Changing trends in indigenous inequalities in mortality: lessons from New Zealand

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Background We describe trends from 1951 to 2006 in inequalities in mortality between the indigenous (Māori) and non-indigenous (non-Māori, mainly European-descended) populations of New Zealand. We relate these trends to the historical context in which they occurred, including major structural adjustment of the economy from the mid 1980s to the mid 1990s, followed by a retreat from neoliberal social and economic policies from the late 1990s onwards. This was accompanied by economic recovery and the introduction of health reforms, including a reorientation of the health system towards primary health care.

Methods Abridged period lifetables for Māori and non-Māori from 1951 to 2006 were constructed using standard demographic methods. Absolute [standardized rate difference (SRD)] and relative [standardized rate ratio (SRR)] mortality inequalities for Māori compared with European/Other ethnic groups (aged 1–74 years) were measured using the New Zealand Census-Mortality Study (an ongoing data linkage study that links mortality to census records) from 1981–84 to 2001–04. The SRDs were decomposed into their contributions from major causes of death. Poisson regression modelling was used to estimate the extent of socio-economic mediation of the ethnic mortality inequality over time.

Results Life expectancy gaps and relative inequalities in mortality rates (aged 1–74 years) widened and then narrowed again, in tandem with the trends in social inequalities (allowing for a short lag). Among females, the contribution of cardiovascular disease to absolute mortality inequalities steadily decreased, but was partly offset by an increasing contribution from cancer. Among males, the contribution of CVD increased from the early 1980s to the 1990s, then decreased again. The extent of socio-economic mediation of the ethnic mortality inequality peaked in 1991–94, again more notably among males.

Conclusion Our results are consistent with a causal association between changing economic inequalities and changing health inequalities between ethnic groups. However, causality cannot be established from a historical analysis alone. Three lessons nevertheless emerge

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from the New Zealand experience: the lag between changes in ethnic social inequality and ethnic health inequality may be short (<5 years); both changes in the distribution of the social determinants of health and an appropriate health system response may be required to address ethnic health inequalities; and timely monitoring of ethnic health inequalities, based on high-quality ethnicity data, may help to sustain political commitment to pro-equity health and social policies.

Introduction

New Zealand is a country with a unique history from which significant learning may be gained relating to ethnic—and in particular, indigenous—inequalities in health (see Box 1). Here, we describe trends in Māori—European inequalities in life expectancy (1951 onwards) and mortality (1981 onwards), building on previous work on ethnic inequalities in New Zealand,[15,16] and complementing parallel work on trends in socio-economic inequalities in mortality.[17]

We hypothesize that, if ethnic health inequalities are causally related to economic restructuring and health reform, then Maori—European health inequalities will have widened during the phase of neoliberal restructuring of the New Zealand economy from 1984 to the early 1990s (allowing for a short lag period), only to narrow once again in response to both the economic recovery from the mid-to-late 1990s and the reform of the health system from the late 1990s onwards.

We further hypothesize that, if the structural reforms were causally related to the widening ethnic mortality inequality over the 1990s, then two patterns should be seen regarding the contribution of different causes to this inequality. First, the contribution of socio-economic mediation to the Maori—European mortality inequality should peak in the early to mid 1990s (when the economic inequality between the two ethnic groups peaked, allowing for a short lag period). Secondly, the contribution of different diseases to the ethnic mortality inequality should vary more over time for conditions that can respond quickly to changing economic conditions (such as cardiovascular diseases and suicide) than for conditions that are less rapidly responsive because of relatively long induction periods (such as cancer).

Materials and methods

New Zealand census-mortality study

Data

Mortality records were assembled for persons alive on the previous census night who died aged 1–74 years within 3 years of the 1981, 1986, 1991, 1996 or 2001 censuses, and were anonymously and probabilistically linked back to the prior census, so creating five national short-term cohort studies.[18,19] The percentages of eligible mortality records linked to a census record were 70.9, 73.7, 76.3, 77.6 and 79.6%, respectively. Over 96% of these linkages were estimated to be true positives.[19] Both to correct for any linkage bias and to avoid under-estimation of mortality rates using the linked datasets, inverse probability linkage weights were calculated for strata based on age, sex, ethnicity, region, cause of death and small area deprivation. For example, if 20 out of 30 deaths among moderately deprived Maori men living in the north of New Zealand were linked to a census record, each of the 20 linked records received a weight of 1.5 (i.e. 30/20). Infants were omitted from the mortality analysis because, given its closed cohort design, infant deaths are not well captured in the New Zealand census-mortality study (NZCMS). People ⩾75 years were omitted because their mortality data were not linked to census data until the 2001–04 cohort, so there is no time series for this age group.

Respondents self-identifying as Māori on the census form were so classified, irrespective of whether they also identified with another ethnic group(s). The comparison group was 'European/Other', comprising those census respondents who did not identify as any of Māori, Pacific or Asian (ethnic categories defined according to standard New Zealand protocols).[10]

Causes of death were classified using ICD-9 from 1981 to 1999 and ICD-10 thereafter. However, since only major condition groupings are used, this coding change should have little impact on trend analysis.

Analyses and measures of association

Age standardized rates, rate differences (SRDs) and rate ratios (SRRs) were calculated for both ethnic groups, using the WHO World Population as the standard, then compared over time looking for trends while being cognizant of 95% confidence intervals (CIs) and P-values for linear trend.

To examine the contribution of causes of death to mortality inequalities (aged 1–74 years), we decomposed the total SRD comparing Māori to European/

Box 1 Historical context of indigenous health inequalities in New Zealand 1840 to early 2000s

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The historical context is the European colonization of New Zealand, which began in the early years of the 19th century. Relations between the indigenous (Māori) population and the settler population (derived mainly from the British Isles) were formalized in the Treaty of Waitangi, signed in 1840. However, the Treaty was repeatedly breached by successive colonial governments, culminating in large-scale dispossession of Māori land.[1,2] By 1900 Māori were a socio-economically disadvantaged, mainly rural and relatively small ethnic minority.[3] The settler-dominated culture that evolved in New Zealand was, however, characterized by strongly egalitarian values, partly driven by a desire to avoid reproducing the rigidly hierarchical class structure of 19th century Britain.[3] Thus New Zealand gave rise to one of the earliest suffrage movements,[3] and social welfare programmes introduced from the 1890s evolved into one of the world's first modern welfare states.[3] Yet little recognition was accorded to the severe and ongoing impact of colonization on Māori until the early 1970s, when New Zealand began to confront the Treaty breaches of the past.[3] This coincided, however, with the economic shocks of the 1970s (in particular, the loss of preferential access to the British market for New Zealand's agricultural produce), and by the early 1980s New Zealand's terms of trade had deteriorated to the extent that economic restructuring and retrenchment of the welfare state was embraced by both major political parties, reflecting the neoliberal policies then prominent in both the UK and the USA.[4]

1980–1990s—Structural reforms
Under successive governments, New Zealand underwent major structural reform from 1984 to the early 1990s, including the introduction of a substantially flattened income tax schedule, a regressive consumption tax, narrowly targeted income support, market rentals for social housing, privatization of major utilities, user charges for many government services (including health care) and a deregulated labour market designed to increase wage and employment flexibility.[3–5] These reforms were accompanied by a sharp increase in social inequality, with the Gini coefficient (a measure of income inequality) increasing from one of the lowest in the OECD in the mid-1980s to one of the highest by the mid-1990s, unemployment rising from ~4 to ~10%, and poverty (income <60% of median net of housing costs) rising from 12 to 27% of households. Māori were much more severely impacted by the structural reforms than were the European majority, reflecting the occupational segregation of Māori into manufacturing, labouring and less skilled service industries—sectors which bore the brunt of the restructuring. Thus Māori unemployment rose from ~11% in 1986 to peak at 25% in 1992, while European unemployment increased from ~3 to 8%. Poverty among Māori households rose from ~14 to 41% over the same period, compared with an increase from 8 to 17% among European households.[6,7]

1990s onwards
By the mid-1990s, public concern about the growing social inequality and its impact on long-held egalitarian values was widespread. The government began to temper its neoliberal approach from the mid-1990s onwards, and this change was accelerated by the election of a centre-left government in 1999, with an explicit platform of 'closing the gaps' between Māori and European ethnic groups and between the privileged and disadvantaged in New Zealand society. This was rapidly followed by increased regulation of the labour and housing markets and increased social assistance. The economy also gradually recovered from the mid-1990s, with unemployment falling to ~10% for Māori and 3.5% for Europeans by 2004, while poverty rates fell to ~22 and 12%, respectively, over this period.[6]

Health reform (1999 onwards)
In the health sector, reducing inequalities between ethnic and socio-economic groups was recognized as a key goal by the late 1990s. The newly elected government implemented the New Zealand Public Health and Disability Act 2000, which explicitly instituted a population health approach and a requirement for the health sector to reduce health inequalities. Responsibility for the delivery of health services was devolved to 21 district health boards (DHBs), who were mandated to assess and meet the health needs of their geographically defined populations, including reducing inequalities within their local communities. At the same time, national strategies including the New Zealand Health Strategy (2000), He Korowai Oranga (Māori Health Strategy) (2001) and the Primary Health Care Strategy (2001) were formulated, all of which included strong commitments to reducing health inequalities. The new focus on health equity was further strengthened by the development by the Ministry of Health of a practical framework for reducing inequalities and a tool—the Health Equity Assessment Tool—for use by DHBs in service planning.[8]

  Acceptance of health equity as a priority within the health sector was assisted by the rapid development of a strong evidence base, often involving joint efforts of Ministry and university-based researchers. This included the development of a small area census based deprivation index (the NZDep) to measure socio-economic position in the absence of any data other than usual domicile;[9] ethnicity data protocols to set standards for accurate recording of ethnicity throughout the sector;[10] inclusion of a racial discrimination module in the New Zealand Health Survey, which has provided fresh insight into the contribution of interpersonal racism to ethnic inequalities in health;[11,12] and an ongoing record linkage study involving linkage of mortality to census records (the New Zealand Census-Mortality Study).[13]

Other ethnic groups into its contributions from each major cause of death.

  Poisson regression modelling was used to assess the contribution of socio-economic factors to ethnic mortality inequalities, for participants aged 25–59 years ('working age'). Socio-economic variables included labour market position, equivalized household income, educational qualifications, car access, housing tenure and (for the 1991–1994, 1996–1999 and 2001–2004 cohorts only) a small area census-based index of deprivation, NZDep.[9] The percentage reduction to the null in the excess rate ratio for

Māori compared with European/Other was interpreted as the contribution of each variable to mediation of ethnic inequalities. The analysis was restricted to the working age group because the labour market position variable, a composite index combining occupational class with employment status, could only be derived for this age group, and was hypothesized as a key mediating variable between structural reforms and differential ethnic mortality trends. (Parallel regression results for 60–74 year olds can be found elsewhere.)[13]

SAS was used for all analyses directly on NZCMS data. Further methodological details are available elsewhere.[13]

Life tables

Data

All-cause mortality data and population data from 1951 to 2006 by 5-year age group, sex, ethnicity and single calendar year were obtained from Statistics New Zealand. (Note that for life expectancy analyses we use Māori and non-Māori ethnic groups, as official statistics do not include a European/Other life expectancy series and Pacific and Asian populations are too small prior to the 1980s for separate time series.) Mortality rates for Māori for the period 1981–2004 were adjusted for undercounting (numerator–denominator bias resulting from Maori ethnicity sometimes not being recorded correctly on death certificates) using adjustors derived from the NZCMS.[20] Although the 2006 rates could not be adjusted, the adjustors have been close to 1.0 for all age by sex groups since 2001.[21] In the absence of linked census–mortality data prior to 1981, it is not possible to correct earlier Māori mortality rates. Thus, the life expectancy estimates for Māori in the 1950s to 1970s may be incorrect by up to 1–2 years, necessitating cautious interpretation.

Methods

Standard demographic methods[22] were used to construct abridged period lifetables with 90+ as the open ended upper age group for each censal year (1951–2006), using deaths and population counts for the 3 years centered on each censal year.

Results

Life expectancy at birth, 1951–2006

Life expectancy at birth (LEo) increased dramatically among both Māori males and females from the 1950s through to the late 1960s, then more slowly to the mid 1980s (Figure 1). The apparent decrease in 1971 may be an artefact resulting from changes to the way ethnicity was classified in the census of that year. From 1986 to 1996, Māori life expectancy plateaued, only to resume its former rapid rate of increase thereafter. In 2006, Māori LEo was estimated at 71.2 years

for males and 75.8 years for females. Among non-Māori, there has been a steady increase in LEo, except among males in the 1960s and early 1970s (coinciding with the peak of the coronary heart disease epidemic). In 2006, non-Māori LEo was estimated at 78.8 and 82.8 years for males and females, respectively.

The ethnic gap in LEo narrowed from an estimated 14.2 years for males and 16.5 years for females in 1951 to 6.6 and 7.1 years, respectively, in 1986, although the gap did not change much from 1976 to 1986 (Figure 2). From 1986 to 1996, however, the gap widened again to 9.7 and 9.8 years for males and females, respectively. From its 1996 peak, the gap then declined once again, to ~8.5 years for males and 8.1 years for females in 2001, and has since declined further to ~7.6 and 7.0 years, respectively, in 2006. Nevertheless, the gap remains large: Māori life expectancy in 2006 is similar to that achieved by non-Māori 30 years ago (1976) for females and 20 years ago (1986) for males.

Inequalities in all-cause mortality, 1981–2004

All-cause mortality (aged 1–74 years) declined from 1981–1984 to 2001–2004 by 42 and 35% for European/Other males and females, respectively, and by 25 and 22% for Māori males and females, respectively (Figure 3). Because of the much higher mortality rates for Māori at all timepoints, these trends resulted in marked increases in relative inequality from 1986–1989 (SRRs 1.81 and 2.27 for males and females, respectively) to 1996–99 (SRRs 2.43 and 2.78), after which relative inequality stabilized for both sexes (Figure 4). Absolute inequality changed less over time, possibly increasing slightly from 1986–1989 to 1996–1999. However, this was followed by a reduction in absolute inequality among males, from an SRD of 485 per 100 000 (95% CI: 449–520) in 1996–1999 to 403 (373–433) per 100 000 in 2001–04. Absolute inequality may also have declined among females from 1996–99 to 2001–04 (Figure 4).

By age group, the narrowing in male absolute inequality between 1996–99 and 2001–04 was seen clearly only in the 25–64-year age group (results shown elsewhere).[13] Among females, however, patterns were similar across all age groups within the 1–74 age range.

Inequalities in cause-specific mortality, 1981–2004

Over the observation period, Māori cardiovascular disease (CVD) mortality rates decreased by 40% for males and 45% for females, compared with decreases of 64 and 65% for European/Others, respectively (Figure 3, and Table Stat Annex 1 in Supplementary data available at *IJE* online). Among females, the absolute inequality (SRD) in CVD decreased monotonically (by about one-third), while relative inequality (SRR) increased by >50% (Table Stat Annex 2 in

Males

Females
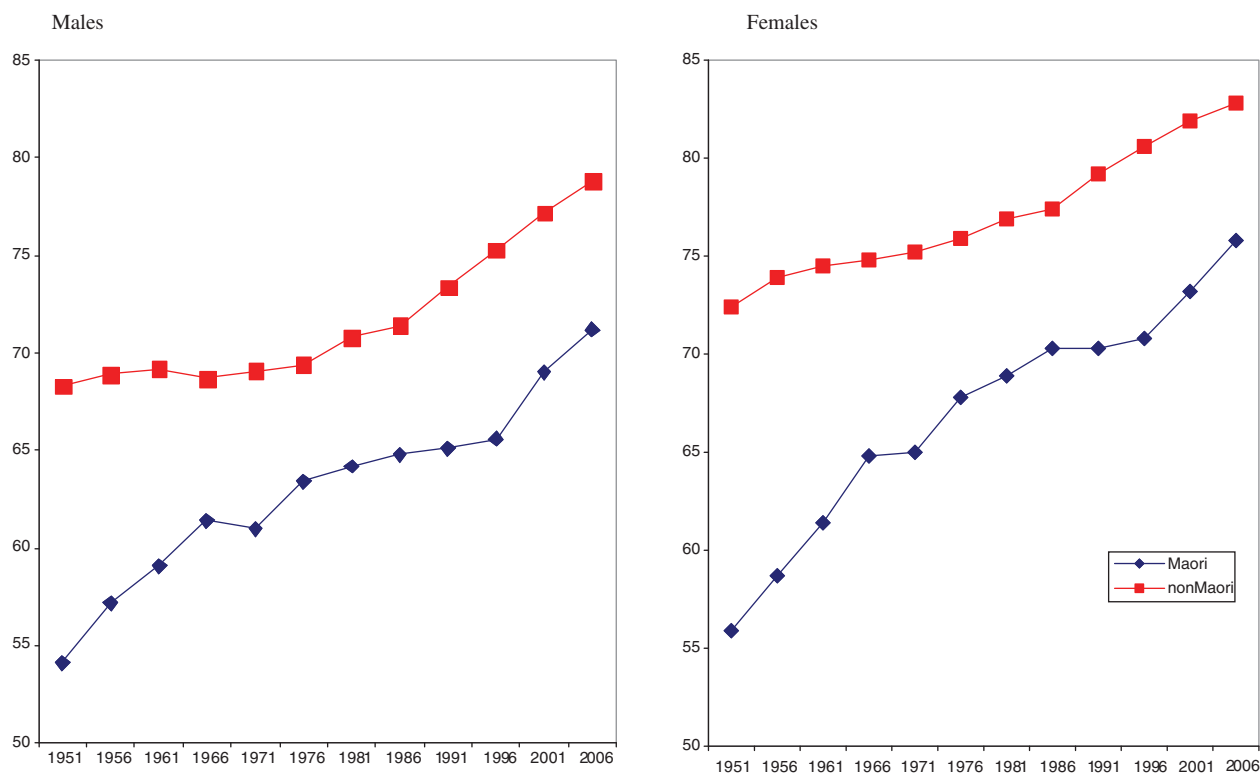
Figure 1 LEo by calendar year, by ethnicity and sex, 1951–2006 (years)
Note: (i) Ethnic mortality rates from 1981 to 2004 have been adjusted for numerator–denominator bias using the NZCMS adjustors. (ii) Māori mortality rates prior to 1981 could not be corrected for numerator–denominator bias, so the LEo estimates for those years may be biased by as much as 1–2 years. However, this will not affect the overall trend. (iii) Māori mortality rates after 2004 could also not be adjusted for numerator–denominator bias. However, the NZCMS adjustors have been close to 1.0 for all age groups since 2001, indicating little numerator–denominator bias in recent years
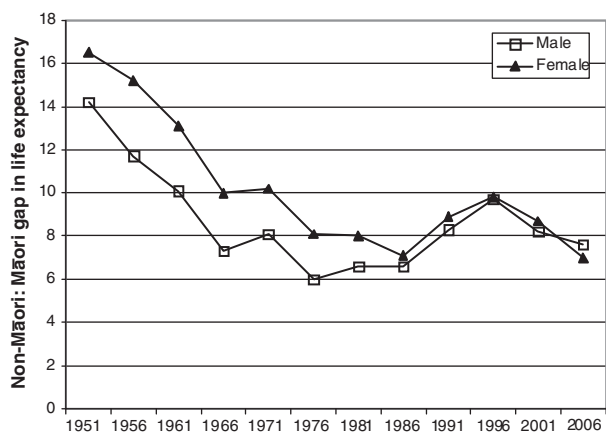

Figure 2 Non-Māori: Māori difference in life expectancy at birth, by sex, 1951–2006 (years). Refer to Figure 1 notes

Supplementary data available at *IJE* online). Among males, however, the trend in SRD was non-linear, first increasing significantly from 152 per 100 000 (95% CI: 120–183) in 1986–89 to 216 (186–245) per 100 000 in 1991–94 (a 42% increase), then declining again to 167 (149–184) per 100 000 in 2001–04. In contrast, the SRR increased monotonically from 1.77 in 1986–89 to 2.99 in 2001–04.

Lung cancer rates for European/Other males decreased throughout the 25 years, but only decreased from 1996–99 to 2001–04 for Māori males (Figure 3). As a consequence, relative and absolute inequalities in male lung cancer increased up to 1996–99, and then decreased to 2001–04 (Table Stat Annex 2 in Supplementary data available at *IJE* online). Female lung cancer and both male and female chronic lung disease mortality inequalities were large but stable over the observation period, whether measured on absolute or relative scales. In contrast, ethnic inequalities in non-lung cancer increased over time, both absolutely (SRD) and relatively (SRR), for both males and females (Figure 3, and Table Stat Annex 2 in Supplementary data available at *IJE* online).

Suicide rates were lower among Māori at the beginning of the observation period, but increased faster over time such that by 1996–99 Māori rates were at least 50% greater than European/Other rates for both males and females. Māori suicide rates then decreased rapidly to 2001–04, more so than the corresponding European/Other rates. Thus absolute and relative inequalities first rose then fell again, similar to the pattern for CVD (Figure 3, and Table Stat Annex 2 in Supplementary data available at *IJE* online).
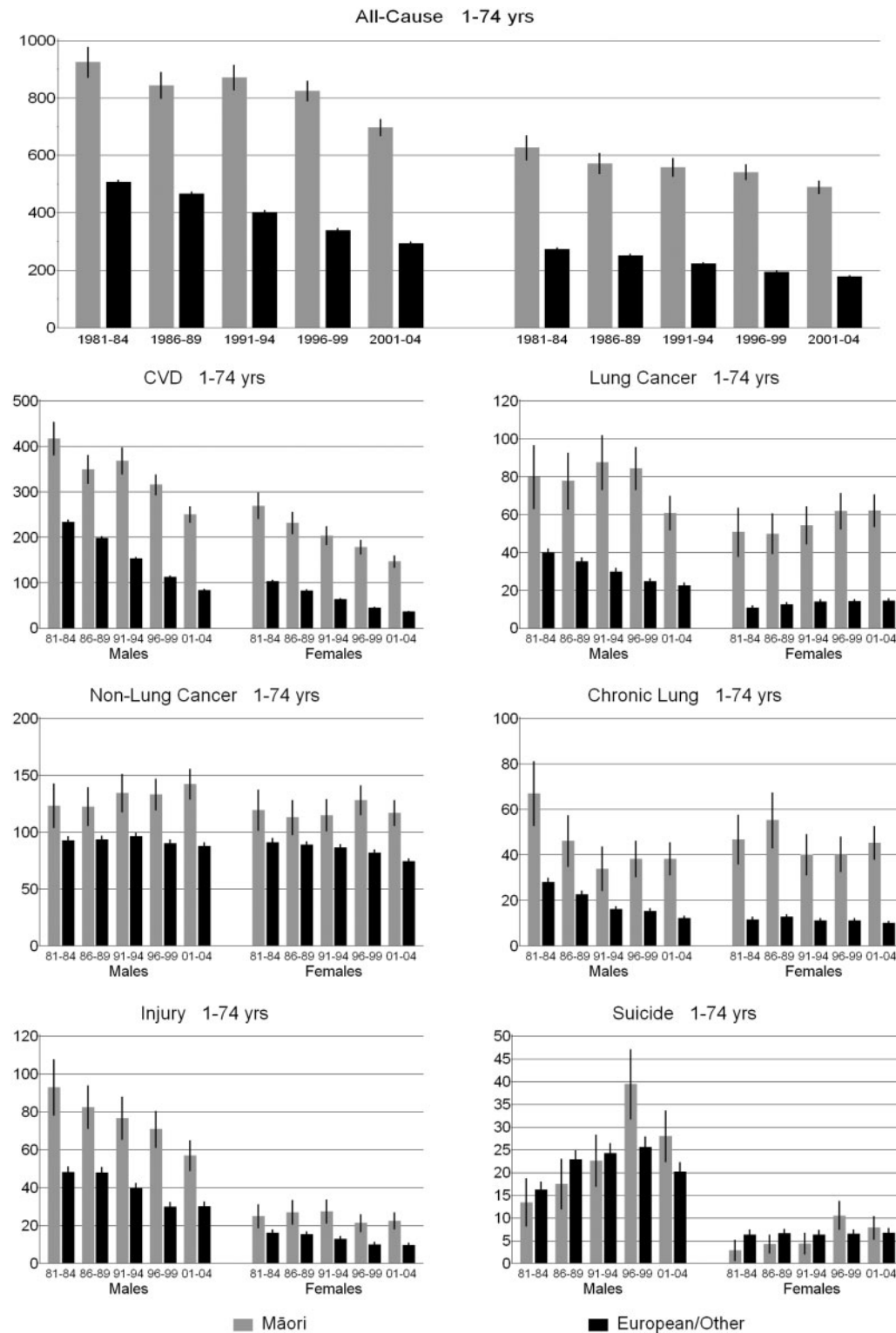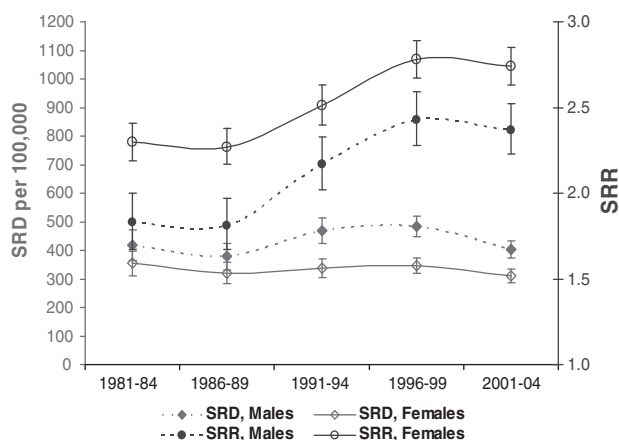
Figure 3 All-cause and cause-specific mortality rates per 100 000 for Māori and European/Other, aged 1–74, 1981–84 to 2001–04
Note: Error bars are 95% CIs. Rates and 95% CIs are shown in Table Stat Annex 1 in Supplementary data (available at *IJE* online)

Contribution of different causes of death to absolute mortality inequalities, 1981–84 to 2001–04

The absolute contribution of each major cause of death to the all-cause SRD (aged 1–74 years) at each timepoint is summarized in Figure 5. Percentage contributions of each cause of death to the total SRD (aged 1–74 years) are shown in Table 1. The key finding is that CVD made a decreasing contribution to inequality over time among females (declining as a percentage of the total SRD in the 1–74 year age group from 47% in 1981–84 to 36% in 2001–04), but an increasing followed by a decreasing percentage

contribution among males, with a peak at 1991–94. Cancer, both lung and non-lung, made an increasing contribution to the gap over time among females, and—for non-lung cancer only—possibly also among males. Suicide and unintentional injury made an increasing contribution until the 1990s, followed by a decreasing contribution—at least among males, and most notably in the 25–44-year age group.

The contribution of causes of death to absolute inequalities by age group varied in a predictable manner: unintentional injury and suicide made much greater percentage contributions among 25–44-years olds, especially among males; and contributions among 45–64- and 65–74-year olds largely reflected the overall pattern for 1–74 year olds combined (age-group results shown in detail elsewhere).[13]
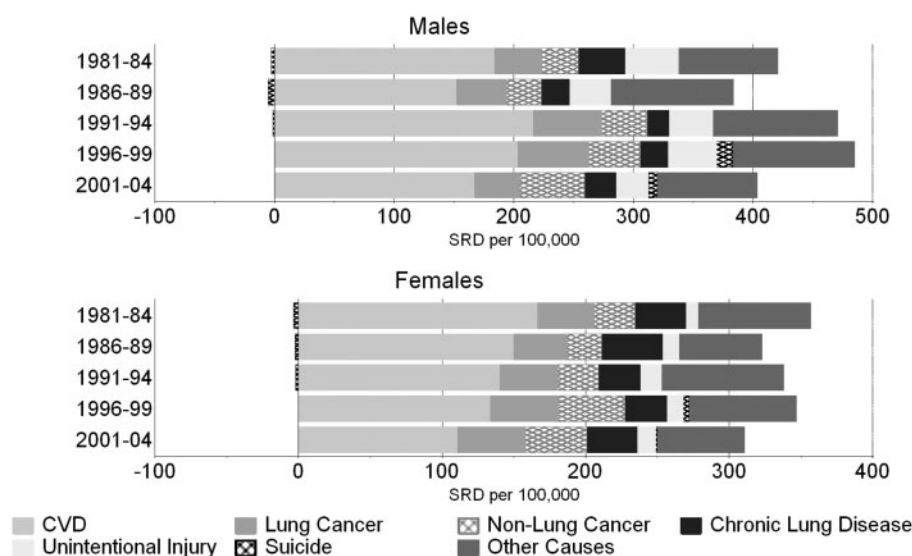
Socio-economic mediation of ethnic mortality inequalities, 1981–2004

Results of regression modelling for the working age group (25–59 years) are shown in Table 2. As socio-economic factors are sequentially added to the model, so the excess rate ratio (RR minus 1) for Māori compared with European/Other decreases. For those cohorts for which NZDep can be calculated, ultimately over half (males) or almost half (females) of the mortality inequality is 'explained' by socio-economic differences between the ethnic groups.

Comparing the contribution of socio-economic factors (other than NZDep, which cannot be measured for all five cohorts) with the male ethnic mortality inequality across cohorts, the percentage reductions were greater in the 1990s than in the 1980s (i.e. 45–49% reduction in the excess rate ratio in the 1990s versus 31–35% in the 1980s). Of particular note, the contribution of labour market position for males

Figure 4 SRRs and SRDs for Māori compared with European/Other, aged 1–74 years, by sex, 1981–84 to 2001–04
Note: Error bars are 95% CIs. Rate ratios, rate differences and 95% CIs are shown in Table Stat Annex 2 in Supplementary data (available at *IJE* online)

Figure 5 Contributions of causes of death to the Māori: European/Other SRD for 1–74-year olds, by sex and census cohort
Note: Percentage contributions of each cause of death are shown in Table 1

Table 1 Percentage contribution of each condition to the Māori: European/Other absolute gap in cause-specific mortality rates (SRD), aged 1–74 years, by sex, 1981–2004

Cause of death	Males					Females				
	1981–84	1986–89	1991–94	1996–99	2001–04	1981–84	1986–89	1991–94	1996–99	2001–04
CVD	44	40	46	42	41	47	47	42	38	36
All cancer	17	19	20	21	23	19	19	21	27	29
Lung cancer	10	11	12	12	9	11	12	12	14	15
Non-lung cancer	7	8	8	9	14	8	8	8	13	14
Chronic lung disease	9	6	4	5	6	10	13	9	8	11
Unintentional injury	11	9	8	8	7	2	4	4	3	4
Suicide	−1	−1	−0	3	2	−1	−1	−1	1	0
Other causes	20	27	22	21	21	22	18	25	22	20

was particularly prominent in the 1990s (13 and 11 percentage point reductions in the excess rate ratio), following lower but increasing contributions in the 1980s (4 and 8 percentage point reductions; Table 2). The pattern among females was not as clear, although the extent of socio-economic mediation was still greater in percentage terms in the 1990s than in the 1980s.

Discussion

Our results show a biphasic pattern of widening in indigenous inequalities in mortality (or life expectancy) in New Zealand from the mid 1980s to the mid 1990s, followed by narrowing once more to the early 2000s, whether measured on an absolute or relative scale.

A causal association between the observed widening in ethnic mortality inequality from (approximately) 1986 to 1996 and the neoliberal reforms of 1984–93 is plausible for at least three reasons. First, the economic restructuring and welfare reforms impacted more severely on Māori (as shown, for example, by the differential rise in unemployment rates between ethnic groups over this period, described in Box 1). Secondly, for working age males at least, we found greater socio-economic mediation of the ethnic mortality inequality in the 1990s than in the 1980s—as would be expected if the association was causal.

Thirdly, trends by cause of death also offer some support for a structural explanation. CVD and suicide are causes of death that can respond relatively quickly to changing social conditions (for CVD, this reflects variable risks of dysrythmia, thrombosis and embolism). We found an increasing contribution of CVD and suicide to the ethnic mortality inequality for males during the 1980s and early 1990s, followed by a decreasing contribution thereafter—consistent with a causal explanation. For females, a biphasic pattern was seen (albeit less clearly) for suicide only. The greater impact of social conditions on

mortality inequality among males than females may reflect differential exposure and response. In fact, trends in unemployment rates were similar by sex within ethnic groups.[14] However, it is not unreasonable to expect the response to job loss to be greater among males if they are more likely to be the main income earners. Indeed, the association of unemployment with mortality during 1981–2004 tends to be stronger for males in the NZCMS datasets.

In contrast, cancer did not show the biphasic pattern observed for CVD. Limited responsiveness to recent social trends is unsurprising for lung cancer mortality, which is largely driven by exposure to tobacco smoke over a period of decades. Nevertheless, an apparent biphasic response was in fact seen for lung cancer among males only; this may result from a cohort effect, reflecting the differential timing of the tobacco epidemic in different ethnic by sex groups. On the other hand, non-lung cancer might be expected to behave differently, given recent improvement in treatment for such cancers as breast and colorectal. However, the non-lung cancer contribution to the ethnic mortality inequality increased monotonically over the observation period and did not display a biphasic pattern.

Finally, as regards cause of death analysis, it has been hypothesized that the widening ethnic mortality gap in the 1980s could reflect differential timing of the coronary disease epidemics in the Maori and non-Maori populations. While coronary mortality did fall more slowly in the former group during the 1980s, peak mortality nevertheless occurred for both groups in the late 1960s or early 1970s.[30]

The recent narrowing in ethnic mortality inequality, reported here, has occurred in tandem with rapid economic recovery—including a marked reduction in many indicators of social inequality between the ethnic groups since the mid 1990s.[6] Narrowing ethnic mortality inequalities have also coincided with the reorientation of the health sector from the late 1990s (see Box 1). Evidence as to the effectiveness of health system reorientation in modifying ethnic inequalities in health would be of great value.

Table 2 Rate ratios for Māori versus European/Other, aged 25–59, by sex and period, from sequential Poisson regression models (95% CI)

Sex	Model	1981–84	1986–89	1991–94	1996–99	2001–04
Males	A: Adjusted for age and region	2.42 (2.18–2.68)	2.22 (2.02–2.43)	2.60 (2.39–2.83)	2.65 (2.44–2.88)	2.57 (2.35–2.81)
	B: Model A plus socio-economic factors[a]	2.04 (1.83–2.27)	1.90 (1.72–2.09)	2.03 (1.86–2.22)	2.09 (1.92–2.28)	2.00 (1.82–2.19)
	C: Model B plus labour market position[b]	1.97 (1.77–2.19)	1.80 (1.63–1.98)	1.81 (1.66–1.98)	1.91 (1.75–2.08)	1.88 (1.71–2.07)
	D: Model C plus NZDep[c]			1.67 (1.52–1.82)	1.78 (1.63–1.95)	1.81 (1.64–1.99)
	Percent reduction excess rate ratio A to B[d]	27	26	36	34	36
	Percent reduction excess rate ratio A to C[d]	31	35	49	45	44
	(Percent point change B to C)[d]	(4)	(8)	(13)	(11)	(8)
	Percent reduction excess rate ratio A to D[d]			58	53	48
Females	A: Adjusted for age and region	2.41 (2.13–2.73)	2.39 (2.13–2.68)	2.82 (2.56–3.11)	2.80 (2.55–3.09)	2.59 (2.33–2.88)
	B: Model A plus socio-economic factors[a]	2.06 (1.80–2.34)	1.99 (1.77–2.25)	2.26 (2.04–2.51)	2.28 (2.06–2.53)	2.02 (1.81–2.26)
	C: Model B plus labour market position[b]	2.04 (1.79–2.32)	1.99 (1.76–2.25)	2.19 (1.97–2.43)	2.23 (2.01–2.47)	2.00 (1.79–2.23)
	D: Model C plus NZDep[c]			2.01 (1.81–2.24)	2.03 (1.83–2.26)	1.83 (1.63–2.05)
	Percent reduction excess rate ratio A to B[d]	25	29	31	29	36
	Percent reduction excess rate ratio A to C[d]	26	29	35	32	37
	(Percent point change B to C)[d]	(1)**	(0)**	(4)	(3)	(1)
	Percent reduction excess rate ratio A to D[d]			44	43	48

[a]Equivalized household income, highest qualification, housing tenure, car access.
[b]Composite categorical variable combining occupational class with employment status.
[c]Small area census based deprivation index.
[d]Using the Hausman test (Greenland S. Invited commentary: variable selection versus shrinkage in the control of multiple confounders, 2008:523–29; Hausman J. Specification tests in econometrics. *Econometrica* 1978;**46**:1251–71) all changes in the β-coefficient for Māori: European/Other from model A to B, A to C, B to C and A to D, were statistically significant except for those indicated by[**].
Note: Analysis was restricted to respondents with complete data: 62–78% of Māori and 75–86% of European/Other males and females had complete data across the five census cohorts.

It is difficult, however, to demonstrate causality between broad and complex health policy changes and trends in health inequalities, especially over a relatively short time frame, particularly in view of sometimes patchy implementation of policies, variable lag times and limited data for such empirical analyses. Demonstrating causality is even more difficult when these health sectoral changes are superimposed on a background of rapid economic growth and narrowing social inequalities between the ethnic groups.

While there is little international evidence on the contribution of health systems *per se* to ethnic inequalities in health, rapid changes in ethnic health inequalities have been reported from other countries undergoing major structural change. Russian males living in Estonia experienced a marked fall in life expectancy in the 1990s while ethnic Estonians experienced a modest increase—in keeping with the shifting balance of political power and access to economic resources between the two ethnic groups.[23] In the USA, black–white differences in life expectancy widened by nearly 2 years from the mid 1980s to the mid 1990s, then fell again to 2003, although these trends were not analysed in relation to socio-economic trends.[24] Structural change in Eastern Europe has been associated with widening socio-economic inequalities in mortality,[25,26] although these trends have not been analysed by ethnicity.

In this article, we have examined the possible association of changing social inequalities between ethnic groups with changing mortality inequalities between these groups. It is in fact likely that trends in ethnic mortality inequalities will also be driven by trends in other factors such as access to and quality of health care, health-related behaviours such as diet and smoking, and cohort effects—all of which may be (at least in part) unrelated to socio-economic trends. Unsurprisingly, therefore, some of the observed ethnic mortality inequality trends by age and sex (both for all-cause and by-cause mortality) are not fully consistent with trends in social inequality, as is the case for example for lung cancer in males. Cohort effects may be at least a partial explanation in this case. We do not claim that trends in social inequality are the sole driver of trends in health inequality between ethnic groups, although we do argue that the observed trends in ethnic mortality inequality in New Zealand were *in part* causally related to differential trends in socio-economic conditions.

Beyond limitations in attributing causality, our study is also not without technical limitations. These include incomplete linkage of mortality to census records (although we used weights); changing census definitions of, and public response to, questions of ethnicity over time (although the population entering or exiting the Māori or European/Other group from one census to the next would need to be both proportionately large and have a very

different mortality rate to bias results substantively); and missing data, especially for income, across the five cohorts that might introduce some selection bias for our regression analyses on observations with complete data (although differing magnitudes of bias over time would be needed to distort the trend comparisons substantively). Our regression modelling of mediating variables assumes that the contribution of each factor is captured by the reduction in the rate ratio for Māori compared with non-Māori—an assumption that is prone to bias.[28,29] However, this bias would have to vary substantively over time to invalidate our interpretation. On the other hand, our study has major technical strengths, including its total population coverage, identical study design repeated at five points over time (i.e. for five sequential census cohorts), and the large number of socio-economic variables available from each census.

In summary, although it is difficult to demonstrate a causal relationship given the historical and observational nature of our study, the observed results are at least consistent with our hypothesis that widening ethnic health inequality was related to structural adjustment from 1984 to 1993 and that the subsequent turnaround in this inequality was in turn facilitated by changes in social policy and the reorientation of the health sector. The New Zealand experience thus supports the findings of the World Health Organization's Commission on the Social Determinants of Health—namely, that substantial progress on health equity requires a systematic policy response that improves daily living conditions of disadvantaged groups, tackles structural inequalities, and measures and monitors health inequalities.[27]

More specifically, our analysis of the New Zealand experience highlights three important lessons. First, the New Zealand experience suggests that the lag between changes in ethnic economic inequalities and ethnic health inequalities can be very short. Thus policies designed to improve daily living conditions and address the structural determinants of the health of indigenous populations (or ethnic minorities) by improving their relative economic position may yield health equity benefits within 5 years.

Secondly, the pattern seen in New Zealand of widening then narrowing ethnic health inequalities coinciding with neoliberal followed by pro-equity changes in social and health policies suggests that both changes in the distribution of social determinants and an appropriate health system response may be required to achieve timely gains in health equity. The New Zealand experience implies that action by the health sector alone is necessary but not sufficient to address health inequalities.

These findings have widespread significance as governments consider an appropriate response to the crisis currently affecting global credit markets. The New Zealand experience suggests that macroeconomic policy choices that mainly impact on

disadvantaged ethnic groups can potentially arrest health development for these groups for a decade or longer. Health protection at times of fiscal uncertainty and economic recession needs to include continued access to employment, social support and preservation of universal access to health services.

Thirdly, monitoring of ethnic inequalities in health, as presented herein, has been a prominent area of focus for Ministry of Health and university-based researchers in New Zealand for at least the last 10 years,[9,10,13] and most probably contributed to raising awareness of health inequalities and garnering political support for pro-equity policies. The New Zealand experience thus implies that demonstration of progress towards health equity through timely and robust monitoring and evaluation, and effective communication of such information to politicians and the public (through the media), can help to maintain health inequality on the political agenda and so contribute to the sustainability of pro-equity policies.

Supplementary Data

Supplementary data are available at *IJE* online.

KEY MESSAGES

- The lag between changes in social inequalities and changes in health inequalities between ethnic groups may be short (<5 years).

- Both changes in the distribution of the social determinants of health and an appropriate health system response may be required to address ethnic inequalities in health.

- Timely monitoring of ethnic health inequalities may help to sustain political commitment to pro-equity health and social policies.

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Commentary: Trends in indigenous inequalities in mortality in New Zealand

Sam Harper

Measuring and monitoring social differences in health is an important component of public health surveillance for at least two reasons. First, social group differences in health tell us something about the potential impacts of structural inequalities in society. Health is a crucial component of overall well-being, and differences in health between important social groups may indicate the degree to which major social institutions structure the resources and opportunities for healthy living.[1] Secondly, continued monitoring of social differences in health provides an opportunity to reconcile temporal trends in health inequalities with aetiological hypotheses regarding the causes of health differences.[2] Whether the social patterning of health reflects social differences in hazardous or protective exposures (including social conditions), health behaviours, proximal risk factors, medical care, or, more likely, some combination of such factors has important implications for designing interventions to address health inequalities.

Building on a strong foundation of previous research on health inequalities in New Zealand, in this issue Tobias and colleagues deliver a particularly good example of monitoring mortality inequalities between Māori and non-Māori populations.[3] They measure inequalities on both the absolute and relative

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