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Widening ethnic mortality disparities in New Zealand 1981–99

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Abstract

The aim of this paper is to determine the extent of undercounting of Mäori and Pacific deaths in New Zealand during the 1980s and 1990s, and to calculate corrected ethnic mortality and life expectancy trends. We calculated adjustment ratios for undercounting of Mäori and Pacific deaths (and over-counting of non-Mäori non-Pacific (nMnP) deaths) using the linked census-mortality data. These ratios were then used to calculate corrected mortality rates and life expectancies.

Mäori deaths were underestimated by a quarter, and Pacific deaths by a third, during the 1980s and early 1990s. Undercounting was minor in the late 1990s following alignment of ethnicity collection on mortality data to approximate the census. Corrected mortality rates demonstrated 30% (males) and 26% (females) decreases among nMnP from 1980–84 to 1996–99, smaller decreases among Mäori (8% and 7%) and no clear change among Pacific people (9% decrease for males, 4% increase for females). The gap in life expectancy increased from an average of 7.7 years in 1980–84 to 10.8 years in 1996–99 for Mäori, and from 3.3 to 7.7 years for Pacific people, in comparison to nMnP people. Deaths among 45–64 and 65 plus year olds, and cardiovascular disease and cancer deaths, were the main contributors to these disparities.

The economic reforms in New Zealand during the 1980s and early 1990s impacted harder upon Mäori and Pacific people in terms of unemployment and income, and are a likely explanation for the diverging mortality trends in this period. Both behavioural factors and health services probably also play a role, but in the absence of trend data by ethnicity, their contribution to diverging mortality trends is unknown. Internationally, our study demonstrates marked undercounting of Mäori and Pacific deaths. We strongly encourage researchers and custodians of vital statistics in other countries to investigate the possibility of undercounting of deaths by ethnicity.

Keywords: Mortality; New Zealand; Ethnic groups; Socio-economic factors; Health services; Risk factors; Numerator–denominator bias; Mäori

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Introduction

New Zealand life expectancy is mid-range for OECD or developed countries (78.9 years in 2002, sexes combined (World Health Organization, 2003)). This figure, however, fails to disclose marked social group differences in life expectancy. For example, males and females living in socio-economically deprived neighbourhoods during 1995–97 had life expectancy of 9 and 7 years less than males and females living in non-deprived neighbourhoods, respectively (Salmond & Crampton, 2000). Likewise, Mäori (the indigenous population of New Zealand; approximately 15% of the population in 2001) and Pacific people (people born in the Pacific Islands or their descendants; approximately 6% of population) have lower life expectancy than the majority non-Mäori non-Pacific (nMnP) group (Ministry of Health, 1999a). However, *trends* in life expectancy and mortality by ethnicity in New Zealand are not well documented and understood. This paper documents trends in life expectancy and mortality by ethnicity and summarises a body of work undertaken and disseminated within New Zealand (Ajwani, Blakely, Robson, Atkinson, & Kiro, 2004; Ajwani et al., 2003; Blakely, Ajwani, Robson, Tobias, & Bonne, 2004). Why is this work of interest to an international audience?

First, New Zealand is a unique 'case study' due to a mix of social, cultural and macroeconomic factors. In the 1950s and 1960s, New Zealand society fared well with one of the highest living standards and GDPs in the world. New Zealand's agricultural economy was strong, in large part due to a privileged position as supplier of butter, meat and wool to Britain, lasting until Britain entered the European Economic Community in 1973 (Belich, 2001). A strong and growing economy underpinned a strong welfare society with reasonably good access to health and other services. Mäori moved rapidly from a rural to urbanised population, responding to the need in major centres for workers in manufacturing and other industrial sectors. In 1946, 74% of Māori were rural dwellers but by 1976, 76% of Māori lived in urban areas having moved there for employment (Pool, 1991). In contrast, European settlers had become predominantly city dwellers by 1911 (King, 2003).

New Zealand society changed dramatically in the 1980s and 1990s, with 1984 often identified as the major turning point following a decade or so of falling terms of trade and double-digit inflation. In response, from 1984 to the early 1990s, New Zealand underwent major social and economic changes including a substantially 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' (Belich, 2001; Boston, Dalziel, & John, 1999; Cheyne, O'Brien, & Belgrave, 1997). Migration of Pacific people (e.g. Samoan, Cook Island) to New Zealand occurred predominantly in the 1950s to mid-1970s, driven initially by the employment opportunities (Cook, Didham, & Khawaja, 1999).The social and macroeconomic changes weighed particularly heavily on Mäori (and Pacific people), with inequalities between Mäori and non-Mäori widening in employment status, education, income and housing (Mowbray, 2001; Te Puni Kokiri, 2000). It has previously been speculated that this economic restructuring may have been a contributing reason to New Zealand's life expectancy falling behind that of its neighbour Australia from the 1970s onwards, and further that the health impacts of the structural reforms on mortality may have been differential by ethnicity (Brown, 1999; O'Donoghue, Howden-Chapman, & Woodward, 2000).

The second reason why this study is of international interest is a methodological one. It has been known for some years in New Zealand that mortality data underestimate the number of Mäori and Pacific deaths relative to that collected by the census (Graham, Jackson, Beaglehole, & de Boer, 1989; Pomare et al., 1995). The reason for this undercount is that, prior to September 1995, each decedent could be identified as either Mäori or Pacific based on 'degree of Mäori (or Pacific) blood' of the deceased's *parents*. Using this information, ethnicity was coded as just one of three options—Mäori, Pacific, nMnP—using a rule of 'Māori (or Pacific) blood greater than half, otherwise nMnP'. This information was often not collected by the undertaker, and missing data were coded as nMnP immediately introducing a systematic bias to undercount Mäori and Pacific deaths. After September 1995, mortality data used an approximation to the 1996 census ethnicity question—and it was compulsory.

The denominator Census data have from 1986 onwards used multiple self-identified ethnic groups (i.e. it was not based on biological origin). (The 1981 census used multiple self-identified ethnic *origin*, specified in fractions.) These different ethnicity collection systems gave rise to numerator–denominator bias when calculating ethnic mortality rates: the mortality data numerators are not consistent with the census data denominators. However, the magnitude of this bias, and how it varied over time, was unknown. This is the major reason why trends in mortality by ethnic group in New Zealand are poorly understood.

The advent of the New Zealand Census-Mortality Study (NZCMS) (Blakely, Salmond, & Woodward, 2000), with its linkage of census and mortality data, has enabled a direct comparison of ethnicity recording on census and mortality data during most of the 1980s and 1990s. This comparison allows the calculation of adjustment factors for numerator–denominator bias that can be applied to ethnic mortality rates. The

potential for such numerator–denominator bias has been recognised previously in the United States (Rosenberg et al., 1999; Sorlie, Rogot, & Johnson, 1992). In the US Black and White mortality rates were found to be reasonably accurate, but mortality rates for Native Americans and Hispanics during the 1980s were underestimated by 27% and 7%, respectively, due to underreporting of these groups on mortality data. The introduction of multiple race categories in the 2000 US census is likely to mean that significant numerator–denominator bias now also exists for Black mortality rates (Ingram et al., 2003). It is likely that numerator–denominator bias by ethnicity also exists in other countries (e.g. Australia for Aboriginal and Torres Strait Island people and Canada for First Nations people). Our New Zealand experience may stimulate similar scrutiny in these countries.

The objectives, therefore, of this paper are:

1. To determine the extent of undercounting of Mäori and Pacific peoples' deaths in New Zealand during the 1980s and 1990s.
2. To determine corrected ethnic mortality trends during the 1980s and 1990s by sex, age group and cause of death.
3. To determine corrected ethnic life expectancy trends during the 1980s and 1990s, and the contribution of age at death and cause of death to ethnic disparities.

Methods

Mortality data: 1980–1999

Mortality data were provided by the New Zealand Health Information Services (NZHIS) for the years 1980–1999 by year of registration of death. Years were grouped into four periods: 1980–84, 1985–89, 1990–95 and 1996–99. The third period is of 6 years duration and the fourth period of 4 years duration to reflect the change in the collection of ethnicity in mortality data from September 1995.

Census data

For each of the above four periods, 1981, 1986, 1991 and 1996 census data by strata of sex, age and ethnicity were used as denominator data in the calculation of mortality rates.

This paper uses both *sole* and *prioritised* concepts of ethnicity. In the 'prioritised' concept, ethnicity was assigned as Mäori if one of the up to three possible self-identified ethnicity responses on the 1986 or the 1991 or the 1996 census was Mäori. For those not allocated as Mäori, the prioritised ethnic group was assigned as Pacific if one of the self-identified ethnic groups was Pacific. The remaining records were assigned as nMnP. The 1981 census collected degree of ethnic origin. To form a prioritised series for the 1981 census, we assigned as Mäori those who recorded any degree of Mäori ethnic origin. Of the rest, those who recorded any degree of Pacific ethnic origin were categorised as Pacific. Using the 'sole' series, ethnicity was assigned as Mäori if only one ethnic group was self-identified and that was Maori (or in 1981, half or more Maori ethnic origin), and similarly for Pacific people.

Calculating adjustment ratios for numerator–denominator bias

We used linked census and mortality data from the NZCMS data to cross-classify census ethnicity counts by mortality data ethnicity counts for decedents aged 1–74 years in each 3-year period after the 1981, 1986, 1991 and 1996 censuses. The NZCMS only follows up for mortality among census respondents aged 0–74 years (i.e. the full New Zealand population aged 0–74 years) for deaths occurring in the 3 years after census night. Details of the record linkage can be found elsewhere (Blakely et al., 2000; Hill, Atkinson, & Blakely, 2002). Briefly, and of relevance to this paper, 71% (1981–84 cohort) to 78% (1996–99 cohort) of eligible mortality records were linked back to a census record, and at least 98% of these links were estimated to be true positives. To calculate adjustment ratios, however, we could only use those links that were highly likely to be correct and where matching on ethnicity played no part in the linkage. This restricted the number of linked census-mortality record pairs to 64%, 69%, 75% and 75% of eligible mortality records in the four census cohorts, respectively.

We calculated census to mortality ratios (adjusters) for Mäori, Pacific and nMnP using weighted versions of these restricted data sets. For example, an adjuster of 1.5 for, say, 45–64 year old Pacific males in 1991–94 means that the observed number of deaths for this group using mortality data has to be multiplied by 1.5 to give the 'true' (i.e. as given by census data) number of deaths. There was marked variation in these adjusters for Mäori by age with greater bias in younger age groups. Within age group, there was little heterogeneity of the ratios by sex or cause of death. Therefore, we used age-specific adjusters to recalculate mortality rates. These correction ratios could only be calculated for wide age ranges (1–14, 15–24, 25–44, 45–64, 65–74 years), so we additionally smoothed the ratios for each 5-year age category (see Table 2, pp. 62–63, in (Ajwani et al., 2003)). Sensitivity analyses (published elsewhere) suggest that the adjusters were not particularly sensitive to the necessary restrictions, weightings and other assumptions required in their calculation (Ajwani et al., 2002).

The NZCMS is not well suited for calculating adjustment ratios for infant deaths and deaths aged 75 years and older—although such estimates were required for our life expectancy calculations. Infant deaths have been linked back to birth certificates in New Zealand. Therefore, by comparing birth certificate ethnicity counts with (unlinked) census counts, we were able to estimate correction ratios for infant deaths. For older deaths (75 years plus) we estimated correction ratios on the basis of extrapolating the above smoothed ratios for 1–74 year olds to older age groups. As the adjustment ratios tended towards 1.0 for older people (among Mäori and nMnP at least), calculations of life expectancy by ethnicity are relatively insensitive to modest errors in our extrapolated adjustment ratios at older ages.

Calculating age-standardised mortality rates

The observed number of deaths in each sex by age by ethnicity (by cause of death) stratum (according to NZHIS data) was multiplied by the above adjustment ratios. These corrected mortality counts and the census (prioritised) population counts were then used to calculate direct age-standardised mortality rates (and 95% confidence intervals) using the WHO world population as the standard population (Ahmad et al., 2000). Note that periods used for calculating adjustment ratios (e.g. March 1981 to March 1984) were subsets of the total period for which mortality rates were calculated (e.g. January 1980 to December 1984).

Life expectancy analyses—1980–1999

Conventional demographic methods for abridged life tables were used to calculate life expectancy from central mortality rates adjusted for numerator–denominator bias as described above. To estimate the contribution of mortality at particular ages to the ethnic differences in life expectancy at birth (between Mäori and Pacific each compared to nMnP people), the Mäori and Pacific mortality rates for the age group of interest were replaced by the corresponding nMnP rates and the increase in life expectancy at birth was then calculated (i.e. age-substituted life expectancy). A similar substitution method was used to estimate the contribution of particular causes of death to the differences in life expectancy.

Results

Numerator–denominator bias

The previous convention and best practice for calculating ethnic mortality rates in New Zealand had been to use the following denominator data: 'half or more blood quantum' counts from the 1981 census, 'sole' ethnicity counts from the 1986 and 1991 censuses, and 'prioritised' ethnicity counts from the 1996 census. Regarding numerator data, there was no choice up to September 1995 (i.e. single options allowed only, and missing treated as nMnP), and prioritised counts have

Table 1
Adjustment ratios for numerator–denominator bias during the 1980s and 1990s

Period:		1981–1984	1986–1989	1991–1994	1996–1999
Census ethnicity definition:		Half or more	Sole	Sole	Prioritised
Mortality ethnicity definition:[a]		—	—	—	Prioritised
Mäori	0–14 yr	1.52	1.57	1.80	1.08
	15–24 yr	1.35	1.53	1.55	1.13
	25–44 yr	1.19	1.47	1.35	1.10
	45–64 yr	1.12	1.31	1.31	1.05
	65–74 yr	1.12	1.18	1.23	1.07
Pacific	0–14 yr	1.94	1.48	1.55	1.01
	15–24 yr	1.39	1.76	1.61	1.11
	25–44 yr	1.58	1.77	1.87	1.06
	45–64 yr	1.53	1.95	1.67	0.98
	65–74 yr	1.53	1.58	1.64	0.95
Non-Mäori non-Pacific	0–14 yr	0.89	0.90	0.84	0.95
	15–24 yr	0.94	0.92	0.91	0.93
	25–44 yr	0.96	0.92	0.91	0.96
	45–64 yr	0.98	0.96	0.94	0.99
	65–74 yr	0.99	0.99	0.98	0.99

[a]There was no option for mortality data up to the end of 1995, hence the dashes.

been used since 1996. Table 1 shows the numerator–denominator bias adjustment ratios that would directly apply to such conventionally calculated mortality rates. They were always substantially greater than 1.0 for Mäori and Pacific people during the first three periods, corresponding to substantial underestimation of Mäori and Pacific mortality rates at all ages. For example, assume that the 0–14 year old Mäori mortality rate in 1991 was previously calculated at 25 per 100,000. The adjustment ratio of 1.80 for 0–14 year olds in Table 1 means that the true mortality rate was 45 per 100,000. Examining the ratios for 1996–99 prioritised numerator and denominator, they are closer to 1.0 meaning that there was less numerator–denominator bias in conventionally calculated mortality rates by ethnicity from 1996 onwards.

Mortality rates

Age-specific mortality rates adjusted for numerator–denominator bias are presented in Table 2 using the prioritised definition of ethnicity. These mortality rates were calculated using 'prioritised' adjustment ratios for all four periods that have previously been published elsewhere (Ajwani et al., 2003). (Note that these ratios are equivalent to those presented in Table 1 of this paper for 1996–99 only (with further smoothing), but for earlier years are calculated using the prioritised definition of ethnicity from census data.) In each period and for each age group, Mäori have higher mortality rates than both Pacific people (apart from 1–14 year olds prior to 1996–99) and nMnP. Pacific people tended to be intermediate. Furthermore, across all age groups there was a pattern of only modest reductions in Mäori and Pacific mortality rates over time (except for 1–14 year old Pacific people) compared to improvement in nMnP mortality. Looking at all ages combined, nMnP mortality rates decreased by 30% (males) and 26% (females) from 1980–84 to 1996–99. However, Mäori mortality rates decreased only modestly (8% and 7%) and there was no clear trend among Pacific people (9% decrease for males, 4% increase for females).

Standardised mortality rates for selected causes of death across the 1–74 age range are presented in Table 3. All ethnic groups enjoyed reductions in cardiovascular (CVD) mortality; however, the percentage reductions were greater among the nMnP group. There were large disparities in respiratory mortality rates between ethnic groups, although all experienced a similar downward trend. Lung cancer mortality rates decreased by 40% for nMnP males, but increased markedly for Mäori and Pacific females. There was a pattern of stable (or even decreasing) colorectal cancer mortality over time for nMnP, an approximately 50% increase in Mäori rates, and an approximately 10-fold increase in Pacific rates. Although confidence intervals were wide for these latter Pacific colorectal mortality rates, the trend was similar for males and females. By the end of the 1990s, all three ethnic groups had similar colorectal cancer mortality rates. Unintentional injury mortality rates decreased among all three ethnic groups, although Mäori had approximately two-fold higher rates than nMnP for all periods. Suicide rates increased dramatically for all ethnic groups, but especially among Mäori.

Life expectancy

Whereas we only presented mortality rates above for the prioritised ethnic series, Table 4 also includes life expectancy estimates for the sole ethnic series. People self-identifying as sole Mäori have lower life expectancy than the larger prioritised Mäori group (the latter includes anyone self-identifying as Mäori plus at least one other ethnic group). This is true also for the sole compared to prioritised Pacific group. Consistent with the mortality rate trends, there was only a small improvement in Mäori and Pacific life expectancy at birth during the 1980s and 1990s—under 2 years in all sexes by ethnic groups. In contrast, there were improvements of 4.8 and 3.6 years among nMnP males and females, respectively (Table 4).

In terms of the gap in life expectancy between Mäori and nMnP, and averaging across sexes and sole/prioritised ethnic concepts, this parameter increased from an average of 7.7 years in 1980–84 to 10.8 years in 1996–99. The corresponding gap between Pacific and nMnP increased from 3.3 to 7.7 years.

Fig. 1 shows the contribution of each age group to the total gap in life expectancy at birth between Mäori and nMnP and between Pacific and nMnP (prioritised series). Two patterns are clear. First, middle-age mortality (45–64 year olds) was the major driver of the overall gap in life expectancy in the 1980s, but by the 1990s old age mortality (65 plus years) overtook it, at least for Mäori females and Pacific males and females. Second, the increasing gap in life expectancy between Mäori or Pacific and nMnP was made up of increases at all age groups.

Fig. 2 shows the contribution of each cause of death to gaps in life expectancy. Cardiovascular disease mortality was the major contributor to ethnic differences in life expectancy, and its contribution increased over time for all but Mäori females. Cancer mortality made an increasingly important contribution to ethnic differences in life expectancy. Lung cancer featured increasingly among Mäori males and females and Pacific males—but not Pacific females. But non-lung cancers grew in importance (as indicated by mortality rates in Table 3). Diabetes also made an increasing contribution over the study period. Furthermore, the impact of

Table 2
Age-standardised all-cause mortality rates (per 100,000; 95% confidence intervals in parentheses) by ethnicity (prioritised series) by age group and sex

Age group	Ethnic group	1980–84		1985–89		1990–95		1996–99		% Change 1980–84 to 1996–99
Males										
1–14 years	Mäori	49.0	(44.8–53.2)	48.9	(44.7–53.1)	41.8	(38.2–45.3)	43.7	(39.7–47.8)	−11
	Pacific	70.6	(60.2–81.0)	50.2	(42.0–58.3)	46.9	(40.5–53.3)	31.3	(25.2–37.4)	−56
	Non-M non-P	35.4	(33.6–37.2)	33.1	(31.3–34.9)	25.6	(24.1–27.1)	20.6	(19.0–22.2)	−42
15–24 years	Mäori	148	(138–157)	159	(150–169)	154	(145–163)	142	(132–152)	−4
	Pacific	125	(105–144)	148	(130–166)	95.5	(83.9–107)	112	(96.4–127)	−10
	Non-M non-P	103	(99.5–106)	106	(102–109)	95.5	(92.4–98.7)	72	(68.9–75.9)	−30
25–44 years	Mäori	284	(270–298)	277	(264–290)	262	(252–273)	253	(242–264)	−11
	Pacific	199	(177–220)	212	(193–231)	180	(166–193)	213	(196–230)	7
	Non-M non-P	129	(126–132)	123	(120–126)	113	(111–116)	95	(92.3–97.6)	−26
45–64 years	Mäori	1750	(1697–1803)	1734	(1685–1783)	1723	(1682–1764)	1569	(1527–1612)	−10
	Pacific	1310	(1204–1415)	1325	(1241–1408)	1071	(1015–1127)	1173	(1109–1237)	−10
	Non-M non-P	787	(779–796)	707	(699–715)	606	(599–612)	502	(495–510)	−36
65–74 years	Mäori	5672	(5452–5891)	5318	(5111–5525)	5469	(5291–5647)	5296	(5118–5473)	−7
	Pacific	4567	(4078–5057)	5075	(4653–5496)	4185	(3922–4448)	4421	(4148–4695)	−3
	Non-M non-P	3205	(3175–3235)	2949	(2921–2977)	2592	(2569–2615)	2122	(2098–2147)	−34
All ages[a]	Mäori	1361	(1323–1399)	1265	(1232–1298)	1296	(1266–1326)	1258	(1227–1289)	−8
	Pacific	1264	(1143–1384)	1155	(1083–1227)	1122	(1065–1178)	1144	(1092–1196)	−9
	Non-M non-P	919	(912–925)	850	(844–855)	745	(740–749)	641	(636–646)	−30

Females										
1–14 years	Mäori	55.4	(49.1–61.6)	61.8	(55.1–68.5)	50.5	(45.1–55.9)	50.6	(44.5–56.6)	−9
	Pacific	66.7	(52.7–80.7)	55.2	(43.3–67.1)	56.7	(46.9–66.5)	32.8	(24.2–41.5)	−51
	Non-M non-P	41.9	(39.1–44.7)	37.7	(35.0–40.4)	29.7	(27.5–31.9)	22.8	(20.4–25.1)	−46
15–24 years	Mäori	202	(187–218)	227	(211–243)	238	(222–253)	200	(183–217)	−1
	Pacific	169	(137–201)	209	(178–239)	135	(115–155)	166	(139–192)	−2
	Non-M non-P	145	(140–151)	156	(150–162)	139	(134–144)	102	(96.1–108)	−30
25–44 years	Mäori	340	(318–361)	356	(335–377)	328	(311–344)	337	(319–355)	−1
	Pacific	254	(220–288)	271	(241–301)	236	(213–258)	246	(219–272)	−3
	Non-M non-P	163	(158–168)	158	(153–162)	149	(145–153)	127	(123–132)	−22
45–64 years	Mäori	2070	(1988–2152)	2012	(1936–2087)	1960	(1897–2023)	1875	(1809–1941)	−9
	Pacific	1631	(1462–1799)	1644	(1512–1776)	1318	(1229–1408)	1464	(1362–1566)	−10
	Non-M non-P	1012	(998–1026)	891	(878–903)	737	(726–748)	607	(596–619)	−40
65–74 years	Mäori	6553	(6216–6890)	6282	(5951–6614)	6543	(6255–6830)	6146	(5865–6428)	−6
	Pacific	6291	(5431–7152)	6788	(6066–7510)	5595	(5135–6056)	5994	(5510–6478)	−5
	Non-M non-P	4266	(4214–4317)	3940	(3892–3988)	3448	(3408–3487)	2757	(2716–2798)	−35
All ages[a]	Mäori	965	(935–995)	886	(860–911)	927	(905–950)	894	(871–917)	−7
	Pacific	672	(613–731)	738	(690–786)	658	(624–691)	696	(662–729)	4
	Non-M non-P	553	(549–557)	525	(521–528)	461	(458–464)	407	(404–410)	−26

All rates are adjusted for numerator–denominator bias.

[a]All ages includes less than 1 year old deaths, and deaths greater than 74 years, using adjustment ratios extrapolated beyond the 1–74 year age range.

Table 3
Age-standardised mortality rates for selected causes of death among 1–74 year olds (per 100,000; 95% confidence intervals in parentheses)

Age group	Ethnic group	1980–84		1985–89		1990–95		1996–99		% Change 1980–84 to 1996–99
Males										
CVD	Mäori	411.9	(394.1–429.7)	381.6	(365.0–398.2)	380.1	(366.0–394.1)	343.8	(329.9–357.8)	−17
	Pacific	322.3	(283.5–361.1)	334.0	(302.3–365.6)	286.9	(265.7–308.0)	284.4	(262.2–306.6)	−12
	Non-M non-P	240.0	(237.0–243.0)	203.3	(200.6–205.9)	158.4	(156.3–160.5)	113.2	(111.1–115.3)	−53
Respiratory	Mäori	89.7	(81.4–97.9)	78.3	(70.6–85.9)	61.4	(55.6–67.3)	52.4	(46.7–58.1)	−42
	Pacific	93.2	(70.8–116)	110.5	(91.4–130)	46.9	(37.7–56.1)	59.1	(48.4–69.7)	−37
	Non-M non-P	40.4	(39.2–41.6)	34.9	(33.8–35.9)	23.9	(23.1–24.7)	20.0	(19.1–20.8)	−50
Lung cancer	Mäori	84.2	(76.0–92.3)	76.3	(68.6–83.9)	86.6	(79.6–93.6)	85.8	(78.7–92.9)	2
	Pacific	54.8	(38.0–71.5)	55.5	(42.5–68.5)	58.6	(48.6–68.6)	64.0	(53.1–74.8)	17
	Non-M non-P	40.6	(39.4–41.9)	36.4	(35.3–37.6)	31.7	(30.7–32.6)	24.5	(23.6–25.5)	−40
Colorectal cancer	Mäori	12.9	(9.8–16.1)	13.7	(10.6–16.8)	14.2	(11.4–16.9)	18.9	(15.5–22.2)	47
	Pacific	1.7	(0.5–3.8)	11.1	(4.9–17.2)	8.1	(4.6–11.5)	17.9	(12.3–23.5)	953
	Non-M non-P	21.4	(20.5–22.3)	21.0	(20.1–21.8)	21.7	(20.9–22.5)	19.6	(18.7–20.5)	−8
Prostate cancer	Mäori	11.5	(8.3–14.7)	13.9	(10.5–17.4)	15.5	(12.4–18.7)	16.1	(12.8–19.3)	40
	Pacific	18.0	(7.4–28.6)	20.8	(11.7–29.8)	13.5	(8.2–18.7)	11.2	(6.5–15.9)	−38
	Non-M non-P	8.8	(8.2–9.3)	8.9	(8.4–9.5)	9.7	(9.2–10.2)	8.6	(8.0–9.1)	−2
Unintentional injury	Mäori	91.6	(85.2–98.0)	89.1	(83.3–94.9)	78.4	(73.7–83.0)	68.6	(63.8–73.4)	−25
	Pacific	69.8	(58.1–81.6)	57.0	(47.4–66.5)	43.0	(37.2–48.9)	39.3	(33.0–45.5)	−44
	Non-M non-P	49.4	(48.0–50.9)	48.8	(47.4–50.2)	39.8	(38.6–41.0)	29.6	(28.4–30.8)	−40
Suicide	Mäori	11.0	(8.8–13.3)	17.2	(14.9–19.6)	22.5	(20.3–24.8)	33.9	(30.7–37.1)	208
	Pacific	10.5	(6.3–14.8)	15.3	(11.3–19.3)	18.9	(15.0–22.7)	17.2	(13.4–21.1)	64
	Non-M non-P	16.1	(15.3–16.9)	19.2	(18.3–20.1)	21.8	(21.0–22.7)	21.6	(20.6–22.6)	34

Females									
CVD	Mäori	282.0	(267.4–296.6)	257.7	(244.6–270.9)	237.0	(226.4–247.6)	191.9	(181.8–201.9)	−32
	Pacific	188.9	(160.9–216.8)	192.6	(169.2–216.1)	152.0	(137.6–166.5)	143.5	(129.1–157.9)	−24
	Non-M non-P	108.9	(107.0–110.8)	87.0	(85.4–88.6)	68.3	(67.0–69.6)	45.7	(44.5–47.0)	−58
Respiratory	Mäori	73.4	(66.2–80.6)	69.7	(63.0–76.4)	63.0	(57.5–68.5)	56.6	(51.1–62.1)	−23
	Pacific	47.4	(33.8–61.0)	51.5	(39.7–63.2)	25.0	(19.4–30.6)	20.8	(15.4–26.1)	−56
	Non-M non-P	19.8	(19.0–20.6)	20.7	(19.9–21.5)	15.6	(14.9–16.2)	13.8	(13.1–14.5)	−30
Lung cancer	Mäori	48.7	(42.6–54.8)	54.5	(48.4–60.5)	59.6	(54.4–64.9)	68.7	(62.7–74.7)	41
	Pacific	5.0	(1.3–8.7)	18.2	(11.2–25.2)	14.3	(9.9–18.8)	20.3	(14.8–25.8)	306
	Non-M non-P	11.6	(10.9–12.2)	13.6	(12.9–14.3)	15.1	(14.5–15.8)	14.0	(13.2–14.7)	21
Colorectal cancer	Mäori	7.1	(4.8–9.3)	9.2	(6.7–11.6)	9.8	(7.7–11.9)	11.2	(8.8–13.6)	58
	Pacific	1.1	(0.3–2.6)	3.8	(0.6–6.9)	5.7	(3.0–8.4)	10.3	(6.5–14.0)	836
	Non-M non-P	17.5	(16.7–18.3)	17.1	(16.3–17.8)	15.8	(15.1–16.4)	14.1	(13.4–14.8)	−19
Breast cancer	Mäori	31.0	(26.6–35.5)	30.6	(26.5–34.8)	29.7	(26.1–33.3)	35.7	(31.7–39.7)	15
	Pacific	14.6	(8.6–20.7)	36.2	(27.8–44.6)	26.5	(21.2–31.8)	42.8	(35.4–50.2)	193
	Non-M non-P	24.4	(23.4–25.3)	24.8	(23.9–25.8)	23.8	(22.9–24.6)	21.3	(20.3–22.2)	−13
Unintentional injury	Mäori	28.3	(24.8–31.7)	32.7	(29.2–36.3)	28.9	(26.0–31.9)	22.4	(19.8–24.9)	−21
	Pacific	12.5	(7.2–17.7)	17.3	(12.8–21.8)	12.7	(9.7–15.7)	11.4	(8.1–14.7)	−9
	Non-M non-P	18.0	(17.1–18.9)	16.8	(16.0–17.6)	13.7	(13.0–14.4)	10.3	(9.6–11.1)	−43
Suicide	Mäori	3.4	(2.3–4.5)	3.3	(2.5–4.2)	5.4	(4.3–6.4)	9.9	(8.3–11.6)	191
	Pacific	4.6	(1.3–7.9)	3.1	(1.3–4.9)	2.9	(1.4–4.4)	5.0	(3.0–7.0)	9
	Non-M non-P	6.0	(5.5–6.6)	5.7	(5.2–6.1)	5.5	(5.1–5.9)	6.1	(5.6–6.7)	2

All rates are adjusted for numerator–denominator bias.

Table 4
Life expectancy (LE) at birth by ethnicity and sex adjusted for numerator–denominator bias, 1980–1999

Ethnic group		Life expectancy by period				Change in LE from 1980–84 to 1996–99	Gap in LE compared to non-Mäori non-Pacific	
		1980–84	1985–89	1990–95	1996–99		1980–84	1996–99
Males								
Mäori	Prioritised	64.6	64.9	65.2	66.3	1.7	6.3	9.4
Mäori	Sole	63.3	64.1	64.3	64.0	0.7	7.6	11.7
Pacific	Prioritised	66.7	66.9	68.6	67.9	1.2	4.2	7.8
Pacific	Sole	67.4	66.9	68.2	67.7	0.3	3.5	8.0
Non-Mäori non-Pacific		70.9	71.9	73.7	75.7	4.8	—	—
Females								
Mäori	Prioritised	69.4	70.5	70.2	71.0	1.6	7.8	9.8
Mäori	Sole	68.0	69.6	69.2	68.7	0.7	9.2	12.1
Pacific	Prioritised	74.2	73.2	75.0	74.2	0.0	3.0	6.6
Pacific	Sole	74.8	72.9	74.6	73.9	−0.9	2.4	6.9
Non-Mäori non-Pacific		77.2	77.9	79.4	80.8	3.6	—	—

The estimates for Maori male life expectancy for 1996–99 are slightly higher than those published previously (0.5 years for prioritised and 0.4 years for sole series) (Ajwani, Blakely, Robson, Bonne, & Tobias, 2003), reflecting technical adjustments to the model (further information available on request from the authors).

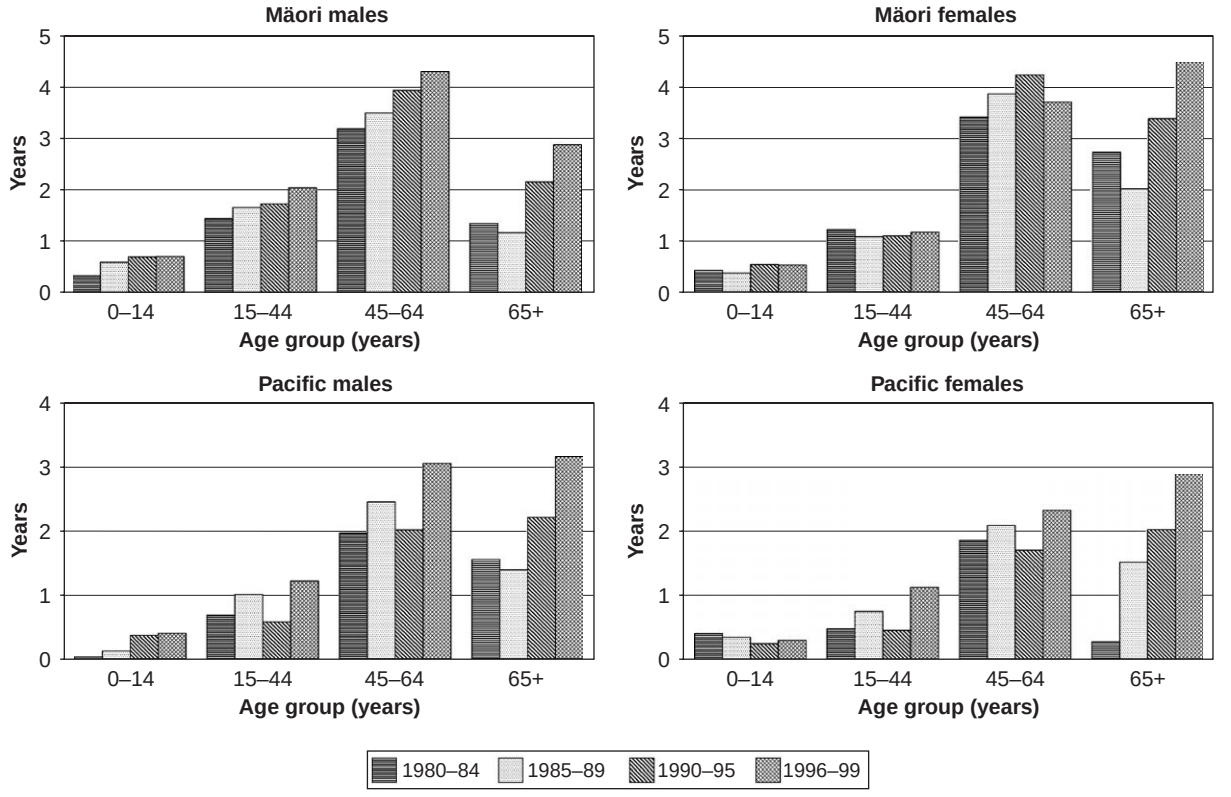

Fig. 1. Life expectancy (at birth, prioritised series) increases for Mäori and Pacific people, by sex, following substitution of nMnP mortality rates for selected age groups.

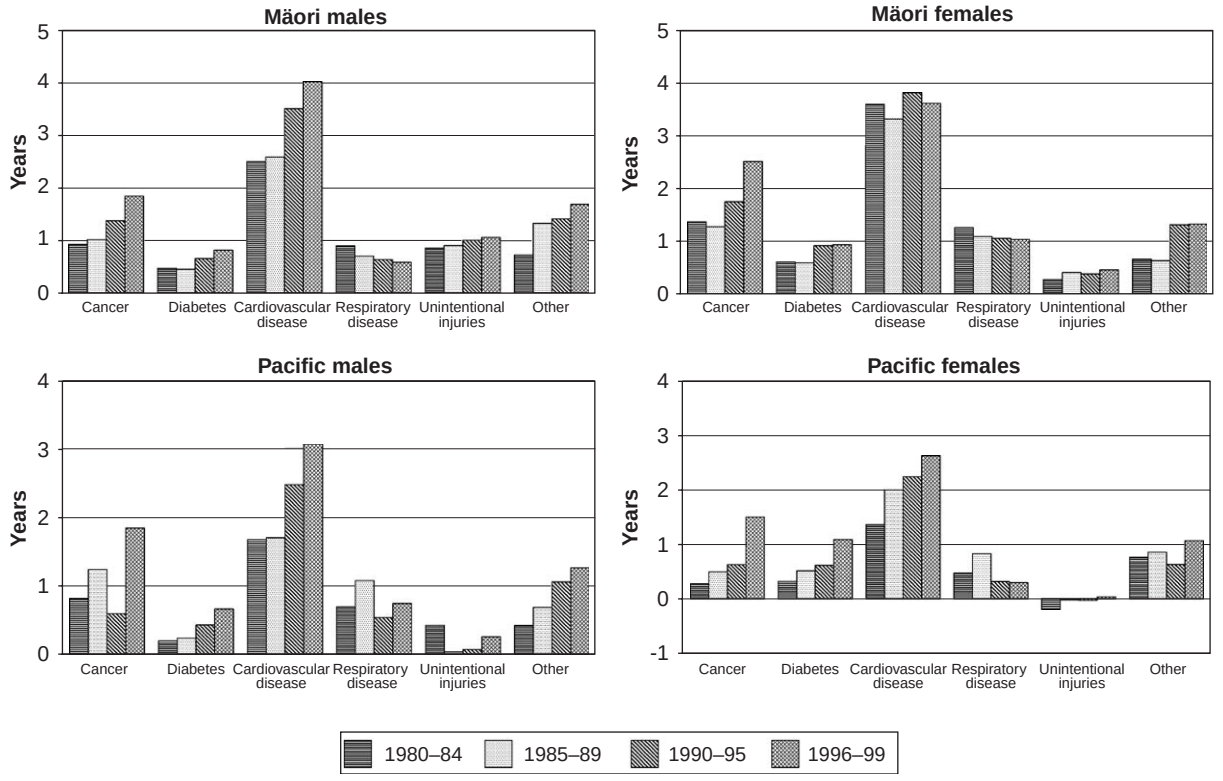

Fig. 2. Life expectancy (at birth) increases for Mäori and Pacific people, by sex, following substitution of nMnP mortality rates for selected causes of death.

diabetes is likely to be underestimated due to coding problems, and will be included within the cardiovascular disease contribution. Both respiratory disease and unintentional injury mortality make notable contributions, but they are relatively static over time as the mortality rates for these two causes of death decreased in parallel across ethnic groups. Finally, the contribution of 'other' diseases has increased over time. (Other includes all causes of death that are not cardiovascular, cancer (malignant), unintentional injury, suicide, respiratory (largely chronic obstructive respirator disease and asthma) or diabetic deaths.) Finer dissection of these other causes of death failed to identify any notable contributors—rather the contribution was spread across many causes of death.

Discussion

There are two major foci of this paper: adjustment for numerator–denominator bias, and the substantive issue of varying trends in mortality rates and life expectancy by ethnic group in New Zealand.

Numerator–denominator bias

Our study has shown that underestimation of Mäori and Pacific mortality rates during the 1980s and early 1990s due to numerator–denominator bias was severe—even with what was thought to be best practice at the time of using the smallest possible census/denominator counts for Mäori and Pacific people to minimise such bias (Pomare et al., 1995). The bias we observed was largest among young Mäori, and affected all age groups for Pacific people (Table 1). Of particular note, the bias was greatly reduced by the use of a close approximation to the census ethnicity question on death certificates from September 1995 onwards.

Within New Zealand, the finding of less numerator–-denominator bias post-1995 is important as it demonstrates the worth of collecting ethnicity data on health data sets using the census question (or as close an approximation to it as feasible). Internationally, the large numerator–denominator bias found in New Zealand should serve as a warning to statistical agencies in other countries to carefully scrutinise their ethnicity data collection methods for the possibility of numerator–denominator bias. For example, statistical agencies

should ensure that the definitions and collection methods used by census and mortality data are as similar as possible, and as complete as possible. The impact of coding rules for missing ethnic data should be determined—are they likely to result in a systematic bias? Ultimately, a direct comparison of ethnicity coding for the same individuals on both mortality and census data is desirable—as demonstrated in this paper. Such a record linkage exercise does require resource, and may be impeded if insufficient matching variables are available on both data sets. There are also privacy and security issues to be worked through. In the absence of linked census-mortality data, cohort studies that use the census question for ethnicity, and that are subsequently followed up for mortality using routine vitals data can be utilised. An example is the National Longitudinal Mortality Study in the US that has been used to quantify numerator–denominator bias in that country (Rosenberg et al., 1999; Sorlie et al., 1992).

Diverging trends in mortality and life expectancy by ethnicity during the 1980s and 1990s

Adjustment of the New Zealand ethnic mortality series for numerator–denominator bias has revealed clear and concerning trends that were hitherto unrecognised. Most notably, *there has been only a small decrease in Māori and Pacific mortality rates over the 1980s and 1990s despite a steady and substantial decrease in nMnP mortality*. As a consequence of this divergent pattern by ethnicity in mortality trends, the gaps between Māori and Pacific and nMnP life expectancy have increased.

Decreasing mortality rates for cardiovascular disease, respiratory disease and unintentional injury among Māori and Pacific people during the 1980s and 1990s have been off-set by increasing cancer (both lung cancer and non-tobacco-related cancers) and suicide mortality rates (Table 3). Further, even for those diseases with decreasing rates over time among all ethnic groups (e.g. ischaemic heart disease), the relative (and often absolute) inequalities between ethnic groups have tended to increase over time.

We have not specifically tried to tease apart age, period and cohort effects. However, it appears unlikely that cohort effects explain the diverging mortality trends. An examination of Table 2 clearly demonstrates substantial decreases in mortality rates for all age groups among nMnP, and (with the exception of 1–14 year olds) much smaller decreases for all age groups among Māori and Pacific people. Therefore, it appears that a 'period effect' is largely responsible for diverging mortality trends. (That said, as the aetiology of cancer and cardiovascular disease takes decades, and assuming that diverging mortality trends are due to more than just changes in survival for these diseases, varying risk factor profiles before the 1980s must also contribute to varying mortality trends by ethnicity in the 1980s and 1990s.)

Putting New Zealand's ethnic life expectancy trends in context: looking back to the 1950s, and forward to the new millennium

Fig. 3 shows trends in Māori and non-Māori life expectancy, by assembling: (a) official Statistics New Zealand (SNZ) life expectancy series for Māori and non-Māori from 1951; (b) estimates of Māori life-expectancy adjusted for numerator–denominator bias during the 1980s and 1990s from this paper; and (c) official SNZ life expectancy series for Māori and non-Māori that used NZCMS adjusters for the late 1990s (Statistics New Zealand, 2004). (Additional comments on these series are in footnotes to Fig. 3. The Pacific population was too small for such an extended series.) It is important to note that whilst each life expectancy estimate for the Māori series from 1951 to 1976 is prone to numerator–denominator bias, the *trend* of large improvements in life expectancy during this period could not possibly be an artifact of this bias. Also, adjusting the non-Māori series during the 1980s and 1990s for numerator–denominator bias has little impact, as they are a much larger population group. Therefore, we have just presented the SNZ non-Māori series (1951–1996) to avoid extra clutter in the figure.

There is a clear pattern in Fig. 3 of converging life expectancy for Māori and non-Māori during the 1950s to 1970s followed by divergence during the 1980s and 1990s as nMnP life expectancy improved more rapidly than Māori life expectancy. Examining the revised SNZ series (1996 and 2001, each using 3 years of mortality data straddling the respective census), Māori life expectancy increased by 2.4 and 1.9 years for males and females, respectively, and non-Māori life expectancy increased by 1.8 and 1.3 years. Allowing for some imprecision in the estimates, and recognising that the series is only for two periods, we can nevertheless conclude that the diverging trends of the 1980s and early 1990s may have ceased.

Explanations for the diverging ethnic mortality trends in New Zealand during the 1980s and 1990s

Considering only Māori and non-Māori estimates for which there are long time trend data, it is clear that life expectancy trends were converging during the 1950s, '60s and early '70s, only to diverge during the 1980s and 1990s (Fig. 3). There are many possible explanations for this pattern of which we will discuss four: structural, risk factors, health services and discrimination. These explanations are not mutually exclusive, rather, they are layered and highly likely to interact with each other.

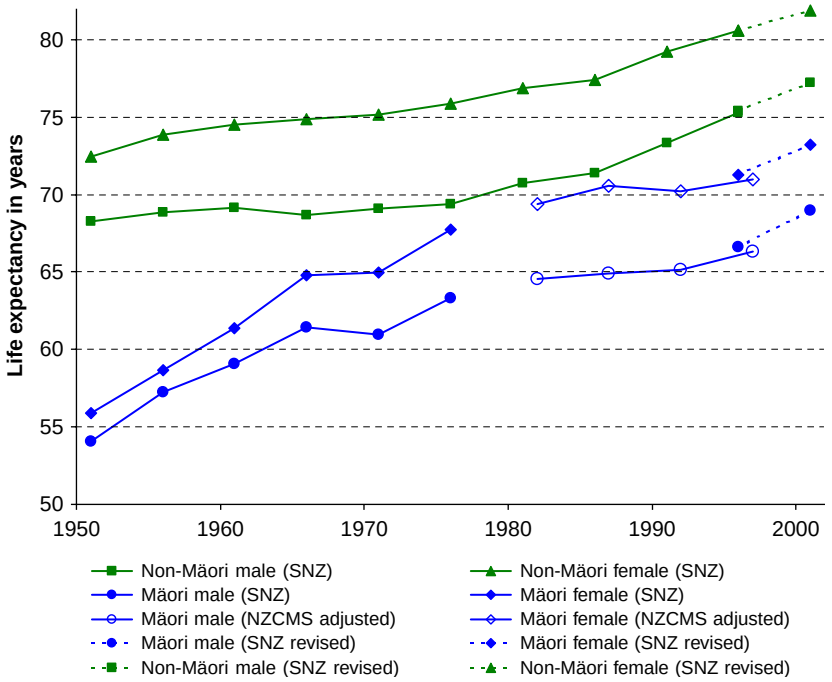

Fig. 3. Māori and non-Māori life expectancy trends, 1950–2002, using official Statistics New Zealand (SNZ) series and New Zealand Census-Mortality Study (NZCMS) estimates adjusted for numerator–denominator bias. The non-Māori (SNZ) series from 1951 to 1996 is unadjusted for numerator–denominator bias. However, because non-Māori are the larger population group the point estimates will be little affected by numerator–denominator bias. The Māori (SNZ) series from 1951 to 1976 is unadjusted for numerator–denominator bias. Thus, we cannot be certain of the accuracy of each point estimate. However, the large increase in Māori life expectancy during this period will not be an artefact of numerator–denominator bias. The Māori (NZCMS adjusted) series from 1980–84 to 1996–99 is for the prioritised Māori ethnic group, and is adjusted for numerator–denominator bias. The Māori (SNZ revised) and non-Māori (SNZ revised) series are for the prioritised ethnic groups, and are adjusted for numerator–denominator bias in the late 1990s by SNZ using NZCMS adjusters. (Preliminary comparisons by SNZ of census and mortality data ethnicity record for 2001 suggested 'these [numerator–denominator] differences [were] not significant enough to reliably adjust death numbers by age, sex and ethnicity' (Statistics New Zealand, 2004).)

Structural explanations

From a structural perspective, it is highly plausible that serious health consequences resulted from the widening inequalities during the 1980s and 1990s in employment, education, income and housing between Māori and Pacific ethnic groups compared to the nMnP group (Mowbray, 2001; Te Puni Kokiri, 2000). For example, using Household Labour Force Survey data Maori unemployment rose from 10.7% in 1986 to a peak of 25.4% in 1992, remained above 15% for the rest of the 1990s, and fell back to 10.2% by 2003 (Ministry of Social Policy, 2004). The unemployment rate for Pacific peoples rose from 6.5% in 1986 to 28.0% in 1991, remained around 15% for the rest of the 1990s, and fell back to 7.7% in 2003. By contrast, unemployment was lowest among Europeans (the vast majority of the nMnP group); their unemployment rate rose from 3.2% in 1986 to a peak of 7.9% in 1992 and had declined to 3.5% by 2003. Looking back further than this data series allows, 1976 census data suggested a Māori unemployment rate of 5%. That is, low unemployment rates were enjoyed by all ethnic groups in the 1970s and early 1980s, but then rose and remained high during the 1990s—particularly for Māori and Pacific people.

Real incomes of Māori and Pacific households dropped during this period and did not recover to the level they had reached in the early 1980s. For example, the percentage of families with one or more European adults with a net-of-housing-cost income less than 60% of the median income was 12.6% in 1987–88, peaked at 23.3% in 1991–92, and fell to 18.5% in 1997–98. By contrast, the equivalent percentages for families with one or more Māori adults were 14.0%, 41.0% and 31.2%, and with one or more Pacific adults were 24.4%, 48.9% and 44.3% (Ministry of Social Policy, 2004). That is, as with unemployment, the incomes of Māori and Pacific were hit harder and for longer than nMnP.

The 1990s also saw a significant drop in social assistance going to Māori communities following the 'mainstreaming' of Māori social services (Cunningham

& Durie, 1999). Māori leaders warned at a major national meeting in 1984, Hui Taumata, that the policies then being introduced would make Māori the 'shock absorbers in the economy'. The above trends in unemployment, income and mortality statistics are all consistent with this prediction.

If the changing socio-economic position of ethnic groups over time is part of the explanation for varying ethnic mortality trends, then socio-economic position should explain at least part of the ethnic differences in mortality at one point in time. In New Zealand, it has previously been shown that either small area socio-economic deprivation (Blakely, Kiro, & Woodward, 2002) or occupational class (Pearce, Pomare, Marshall, & Borman, 1993) separately each explain about a quarter to a third of ethnic differences in mortality. As socio-economic position is more than just one socio-economic factor—rather it is a complex construct of many socio-economic factors occurring over the life course (Blakely, Hunt, & Woodward, 2005; Blakely & Pearce, 2002)—it is highly probable that a much greater proportion of the ethnic disparities in mortality would be accounted for when adjusting for multiple socio-economic factors. If structural reform of the economy (via differential impacts on ethnic groups depending on their respective socio-economic positions) caused the diverging ethnic mortality trends, we would also expect socio-economic position to explain a higher proportion of ethnic differences in mortality in the 1990s compared to early 1980s. We are currently conducting these analyses.

There is, however, ample evidence from elsewhere that rapid social change may harm population health, and that these effects may be strongest in disadvantaged sections of the population. The social upheaval in the former Soviet Union was associated with increasing mortality rates from many causes of death (most notably cardiovascular and injury (Notzon et al., 1998)). Rates of death have since fallen and then risen again in concert with the economic cycle (Men, Brennan, Boffetta, & Zaridze, 2003). Increased binge drinking of alcohol has been implicated as one likely mechanism, but tobacco, stress, diet and health system factors are also likely explanations (Cockerham, 1997; Shkolnikov, McKee, & Leon, 2001). The health impacts of the social upheaval were most apparent among people of lower socio-economic position (Plavinksi, Plavinskaya, & Klimov, 2003; Shkolinov, Leon, Adamets, Andreev, & Deev, 1998). For example, Shkolnikov report that between 1988–89 and 1993–94 in Russia, the standardised mortality ratios (using 1988–89 as the reference period) increased among less educated males by 57% compared to a smaller 35% increase among higher-educated males. Among females, these increases were also greater among the less educated (30% compared to 8%).

In New Zealand the social changes during the 1980s and 1990s were far more muted than events in the former Soviet Union, but the structural reforms certainly impacted most severely on Māori and Pacific peoples' socio-economic position. The mechanisms whereby social change 'got under the skin' for Māori and Pacific people in New Zealand are likely to differ from that in the former Soviet countries, e.g. there were no sudden increases in alcohol consumption in New Zealand (Ministry of Health, 1999b). What might those mechanisms be? We consider lifestyle risk factors and health services below.

Lifestyle risk factor explanations

Lifestyle explanations must play some role in explaining differing ethnic trends. However, lifestyle explanations may decontextualise behaviour which in turn may lead to victim blaming (Krieger, 1994; Pearce, 1996). Risk factors themselves must be understood as being structured by the distal social determinants of health—specifically, in the current context, the structural adjustments undergone by the New Zealand economy in the 1980s and early 1990s.

Our study points to cardiovascular disease, diabetes and cancer as the major causes of increasing ethnic disparities in mortality up to 1999. The 1980s and 1990s saw rapidly declining cardiovascular disease mortality among nMnP, but a slower decline among Māori and Pacific people (Table 3). Unfortunately, there is a paucity of research and monitoring in New Zealand on trends by ethnicity for both cardiovascular incidence and risk factors.

Tobacco consumption has been consistently higher among Māori (but not Pacific people) (Borman, Wilson, & Maling, 1999), but smoking rates have tended to fall for all ethnic groups during the 1980s and 1990s—albeit faster in relative terms among nMnP people (Hill, Blakely, Thomson, & Howden-Chapman, 2003). Of note, smoking among 45–64 year old Māori males decreased from 45.8% at the 1981 census to 35.4% at the 1996 census, but cardiovascular disease (and ischaemic heart disease) mortality rates among Māori males only decreased modestly (Table 3). Whilst the increased excess cancer risk due to tobacco takes decades to subside, the excess cardiovascular disease risk 'washes out' more rapidly. Therefore, tobacco smoking seems unlikely to the main reason for slower rates of improvement in cardiovascular disease among Māori and Pacific people—although it is undoubtedly still important. Presumably, greater improvements in risk factor profiles (from the social to the behavioural) and access to life-saving treatments among nMnP has also contributed to a more rapid reduction in cardiovascular mortality among this group.

Cross-sectional survey data on biological and behavioural risk factors such as obesity and high blood

pressure are consistent with the ethnic disparities in mortality described in this report (Bullen et al., 1996; Skeaff, Mann, McKenzie, & Rusell, 2001; Wilson, Wilson, & Russell, 2001). But *trend* data for these risk factors by ethnicity over time are both limited and statistically imprecise. Nevertheless, ethnic-specific estimates of obesity and fat intake from the 1989 Life in New Zealand Survey and the 1997 National Nutrition Survey show similar changes over time for both Mäori and non-Maori, albeit with a 'better' profile for non-Mäori at both points in time (Russell, Parnell, Wilson, & the principal investigators of the 1997 National Nutritional Survey, 1999).

Regarding other risks factors, the 1996 NZ Health Survey data show similar levels of vigorous and moderate physical activity for Mäori and non-Mäori (Ministry of Health, 1999b). Alcohol consumption levels were also not dissimilar—although there was variation in drinking patterns by ethnicity.

Health service explanations

Differential incidence of disease by ethnicity may be compounded by differential access to health care and differential quality of care leading to differential mortality (Jones, 2001). Higher rates of co-morbidity, multiple disabilities, more complex health needs and lower incomes, make access to optimal health care a particularly important issue when considering mortality differentials between Mäori and non-Mäori. For example, receipt of coronary artery bypass grafts and angioplasty (two invasive procedures to treat ischaemic heart disease) have been shown to be lower for Maori and Pacific people *despite* their ischaemic heart disease mortality rates being higher than those of nMnP people (Tukuitonga & Bindman, 2002; Westbrooke, Baxter, & Hogan, 2000).

Could differential access to, and quality of, health services contribute to diverging ethnic mortality *trends* in the 1980s and 1990s? Possibly, as health system restructuring was also a feature of this period. The early 1990s saw the introduction of a funder/provider split, a competitive model for provision, business objectives for hospitals, increased 'efficiencies' through the introduction of managerialism, capped budgets, increased 'flexibility' of the health workforce, withdrawal of services from public hospitals, restricted access to free emergency care, additional co-payments (although many were removed again in the mid- to late-1990s), and increasing use of contracts in primary care (Barnett & Barnett, 1999). US research has found that co-payments discourage health care visits for low-income people, irrespective of how medically necessary the visit was thought to be (including visits for preventive care (Miller, 1996)). There is evidence that this is also the case in New Zealand. Recent surveys in New Zealand have found that adults with below-average income were more likely to report having gone without needed care because of the cost (Ministry of Health, 1999b). The Commonwealth Fund 2001 Survey also found that Mäori adults were twice as likely as non-Mäori to have gone without needed care in the past year because of the cost—partly reflecting income differences. However, even when controlling for income, access was significantly lower for Mäori (Schoen et al., 2002).

Improving medical treatments for life-threatening diseases also opens the possibility for changing ethnic inequalities in mortality over time. For example, it has been estimated that approximately half the reduction in coronary heart disease mortality from 1982 to 1993 in New Zealand (not stratified by ethnicity) was due to medical therapies, and the other half due to reductions in major risk factors (Capewell, Beaglehole, Seddon, & McMurray, 2000). Given the international evidence that medical therapies are having an increasing role in driving down heart disease mortality rates (Hunink et al., 1997), it seems plausible that (as would be predicted by the inverse care law (Hart, 1971) and more recently the inverse equity law (Victora, Vaughan, Barros, Silva, & Tomasi, 2000)) nMnP people may have received greater and increasing health benefits over time from these new and effective treatments compared to Mäori and Pacific people. A similar argument might also apply with respect to cancer treatment services. For example, there is ample evidence from the United States of racial disparities in the access to and quality of cancer therapies, even after adjusting for clinical factors (e.g. co-morbidity) (Smedley, Stith, & Nelson, 2002). It must be stressed that improving medical treatments need not inevitably lead to widening inequalities in health—rather, if delivered equitably, they might be an opportunity for *decreasing* inequalities in health.

On the other hand, the same period in New Zealand saw the development of increased numbers of Mäori (and Pacific) health providers. Yet by 2000–01 these providers were still only receiving $180 million of the $6.6 billion health budget and were only providing a limited range of primary care services to a relatively small proportion of the Mäori population. Therefore, any effect such services may have had on reducing inequalities may have been either swamped by structural and other factors, or simply not have become manifest by the mid-to-late 1990s given lag effects between primary care and mortality outcomes. It is a moot point whether the apparent return to an improving trend in Mäori life expectancy in recent years can be, in part at least, attributed to these 'by Mäori for Mäori' primary health services.

In summary, there is some New Zealand evidence for ethnic differences in access to, and quality of, health care. While unlikely to account for either all of the inequality in mortality between the ethnic groups at one

point in time, or all of the diverging trends in inequality over time (demonstrated in this report), such health service explanations may have made an important contribution to the observed disparity for specific diseases.

Discrimination

There are clues that ethnic discrimination (racism) also plays a role in generating ethnic inequalities in health. One model proposes three levels at which racism impacts upon health: institutional, interpersonal and internalised (Jones, 2000). The institutional racism may be manifest by different employment opportunities. For example, even with similar levels of education, and taking other factors into account (such as age, marital status and length of time working), non-Māori have been found to be advantaged in the job market, both in terms of occupational status and wages. This has been attributed to discrimination against Māori in the job market (Alexander, Genc, & Jaforullah, 2002). There is also some evidence of systematic discrimination against Māori in the provision of some social services at various points in time (Howell & Hackwell, 2003; MacDonald, 1986; McClure, 1998; Ministerial Advisory Committee on a Maori perspective to the Department of Social Welfare, 1986). Experience of interpersonal racism may impact directly on blood pressure and other risk factors (Krieger & Sydney, 1996). It is also possible that stress, in its many and varied forms, experienced as a result of discrimination contributes to health inequalities (Berkman, 1997; Brunner, 1997; McEwen, 1998). Whilst it is likely that discrimination plays some role in ethnic inequalities at any one point in time, we have no *direct* evidence that discrimination increased during the 1980s and 1990s accompanying the widening mortality inequalities.

Psychosocial stress is accepted by many researchers as an important mechanism for socio-economic differences in health (Brunner & Marmot, 1999). This, together with material and behavioural pathways, may provide a link from discrimination and the structural changes to ethnic disparities in mortality. But, again, we have no direct evidence supporting or refuting the hypothesis of diverging levels of psychosocial stress over time by ethnicity. There is, however, intriguing evidence that psychosocial stress arising from inter-ethnic group inequality may be important. The prevalence of smoking among Māori in 1996 has been found to be associated with the size of the gap in average incomes and educational attainment between Māori and non-Māori across 73 regions of New Zealand (Barnett, Moon, & Kearns, 2004). One possible interpretation of this study offered by the authors was that increasing perceptions of inequality among Māori led to greater psychosocial stress and, in turn, to the utilisation of smoking as a coping response.

Conclusion

We found large biases in mortality statistics due to undercounting of Māori and Pacific deaths during the 1980s and early 1990s in New Zealand. We urge researchers in other countries to consider the possibility of numerator–denominator bias affecting ethnic mortality rates in their country. Having corrected for this numerator–denominator bias, we found marked differences in ethnic mortality rates and trends in these rates. Following three decades of converging life expectancy trends in New Zealand between Māori and non-Māori post-WWII, the 1980s and 1990s saw a divergence due to strong improvements among non-Māori compared to little, if any, improvement among Māori (and Pacific) ethnic groups. Mortality among 45–64 and 65 plus year olds, especially cancer and cardiovascular disease mortality, were major contributors to growing ethnic inequalities in mortality during the 1980s and 1990s. There are several interconnected levels of likely explanation for these diverging trends. First, it seems inescapable that the varying socio-economic impacts by ethnicity from the structural reforms in New Zealand during the 1980s and 1990s were part of the explanation. Second, it is likely that varying lifestyle risk factors explain part of the mortality inequalities by ethnicity—but there is a lack of trend data on risk factors to make a case that they are an explanation for diverging ethnic mortality trends. Third, access to, and the quality of, health services probably contribute to ethnic inequalities at any one point in time—but, again, trend data on health services access and utilisation by ethnicity are absent. Fourth, discrimination may form a backdrop for these levels of explanations.

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Summary statistics New Zealand security statement

The NZCMS is a study of the relationship between socio-economic factors and mortality in New Zealand, based on the integration of anonymised population census data from Statistics New Zealand and mortality

data from the New Zealand Health Information Service. The project was approved by Statistics New Zealand as a Data Laboratory project under the Microdata Access Protocols in 1997. The data sets created by the integration process are covered by the Statistics Act and can be used for statistical purposes only. Only approved researchers who have signed Statistics New Zealand's declaration of secrecy can access the integrated data in the Data Laboratory. (A full security statement is in a technical report at http://www.wnmeds.ac.NewZealand/nzcms-info.htm.) For further information about confidentiality matters in regard to this study please contact Statistics New Zealand.

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