95% CI 7%, 26%), indicating socioeconomic deprivation accounts for some of the rural–urban disparity observed. For non-Māori in the same age group, there was no evidence that socioeconomic deprivation accounted for the rural–urban disparity observed in the all-cause mortality rates (both the unadjusted and sex-NZDep adjusted MRRs were 1.29). For Māori 45–59 years old, adjustment for socioeconomic deprivation reduced the disparity in all-cause mortality from 9% (95% CI 1%, 16%) higher rates for rural residents to practically equal (aMRR 0.99, 95% CI 0.92, 1.06). For non-Māori aged 45–59 years, a similar pattern was observed with an unadjusted MRR for all-cause mortality of 1.05 (95% CI 1.00, 1.10) and a sex-NZDep adjusted MRR of 0.99 (95% 0.95, 1.04). For both Māori and non-Māori, in those aged 60–74 years, rural and urban all-cause unadjusted mortality rates were similar; when adjusted for sex and NZDep, all-cause mortality rates were lower for rural residents than urban residents (Māori aMRR 0.91, 95% CI 0.86, 0.96; non-Māori aMRR 0.91, 95% CI 0.89, 0.94). In those aged 75 years and older, adjustment for socioeconomic deprivation did not materially change the rural: urban all-cause mortality rate ratio for either Māori or non-Māori.

Similar to the patterns for all-cause mortality, the largest rural–urban disparity for amenable mortality is observed in the youngest age-group (Table 3; Figure). For Māori under 45 years, unadjusted amenable mortality rates for rural residents are 31% higher (95% CI 17%, 47%) than for urban residents. Adjustment for socioeconomic deprivation made minimal impact with a corresponding adjusted estimate of 26% (95% CI 13%, 41%). Considerable rural–urban disparity in amenable mortality is apparent for non-Māori under 45 years, yet interestingly, the unadjusted and adjusted MRRs are equivalent, indicating that socioeconomic deprivation does not account for any of the observed disparity (MRR 1.45, 95% CI 1.33, 1.58; aMRR 1.46, 95% CI 1.33, 1.59). For non-Māori aged 60–74 years, adjustment for socioeconomic deprivation did have an impact; in this group, the unadjusted amenable mortality rates were similar for rural and urban residents (MRR 1.01, 95% CI 0.97, 1.05), whereas the sex-NZDep adjusted rates indicated that rural residents had lower amenable mortality rates (aMRR 0.92, 95% CI 0.88, 0.96).

TABLE 2 | Frequencies, rates and percentages of rural and urban mortality (all-cause and amenable) by age group for total New Zealand population, Māori and non-Māori (2014–2018).

	Total		Rural				Urban			
					Rate per 100000 PY				Rate per 100000 PY	
	n	% (Col)	*n*	% of All-cause	Est	95% CI	*n*	% of All-cause	Est	95% CI
Total										
All-cause mortality										
< 45 years	8438	5.3	1813		80	(77, 84)	6625		59	(58, 61)
45–59 years	14354	9.0	3244		350	(338, 362)	11110		309	(303, 315)
60–74 years	35531	22.2	8829		1131	(1107, 1154)	26702		1114	(1101, 1127)
≥ 75 years	101847	63.6	21395		6672	(6583, 6762)	80452		7258	(7208, 7308)
Amenable mortality										
< 45 years	4597	17.1	1072	59.1	47	(45, 50)	3525	53.2	31	(30, 33)
45–59 years	6686	24.8	1584	48.8	171	(163, 180)	5102	45.9	142	(138, 146)
60–74 years	15639	58.1	3982	45.1	510	(494, 526)	11657	43.7	486	(478, 495)
Māori										
All-cause mortality										
< 45 years	2687	15.3	746		118	(110, 127)	1941		97	(93, 101)
45–59 years	3666	20.8	1080		695	(632, 764)	2586		640	(616, 666)
60–74 years	5926	33.7	1868		2196	(2098, 2298)	4058		2260	(2191, 2330)
≥ 75 years	5324	30.2	1766		7920	(7555, 8298)	3558		8225	(7957, 8500)
Amenable mortality										
< 45 years	1501	24.5	439	58.8	70	(63, 76)	1062	54.7	53	(50, 56)
45–59 years	1764	28.8	529	49.0	340	(312, 371)	1235	47.8	306	(289, 323)
60–74 years	2857	46.7	915	49.0	1076	(1007, 1148)	1942	47.9	1081	(1034, 1131)
Non-Māori										
All-cause mortality										
< 45 years	5751	4.0	1067		66	(62, 70)	4684		51	(50, 52)
45–59 years	10688	7.5	2164		281	(269, 293)	8524		267	(262, 273)
60–74 years	29605	20.8	6961		1000	(977, 1024)	22644		1021	(1008, 1035)
≥ 75 years	96523	67.7	19629		6579	(6487, 6672)	76894		7219	(7168, 7270)
Amenable mortality										
< 45 years	3096	14.9	633	59.3	39	(36, 42)	2463	52.6	27	(26, 28)
45–59 years	4922	23.7	1055	48.8	137	(129, 145)	3867	45.4	121	(117, 125)
60–74 years	12782	61.5	3067	44.1	441	(425, 457)	9715	42.9	438	(429, 447)

4 | Discussion

The vast majority of New Zealanders reside in urban areas, as do the majority of Māori. Almost half (47%) of all Māori live in urban (U1 or U2) areas of high socioeconomic deprivation (NZDep Q4 or Q5). Māori are, however, more likely than non-Māori to live in rural areas. This, as a relative difference, is more apparent in R2 compared to R1 and similarly in R3 compared to R2. There is a disproportionate concentration of wealth in the larger cities, with the percentage of residents in the least socioeconomically deprived quintile (NZDep Q1) noticeably lower in more rural and remote communities, and a concentration of socioeconomic

TABLE 3 | Crude and adjusted rural: urban Mortality Rate Ratios (MRRs) for total New Zealand population, Māori and non-Māori (2014–2018): all-cause and amenable mortality.

	Rural: Urban MRR							
	<45 years		45–59 years		60–74 years		≥75 years	
	Est.	95% CI	Est.	95% CI	Est.	95% CI	Est.	95% CI
Total								
All-cause mortality								
Crude	1.36	(1.29, 1.43)	1.13	(1.09, 1.18)	1.01	(0.99, 1.04)	0.92	(0.91, 0.93)
Adjusted								
Sex	1.35	(1.28, 1.42)	1.13	(1.09, 1.17)	1.01	(0.98, 1.03)	0.91	(0.90, 0.93)
Sex, ethnicity	1.26	(1.20, 1.32)	1.06	(1.02, 1.10)	0.97	(0.95, 0.99)	0.91	(0.90, 0.92)
Sex, NZDep	1.32	(1.25, 1.39)	1.04	(1.00, 1.08)	0.93	(0.91, 0.95)	0.90	(0.89, 0.91)
Sex, ethnicity, NZDep	1.24	(1.18, 1.31)	0.99	(0.95, 1.03)	0.91	(0.89, 0.93)	0.90	(0.88, 0.91)
Amenable mortality								
Crude	1.51	(1.41, 1.61)	1.20	(1.14, 1.27)	1.05	(1.01, 1.09)	*n*/a	
Adjusted								
Sex	1.50	(1.40, 1.61)	1.20	(1.13, 1.27)	1.04	(1.00, 1.08)		
Sex, ethnicity	1.39	(1.30, 1.49)	1.12	(1.06, 1.19)	0.99	(0.96, 1.03)		
Sex, NZDep	1.46	(1.37, 1.57)	1.10	(1.04, 1.16)	0.94	(0.91, 0.98)		
Sex, ethnicity, NZDep	1.37	(1.28, 1.47)	1.05	(0.99, 1.11)	0.92	(0.89, 0.95)		
Māori								
All-cause mortality								
Crude	1.22	(1.12, 1.33)	1.09	(1.01, 1.16)	0.97	(0.92, 1.03)	0.96	(0.91, 1.02)
Adjusted								
Sex	1.22	(1.12, 1.32)	1.08	(1.01, 1.16)	0.97	(0.92, 1.03)	0.96	(0.91, 1.01)
Sex, NZDep	1.16	(1.07, 1.26)	0.99	(0.92, 1.06)	0.91	(0.86, 0.96)	0.94	(0.89, 1.00)
Amenable mortality								
Crude	1.31	(1.17, 1.47)	1.11	(1.01, 1.23)	0.99	(0.92, 1.08)	n/a	
Adjusted								
Sex	1.31	(1.17, 1.46)	1.11	(1.01, 1.23)	0.99	(0.92, 1.08)		
Sex, NZDep	1.26	(1.13, 1.41)	1.01	(0.91, 1.12)	0.93	(0.86, 1.01)		
Non-Māori								
All-cause mortality								
Crude	1.29	(1.20, 1.37)	1.05	(1.00, 1.10)	0.98	(0.95, 1.01)	0.91	(0.90, 0.93)
Adjusted								
Sex	1.28	(1.20, 1.37)	1.05	(1.00, 1.10)	0.97	(0.94, 1.00)	0.91	(0.89, 0.92)
Sex, NZDep	1.29	(1.21, 1.38)	0.99	(0.95, 1.04)	0.91	(0.89, 0.94)	0.90	(0.88, 0.91)
Amenable mortality								
Crude	1.45	(1.33, 1.58)	1.13	(1.05, 1.21)	1.01	(0.97, 1.05)	n/a	

(Continues)

TABLE 3 | (Continued)

	Rural: Urban MRR							
	<45 years		45–59 years		60–74 years		≥75 years	
	Est.	95% CI	Est.	95% CI	Est.	95% CI	Est.	95% CI
Adjusted								
Sex	1.44	(1.32, 1.58)	1.12	(1.05, 1.20)	0.99	(0.95, 1.03)		
Sex, NZDep	1.46	(1.33, 1.59)	1.07	(1.00, 1.14)	0.92	(0.88, 0.96)		

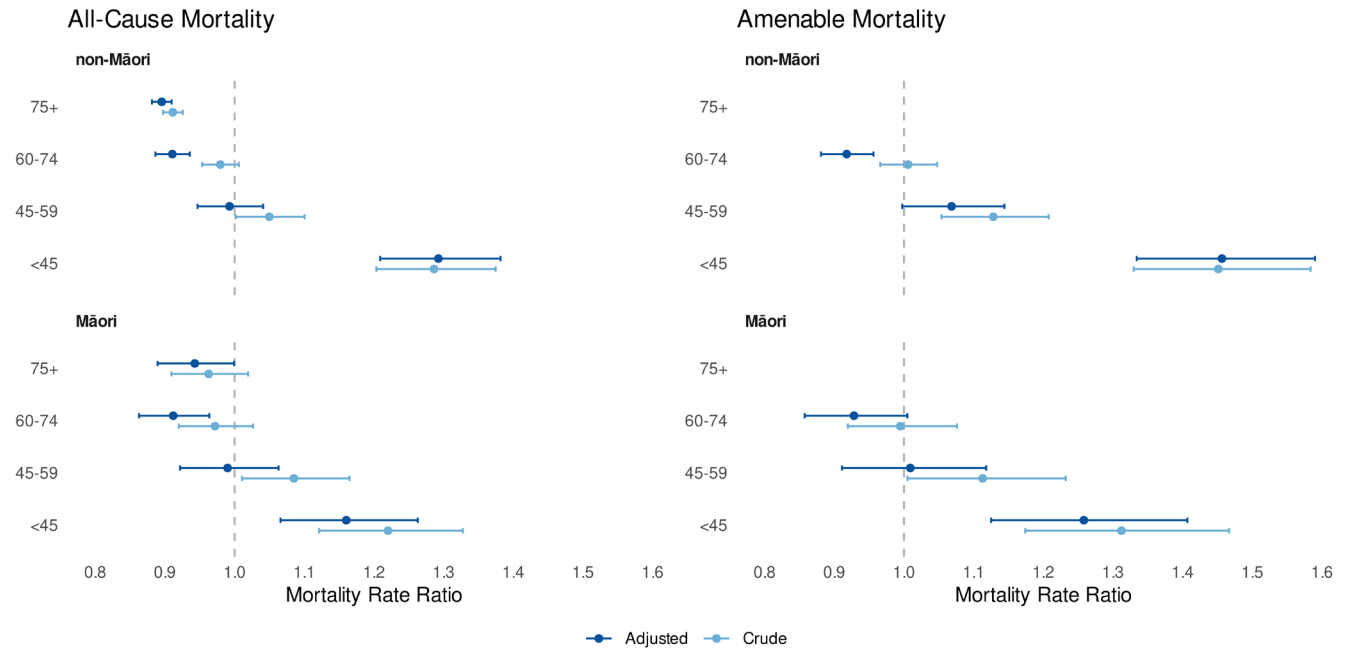

FIGURE 2 | Rural: urban mortality rate ratios for Māori and non-Māori crude and adjusted for sex and socioeconomic deprivation (NZDep) by age group (All-cause mortality: <45, 45–59, 60–74, 75+ years; amenable mortality: <45, 45–59, 60–74 years).

deprivation in remote communities. This pattern is more pronounced for Māori. Māori are overall much younger than non-Māori. Rural residents are, however, much more likely to be 45 years or older than urban dwellers, an effect that is more pronounced in areas of high socioeconomic deprivation.

Multiple associations exist between ethnicity, rurality and socioeconomic deprivation by age, resulting in a series of complex intersecting patterns of mortality rates. The rural–urban disparities in all-cause and amenable mortality observed for younger groups (<45 years) cannot be fully explained by differences in socioeconomic deprivation and ethnicity.

The findings of this study challenge the assumption that rural–urban differences in life expectancy can be explained by ethnicity and socioeconomic status, suggesting that the reality is more complex. The substantive health burden sits where the majority of the population lives, in our large cities, and is associated with socioeconomic deprivation and ethnicity, but rural areas are home to disproportionately large at-risk subpopulations that have poor health outcomes and high healthcare needs. The characteristics of at-risk rural subpopulations include (1) a higher proportion of residents of Māori ethnicity, (2) higher levels of socioeconomic deprivation, and (3) older age structures. These characteristics frequently exist in combination, compounding already poorer health outcomes.

Rural health services in NZ are delivered almost exclusively by generalist health professionals with few specialist services or complex diagnostics. Despite a higher health burden, rural residents have lower utilisation rates of some health services, including hospitalisations [29].

It could be hypothesised that those with financial and social capital have the means to overcome the burden of distance from health and other services. This could include migrating to the city in response to advanced age and frailty, a possible explanation for the apparent lower mortality amongst the rural elderly, relative to urban peers [9]. The extent to which limited access to health services and residential care in rural areas drive this migration is unknown. The differential impact on health outcomes for that large cohort of elderly rural residents who live in areas of high socioeconomic deprivation, and who may not have the means to shift to the city, may be significant. It is therefore important that rural health policy targets rural residents whose health status is affected by the compounding impacts of ethnicity,

socioeconomic deprivation and age. The rural context demands different healthcare strategies. Having multiple health service providers, each targeting different population groups, is often not viable in rural areas because of their small and dispersed populations. As a consequence, programmes such as the VLCA (Very Low Cost Access) General Practice scheme, the flagship primary care equity scheme, can fail to penetrate rural communities [30].

NZDep is an area measure of socioeconomic deprivation that averages the heterogeneity present in small geographic units; in the case of this study, SA1s [31]. Since SA1s contain roughly similar numbers of people, rural SA1s often encompass large geographic areas with potentially even greater heterogeneity than that seen in more concentrated urban areas. This may result in fewer rural residents being categorised as having very low (or very high) levels of socioeconomic deprivation according to NZDep. The impact of this on the rural–urban analyses undertaken is unknown. Similarly, the binary version of the GCH used in parts of this study may be masking differences that would be more evident if the more nuanced 5-category GCH had been used. Future analyses should consider other ethnic groups, including Pacific peoples. Ongoing research is being undertaken to examine residential migration patterns between rural and urban areas driven by changes in health status, and the impact this has on sociodemographic and mortality data [32].

5 | Conclusion

Rural–urban disparities in all-cause and amenable mortality evident in younger age groups cannot be fully explained by ethnicity or socioeconomic deprivation. Māori ethnicity, living in rural areas and socioeconomic deprivation frequently co-exist, and for these communities the impact of these factors on mortality rates will be compounding. Health policy needs to be designed with this in mind.

Author Contributions

G. Davie: conceptualization, project administration, data curation, formal analysis, funding acquisition, methodology, writing – original draft, writing – review and editing. **J. Whitehead:** funding acquisition, methodology, writing – original draft, writing – review and editing. **S. Crengle:** conceptualization, funding acquisition, methodology, writing – review and editing. **J. Atkinson:** data curation, funding acquisition, methodology, visualization, writing – review and editing. **P. Crampton:** funding acquisition, methodology, writing – review and editing. **B. de Graaf:** data curation, funding acquisition, methodology, visualization, writing – review and editing. **K. Blattner:** funding acquisition, methodology, writing – review and editing. **G. Nixon:** conceptualization, project administration, funding acquisition, methodology, writing – original draft, writing – review and editing.

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Ethics Statement

Ethics approval was obtained from the University of Otago Human Research Ethics Committee (HD19/069).

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Extracts of the Mortality Collection can be obtained from data-enquiries@health.govt.nz and Census usually residents counts from info@stats.govt.nz.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Table S1:** Amenable mortality codes.