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Have geographical inequalities in cause-specific mortality in New Zealand increased during the period 1980–2001?

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Abstract

Aims To monitor geographical inequalities in cause-specific mortality in New Zealand during the period 1980 to 2001, a time of rapid social and economic change.

Methods Age-standardised rates of all-cause mortality, as well as for nine of the leading causes of death among males and females, were calculated for District Health Boards (DHBs) for the periods 1980–1982, 1985–1987, 1990–1992, 1995–1997, and 1999–2001. Geographical inequalities in health were evaluated using the DHB-level cause-specific Rate Ratio (RR; age standardised rates 1999–2001:1980–1982), and the Relative Index of Inequality (RII).

Results Between 1980 and 2001, all-cause mortality rates fell for both males and females. However, age-standardised rates have risen for chronic obstructive pulmonary disease, diabetes mellitus, and cancer. The overall reductions in mortality rates have not been uniform across all regions as the all-cause mortality RR for each DHB ranged from 0.98 to 0.69 for males and 1.10 to 0.69 for females. The RRs for cause-specific mortality are more varied with large decreases and increases in mortality attributable to specific causes in some DHBs. There has also been a sharp rise in geographical inequalities in health measured using the RII, and this trend is consistent for most types of mortality.

Conclusions Although overall mortality rates decreased over the 1980s and 1990s, this trend has not been consistent for all causes of mortality or in all regions of the country resulting in higher geographical inequalities in all-cause and most types of mortality.

Recent research has demonstrated that among Organisation for Economic Cooperation and Development (OECD) countries, mortality rates continue to decrease each year. During the period 1960 to 2003 average life expectancy among OECD countries rose from 68.5 to 77.8 years.[1] However, whilst these improvements in health are welcomed, earlier research has established that equal progress is not always made among all socioeconomic groups, or in all geographical areas of each country.

There is overwhelming evidence that rates of ill health are significantly higher among more socially and materially disadvantaged individuals, and these gaps (in relative terms at least) have widened,[2,3] leading to the emergence of significant inequalities in health.

New Zealand is no exception to these international trends. Whilst life expectancy has risen during the period between 1980–82 and 2000–02 from 70.4 to 76.3 for males and 76.4 to 81.1 for females,[4] there are significant variations in health between different socioeconomic and ethnic groups within the country; gaps that have widened

since the 1980s.[5] For example, one study found that although there was a decrease in overall mortality rates among New Zealand men aged 15–64 between the periods 1975–77 and 1995–97, the relative inequalities in the premature mortality rates between social classes increased by approximately 25%.[6] Similarly, using linked census-mortality data for the period 1980-84 and 1996-99, compared to non-Māori, non-Pacific the relative gap in life expectancy grew from 7.7 to 10.8 years for Māori and from 3.3 to 7.7 years for Pacific people.[7]

In addition to variations in health between different socioeconomic groups in New Zealand, there are also gradients across geographical areas. Regional inequalities across the country have been noted for mortality,[8] cancer incidence,[9] and health-related behaviours such as smoking.[10] Further, not only are there significant spatial variations in health, but geographical inequalities in health in New Zealand are also increasing.

Recent work has found that when ranking regions within New Zealand by deprivation, regional inequalities in mortality widened during the 1980s and 1990s by approximately 50%.[11] However, with only a few exceptions,[12] there is a paucity of New Zealand work that has considered geographical inequalities in cause-specific mortality. This is despite the growing international interest in geographical inequalities in health[13,14] as well as the emerging recognition of the importance of geographical context in explaining health outcomes.[15–17] Further, the reduction of health inequalities is a key priority of the New Zealand government and monitoring inequalities in health is an important first step towards achieving this target.

Given such concerns, the objective of this paper is to investigate the association between social inequalities and cause-specific mortality rates from an area perspective, building on earlier work examining geographical inequalities in all-cause mortality.[8,11] We examine changes in cause-specific mortality rates for males and females between 1980 and 2001, by District Health Boards and consider whether geographical inequality in cause-specific mortality has risen during this period.

Methods

Mortality records were extracted for the period 1980 to 2001 from the New Zealand Health Information Service (NZHIS) Mortality Collection. For each year, the mortality data were configured to the 21 District Health Boards (DHBs) across the country using consistent geographical units (2001 boundaries). The DHBs were formed in 2001 and are responsible for the provision of health and disability services.

The boards have an average population of 194,000 and range from 31,000 to 489,000.[18] The small number of unspecified and overseas deaths were excluded from the analyses. In addition, identical datasets were extracted for some of the leading causes of death in New Zealand (Table 1). The leading causes of death that were examined included ischaemic heart disease, cerebrovascular disease, chronic obstructive pulmonary disease (COPD), diabetes mellitus; prostate cancer (males only), breast cancer (females only), lung cancer, colorectal cancer, as well as total cancer (which included cases of prostate and breast cancer).

Table 1. Summary information for mortality cases in New Zealand 1980 to 2001.

Cause of death	ICD-10 Code(s)	Count of cases (1980–2001)	
		Males	Females
All-cause mortality		310688	280216
Ischaemic heart disease	I20-I25	78879	59533
Cerebrovascular disease	I60-I69	21798	33343
Chronic obstructive pulmonary disease	J44	13474	8035
Diabetes mellitus	E10-E14	5024	5023
Prostate cancer	C61	8797	n/a
Breast cancer	C50	n/a	11665
Lung cancer	C33-C34	18028	8599
Colorectal cancer	C18-C21	10570	10508
Total cancer	C00-C96	71951	63416

(n/a=not applicable)

Directly age/sex-standardised mortality rates (ASRs) were calculated for each DHB for the periods 1980–82, 1985–87, 1990–92, 1995–97, and 1999–2001 (mortality data for 2002 were not available at the time of study), using the total contemporary New Zealand population as the standard. Age-standardised rates were calculated for all-cause mortality, as well as for each of the nine causes of mortality. For each time period, the total population for each age-sex group (e.g. 1980, 1981, and 1982) was used as the denominator.

Age- and sex-specific population data for 36 groups (males and females 0–4, 5–9, 10–14 up to 85+) were supplied from the five Censuses that took place during this period. For inter-Census years, population estimates were calculated for each age-sex group through linear interpolation.

To examine whether changes in health status have been consistent across all regions of New Zealand, the (rate) ratio of the age-standardised rate in 1999–2001 compared to the rate in 1980–1982 was calculated for each health measure and each DHB. In order to identify whether inequalities in cause-specific mortality became geographically polarised over the study period, the Relative Index of Inequality (RII) was calculated for all-cause mortality as well as for each cause for the five time periods.

The RII provides a consistent measure of health inequalities across a population because it incorporates the mortality rates of all DHBs rather than comparing, say, just those areas with the highest and lowest mortality rates. Further, the metric provides an easily interpretable measure of the socioeconomic gap in mortality between different social groups or geographical areas.[19]

The RII was calculated by ranking DHBs by a measure of poverty in 2001 weighted by the total population in 2001.[20] Poverty was measured using the 2001 New Zealand Deprivation Index (NZDep 2001), an index based on nine socioeconomic variables taken from the 2001 New Zealand census.[21]

The NZDep 2001 is available for Census Area Units (CAUs) which are the second smallest unit of dissemination of New Zealand census data and each area comprises of approximately 2300 people. DHB-level poverty was estimated using the mean NZDep 2001 score calculated from the constituent CAUs of each DHB. The RII is then obtained by regressing (using linear regression) each of the weighted scores on each of the health outcomes (e.g. age-standardised all-cause mortality). The regression coefficient from this model is the Slope Index of Inequality (SII). The RII can then be calculated as:

$$RII = \text{intercept} / (\text{intercept}-SII)$$

The index provides a measure of the extent of inequalities that can be best summarised as the averaged difference between the poorest and least poor in society. Furthermore, the RII is less sensitive to changing definitions of poverty over time, hence the measure allows comparisons between different time periods.[22] It is also the most appropriate measure for the comparison of rates and ratio spreads.[23] Further details on the RII are described elsewhere.[19 20] All results are reported for all-cause mortality and each of the different causes of mortality, stratified by sex.

Results

Temporal trends in mortality—The 3-year averaged age-standardised rates of all-cause mortality reduced among both males and females during the period 1980 to 2001 (Tables 2 and 3). For males there was a slight increase in the all-cause age-standardised rates between 1980-82 and 1985-87 from 888.2 to 893.9 per 100,000 (Table 2). However, this small rise was followed by a reduction in each of the subsequent years, and by 1999–2001 the age-standardised rate was 778.0 per 100,000; an overall reduction of 14% over the study period. Similarly, between 1980 and 2001 the age-standardised rates of ischaemic heart disease, cerebrovascular disease, and lung cancer have all decreased by between 10% and 38%. However, for the remaining causes of death (chronic obstructive pulmonary disease, diabetes mellitus, prostate cancer, colorectal cancer, total cancer), the rates have increased by between 21% (colorectal cancer) and 88% (diabetes mellitus).

Table 2. Age-standardised mortality rates for males 1980–82, 1985–87, 1990–92, 1995–97, and 1999–2001

Cause of death	1980–82	1985–87	1990–92	1995–97	1999–01
All-cause mortality	888.2	893.9	844.7	808.6	778.0
Ischaemic heart disease	250.9	242.1	211.5	185.4	182.4
Cerebrovascular disease	70.1	62.8	56.5	50.9	56.9
Chronic obstructive pulmonary disease	33.1	36.1	33.2	39.6	42.9
Diabetes mellitus	11.3	11.1	11.6	14.6	21.2
Prostate cancer	17.0	20.3	24.1	26.2	30.7
Lung cancer	50.5	51.6	48.7	44.9	46.0
Colorectal cancer	25.6	27.3	29.4	29.1	31.1
Total cancer	175.6	187.3	195.4	195.0	218.7

For females, the all-cause age-standardised rates followed a similar trend to those for males with a slight increase between 1980–82 and 1985–97 (746.6 to 775.3 per 100,000) followed by a persistent decrease over the remainder of the study period (Table 3). By 1999–01, the all-cause age-standardised rate among females had fallen to 712.5 per 100,000, a reduction of 5% over the study period. Similar to males, there was a reduction in the mortality rates for ischaemic heart disease and cerebrovascular disease, but unlike males there was an increase in the rate of lung cancer.

Although the female rate was lower than that for males, it nevertheless increased by 80% (from 16.6 to 29.0 per 100,000) between 1980–82 and 1999–2001. There were also increases in the age-standardised rates of COPD, diabetes mellitus, breast cancer, colorectal cancer, and total cancer over the study period by between 4% (colorectal cancer) and 327% (chronic obstructive pulmonary disease).

Table 3. Age-standardised mortality rates for females 1980–82, 1985–87, 1990–92, 1995–97, and 1999–2001

Cause of death	1980–82	1985–87	1990–92	1995–97	1999–01
All-cause mortality	746.6	775.3	735.9	732.4	712.5
Ischaemic heart disease	170.6	174.4	156.6	139.3	146.6
Cerebrovascular disease	101.2	92.9	84.3	78.8	85.6
Chronic obstructive pulmonary disease	10.5	15.1	20.0	27.3	34.3
Diabetes mellitus	11.8	11.2	11.1	14.2	19.2
Breast cancer	28.4	31.3	31.3	31.4	31.8
Lung cancer	16.6	19.5	22.8	25.1	29.0
Colorectal cancer	27.5	28.4	27.0	26.1	28.7
Total cancer	147.5	161.1	168.2	171.3	182.4

Geographical trends—Whilst national mortality rates have fallen over the study period, the reduction has not been consistent for all DHBs across the country (Tables 4 and 5). For males, the Rate Ratios (RRs) of the all-cause mortality rates in 1999–01 compared to the rates in 1980–82 were less than 1.0, which suggests that all areas experienced a reduction in all-cause mortality over the study period (Table 4). However, some regions (e.g. Whanganui, Tairawhiti, Lakes, and Northland) experienced only very small reductions while in others (such as the Capital and Coast, Otago, South Canterbury, Auckland, and Westland DHBs) the all-cause mortality rates declined by more than 15%.

With regards to the cause-specific analysis, similar trends to the all-cause analysis were noted for ischaemic heart disease and cerebrovascular disease with most DHBs being characterised by RRs of less then 1.0 although again the reduction was not equal throughout the country. However, for the other leading causes of death (COPD, diabetes mellitus; prostate cancer, lung cancer, colorectal cancer, and total cancer), mortality rates have tended to increase in most DHBs. Further, the increases in mortality from these causes were not consistent in all regions across New Zealand. For example, for diabetes mellitus the RRs ranged from 1.26 in Nelson-Marlborough to 4.71 in Whanganui, which demonstrates that age-standardised mortality rates had increased by between 26% and more than four-fold over the study period.

For females, there are some important differences to the male results (Table 5). First, the higher RR for females (0.95 compared to 0.88 for males) indicates that there has been a smaller relative decrease in all-cause mortality for females than for males over the study period. Second, although at the national level there was a reduction in female all-cause mortality, in some regions (most notably the Waitemata, Hawke's Bay, Hutt Valley, Tairawhiti, Whanganui, and Lakes DHBs) there was a slight increase in the age-standardised rates during the 1980s and 1990s. With the exception of the West Coast and Wairarapa DHBs, the remaining regions had a RR of between 0.9 and 1.0 thus suggesting that the reduction in all-cause mortality was less than 10% in most DHBs.

Table 4. Rate Ratio for age-standardised mortality rates in 1999–2001 compared to 1980–1982 (males)

District Health Board	All cause	IHD	CVD	COPD	Diabetes mellitus	Prostate cancer	Lung cancer	Colorectal cancer	Total cancer
Northland	0.96	0.94	0.64	1.55	2.34	2.03	1.40	1.89	1.51
Waitemata	0.85	0.67	0.84	1.40	1.84	1.40	0.83	1.18	1.14
Auckland	0.82	0.66	0.82	1.47	1.64	1.63	0.78	1.04	1.08
Counties Manukau	0.89	0.66	0.85	1.35	1.61	1.57	0.76	1.15	1.07
Waikato	0.93	0.78	0.88	1.51	1.77	2.06	0.92	1.37	1.27
Lakes	0.96	0.85	0.94	2.11	2.89	2.84	1.18	1.55	1.51
Bay of Plenty	0.91	0.75	0.79	1.55	1.64	2.50	0.98	1.47	1.38
Tairawhiti	0.96	0.79	0.69	1.19	2.15	1.29	1.06	1.11	1.28
Taranaki	0.90	0.90	0.95	1.65	2.42	2.60	1.00	1.11	1.35
Hawke's Bay	0.89	0.84	0.87	1.18	2.08	2.62	1.31	1.03	1.41
Whanganui	0.98	0.98	0.77	1.30	4.71	2.28	1.06	1.43	1.51
Mid Central	0.90	0.81	0.92	1.43	2.23	1.87	0.87	1.06	1.22
Hutt Valley	0.86	0.63	0.76	1.14	1.37	2.15	0.83	0.83	1.27
Capital and Coast	0.83	0.68	0.93	0.92	2.31	1.52	0.65	1.31	1.19
Wairarapa	0.88	0.74	0.48	1.10	1.72	1.46	0.66	0.96	1.00
Nelson-Marlborough	0.88	0.66	0.90	1.41	1.26	1.74	1.04	1.33	1.48
West Coast	0.69	0.63	0.65	1.25	2.70	4.29	0.70	1.08	1.05
Canterbury	0.85	0.70	0.77	1.23	1.44	1.31	0.97	1.46	1.25
South Canterbury	0.82	0.62	0.69	1.28	1.69	1.60	0.67	0.73	1.15
Otago	0.83	0.67	0.69	0.95	1.71	2.27	1.06	1.23	1.31
Southland	0.87	0.89	1.19	1.35	2.31	2.37	0.97	1.50	1.50
New Zealand	**0.88**	**0.73**	**0.81**	**1.29**	**1.88**	**1.81**	**0.91**	**1.22**	**1.25**

(IHD=Ischaemic heart disease; CVD=Cerebrovascular disease; COPD=Chronic obstructive pulmonary disease)

Similar to males, in most DHBs there was a reduction in the mortality rates attributed to ischaemic heart disease and cerebrovascular disease. However, some DHBs saw an increase in mortality for these two causes of mortality and in Tairawhiti and Lakes DHBs mortality rates increased for both causes by as much as 35%. For all of the remaining leading causes of death (COPD, diabetes mellitus; breast cancer, lung cancer, colorectal cancer, and total cancer) the 3-year average age-standardised rates tended to increase in most DHBs during the 1980s and 1990s. For example, the RRs for COPD ranged from 1.89 (Wairarapa) to 8.70 (Wairarapa), which suggests that the mortality rates for this cause rose by between 89% and more than eight-fold. Similarly, mortality rates due to diabetes mellitus rose in all DHBs by between 13% (Tairawhiti) and 246% (Northland). Interestingly, in the Whanganui and Lakes DHBs age-standardised mortality rates increased not only for all-cause mortality but also for all but one of the specific causes of mortality.

The RII for all-cause mortality was roughly equal over the first part of the study period but then rose sharply between 1995–97 and 1999–2001 (Table 6). Between 1980–82 and 1999–2001 the RII for all-cause mortality rose from 1.11 to 1.24 for males and from 1.13 to 1.17 for females. The results therefore show that the level of health inequalities in New Zealand equates to in an increase in excess mortality, for the worst off areas, from 11% to 24% for males and 13% to 17% for females.

Table 5. Rate Ratio for age-standardised mortality rates in 1999–2001 compared to 1980–1982 (females)

District Health Board	All cause	IHD	CVD	COPD	Diabetes mellitus	Breast cancer	Lung cancer	Colorectal cancer	Total cancer
Northland	0.99	0.87	0.82	2.81	2.46	1.50	1.90	0.85	1.44
Waitemata	1.03	0.83	0.81	3.06	1.21	1.22	1.56	1.06	1.22
Auckland	0.90	0.79	0.81	2.69	2.32	0.95	1.11	0.74	0.99
Counties Manukau	0.92	0.70	0.78	4.67	1.38	0.82	1.74	0.84	1.02
Waikato	0.95	0.82	0.84	3.45	1.33	1.24	1.68	0.83	1.17
Lakes	1.10	1.35	1.16	2.19	1.47	0.73	2.14	1.08	1.46
Bay of Plenty	0.99	0.81	1.07	4.01	1.56	1.47	1.91	1.56	1.42
Tairawhiti	1.07	1.32	0.67	2.02	1.13	1.08	1.26	0.93	1.19
Wairarapa	0.96	1.02	0.98	8.70	2.26	1.18	1.42	0.96	1.35
Hawke's Bay	1.04	1.08	0.97	3.65	1.77	1.68	1.89	1.28	1.48
Whanganui	1.10	1.17	1.21	4.72	1.75	0.98	2.91	1.15	1.48
MidCentral	0.95	0.93	0.96	5.09	1.63	1.04	1.78	1.07	1.21
Hutt Valley	1.04	0.77	0.78	2.23	1.59	1.55	1.46	0.88	1.41
Capital and Coast	0.94	0.86	0.92	3.13	2.38	0.98	1.43	1.04	1.18
Wairarapa	0.88	0.86	0.49	1.89	1.86	1.18	3.08	0.89	1.50
Nelson-Marlborough	0.98	0.99	1.01	3.54	1.29	1.62	1.60	1.10	1.41
West Coast	0.69	0.60	0.52	3.23	1.56	0.60	4.79	1.79	1.15
Canterbury	0.90	0.87	0.78	3.30	1.32	1.00	2.08	1.05	1.22
South Canterbury	0.93	0.82	0.64	4.62	1.64	1.22	2.77	1.37	1.42
Otago	0.94	0.78	0.94	3.72	1.57	1.40	2.27	1.23	1.25
Southland	0.94	1.00	1.02	2.12	1.37	0.91	1.70	1.76	1.34
New Zealand	**0.95**	**0.86**	**0.85**	**3.26**	**1.63**	**1.12**	**1.75**	**1.04**	**1.24**

(IHD=Ischaemic heart disease; CVD=Cerebrovascular disease; COPD=Chronic obstructive pulmonary disease)

It is noteworthy that for some causes of death the RII values are considerably higher than those noted for all-cause mortality. For example, the RII for mortality attributed to diabetes mellitus was in excess of 2.0 for males and females, which suggests that there was an excess mortality of more than 100% in the poorest areas of New Zealand. However, for other causes of death, particularly colorectal cancer, the RII was consistently close to 1.0 which suggests that there were no significant inequalities attributable to this cause.

Nonetheless, the trend in the RII for the cause-specific mortality results are generally consistent with the all-cause analysis with an overall increase in inequality over the study period. The RII values are usually higher for males than females and the increase has been more consistent in the former.

Table 6. Relative Index of Inequality for all-cause and causes-specific mortality in New Zealand 1980–2001

Cause of death	Male					Female				
	1980–82	1985–87	1990–92	1995–97	1999–01	1980–82	1985–87	1990–92	1995–97	1999–01
All-cause mortality	1.11	1.12	1.12	1.14	1.24	1.13	1.16	1.12	1.14	1.17
Ischaemic heart disease	0.96	1.03	1.04	0.99	1.15	1.03	0.99	0.99	1.04	1.07
Cerebrovascular disease	1.10	1.06	0.99	1.09	1.07	0.94	1.07	0.96	0.91	1.02
Chronic obstructive pulmonary disease	0.99	1.06	1.08	1.04	1.27	1.00	1.56	1.40	1.10	1.18
Diabetes mellitus	1.79	1.43	1.75	2.11	2.49	1.80	1.31	2.32	2.85	2.13
Prostate (M) or breast (F) cancer	0.86	0.92	0.96	1.10	1.29	0.99	1.03	1.02	1.17	0.99
Lung cancer	1.04	1.19	1.19	1.06	1.24	1.49	1.34	1.46	1.51	1.63
Colorectal cancer	0.90	1.01	0.90	1.07	0.93	1.08	1.00	1.02	0.98	0.93
Total cancer	1.03	1.05	1.02	1.06	1.11	1.08	1.07	1.00	1.13	1.10

Discussion

The main finding of this study is that during the 1980s and 1990s there were rising spatial inequalities in health for males and females in New Zealand as measured using all-cause mortality as well as for most of the leading causes of death. Whilst overall all-cause mortality declined by approximately 12% over the study period, this was not true of all regions with some DHBs witnessing considerable mortality reductions compared to only modest declines in others.

Further, relative inequality in mortality between areas of high and low social deprivation increased, which suggests that there have been larger reductions in mortality in less deprived regions of the country. The reduction in all-cause mortality was also greatest for males with females showing fewer relative gains and, in some areas, absolute increases in mortality occurred.

Not surprisingly, there has also been a widening in inequality for each of the leading causes of mortality. Whilst two of the major causes of death (ischaemic heart disease and cerebrovascular disease) have mirrored the overall reduction in all-cause mortality, for some causes of death, in particular chronic obstructive pulmonary disease, diabetes mellitus, all of the individual cancer types (except male lung cancer) and total cancers, there was an increase in the age-standardised rates. However, as with all-cause mortality, the national-level increases or decreases in the age-standardised rates of each cause have not been consistent in all regions.

Further, the rising spatial inequalities between rich and poor regions of the country noted for all-cause mortality are not consistent for all mortality types. Nonetheless, by the end of the study period for most of the leading causes of death (except colorectal cancer, and breast cancer among women) there was at least a small and increasing excess in mortality in more socially deprived regions of the country. Indeed for some causes of death (especially diabetes mellitus) there was a particularly strong socioeconomic gradient.

These trends are consistent with the international studies that have monitored geographical inequalities in health. Research in the UK,[13,23,24] US,[25] and Australia[26] has noted that health has become more geographically polarised over the 1980s and 1990s. The current research is also consistent with earlier New Zealand research examining spatial inequalities in all-cause mortality, which found a spatial polarisation in life expectancy over the 1980s and 1990s.[8,11] Further, our findings concur with other New Zealand studies that have examined ethnic and social inequalities in health.[7,27]

There are several plausible explanations for rising geographical inequalities in health in New Zealand. First, the 1980s and 1990s saw the implementation of a neoliberal economic and social agenda in New Zealand which led to economic restructuring and substantial alterations to the welfare state, particularly in the areas of housing, health, and education.[28] One important outcome of this transformation was a significant increase in levels of economic and social inequality between the rich and the poor. This changing social and political environment particularly disadvantaged lower socioeconomic groups and areas as well as Māori and Pacific people[27,29] and is likely

to be an important explanation for the diverging health status between high and less deprived regions across the country.

Second, as has previously been suggested,[11] selective migration patterns between New Zealand regions may help to explain why regional health status in New Zealand became more geographically polarised between 1980 and 2001. This interpretation is consistent with work in the UK which found that the differential migration patterns of ill people relative to healthy contributes to the widening geographical divide in health in that country.[30]

Compared to other OECD countries, New Zealand has high levels of immigration (19.5% of the New Zealand population were born overseas)[31] and emigration, which is likely to result in the perpetual re-sorting of people by area. Most migrants into New Zealand are highly skilled and have high levels of educational attainment and tend to locate in the main urban centres, particularly Auckland.[32] These selective trends in population turnover may partially explain the rising relative inequalities in health observed in this study.

Third, it is possible that there are characteristics of the DHBs that exert an independent influence on the health of the residents of those areas. This interpretation would be consistent with the substantial body of literature that has identified various 'place effects' that operate across the lifecourse, and influence the health outcomes and health inequalities of local residents.[33]

Researchers are continuing in their attempts to untangle the 'compositional' (individual-level) and 'contextual' (ecological) explanations for health inequalities. Potentially, the most pertinent place-based process that operates at the DHB level is the provision of healthcare.

The healthcare reforms of the 1980s and 1990s, which resulted in substantial co-payments, led to the under utilisation of healthcare services among the most at-risk groups.[34] Poor access to primary health care services has been linked to worse health outcomes and increased hospitalisation among the more disadvantaged social groups.[35,36] Moreover, the unequal rationing of primary health care services has been shown to have affected some regions more than others and is likely to contribute to the emerging inequalities in health between DHBs across New Zealand.

It should be noted that we have examined spatial inequalities in health across relatively broad geographical areas (the 21 DHBs in New Zealand). However, DHBs are likely to exhibit considerable internal heterogeneity particularly with respect to social deprivation. It is probable that operationalising smaller geographical units, which more precisely specify area-level socioeconomic status, would have revealed wider spatial inequalities in health.

Similarly, it is not possible using ecological data to ascertain the socioeconomic circumstances of individual mortality cases. Therefore, it cannot be assumed that what is identified at the area-level is necessary a reflection of what is occurring at the individual-level (the ecological fallacy). Also, in any mortality study there are always potential data quality issues, particularly in terms of misdiagnoses of the causes of death, or the effect of multiple causes.

Some minor problems may also have arisen as a result of using cross-sectional data based on the average mortality rate for each 3-year period. Depending upon the rate of population change, interpolation of rates based on census estimates may have resulted in some minor variations in estimates for some DHBs.

The findings of this research should be of significant interest to policy makers in New Zealand. Although reducing health inequalities has been identified in the New Zealand Health Strategy as a key government priority,[37] our findings suggest that government policies have not been effective in reducing the spatial divide.

Given the increased importance of DHBs in promoting health and greater local accountability for monitoring and addressing adverse health outcomes we suggest that more attention needs to be paid to geographical differences in health and how the causes of ill health and mortality are likely to vary between different regions. This assertion is important because the causes of spatial variations in health are not simply a function of ethnic or social differences in the population composition of different DHBs.

Therefore, it is imperative that in the future, policy makers pay greater attention to local contextual and compositional factors affecting health and the extent to which DHB trends in health outcomes are similar or different to those in other regions. It is also important that future research monitors the inequalities between key at-risk groups and evaluates the government's strategies to reduce the health divide.

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