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## Inequalities in mortality during and after restructuring of the New Zealand economy: repeated cohort studies

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### ABSTRACT

**Objectives** To determine whether disparities between income and mortality changed during a period of major structural and macroeconomic reform and to estimate the changing contribution of different diseases to these disparities.

**Design** Repeated cohort studies.

**Data sources** 1981, 1986, 1991, 1996, and 2001 censuses linked to mortality data.

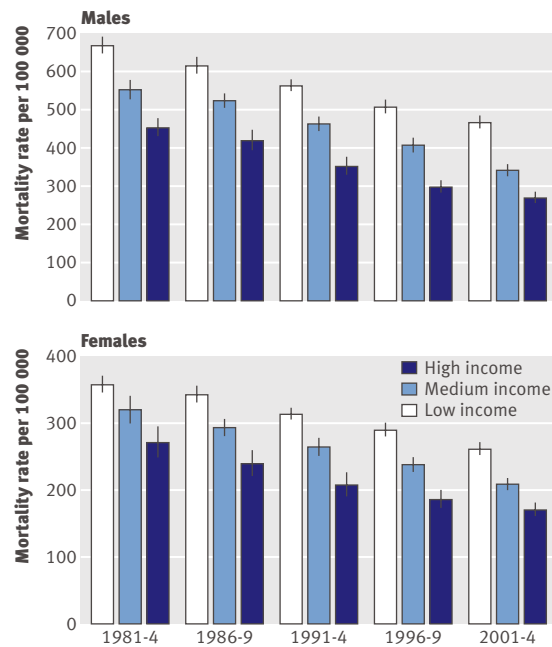
**Population** Total New Zealand population, ages 1-74 years.

**Methods** Mortality rates standardised for age and ethnicity were calculated for each census cohort by level of household income. Standardised rate differences and rate ratios, and slope and relative indices of inequality (SII and RII), were calculated to measure disparities on both absolute and relative scales.

**Results** All cause mortality rates declined over the 25 year study period in all groups stratified by sex, age, and income, except for 25-44 year olds of both sexes on low

incomes among whom there was little change. In all age groups pooled, relative inequalities increased from 1981-4 to 1996-9 (RIIs increased from 1.85 (95% confidence interval 1.67 to 2.04) to 2.54 (2.29 to 2.82) for males and from 1.54 (1.35 to 1.76) to 2.12 (1.88 to 2.39) for females), then stabilised in 2001-4 (RIIs of 2.60 (2.34 to 2.89) and 2.18 (1.93 to 2.45), respectively). Absolute inequalities were stable over time, with a possible fall from 1996-9 to 2001-4. Cardiovascular disease was the major contributor to the observed disparities between income and mortality but decreased in importance from 45% in 1981-4 to 33% in 2001-4 for males and from 50% to 29% for females. The corresponding contribution of cancer increased from 16% to 22% for males and from 12% to 25% for females.

**Conclusions** During and after restructuring of the economy disparities in mortality between income groups in New Zealand increased in relative terms (but not in absolute terms), but it is difficult to confidently draw a causal link with structural reforms. The contribution of different



**Fig 1** All cause mortality rates (per 100 000) by three income groups by period for all ages (1-74 years) combined. Rates and 95% confidence intervals are presented in tables A and B on [bmj.com](http://bmj.com). Error bars are 95% confidence intervals

causes of death to this inequality changed over time, indicating a need to re-prioritise health policy accordingly.

## INTRODUCTION

New Zealand underwent major structural reform from 1984 to the early 1990s, including the introduction of a flattened tax system, fully targeted income support, a regressive consumption tax, market rentals for housing, privatisation of major utilities, user charges for health, education, and other government services, and a restructured labour market designed to facilitate “flexibility.”<sup>1-3</sup> At the same time as these reforms, rates of unemployment and poverty rose. Unemployment rates increased from 4.1% in 1986 to 10.4% in 1992, then steadily fell to 3.7% in 2005.<sup>4</sup> The proportion of the population aged 15 years and older with incomes below the 60% median income poverty threshold increased from 12.3% in 1987-8 to 26.5% in 1992-3, then fell to 20.9% in 1997-8, and has remained stable ever since.<sup>4</sup> Measures of income inequality show similar trends.<sup>4,5</sup>

In the 1970s McKeown supported the importance of standard of living and nutrition as determinants of trends in mortality,<sup>6</sup> while Preston argued that economic development was less important and suggested that advancements in medical care and related technologies might be the key.<sup>7</sup> This debate continues today.<sup>8-13</sup> There is less empirical work examining the association of trends in health inequalities with trends in economic conditions. One study in Russia found that changes in mortality rates were greatest among those with little education.<sup>14</sup> Across six European countries, however, relative socioeconomic inequalities in

mortality increased similarly from the early 1980s to early 1990s, despite differing trends in macroeconomic performance.<sup>15</sup> Likewise, relative inequalities in mortality by education in New Zealand and three Scandinavian countries increased similarly during the 1980s and 1990s.<sup>16</sup>

We examined trends in disparities in mortality by equalised household income within New Zealand over a period of major structural reform. In a secondary objective we quantified the changing contribution of different causes of death to the observed disparity.

## METHODS

### Data

We assembled mortality records for people alive on the previous census night who died aged 1-74 years within three years of the 1981, 1986, 1991, 1996, or 2001 censuses. We anonymously and probabilistically linked these mortality records to corresponding census records. The percentages of eligible mortality records linked to a census record were 70.9%, 73.7%, 76.3%, 77.6%, and 79.6% for the five census cohorts, respectively. We calculated weights for strata based on age, sex, ethnicity, and small area deprivation.

We equalised household income from the census for the number of adults and children, then adjusted for inflation. Person years and weighted deaths by approximate thirds of income (by using constant income cut points across cohorts) were used for calculation of all standardised rates. We also used five categories of income (approximate fifths) to calculate more sophisticated measures of inequality.

### Analyses and measures of association

We calculated rates standardised for age and ethnicity, rate differences, and rate ratios using the three level income variable and using a matrix of the age distribution from WHO's world population and the ethnic distribution of New Zealand at the 2001 census (14.1% Maori, 5.2% Pacific, 80.7% other) as the standard population.

We calculated the slope index of inequality (SII) and relative index of inequality (RII).<sup>17,18</sup> These analyses used five groups of income, of approximate fifths on average over time.

We conducted comparisons over time by comparing mortality rates, standardised rate differences, standardised rate ratios, SIIs, and RIIs over the five census cohorts. We used the natural logarithm of the standardised rate ratios and RIIs in tests of trend. We broke down the total SII into its contributions from each cause of death.

## RESULTS

We had data on age, sex, and ethnicity for all subjects, but household income data were missing for 14.2-19.3% of the eligible person years by sex across the five cohorts.

All cause mortality (standardised for age and ethnicity) declined similarly in absolute terms for all three income groups over the 25 year study period

(fig 1). In relative terms, however, rates fell by a greater percentage in the high income groups (41% and 37% for males and females; tables A and B on [bmj.com](#)) than in the low income groups (30% and 27%). Accordingly, absolute measures of the disparity between income and mortality (standardised rate differences and SII) were similar over time (pooling ages), but the standardised rate ratios and RIIs increased.

Closer examination of trends in disparities in all cause mortality showed two additional patterns. Firstly, there was evidence among both males and females of a possible decrease in absolute inequalities (standardised rate differences and SII) and stabilisation in relative inequalities (standardised rate ratios and RII), for the most recent period—that is, from 1996-9 to 2001-4 (fig 2). Secondly, the RII increased from 1981-4 to 2001-4 by 88% and 119% for males and females, respectively, compared with increases in the standardised rate ratio of “only” 60% and 69%, respectively. This greater increase in the RII than the standardised rate ratio is expected as the RII also incorporates the widening that occurred in the underlying income distribution over the study period.

There were variations in trends by age group. Among young adults (25-44 years) mortality rates fell by only 6% for men and 11% for women in the low income group compared with falls of 34% and 45%, respectively, in the high income group (see tables A and B on [bmj.com](#)). Accordingly, both absolute and relative inequalities increased substantially over time in this age group. By contrast, among older men (65-74 years) the percentage falls in mortality rates were similar across income groups, so absolute inequalities decreased and relative inequalities remained stable over time. Remaining adult age groups (that is, men aged 45-64 and women aged 45-74) showed patterns consistent with the overall pattern of stable absolute but increasing relative inequalities over time.

Among middle aged and older adults absolute disparities (that is, SII) seemed to narrow from 1996-9 to 2001-4, and relative disparities (that is, RIIs) tended to stabilise over this most recent period. Considered individually, none of these apparent changes in trajectory are significant at conventional levels, but the pattern is similar across each of the four sex by age groups (that is, men and women aged 45-64 and 65-74), suggesting that chance is an unlikely explanation.

Important variations exist in trends in cause specific mortality by income (see [bmj.com](#)). Cardiovascular mortality rates fell markedly by 52-61% across sexes and income groups (standardised for age and ethnicity), with corresponding increases in relative inequality but falls in absolute inequality. Mortality from lung cancer in men fell in all income groups, but among women this rate initially increased then fell among the low income group, while remaining stable over the whole study period in the medium income group, and falling continuously in the high income group. There was less change over time in mortality for other cancers. There were marked disparities in mortality from chronic lung disease at all points in time and falls

over time in mortality from this cause in all income groups among men but not women. Rates of unintentional injury tended to fall in all income groups, with moderate and persistent disparities (increasing in relative terms for males). Suicide rates by income group were unstable over time for females, but increased over time in all income groups for males up to 1996-9 (more so for the low income group), then fell for all income groups from 1996-9 to 2001-4.

Figure 3 shows the SII for all cause mortality by sex and period (ages pooled), decomposed by cause of death. Cardiovascular disease was the major contributor to the SII (ages pooled) at all times, but its contribution decreased over time: from 45% in 1981-4 to 33% in 2001-4 for males, and from 50% to 29% for females (table D on [bmj.com](#)). Conversely, the contribution of cancer increased from 16% to 22% for males and from 12% to 25% for females (pooling age groups). However, the contribution of cancer did not increase further from 1996-9 to 2001-4. Chronic lung disease contributed approximately 10% to the SII at each period (pooling ages). “Other” causes of death consistently explained about a quarter of the total absolute disparity (pooling ages) for both sexes, however no single disease stood out upon further disaggregating this cause category.

Across three adult age groups (25-44, 45-64, and 65-74 years) the contribution of different causes of death to the SII show that suicide and unintentional injury clearly make the major contribution to inequalities in mortality among young adults (ages 25-44). Furthermore, the contributions of both suicide and unintentional injury increase over time, and explain much of the increase in SII over time in this age group, especially for men. Among older people (ages 65-74) the decreasing contribution of cardiovascular disease was offset by an increasing contribution of cancer in women, resulting in a stable SII over time, but not so in men, for whom the total SII decreased over time.

## DISCUSSION

During the 1980s and 1990s, disparities in mortality by income in New Zealand were stable in absolute terms,

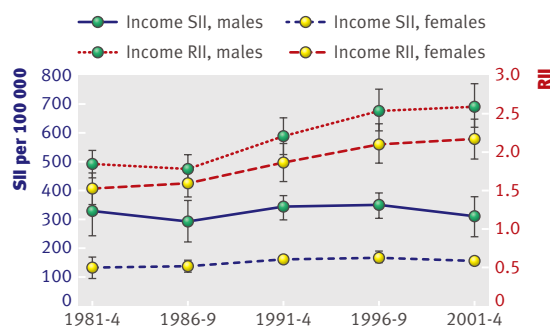
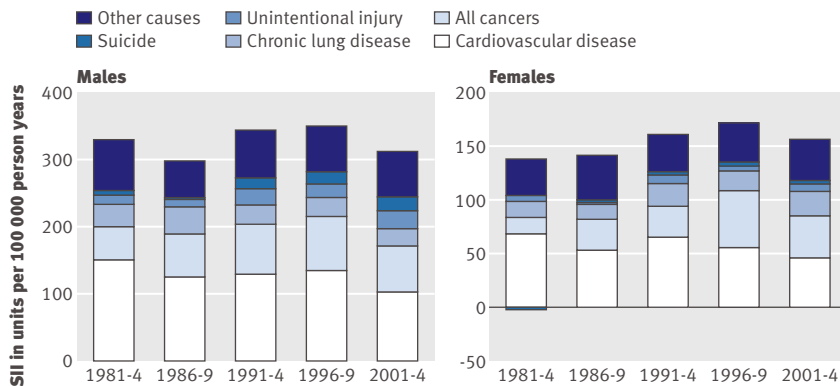


Fig 2 Trends in absolute (slope index of inequality (SII)) and relative (relative index of inequality (RII)) inequalities in all cause mortality by income for all ages (1-74 years) combined. Error bars are 95% confidence intervals



**Fig 3** Contribution of causes of death to SII for all ages (1-74 years) combined. Total height of bars is all cause mortality SII shown in table 2 on [bmj.com](#). Height of each component is cause specific SII shown in table 3 on [bmj.com](#). Contribution of suicide for females in 1981-4 is shown below 0 as suicide rates were slightly greater among people on high income. Percentage contribution of each cause of death is shown in table D on [bmj.com](#)

but increased in relative terms, after adjustment for changes in the age and ethnic distribution of the population. This finding is consistent with an expectation that in times of increasing social inequality and poverty, health inequalities will increase, in relative terms at least. From 1996-9 to 2001-4, however, this trend seems to have ceased, with relative inequalities stabilising and absolute inequalities narrowing. It is tempting to conclude that a partial reversal of neoliberal policies since the mid- to late 1990s in New Zealand has been responsible for this turning point in health inequality. On the other hand, improved macroeconomic performance and excellent labour market performance leading to low levels of unemployment provides an alternative, or additional, explanation.

While there is some evidence from the ex-Soviet countries that population mortality rates and disparities in these rates can respond rapidly to macroeconomic change,<sup>14</sup> there is also evidence that relative inequalities in mortality have inexorably increased in many rich countries in the past two decades<sup>15 16</sup> and that overall mortality rates can even fall more rapidly during economic recessions.<sup>19 20</sup> The importance of social and healthcare services has also been argued as an offset against, or modifier of, any association between income distribution and health inequalities.<sup>21</sup>

Re-examining our findings in this light, it is interesting to note the strong and relentless decrease in mortality from cardiovascular disease for all income groups throughout this period, most probably reflecting both reduction in exposure to risk factors and improvement in access to and effectiveness of clinical treatment.<sup>22 23</sup> Distal social and economic factors may modify the rate of secular changes in proximal risk factors (such as smoking and diet) and access to treatments (such as cholesterol lowering medications), perhaps differentially by socioeconomic position. It is clear, however, that social and economic factors are not the only determinant of trends in mortality. It is

interesting to note the gradual widening of inequalities in mortality from cancer. Again, this most probably reflects differential trends by socioeconomic position in exposures to risk factors and in access to high quality clinical treatment. Contrary to our expectations,<sup>24</sup> however, cancer inequalities did not further widen from 1996-9 to 2001-4.

We have shown that cardiovascular disease is a major driver of trends in income-mortality gradients in New Zealand. Profound decreases in mortality from coronary heart disease and stroke in all income groups mean that, unless relative inequalities become high, absolute inequalities must decline and consequently the contribution of cardiovascular disease to the total mortality gap must, at some point, also decline. It remains to be seen whether the obesity epidemic might cause mortality rates from cardiovascular disease to increase again.<sup>25</sup>

An important finding is the widening income-mortality disparity among young adults (25-44 years). Suicide and unintentional injury made substantial contributions to widening inequality between income and mortality in this age group. This finding suggests that underprivileged young adults are being left behind in New Zealand society and identifies an issue requiring urgent research and policy attention.

#### Limitations

We could not completely link all eligible mortality records to census records, though we believe the weights used in our analyses remove resultant linkage bias.<sup>24</sup> Income is susceptible to reverse causation (that is, poor health before death causing reduced income). We do not believe reverse causation to be a major source of bias: income is measured at the household level for the year preceding census night, up to three years before death. We observed similar patterns across several age groups, which provides some reassurance that the interesting change in direction of

#### WHAT IS ALREADY KNOWN ON THIS TOPIC

New Zealand underwent a period of major structural and macroeconomic reform in the 1980s and 1990s, resulting in increasing (followed by decreasing) poverty and unemployment rates, and widening income inequalities

#### WHAT THIS STUDY ADDS

Mortality rates fell in all income groups from 1981-4 to 2001-4

Mortality disparities by income increased in relative terms from 1981-4 to 1996-9, then stabilised to 2001-4 but in absolute terms remained stable from 1981-4 to 1996-9, then possibly decreased slightly to 2001-4

Cardiovascular disease was the major contributor to disparities but decreased in importance over time as cancer increased

There was little improvement over time in mortality rates among low income young adults (25-44 years)

trend identified between 1996-9 and 2001-4 is probably not caused by chance. Finally, it is difficult to infer a causal link between structural or macroeconomic reform and trends in health inequalities in an observational study.

### Conclusions

Our findings are possibly consistent with, but far from proof of, a causal association between changing social and economic conditions and changing disparities between income and mortality. Importantly, we have shown that the contribution of different diseases to the total disparity in mortality by income has changed over time. If health disparities are to continue to narrow health policy will need to focus increasingly on improving access to and quality of cancer prevention and treatment services for disadvantaged groups. At the same time, recent improvements in cardiovascular health need to be sustained and further strengthened, particularly for disadvantaged social groups.

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