

W What is the contribution of smoking and socioeconomic position to ethnic inequalities in mortality in New Zealand?

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Summary

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Background Mortality rates for Māori are twice those for non-Māori in New Zealand. We have assessed the contribution of tobacco smoking and socioeconomic position to these inequalities in 45–74-year-old census respondents during 1981–84 and 1996–99 (2.3 and 2.7 million person-years, respectively).

Methods We used linked census and mortality cohort datasets with measures of socioeconomic position (household income, highest educational qualification, car access, labour-force status, and neighbourhood deprivation) and smoking (never, ex, current). We used direct standardisation to adjust for smoking and Poisson regression to adjust for socioeconomic position.

Findings The apparent contribution of smoking to mortality differences between Māori and non-Māori non-Pacific people was greatest for women in 1996–99 (8% reduction in standardised rate difference); it had increased from 3% in 1981–84. The corresponding reductions in men were 5% in 1996–99 and –1% in 1981–84. The apparent contribution of socioeconomic factors to mortality differences between Māori and non-Māori non-Pacific was greatest for men (39% in 1981–84 and 37% in 1996–99) and increased over time for women (from 23% in 1981–84 to 32% in 1996–99).

Interpretation Although small, the contribution of smoking to ethnic inequalities in mortality increased over time and might grow more during the next two decades if differences in smoking between ethnic groups continue to increase. Better measurement of socioeconomic position (eg, lifecourse measures, asset wealth) might increase the proportion of ethnic inequalities attributable to socioeconomic position, perhaps to about half. Action to redress socioeconomic gaps and control of tobacco use will both be important in reducing ethnic inequalities in health.

Introduction

There are large and increasing inequalities in mortality by ethnicity in New Zealand.¹ Māori, the Indigenous population of New Zealand that migrated from Polynesia about 1000 years ago, have roughly twice the mortality rate of non-Māori non-Pacific people (largely of European extraction, arriving in New Zealand in a continuing migration since the early 1800s). Pacific people, mostly migrants from the Pacific Islands (eg, Tonga, Samoa) since World War II, have mortality rates between those of the other two ethnic groups. Trends in life expectancy since 1950 for Māori and non-Māori show convergence between Māori and non-Māori up to the 1970s, then divergence in the 1980s and 1990s, and lately a possible start of parallel tracking of life expectancy trends (figure 1).

There are many possible explanations for these mortality inequalities. Similar to the experience of other Indigenous populations, the colonisation of New Zealand since the 1800s severely affected the Māori with loss of land and other resources.^{2–5} Socioeconomic resources are now unequally distributed: Māori and Pacific people have lower incomes, employment rates, and educational achievement than non-Māori non-Pacific people.⁶ Racism, whether structural (eg, as the result of colonisation) or interpersonal, also affects health.^{7–9} Access to, and quality of, health services contribute to ethnic inequalities. Even in a country such as New Zealand with a mostly universal

health-care system, there is growing evidence that Māori have less access to, or lower quality of, life-saving treatments.^{10–13} Proximal health risk factors such as smoking are also unevenly distributed by ethnic group.¹⁴ There are some genetic differences between groups with common ancestral origins,¹⁵ but their role in the total mortality disparity is debatable.

We used linked census-mortality data that create cohort studies of the entire New Zealand population to assess the contribution of tobacco smoking and socioeconomic position to ethnic inequalities in mortality. To address the issue of the contribution of smoking to these inequalities is challenging, for many reasons. First, smoking is a proximal or downstream risk factor for health that is strongly patterned by socioeconomic and other factors. For example, higher socioeconomic groups and non-marginalised populations tend to adopt smoking earlier, but also drop smoking earlier, than lower socioeconomic groups and marginalised populations.¹⁶ However, in New Zealand, tobacco was a common trade commodity between Māori and non-Māori in the 1800s, resulting in widespread uptake of smoking among Māori.¹⁷ Second, the tobacco epidemic is dynamic, with varying smoking prevalence over time, by sex, and by ethnic group. No long-term trend data on tobacco smoking by ethnicity are available, but from 1981 to 1996 the prevalence of smoking in the age-group 15–79 years fell from 50% to 38% in Māori men and from 52% to 45% in Māori women. The

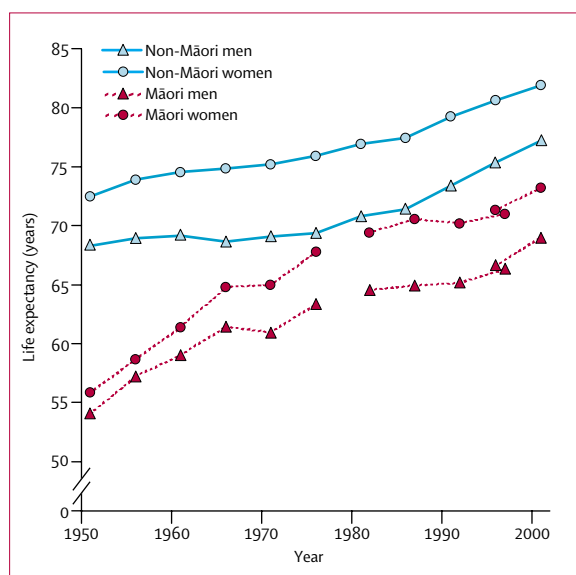


Figure 1: Māori and non-Māori life-expectancy trends by sex, 1950–2002

Source: Blakely and colleagues.¹ The Māori series is shown in three stages, reflecting differing ability to adjust for numerator-denominator bias (ie, differential recording of ethnicity on mortality compared with census data). Between 1951 and 1976, no assessment or adjustment for any numerator-denominator bias is possible, so we cannot be certain of the accuracy of each point estimate. However, the large increase in Māori life expectancy during this period is not an artifact of numerator-denominator bias. During the 1980s and 1990s, adjustment for undercounting of Māori deaths was possible through use of the New Zealand Census-Mortality Study (NZC-MS). Statistics New Zealand have revised the 1995–97 estimates by use of NZC-MS adjusters, and found that for 2000–02 “these [numerator-denominator] differences [were] not significant enough to reliably adjust death numbers by age, sex and ethnicity”.¹⁸ Trends in life expectancy of Pacific and non-Māori non-Pacific people are not available before the 1980s owing to the small population size. Thus, only Māori and non-Māori trends are shown.

relative decreases in non-Māori non-Pacific people were greater: 33% to 23% in men and 28% to 20% in women. Consequently, the contribution of smoking to ethnic inequalities will also vary over time and by sex. Third, assessment from observational data of how much of a given exposure-outcome association (eg, ethnicity-mortality association) is mediated by intermediary variables such as smoking is difficult^{19–21} because the intermediary variables are correlated with other known and unknown variables that also have independent associations with the exposure and the outcome. Thus, statistical adjustment for the potential intermediary variable might also adjust for other causal (or confounding) mechanisms. However, in the absence of a longitudinal study with many repeated measures, carefully thought out and staged analyses are still able to provide information about the contributions of various causal mechanisms to social inequalities in health.²² Fourth, the relative strength of the association of smoking with mortality varies with ethnic group in New Zealand. We reported that the relative risk of mortality for current versus never smokers was greater for non-Māori non-Pacific people than for Māori in 1996–99 (2.22 [95% CI 2.12–2.33] vs 1.51 [1.35–1.69]

in men and 2.20 [2.09–2.33] vs 1.45 [1.27–1.66] in women).²³ This heterogeneity of the relative risk points to the importance of other competing risk factors for poor health for Māori, such that the relative contribution of smoking is partly overshadowed. But it also presents methodological challenges to assessment of the contribution of smoking to ethnic inequalities in mortality.

Assessment and interpretation of the contribution of socioeconomic position to ethnic inequalities is also challenging.^{24,25} To account for ethnic inequalities by controlling for socioeconomic factors does not make ethnic inequalities in health acceptable. Rather, the unequal (and unfair) distribution of socioeconomic resources between ethnic groups in the first place is part of the reason for ethnic disparities; redressing socioeconomic inequalities is therefore a strategy to reduce ethnic inequalities in health. Second, socioeconomic position is a multifaceted construct. No study can claim to measure all facets of socioeconomic position fully and accurately over the lifecourse. Therefore, the true contribution of socioeconomic position to ethnic inequalities is likely to be greater than that identified empirically.²⁶

Methods

Dataset

1981 and 1996 census records were each anonymously and probabilistically linked to 3 years of subsequent mortality data,^{27,28} creating two separate cohort studies of the New Zealand population followed up for 3 years. 73% of eligible mortality records for the age-group 45–74 years were linked for the 1981–84 cohort, and 81% for the 1996–99 cohort.²⁹ We defined this age-group because the New Zealand Census-Mortality Study does not attempt to link people aged 75 years and older on census night, and deaths before 45 years of age are less likely to be related to smoking. Of the mortality records linked, at least 98% are estimated to be true links.³⁰ The proportion of mortality records linked to a census record varied by sex, age, ethnicity, and neighbourhood deprivation.²⁸ Deprivation was measured by a 1996 index calculated from census data on socioeconomic characteristics (eg, car access, tenure, and receipt of benefits) at aggregations of about 100 people, and assigned to mortality data by use of address.³¹ Weights were therefore applied to adjust for linkage bias. For example, if 20 of 30 Māori men who died aged 45–64 years and living in moderately deprived small areas of New Zealand were linked to a census record, each of the 20 linked records received a weight of 1.5 (30/20). Similar inverse probability weights were calculated and applied to many strata²⁹ and used in all analyses in this report.

The 1996 census elicited up to three self-identified ethnicities from each respondent. To facilitate analyses, we assigned each respondent to a mutually exclusive ethnic group by means of a prioritisation system

commonly used in New Zealand: Māori, if any one of the responses was Māori (7.5% of 45–74-year-old person-time in 1996–99 cohort; table 1); Pacific, if any one response was Pacific but not Māori (2.6%); and the remainder non-Māori non-Pacific (mostly New Zealanders of European descent, but strictly speaking not an ethnic group; 89.9%). The 1981 census elicited fractionated ethnic origin, and we assigned: Māori, if any Māori origin (5.5% of 45–74-year-old person-time in 1981–84 cohort); Pacific, if any Pacific origin but no Māori origin (1.2%); and the remainder non-Māori non-Pacific (93.3%). This ethnic classification of 1981 and 1996 censuses has been used previously for comparisons over time.^{32,33}

Smoking status was specified as never smoker, ex-smoker, or current smoker; the questions were very similar for the 1981 and 1996 censuses. Socioeconomic position was characterised as: total household income, with adjustment, by use of an index specific for New Zealand,³⁴ for the number of children and adults in the household to allow for economies of scale; highest educational qualification (higher than school, school, or none); car access (none, one, two or more; simultaneously a measure of asset wealth and access to community resources³⁵); labour-force status (employed, unemployed, non-active); and neighbourhood deprivation measured by NZDep96.³¹

Analyses

Direct standardisation was used to assess the contribution of smoking to ethnic inequalities, by comparison of age-standardised mortality rates with age-smoking-standardised mortality rates. This method has the advantage that it does not assume a uniform relative risk for smoking across all ethnic groups. The analyses were based on New Zealand residents with complete data for sex, age, ethnicity, and smoking (98% and 92% of the total eligible person-time available for analyses in 1981–84 and 1996–99, respectively; 2.3 and 2.7 million years; table 1).

The standard population was the 1996 census Māori population count, separately by sex and cross-classified by age (5-year groups) and smoking status. Age-standardised rates, rate differences (SRD) and rate ratios (SRR) were compared with age-smoking-standardised rates, SRD, and SRR. The contribution of smoking to ethnic inequalities in mortality was calculated as the percentage change in the age-standardised to age-smoking-standardised SRD.

Poisson regression was used to assess the contribution of socioeconomic position to ethnic inequalities. We excluded Pacific people from these analyses owing to sparse data, because data on some socioeconomic factors were missing for about 20% of census respondents, analyses were done on 1.7 and 2.2 million person-years for analyses in 1981–84 and 1996–99, respectively (table 1). The socioeconomic data were missing mainly for two reasons: any census respondent not at his or her usual residence on census night had to be excluded; non-response of the person, or any other adult in the household, to the question about personal income meant that the household income could not be ascertained. The contribution of socioeconomic factors to ethnic inequalities was calculated as the percentage change in the excess relative risk (ie, relative risk minus 1).

Role of the funding source

The funding sources had no role in the study design, the collection, analysis, or interpretation of data, or the writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

Table 2 shows the distribution of person-years and deaths and age-standardised mortality rates within smoking by ethnicity groups, for census respondents with complete sex, age, ethnicity, and smoking data. The number of

	Men			Women		
	All usually resident census respondents	Proportion with complete smoking data	Proportion with complete smoking and socioeconomic data	All usually resident census respondents	Proportion with complete smoking data	Proportion with complete smoking and socioeconomic data
1981–84						
nMnP	1 021 776	98%	74%	1 088 376	98%	74%
Pacific	13 587	96%	54%	13 266	95%	56%
Māori	61 749	96%	60%	63 663	95%	60%
Total	1 097 112	98%	73%	1 165 305	98%	73%
1996–99						
nMnP	1 260 339	92%	78%	1 305 342	92%	79%
Pacific	35 721	92%	56%	38 571	91%	55%
Māori	104 100	94%	69%	111 120	93%	67%
Total	1 400 160	93%	77%	1 455 033	92%	77%

nMnP= non-Māori non-Pacific people.

Table 1: Person-years available for analyses and proportions with complete smoking data and complete smoking and socioeconomic data

	Men, 1981-84			Men, 1996-99			Women, 1981-84			Women, 1996-99		
	Never smoker	Ex-smoker	Current smoker	Never smoker	Ex-smoker	Current smoker	Never smoker	Ex-smoker	Current smoker	Never smoker	Ex-smoker	Current smoker
Person-years												
nMnP	288 646	383 049	333 695	481 962	457 153	224 980	625 645	177 959	263 386	723 050	290 737	192 741
Pacific	4949	2244	5880	16 201	5004	11 673	8153	1394	3067	25 783	2943	6205
Māori	17 982	14 811	26 379	35 453	29 653	33 130	23 383	10 891	26 338	40 701	24 053	38 840
Distribution of person-years by smoking within ethnic groups												
nMnP	28.7%	38.1%	33.2%	41.4%	39.3%	19.3%	58.6%	16.7%	24.7%	59.9%	24.1%	16.0%
Pacific	37.9%	17.2%	45.0%	49.3%	15.2%	35.5%	64.6%	11.1%	24.3%	73.8%	8.4%	17.8%
Māori	30.4%	25.0%	44.6%	36.1%	30.2%	33.7%	38.6%	18.0%	43.5%	39.3%	23.2%	37.5%
Deaths from any cause												
nMnP	4269	8700	7908	4272	7425	4119	6672	2700	3645	4806	3159	2253
Pacific	66	66	81	282	135	198	87	33	21	315	42	63
Māori	474	444	708	780	747	918	453	303	441	657	558	675
Age-standardised mortality rate per 100 000												
nMnP	1124	1447	1928	700	949	1584	712	1046	1168	473	750	1047
Pacific	1433	2624	1579	1695	2286	1834	1046	2117	671	1139	1187	1139
Māori	2511	2666	2816	1994	2174	3075	1709	2494	1875	1341	2136	2047

Person-time and numbers of deaths are weighted as described in the Methods. All numbers are randomly rounded to a near multiple of three as per confidentiality requirements of Statistics New Zealand. The minimum cell size is fixed at 6. Dataset is restricted to respondents with complete data for sex, age, ethnicity, and smoking.

Table 2: Person-time and deaths among 45–74-year-old individuals, by strata of census-cohort, sex, ethnicity, and smoking

deaths of people of Pacific ethnicity in some cells is small (eg, 21 for current women smokers during 1981–84), so findings for Pacific people should be interpreted with caution. Mortality rates of current smokers increased slightly from 1981–84 to 1996–99 in Māori and Pacific groups (table 2; although 95% CI overlapped for all comparisons), but rates fell slightly in non-Māori non-Pacific people. By contrast, mortality rates tended to fall over time among never smokers and ex-smokers from all three ethnic groups.

Figure 2 and table 3 show the age-standardised and age-smoking-standardised mortality rates per 100 000 people, and table 3 also shows the SRD and SRR. Examination of only the age-standardised rates in figure 2 shows that in both absolute and relative terms the reduction in mortality rates from 1981–84 to 1996–99 was greater among non-Māori non-Pacific people than among Māori or Pacific—ie, ethnic inequalities in mortality widened over time as shown by the increasing SRD and SRR from 1981–84 to 1996–99 (table 3).

Additional standardisation by smoking produced only minor changes in 1996–99 Māori mortality rates since the 1996 Māori population was the standard. By contrast, all the mortality rates for non-Māori non-Pacific and Pacific people (except non-Māori non-Pacific men in 1981–84) increased after additional standardisation for smoking because they are weighted to the more adverse Māori smoking distribution in 1996.

What was the effect of standardisation for smoking on ethnic mortality gaps? For men in 1981–84 the Māori compared with non-Māori non-Pacific SRD changed little

after standardisation for smoking (table 3; 1157 to 1168 per 100 000 years). However, for women in 1981–84 the SRD comparing Māori with non-Māori non-Pacific people decreased by 3% after standardisation for smoking. In 1996–99, it decreased by 5% for men and 8% for women. Although the changes in the SRD due to additional standardisation for smoking were well within the 95% CI, the same population sample (eg, 1981–84 women) is being reanalysed; this is not a comparison of two different

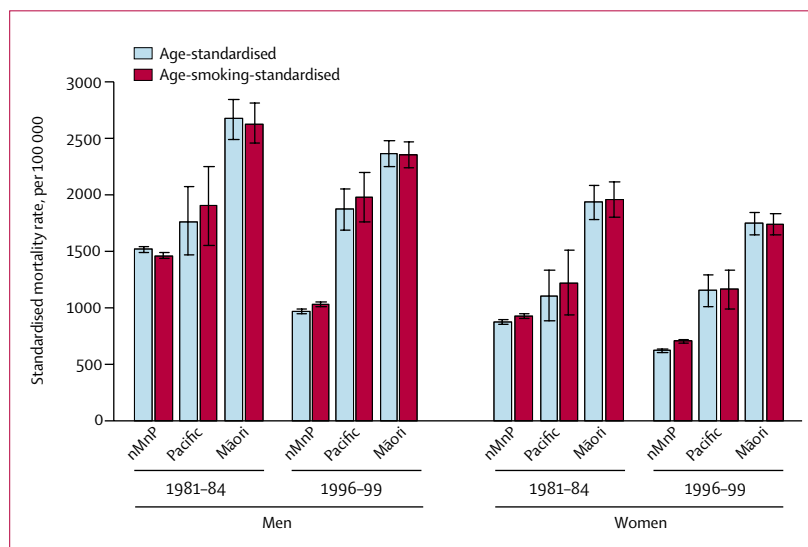


Figure 2: Mortality rates standardised for age or age and smoking per 100 000 for 45–74-year-old respondents by cohort, sex, and ethnic group
Error bars are 95% CI.

	Age-standardised			Age and smoking standardised			Percentage reduction in SRD
	SR per 10 ⁵	SRD per 10 ⁵ (95% CI)	SRR (95% CI)	SR per 10 ⁵	SRD per 10 ⁵ (95% CI)	SRR (95% CI)	
Men: 1981–84							
nMnP	1513	0	1.00	1460	0	1.00	
Pacific	1766	253 (–49 to 556)	1.17 (0.98 to 1.39)	1903	443 (94 to 793)	1.30 (1.08 to 1.57)	–75%
Māori	2670	1157 (981 to 1333)	1.76 (1.65 to 1.89)	2629	1168 (988 to 1349)	1.80 (1.68 to 1.93)	–1%
Men: 1996–99							
nMnP	966	0	1.00	1026	0	1.00	
Pacific	1869	903 (717 to 1089)	1.94 (1.75 to 2.14)	1976	950 (732 to 1168)	1.93 (1.72 to 2.15)	–5%
Māori	2367	1401 (1286 to 1516)	2.45 (2.33 to 2.58)	2359	1333 (1218 to 1447)	2.30 (2.18 to 2.42)	5%
Women: 1981–84							
nMnP	872	0	1.00	923	0	1.00	
Pacific	1107	235 (6 to 464)	1.27 (1.03 to 1.56)	1222	299 (131 to 586)	1.32 (1.05 to 1.67)	–27%
Māori	1932	1060 (912 to 1207)	2.22 (2.05 to 2.40)	1954	1031 (879 to 1183)	2.12 (1.95 to 2.29)	3%
Women: 1996–99							
nMnP	620	0	1.00	697	0	1.00	
Pacific	1146	526 (387 to 664)	1.85 (1.64 to 2.09)	1160	463 (291 to 635)	1.66 (1.43 to 1.93)	12%
Māori	1744	1124 (1028 to 1221)	2.81 (2.65 to 2.99)	1734	1037 (940 to 1134)	2.49 (2.34 to 2.64)	8%

Table 3: Standardised rates (SR) of all-cause mortality per 100 000 and SRR and SRD age-standardised and age-smoking-standardised

populations (eg, 1981–84 compared with 1996–99 women). Thus, changes in the central estimate of the SRD after standardisation for smoking are meaningful. In terms of patterns in the Māori to non-Māori non-Pacific people SRD, in both periods the percentage contribution of smoking to absolute gaps in mortality was greater for women, and in both sexes the contribution increased over time.

Results for Pacific compared with non-Māori non-Pacific people for both 1981–84 and 1996–99 should be interpreted with caution owing to statistical imprecision of the SRD. Nevertheless, the standardisation for smoking

suggests that the Pacific to non-Māori non-Pacific mortality gap in 1981–84 would have been a quarter (women; –27% in table 3) to three-quarters (men; –75%) greater had smoking rates been the same across ethnic groups. This finding reflects the low smoking prevalence among Pacific people in 1981. By 1996–99, standardisation for smoking made only small differences in the Pacific compared with non-Māori non-Pacific SRD.

Table 4 shows the rate ratios comparing Māori with non-Māori non-Pacific people before and after restriction to respondents with complete socioeconomic data, and adjustment for household income, highest qualification,

	Complete demographic and smoking data	Models on census respondents with complete demographic, smoking, and socioeconomic data			Percentage reduction Māori to nMnP excess rate ratio	
	Model 0: age-adjusted	Model 1: age-adjusted	Model 2: adjusted for age and socioeconomic factors	Model 3: adjusted for age, socioeconomic factors, and smoking	Model 1 to 2	Model 1 to 3
Men: 1981–84						
nMnP	1.00	1.00	1.00	1.00		
Māori	1.75 (1.64–1.87)	1.83 (1.68–1.99)	1.51 (1.38–1.64)	1.52 (1.39–1.65)	39	37
Men: 1996–99						
nMnP	1.00	1.00	1.00	1.00		
Māori	2.43 (2.31–2.56)	2.39 (2.25–2.54)	1.87 (1.76–1.99)	1.85 (1.74–1.97)	37	39
Women: 1981–84						
nMnP	1.00	1.00	1.00	1.00		
Māori	2.25 (2.08–2.42)	2.31 (2.10–2.55)	2.01 (1.81–2.22)	1.87 (1.69–2.07)	23	34
Women: 1996–99						
nMnP	1.00	1.00	1.00	1.00		
Māori	2.82 (2.66–2.99)	2.77 (2.58–2.97)	2.21 (2.05–2.38)	2.03 (1.89–2.19)	32	42

95% CI are given in parentheses. Percentage reduction in the rate ratio is that for the excess rate ratio (ie, rate ratio–1).

Table 4: Poisson regression rate ratios for Māori compared with non-Māori non-Pacific

car access, labour-force status, and small area deprivation. There were small changes in the rate ratios after restriction of the analyses to individuals with complete socioeconomic data (model 0 compared with model 1), suggesting no substantial selection biases. With regard to the apparent contribution of socioeconomic factors, as measured, to mortality differences between Māori and non-Māori non-Pacific people, it was greatest for men (39% in 1981–84 and 37% in 1996–99) and increased over time for women (from 23% in 1981–84 to 32% in 1996–99). Additional adjustment for smoking, albeit with the assumption of a common relative risk of the smoking-mortality association across ethnic groups, accounted for 34% to 42% of the ethnic disparity.

Discussion

What is the contribution of smoking to ethnic inequalities in mortality in New Zealand? In terms of Māori to non-Māori non-Pacific mortality gaps during the 1980s and 1990s, these analyses suggest a contribution somewhere between very little and around 10%. But there are two important patterns. First, the contribution to the gap was greater for women than for men in both cohorts. Second, the contribution increased over time in both men and women, reaching about 5% and 8%, respectively, in 1996–99. The latter trend is particularly important. In the light of the continuing trends in smoking since 1996 by ethnicity,¹⁴ the contribution of smoking to Māori to non-Māori non-Pacific mortality gaps will probably increase.

The findings of this study have some specificity to New Zealand, but also to some extent can be generalised to other countries where Indigenous populations have higher smoking rates and lower socioeconomic position than other ethnic groups. An internationally relevant feature of this New Zealand study is that, to our knowledge, there is no similar dataset or study internationally with the same statistical power and range of measures for ethnicity, smoking, socioeconomic factors, and mortality. We could not identify similar studies in other countries directly examining the contribution of smoking to ethnic or racial inequalities in adult mortality. However, a Canadian study found that the proportion of the all-age mortality rate attributable to smoking was actually slightly less among First Nations people than the remaining British Columbia population, despite a higher smoking prevalence among First Nations people.³⁶ One possible explanation offered was the younger age structure of the First Nations population. Within New Zealand, the most thorough previous work showed that about a quarter of the Māori to non-Māori gap in life expectancy in the late 1990s might be due to smoking.³⁷ But that work was based on the assumption that smoking-mortality relative risk association was the same across ethnic groups, which has since been shown to be false.²³

Our finding of a negligible to 10% contribution of tobacco smoking to the gap between Māori and non-Māori non-Pacific mortality rates might seem surprisingly low.

One possible reason is that Māori smokers have not yet been smoking long enough and heavily enough for the full mortality effect of smoking to be felt (eg, long time-lags for causes of death such as cancer). The small increase in mortality rates from 1981–84 to 1996–99 in Māori (and Pacific) smokers, compared with small decreases in non-Māori non-Pacific smokers (table 2), provides some support for this idea. However, there are several arguments against this notion. First, lung-cancer mortality rates (the commonly used marker of the maturity of the tobacco epidemic³⁸) in the late 1990s were already three times higher for Māori men and five times higher among Māori women than for non-Māori non-Pacific counterparts,¹ which suggests that the tobacco epidemic is well advanced in Māori. Second, health survey data for 1996–97 found a similar daily amount of cigarettes consumed per day for Māori and European smokers, although fewer cigarettes per day were smoked by Pacific smokers.³⁹ Third, Māori were exposed to tobacco early in the colonisation process.

Our analyses include a simple measure of active smoking, but no measure of exposure to second-hand smoke. Since Māori have had a greater frequency and intensity of exposure to second-hand smoke than non-Māori, because of the higher density of smokers in their social networks, whether in the home⁴⁰ or workplace, some of the ethnic disparities in mortality are also likely to be attributable to this additional exposure. Therefore, the total contribution of tobacco to ethnic disparities in mortality is probably greater than that attributable to active smoking alone.

There are four possible biases that could affect the smoking results. First, adjustment for smoking might also adjust for other variables that are correlated with smoking, such as socioeconomic position. Other Poisson regression models (available from authors on request) suggest that this effect might be occurring, in that the apparent contribution of smoking to ethnic inequalities is greater if there is no adjustment for socioeconomic factors before smoking is added to the model. In other words, our standardisation analyses, although accommodating the varying relative risk association of smoking with mortality across ethnic groups, probably slightly overestimate the contribution of smoking to the mortality gaps.

Second, it is inevitable that a simple one-off question on smoking will result in some misclassification of people into smoking categories, probably non-differentially between ethnic groups. Such misclassification will probably mean a bias towards underestimation of the contribution of smoking to ethnic mortality gaps, offsetting the first bias above.

A third possible limitation in this study is that the New Zealand Census-Mortality Study does not achieve complete linkage of eligible mortality records back to census records. We adjusted for any resultant linkage bias by sociodemographic factors using weights;²⁹ however, we cannot guarantee that this process fully adjusts for any

possible residual linkage bias by smoking status. Nevertheless, we believe that any residual linkage bias is likely to be negligible.

Fourth, and relevant to both the analyses adjusted for smoking alone and for socioeconomic position, the definition of ethnicity changed from fractionated ethnic origin in the 1981 census (eg, 7/8 European, 1/8 Māori) to self-identified ethnicity in 1996 elicited by the question: "Tick as many circles as you need to show which ethnic group(s) you belong to". This change in the question and secular trends in how people viewed their own ethnicity led to a greater increase in the Māori population than expected on the basis of demographic projections alone. However, this demographic change is unlikely to cause substantial bias in our comparisons over time of the contribution to ethnic inequalities in mortality for the following reasons. First, changes over time in ethnic group sizes were not large for older people⁴¹ (eg, 45–77-year-old age-group as in this report). Second, the smoking (or socioeconomic) prevalence in the newly self-identified Māori and Pacific people in 1996 would have to be very different from that in the previous groupings to change the total ethnic group smoking (or socioeconomic) prevalence. Third, and most pertinent to this study, there would have to be complex differences in the mortality rates (by strata of smoking or socioeconomic position) between the new and the old groupings of people by ethnicity.

We may have slightly underestimated the total contribution of tobacco to ethnic mortality gaps in New Zealand during the 1980s and 1990s owing to misclassification of smoking status and the lack of allowance for passive smoking. Nevertheless, the contribution of active smoking to recent ethnic gaps in mortality cannot be much greater than we have estimated. Consider women in 1996–99. Even though the prevalence of current smoking is greater among Māori than non-Māori non-Pacific women (37.5% vs 16.0%; table 2, with no meaningful difference in ex-smoker proportion), the absolute difference in current smokers is what matters (21.5%). Simplistically, only the excess mortality risk from smoking in this percentage of the population can contribute to the large gaps in mortality between the total Māori and non-Māori non-Pacific populations. Under such a reduced scenario for women in 1996–99, the contribution of active smoking to mortality gaps could not mathematically be much greater than 10% (our estimate was 8%, table 3), without also making the smoking-mortality relative risks implausibly high (eg, >3.0).

Do these results mean that tobacco control should be downgraded as a strategy to reduce ethnic inequalities in mortality? We believe not. Achievement of a largely smoke-free New Zealand would cause substantial reductions in mortality for both Māori and non-Māori non-Pacific (ie, the common effect of smoking for both ethnic groups), but, importantly, it would also reduce the gap in mortality rates between Māori and non-Māori non-

Pacific by around 10%. For important specific causes of death more strongly related to tobacco, such as lung cancer and ischaemic heart disease, the proportional contribution of tobacco to ethnic mortality gaps will be greater than 10%. Also, in absolute terms these degrees of reduction translate to a substantial number of premature deaths avoided. Intensification of both national tobacco-control efforts and those specifically for Māori, and improvement in the accessibility and acceptability of national services will be crucial (eg, cessation programmes⁴² and mass media campaigns⁴³).

The contribution of socioeconomic position to ethnic disparities in mortality in New Zealand was substantially greater than that of smoking. As in our study, socioeconomic differences between blacks and whites in the USA do not fully explain ethnic differences in mortality,⁴⁴ but we are not aware of similar studies on Indigenous populations. However, socioeconomic position is a multifaceted construct that is difficult to measure fully and accurately at one point in time, let alone over the life course. Such measurement error, even in this study that included several measures, will mean that the true and total contribution of socioeconomic position is likely to be greater than that assessed empirically.²⁶ We have not undertaken formal modelling of the effect of measurement error of socioeconomic position in these analyses, but for this age-group a statement that about half of ethnic differences in mortality might be attributable to socioeconomic position seems reasonable.⁴⁵ Therefore, tackling socioeconomic disparities between ethnic groups stands out as an important strategy to reduce ethnic inequalities in mortality. The 1980s and 1990s in New Zealand were a period of major structural reform and social change, with more severe effects on Māori than on non-Māori. For example, Household Labour Force Survey data show that Māori unemployment rose from 10.7% in 1986 to a peak of 25.4% in 1992, remained above 15.0% for the rest of the 1990s, and fell back to 10.2% by 2003.⁴⁶ By contrast, unemployment was lowest in Europeans (the vast majority of the non-Māori non-Pacific 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. But what of the past 10 years and the near future? Since 1984, although perhaps largely overwhelmed by the above-mentioned reforms, there has been substantial Māori development (including tailored health services and programmes). Gaps in employment and educational and income achievement between Māori and non-Māori are decreasing.^{6,45} And although the political and public support for government policies to reduce ethnic inequalities has been fragile at times, there remains political consensus to redress breaches of the Treaty of Waitangi (signed in 1840 between the British Crown and Māori chiefs). The most recent evidence on life expectancy trends for Māori and non-Māori suggest that the divergence seen during the 1980s and 1990s has stopped,

with roughly equal improvements in life expectancy from the 1990s to 2000–02,¹ but a trend is far from established.

A limitation of our analyses of the contribution of socioeconomic position to ethnic inequalities in mortality was that about a quarter of the person-time had to be excluded because socioeconomic data (and to a lesser extent smoking data) were missing, and the proportion missing was greater among Māori and Pacific people (table 1). Although the Māori to non-Māori non-Pacific mortality rate ratio did not vary much after exclusion of all census respondents with missing socioeconomic data (table 4, model 0 compared with model 1), we cannot completely rule out any effect of selection bias on our results.

The final major conclusion of this study is that, even if perfectly measured, smoking and socioeconomic position are not a full explanation for the relatively worse health status of Māori, pointing to the importance of other factors also contributing to disparities.

Summary Statistics New Zealand Security Statement

The New Zealand Census-Mortality Study is a study of the relation between social 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. This project was approved by Statistics New Zealand as a Data Laboratory project under the Microdata Access Protocols in 1997. The datasets 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. For further information about confidentiality matters in regard to this study please contact Statistics New Zealand.

Contributors

T Blakely is the guarantor of this paper. He conceived the paper and led the design, interpretation, and preparation of drafts. J Fawcett led the analyses and contributed to the interpretation of results and revision of drafts. D Hunt and N Wilson contributed to the interpretation of results and drafting of the paper.

Conflict of interest statement

We declare that we have no conflict of interest.

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