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**UNLOCKING THE NUMERATOR
-DENOMINATOR
BIAS,
1991-94 DEATHS.**

NZCMS Technical Report No. 2

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Statistic New Zealand's Security Statement

The New Zealand Census-Mortality Study was initiated by Dr Tony Blakely and his co-researchers from the Wellington School of Medicine, University of Otago. It was approved by the Government Statistician as a Data Laboratory project under the Microdata Access Protocols.

Requirements of the Statistics Act

Under the Statistics Act 1975 the Government Statistician has legal authority to collect and hold information about people, households and businesses, as well as the responsibility of protecting individual information and limits to the use to which such information can be put. The obligations of the Statistics Act 1975 on data collected under the Act are summarised below.

1. Information collected under the Statistics Act 1975 can be used only for statistical purposes.
2. No information contained in any individual schedule is to be separately published or disclosed to any person who is not an employee of Statistics New Zealand, except as permitted by sections 21(3B), 37A, 37B and 37C of the Act.
3. This project was carried out under section 21(3B). Under Section 21(3B) the Government Statistician requires an independent contractor under contract to Statistics New Zealand, and any employee of the contractor, to make a statutory declaration of secrecy similar to that required of Statistics New Zealand employees where they will have access to information collected under the Act. For the purposes of implementing the confidentiality provisions of the Act, such contractors are deemed to be employees of Statistics New Zealand.

4. Statistical information published by Statistics New Zealand, and its contracted researchers, shall be arranged in such a manner as to prevent any individual information from being identifiable by any person (other than the person who supplied the information), unless the person owning the information has consented to the publication in such manner, or the publication of information in that manner could not reasonably have been foreseen.

5. The Government Statistician is to make office rules to prevent the unauthorised disclosure of individual information in published statistics.

6. Information provided under the Act is privileged. Except for a prosecution under the Act, no information that is provided under the Act can be disclosed or used in any proceedings. Furthermore no person who has completed a statutory declaration of secrecy under section 21 can be compelled in any proceedings to give oral testimony regarding individual information or produce a document with respect to any information obtained in the course of administering the Act, except as provided for in the Act.

Census data

The Population Census is the most important stocktake of the population that is carried out. The statistics that are produced provide a regular picture of society. Results are used widely in making decisions affecting every neighbourhood. They are used in planning essential local services, and they also help to monitor social programmes ranging from housing to health.

Traditionally census data is published by Statistics New Zealand in aggregated tables and graphs for use throughout schools, business and homes. Recently Statistics New Zealand has sought to increase the benefits that can be obtained from its data by providing access to approved researchers to carry out research projects. Microdata access is provided, at the discretion of the Government Statistician, to allow authoritative statistical research of benefit to the public of New Zealand.

This project used anonymous census data and mortality data which were integrated using a

probabilistic linking methodology to create a single dataset that allows the researchers to undertake a statistical study of the association of mortality and socio-economic factors. This is the first time that the census has been linked to an administrative dataset for purposes apart from improving the quality of Statistics New Zealand surveys. The project has been closely monitored to ensure it complies with Statistics New Zealand's strict confidentiality requirements.

Further information

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Chapter 1: Introduction

This Technical Report on the numerator-denominator analyses for the 1991 census linkage serves as a more detailed resource to complement the paper “*Unlocking the numerator-denominator bias. I: Adjustment ratios by ethnicity for 1991-94 mortality data*” submitted to the New Zealand Medical Journal. That paper provides the justification and interpretation for this body of work. This Report:

- details some of the data issues
- provides an extensive list of tables of adjustment ratios
- considers the possibility of residual systematic bias in the analyses
- presents a sensitivity analysis of the possible impact of any residual bias
- makes recommendations for the same analyses to be conducted for 1981-84, 1986-89, and 1996-99 as the NZCMS progresses.

Chapter 2: Methods

1 Linked census and mortality data set for numerator-denominator analyses

In order to investigate the numerator-denominator bias we required mortality data linked to census data. For the linkage of the 1991 census to 1991-94 mortality data, 31,635 of the 41,310 mortality records were anonymously and probabilistically linked to the 1991 census.^{1 2} However, there were two problems using this set of linked records to investigate numerator-denominator bias.

- Ethnicity was a matching variable. Therefore, these linked records would be systematically biased to include those where ethnicity agreed between census and mortality data.
- Whilst false positive links are not overly problematic for the cohort analyses, they may be problematic for the numerator-denominator analyses. For example, if 10% of Maori deaths (by NMDS death registration form ethnicity) were linked to the wrong census record, and given that ethnicity was not a particularly good matching variable, it is likely that the majority of these 10% of Maori mortality records would be linked to a non-Maori census record due to the majority of the New Zealand population being non-Maori. The effect of this bias would be to cause an *overestimate* of the numerator-denominator bias between mortality and census data. (With the advantage of hindsight, however, concern about this bias may be somewhat overshadowed by the low percentage of Maori and Pacific mortality records in the final data set used in the numerator-denominator analyses. See Chapter 5 for future recommendations.)

These two problems were relatively easily overcome. *Any links accepted in the first pass of the 1991 linkage that agreed exactly on sex, date of birth, and country of birth would have been accepted regardless of whether or not ethnicity disagreed.* This can be

deduced from the u and m probabilities presented on page 74 of the Technical Report of the linkage of 1991 census to mortality records.¹ In pass 1 the weight cut-off was 23.0. Any link that had exact agreement on the above variables would get a *minimum* weight score of 31. And if there was a disagreement on ethnicity (both NMDS and NHI) then the *maximum* disagreement weight would be about 4. Thus, the minimum total weight would be 27.0, well in excess of the 23.0 cut-off. Thus, taking the sample of pass 1 links that agreed exactly on these non-ethnic variables ensured:

- disagreement on ethnicity between census and mortality data did not affect their chances of being included
- that only links with a high probability of being a true link (i.e. PPV >99%) were included.

By this requirement, SNZ provided 22,590 mortality records in the data-lab for the numerator-denominator analyses (54.7% of the total 41,310 eligible mortality records, and 71.4% of the linked records). Notably, only 34.5% and 35.7% of the Maori and Pacific mortality records (based on the NMDS death registration form) remained in the n=22,590 data set compared to the n=41,310 data set, compared to 56.9% of non-Maori non-Pacific mortality records.

To calculate the adjustment ratios for numerator-denominator bias, in principle all that was required was to cross-classify the mortality data ethnicity (NMDS death form of NHI file) with the census ethnicity (sole or prioritised). However, because of the varying percentage inclusion by ethnicity in the final data set, simple cross-classifications were severely biased. To overcome this problem, the n=22,590 data set had to be 'weighted' to represent the n=41,310 data set.

2 Weighting

Whilst the census ethnicity was only available for 22,590 mortality records, there was near complete information on sex, age, ethnicity (NMDS and NHI), regional health

authority (RHA) and NZDep91 for the 41,310 mortality records. Thus, it was possible to weight the numerator-denominator analyses on the 22,590 records by the demographic distribution of the full 41,310 mortality records. This meant that we were not assuming that the census self-identified ethnicity distribution *overall* of the 45.3% of decedents not included in the final data set for analysis was the same as that for the 54.7% included in the final data set. Rather, by weighting the mortality records in the final data set, we are assuming that within each weighted strata of [NMDS ethnic group] by [sex] by [age-group] by [RHA] by [NZDep91 group] the distribution of census self-identified ethnicity was the same for those included in the final data set as it was for all eligible mortality records.

For example, assume one stratum used in the weighting was Maori (NMDS ethnic group) females aged 45-64 years living in a NZDep91 decile 7-8 area in the Northern RHA. Further, assume that there were 10 females in this stratum in the final data set compared to 30 females in this stratum in the data set of all eligible mortality records. The weighting method we used would have assigned a weight of 3.0 to each of the 10 females in the final data set. Thus, weighted cross-tabulations of mortality data ethnicity by census ethnicity 'count' each of these 10 women three times. Importantly, the assumption in this weighting procedure was that the 10 females in the final data-set are representative of the 30 women not in the final data set with respect to their census self-identified ethnicity. This same procedure is conducted for every other weighted stratum. Thus, any bias between the final data set and the data set of all eligible mortality records in how individuals self-identified ethnicity on the census that is explained by NMDS ethnicity, sex, age, RHA, and NZDep91 is controlled by the weighting. For any residual bias to remain in the numerator-denominator analyses would require systematic bias that was not explained by NMDS ethnicity, sex, age, RHA, and NZDep91 group.

Whilst any such residual bias is likely to be small, it may still have existed. For example, residential mobility may vary within strata between those in the final data set and those not, *and* residential mobility may be associated with census self-identified ethnicity. Alternatively, socio-economic status (not captured by NZDep91) may likewise vary

within strata, and be associated with self-identified ethnicity. Sensitivity analyses about this residual systematic bias in the numerator-denominator analyses are presented in Chapter 4 (Page 30).

These weights were derived in two steps.

2.1 Step 1: Weighting n=22,578 data set by n=36,927 data set (i.e. NZDep91 scores nonmissing)

The number of mortality records in each of 243 separate demographic strata were determined for the mortality records with non-missing NZDep91 scores in the eligible and unlock data sets, n=36,927 and 22,578 respectively. (Note that 4,383 of the 41,310 eligible mortality records (10.6%) had no available NZDep91, and that 12 of the 22,590 mortality records selected for the numerator-denominator analyses (0.05%) had no available NZDep91.)

For non-Maori non-Pacific decedents (according to NMDS ethnicity) there were 160 strata formed by cross classifying sex by the five age-groups (0-14, 15-24, 25-44, 45-64, and 65-74 years) by the four regional health authority areas (Northern, Midland, Central, and Southern) by four categories of NZDep91 (deciles 1-4, 5-6, 7-8, and 9-10), i.e. $160 = 2 \times 5 \times 4 \times 4$. For Maori and Pacific decedents it was not possible to stratify this thinly due to small numbers in many strata that would have made the weights unstable. Thus, the categories were aggregated to ensure that no strata had less than 3 decedents on the n=22,578 data set, and in most instances more than 10. For Maori, 68 strata were created by:

- combining sexes, and by aggregating RHAs as [Northern and Midland] and [Central and Southern], and NZDep91 as [deciles 1-8] and [deciles 9-10], for 0-14 and 15-24 year olds
- aggregating RHAs as [Northern], [Midland] and [Central and Southern], and NZDep91 as [deciles 1-6] [deciles 7-8] and [deciles 9-10], for 25-44 and 65-74 year olds

- aggregating RHAs as [Northern], [Midland] and [Central and Southern], but leaving NZDep91 as the four levels, for 45-64 year olds.

For Pacific decedents, only 15 strata were created. For each age-group sexes and RHAs were combined, and NZDep91 aggregated as:

- [deciles 1-8] and [deciles 9-10] for 0-14 and 15-24 year olds
- [decile 1-6], [deciles 7-8] and [deciles 9-10] 25-44 year olds
- the four default levels for 45-64 and 65-74 year olds.

For each of these 243 total strata, the number of deaths in the n=36,927 data set was divided by the number of deaths in the n=22,578 data set to get a stratum specific weight.

2.2 Step 2: Weighting n=36,927 data set by n=41,310 data set (i.e. NZDep91 scores missing)

A second weight was calculated for the demographic (sex, age, ethnicity and RHA) distribution in the full eligible mortality data set (n=41,310) compared to the 36,927 eligible mortality records with a NZDep91 value. A total of 90 strata were formed, 40 each for Maori and non-Maori non-Pacific (sex [2] by age-group [5] by RHA [4] = 40). For Pacific decedents, RHA was simply disregarded making 10 strata.

The product of the above two weights was then assigned to each mortality record in the n=22,578 data set. Note that the weighted frequencies of age-group and ethnicity (death registration form) on the unlock data set gave the same frequency distribution as that unweighted for all eligible mortality records. However, the weighted distribution by sex was not quite identical due to combining sexes in some instances during the weighting algorithms.

3 Numerator-denominator analyses

The 1991 census coded up to three different self-identified ethnic groups for each person. The sole ethnic group was allocated as Maori if the census form stated only one self-

identified ethnic group, and that was Maori. The sole group was allocated as Pacific if the census form stated only one self-identified ethnic group, and that was Pacific. The remainder were assigned as non-Maori non-Pacific. The prioritised ethnic group was assigned as Maori if any one of the self-identified ethnic groups was Maori. For those not allocated as Maori, the prioritised ethnic group was assigned as Pacific if any one of the self-identified ethnic groups was Pacific. The remainder were assigned as non-Maori non-Pacific.

The numerator-denominator bias was simply determined by cross classifying the death registration form ethnicity by the census sole or prioritised ethnicity. Further, this cross-classification (for sole census ethnicity only) was conducted by strata of sex, age, RHA, and small area deprivation to determine heterogeneity of the numerator-denominator bias. All cross-classifications were conducted with weighted data, thus generating tables with total counts the same as those for the full eligible mortality data-set. The numerator-denominator bias was expressed as the ratio of the census to mortality data counts.

Chapter 3: Archive of adjustment ratios

1 NMDS death registration form and NHI file ethnicity to census ratios, non-stratified

Table 1 (NMDS death registration form ethnicity) was presented in the NZMJ paper, but not Table 2 (NHI file ethnicity).

Table 1: Death registration form ethnicity by census sole and prioritised ethnicity, for 1991-94 mortality records linked to a 1991 census record

Census Ethnic group	Death registration form ethnicity			Total	Census to mortality ratio [†]
	Maori	Pacific	non-M non-P		
<i>Sole</i>					
Maori	3,162	6	1,314	4,482	1.29
Pacific People	12	618	474	1,101	1.68
Non-M non-P	300	30	35,397	35,727	0.96
Total	3,471	654	37,182	41,310	
<i>Prioritised</i>					
Maori	3,342	12	1,719	5,076	1.46
Pacific People	12	639	513	1,164	1.78
Non-M non-P	120	6	34,947	35,070	0.94
Total	3,471	654	37,182	41,310	

All numbers in table are weighted, and then random rounded to a multiple of three as per Statistics New Zealand protocol. Minimum cell size is 6.

[†] The census to mortality ratio is the census total divided by the death registration form total, e.g. for Maori sole ethnicity $1.29 = 4,482/3,471$. As such, 1.29 is the correction factor to apply to 1991-1994 ethnic specific mortality rates calculated using sole ethnicity as the denominator.

Table 2: NHI file ethnicity by census sole and prioritised ethnicity, for 1991-94 mortality records linked to a 1991 census record

Census Ethnic group	NHI file ethnicity			Total	Census to mortality ratio [†]
	Maori	Pacific	non-M non-P		
<i>Sole</i>					
Maori	3,525	12	882	4,422	1.12
Pacific People	9	879	207	1,095	1.19
non-M non-P	420	36	33,795	34,254	0.98
Total	3,954	924	34,881	39,765	
<i>Prioritised</i>					
Maori	3,768	15	1,209	4,989	1.26
Pacific People	9	900	246	1,158	1.25
non-M non-P	174	12	33,432	33,621	0.96
Total	3,954	924	34,881	39,765	

All numbers in table are weighted, and then random rounded to a multiple of three as per Statistics New Zealand protocol. Minimum cell size is 6.

[†] The census to mortality ratio is the census total divided by the NHI file ethnicity total, e.g. for Maori sole ethnicity $1.12 = 4,422/3,954$. As such, 1.12 is the correction factor to apply to 1991-1994 ethnic specific mortality rates calculated using sole ethnicity as the denominator.

2 NMDS death registration form ethnicity to census ratios, one level of stratification

Other than those tables by sex and cause of death, these tables are published in the NZMJ paper.

Table 3: Number of deaths by death registration form ethnicity, and census sole and prioritised ethnicity, stratified by sex

Sex	Ethnic group	Death reg form	Census sole	Census prioritised	Census sole to death reg ratio
Males	Maori	2,034	2,658	3,006	1.31
	Pacific People	399	678	708	1.70
	non-M non-P	22,773	21,864	21,486	0.96
	Total	25,200	25,200	25,200	
Females	Maori	1,440	1,824	2,070	1.27
	Pacific People	255	423	456	1.66
	non-M non-P	14,409	13,863	13,584	0.96
	Total	16,107	16,107	16,107	

All numbers in table are weighted, and then random rounded to a multiple of three as per Statistics New Zealand protocol. Minimum cell size is 6.

The true ratio (calculated without random rounding due to Statistics New Zealand protocol) was within plus or minus 0.05 of the given ratio.

Table 4: Number of deaths stratified by age by: death registration form ethnicity, census sole ethnicity, and census prioritised ethnicity

Age group	Ethnic group	Death reg form	Census sole	Census prioritised	Census sole to death reg ratio
0-14 years	Maori	96	183	243	1.91*
	Pacific People	45	72	81	1.60**
	non-M non-P	687	573	507	0.83
	Total	831	831	831	
15-24 years	Maori	210	315	417	1.50
	Pacific People	45	84	93	1.87**
	non-M non-P	1,512	1,368	1,251	0.90
	Total	1,764	1,764	1,764	
25-44 years	Maori	582	819	912	1.41
	Pacific People	117	219	225	1.87
	non-M non-P	3,510	3,171	3,066	0.90
	Total	4,206	4,206	4,206	
45-64 years	Maori	1,713	2,160	2,373	1.26
	Pacific People	273	450	468	1.65
	non-M non-P	12,933	12,309	12,078	0.95
	Total	14,922	14,922	14,922	
65-74 years	Maori	873	1,005	1,128	1.15
	Pacific People	171	279	291	1.63
	non-M non-P	18,537	18,303	18,165	0.99
	Total	19,584	19,584	19,584	

All numbers in table are weighted, and then random rounded to a multiple of three as per Statistics New Zealand protocol. Unless indicated with an asterix(es), the true ratio (calculated without random rounding due to Statistics New Zealand protocol) was within plus or minus 0.05 of the given ratio.

* Due to Statistics New Zealand random rounding protocol, the true ratio may be as much as 0.1 above or below the given ratio.

** The true ratio may be as much as 0.2 above or below the given ratio.

Unlocking the Numerator-Denominator Bias, 1991-94 Deaths

Table 5: Number of deaths stratified by small area deprivation by: death registration form ethnicity, census sole ethnicity, and census prioritised ethnicity

Decile of NZDep91	Ethnic group	Death reg form	Census sole	Census prioritised	Census sole to death reg ratio
Deciles 1-4	Maori	276	408	513	1.48
	Pacific People	45	66	78	1.47**
	non-M non-P	13,020	12,867	12,747	0.99
	Total	13,341	13,341	13,341	
Deciles 5-6	Maori	438	522	615	1.19
	Pacific People	66	120	126	1.82*
	non-M non-P	7,344	7,209	7,107	0.98
	Total	7,848	7,848	7,848	
Deciles 7-8	Maori	837	1,044	1,221	1.25
	Pacific People	144	237	264	1.65
	non-M non-P	8,334	8,034	7,833	0.96
	Total	9,315	9,315	9,315	
Deciles 9-10	Maori	1,917	2,508	2,724	1.31
	Pacific People	402	681	696	1.69
	non-M non-P	8,484	7,614	7,383	0.90
	Total	10,806	10,806	10,806	

All numbers in table are weighted, and then random rounded to a multiple of three as per Statistics New Zealand protocol. Unless indicated with an asterix(es), the true ratio (calculated without random rounding due to Statistics New Zealand protocol) was within plus or minus 0.05 of the given ratio.

* Due to Statistics New Zealand random rounding protocol, the true ratio may be as much as 0.1 above or below the given ratio.

** The true ratio may be as much as 0.2 above or below the given ratio.

Table 6: Number of deaths stratified by regional health authority by: death registration form ethnicity, census sole ethnicity, and census prioritised ethnicity (Maori/non-Maori breakdown)

RHA	Ethnic group	Death reg form	Census sole	Census prioritised	Census sole to death reg ratio
Northern	Maori	1,284	1,464	1,647	1.14
	non-M non-P	10,635	10,134	9,915	0.95
	Total	12,390	12,390	12,390	
Midland	Maori	1,512	1,767	1,929	1.17
	non-M non-P	7,218	6,945	6,777	0.96
	Total	8,775	8,775	8,775	
Central	Maori	543	984	1,137	1.81
	non-M non-P	9,834	9,336	9,168	0.95
	Total	10,518	10,518	10,518	
Southern	Maori	132	267	360	2.02
	non-M non-P	9,495	9,309	9,213	0.98
	Total	9,630	9,630	9,630	

All numbers in table are weighted, and then random rounded to a multiple of three as per Statistics New Zealand protocol. The true ratio (calculated without random rounding due to Statistics New Zealand protocol) was within plus or minus 0.05 of the given ratio.

Table 7: Number of deaths stratified by regional health authority by: death registration form ethnicity, census sole ethnicity, and census prioritised ethnicity (Maori/Pacific People/non-Maori non-Pacific breakdown)

RHA	Ethnic group	Death reg form	Census sole	Census prioritised	Census sole to death reg ratio
Northern	Maori	1,284	1,464	1,647	1.14
	Pacific People	474	792	828	1.67
	non-M non-P	10,635	10,131	9,915	0.95
	Total	12,390	12,390	12,390	
Midland	Maori	1,512	1,767	1,929	1.17
	Pacific People	42	63	69	1.50**
	non-M non-P	7,221	6,945	6,777	0.96
	Total	8,775	8,775	8,775	
Central/Sth.	Maori	675	1,248	1,500	1.85
	Pacific People	141	249	270	1.77
	non-M non-P	19,329	18,648	18,378	0.96
	Total	20,145	20,145	20,145	

All numbers in table are weighted, and then random rounded to a multiple of three as per Statistics New Zealand protocol. Unless indicated with an asterix(es), the true ratio (calculated without random rounding due to Statistics New Zealand protocol) was within plus or minus 0.05 of the given ratio.

** Due to Statistics New Zealand random rounding protocol, the true ratio may be as much as 0.2 above or below the given ratio.

Unlocking the Numerator-Denominator Bias, 1991-94 Deaths

Table 8: Number of deaths by death registration form ethnicity, and census sole and prioritised ethnicity, stratified by cause of death among 25-64 and 65-74 year olds

Cause of death	Ethnic group	Death reg form	Census sole	Census prioritised	Census sole to death reg ratio
<i>25-64 year olds</i>					
Cancer	Maori	723	885	1,008	1.22
	Pacific People	96	189	195	1.97*
	non-M non-P	6,957	6,705	6,576	0.96
	Total	7,779	7,779	7,779	
CVD	Maori	831	1,125	1,218	1.35
	Pacific People	195	309	321	1.58
	non-M non-P	5,448	5,040	4,935	0.93
	Total	6,477	6,477	6,477	
Other	Maori	741	966	1,059	1.30
	Pacific People	96	174	180	1.81*
	non-M non-P	4,035	3,735	3,636	0.93
	Total	4,872	4,872	4,872	
<i>65-74 year olds</i>					
Cancer	Maori	246	288	324	1.17
	Pacific People	60	96	99	1.60*
	non-M non-P	6,435	6,357	6,321	0.99
	Total	6,744	6,744	6,744	
CVD	Maori	399	450	522	1.13
	Pacific People	75	117	126	1.56*
	non-M non-P	8,556	8,460	8,379	0.99
	Total	9,027	9,027	9,027	
Other	Maori	225	264	282	1.17
	Pacific People	36	66	66	1.83**
	non-M non-P	3,552	3,486	3,462	0.98
	Total	3,813	3,813	3,813	

Unless indicated with an asterix(es), the true ratio (calculated without random rounding due to Statistics New Zealand protocol) was within plus or minus 0.05 of the given ratio.

* Due to Statistics New Zealand random rounding protocol, the true ratio may be as much as 0.1 above or below the given ratio.

** The true ratio may be as much as 0.2 above or below the given ratio.

3 NMDS death registration form ethnicity to census ratios, two levels of stratification

Table 9: Number of MALE deaths stratified by age by: death registration form ethnicity, census sole ethnicity, and census prioritised ethnicity

Age group	Ethnic group	Death reg form	Census sole	Census prioritised	Census sole to death reg ratio
<i>Males</i>					
0-14 years	Maori	60	102	141	1.70*
	Pacific People	30	51	54	1.70**
	non-M non-P	411	348	309	0.85
	Total	501	501	501	
15-24 years	Maori	156	231	306	1.48
	Pacific People	15	60	66	4.00***
	non-M non-P	1,143	1,029	945	0.90
	Total	1,314	1,314	1,314	
25-44 years	Maori	366	528	591	1.44
	Pacific People	66	99	102	1.50*
	non-M non-P	2,229	2,034	1,971	0.91
	Total	2,661	2,661	2,661	
45-64 years	Maori	954	1,212	1,329	1.27
	Pacific People	174	309	315	1.78
	non-M non-P	8,037	7,641	7,515	0.95
	Total	9,162	9,162	9,162	
65-74 years	Maori	498	585	642	1.17
	Pacific People	111	165	174	1.49
	non-M non-P	10,953	10,812	10,749	0.99
	Total	11,559	11,559	11,559	

Unless indicated with an asterix(es), the true ratio (calculated without random rounding due to Statistics New Zealand protocol) was within plus or minus 0.05 of the given ratio.

* Due to Statistics New Zealand random rounding protocol, the true ratio may be as much as 0.1 above or below the given ratio.

** The true ratio may be as much as 0.2 above or below the given ratio.

*** The true ratio may be as much as 0.77 above or below the given ratio.

Table 10: Number of FEMALE deaths stratified by age by: death registration form ethnicity, census sole ethnicity, and census prioritised ethnicity

Age group	Ethnic group	Death reg form	Census sole	Census prioritised	Census sole to death reg ratio
Females					
0-14 years	Maori	39	81	102	2.08**
	Pacific People	12	21	27	1.75***
	non-M non-P	276	225	198	0.82
	Total	330	330	330	
15-24 years	Maori	51	87	111	1.71**
	Pacific People	27	21	30	0.78**
	non-M non-P	369	342	306	0.93
	Total	450	450	450	
25-44 years	Maori	216	291	324	1.35
	Pacific People	51	120	126	2.35**
	non-M non-P	1,278	1,134	1,095	0.89
	Total	1,545	1,545	1,545	
45-64 years	Maori	759	948	1,044	1.25
	Pacific People	102	144	150	1.41
	non-M non-P	4,899	4,668	4,563	0.95
	Total	5,760	5,760	5,760	
65-74 years	Maori	378	420	486	1.11
	Pacific People	63	114	120	1.81*
	non-M non-P	7,587	7,494	7,416	0.99
	Total	8,025	8,025	8,025	

All numbers in table are weighted, and then random rounded to a multiple of three as per Statistics New Zealand protocol. Unless indicated with an asterix(es), the true ratio (calculated without random rounding due to Statistics New Zealand protocol) was within plus or minus 0.05 of the given ratio.

* Due to Statistics New Zealand random rounding protocol, the true ratio may be as much as 0.1 above or below the given ratio.

** The true ratio may be as much as 0.2 above or below the given ratio.

*** The true ratio may be as much as 0.55 above or below the given ratio.

Table 11: Number of deaths stratified by sex and small area deprivation by: death registration form ethnicity, census sole ethnicity, and census prioritised ethnicity

Decile of NZDep91	Ethnic group	Death reg form	Census sole	Census prioritised	Census sole to death reg ratio
Males					
Deciles 1-4	Maori	174	237	303	1.36
	Pacific People	24	45	51	1.88***
	non-M non-P	7,989	7,905	7,833	0.99
	Total	8,187	8,187	8,187	
Deciles 5-6	Maori	279	324	384	1.16
	Pacific People	36	57	57	1.58**
	non-M non-P	4,494	4,425	4,365	0.98
	Total	4,809	4,809	4,809	
Deciles 7-8	Maori	504	639	741	1.27
	Pacific People	96	153	165	1.59*
	non-M non-P	5,067	4,875	4,752	0.96
	Total	5,664	5,664	5,664	
Deciles 9-10	Maori	1,080	1,458	1,578	1.35
	Pacific People	246	429	435	1.74
	non-M non-P	5,223	4,662	4,530	0.89
	Total	6,543	6,543	6,543	
Females					
Deciles 1-4	Maori	102	171	213	1.68*
	Pacific People	21	21	27	1.00***
	non-M non-P	5,031	4,962	4,911	0.99
	Total	5,157	5,157	5,157	
Deciles 5-6	Maori	159	195	231	1.23
	Pacific People	30	63	69	2.10***
	non-M non-P	2,850	2,781	2,742	0.98
	Total	3,042	3,042	3,042	
Deciles 7-8	Maori	336	405	477	1.21
	Pacific People	48	84	96	1.75**
	non-M non-P	3,267	3,162	3,078	0.97
	Total	3,651	3,651	3,651	
Deciles 9-10	Maori	840	1,050	1,149	1.25
	Pacific People	156	255	261	1.63
	non-M non-P	3,261	2,955	2,850	0.91
	Total	4,260	4,260	4,260	

All numbers in table are weighted, and then random rounded to a multiple of three as per Statistics New Zealand protocol. Unless indicated with an asterix(es), the true ratio (calculated without random rounding due to Statistics New Zealand protocol) was within plus or minus 0.05 of the given ratio.

* Due to Statistics New Zealand random rounding protocol, the true ratio may be as much as 0.1 above or below the given ratio.

** The true ratio may be as much as 0.2 above or below the given ratio.

*** The true ratio may be as much as 0.22 above or below the given ratio.

Table 12: Number of deaths stratified by sex and regional health authority by: death registration form ethnicity, census sole ethnicity, and census prioritised ethnicity

RHA	Ethnic group	Death reg form	Census sole	Census prioritised	Census sole to death reg ratio
Males					
Northern	Maori	783	894	1,005	1.14
	Pacific People	297	480	498	1.62
	non-M non-P	6,465	6,171	6,039	0.95
	Total	7,545	7,545	7,545	
Midland	Maori	843	1,005	1,095	1.19
	Pacific People	18	39	39	2.17***
	non-M non-P	4,479	4,299	4,206	0.96
	Total	5,343	5,343	5,343	
Central/Sth.	Maori	405	759	903	1.87
	Pacific People	81	162	171	2.00*
	non-M non-P	11,826	11,394	11,238	0.96
	Total	12,315	12,315	12,315	
Females					
Northern	Maori	501	570	645	1.14
	Pacific People	174	315	330	1.81
	non-M non-P	4,170	3,960	3,873	0.95
	Total	4,845	4,845	4,845	
Midland	Maori	669	762	834	1.14
	Pacific People	24	24	30	1.00**
	non-M non-P	2,739	2,646	2,571	0.97
	Total	3,435	3,435	3,435	
Central/Sth.	Maori	270	492	594	1.82
	Pacific People	60	87	99	1.45*
	non-M non-P	7,500	7,254	7,140	0.97
	Total	7,830	7,830	7,830	

All numbers in table are weighted, and then random rounded to a multiple of three as per Statistics New Zealand protocol. Unless indicated with an asterix(es), the true ratio (calculated without random rounding due to Statistics New Zealand protocol) was within plus or minus 0.05 of the given ratio.

* Due to Statistics New Zealand random rounding protocol, the true ratio may be as much as 0.1 above or below the given ratio.

** The true ratio may be as much as 0.2 above or below the given ratio.

*** The true ratio may be as much as 0.4 above or below the given ratio.

Unlocking the Numerator-Denominator Bias, 1991-94 Deaths

Table 13: Number of deaths stratified by age and small area deprivation by: death registration form ethnicity, census sole ethnicity, and census prioritised ethnicity. 0-44 year olds

Decile of NZDep91	Ethnic group	Death reg form	Census sole	Census prioritised	Census sole to death reg ratio
0-24 years					
Deciles 1-4	Maori	18	42	72	2.33***
	Pacific People	†	†	†	-
	non-M non-P	660	636	603	0.96
	Total	684	684	684	
Deciles 5-6	Maori	33	45	69	1.36**
	Pacific People	9	9	9	1.00****
	non-M non-P	444	432	405	0.97
	Total	486	486	486	
Deciles 7-8	Maori	66	105	144	1.59*
	Pacific People	21	27	36	1.29***
	non-M non-P	489	444	393	0.91
	Total	573	573	573	
Deciles 9-10	Maori	189	309	375	1.63
	Pacific People	57	114	120	2.00**
	non-M non-P	609	432	357	0.71
	Total	852	852	852	
25-44 years					
Deciles 1-4	Maori	42	78	93	1.86**
	Pacific People	†	†	†	-
	non-M non-P	1,185	1,152	1,131	0.97
	Total	1,230	1,230	1,230	
Deciles 5-6	Maori	66	75	90	1.14*
	Pacific People	18	27	27	1.50***
	non-M non-P	660	645	633	0.98
	Total	747	747	747	
Deciles 7-8	Maori	141	204	231	1.45
	Pacific People	24	39	42	1.63***
	non-M non-P	777	699	669	0.90
	Total	945	945	945	
Deciles 9-10	Maori	333	459	501	1.38
	Pacific People	69	150	153	2.17*
	non-M non-P	882	675	633	0.77
	Total	1,287	1,287	1,287	

Unless indicated with an asterix(es), the true ratio (calculated without random rounding due to Statistics New Zealand protocol) was within plus or minus 0.05 of the given ratio.

* Due to Statistics New Zealand random rounding protocol, the true ratio may be as much as 0.1 above or below the given ratio.

** The true ratio may be as much as 0.2 above or below the given ratio.

*** The true ratio may be as much as 0.42 above or below the given ratio.

**** The true ratio may be as much as 1.57 or as small as 0.64.

† = whilst the numbers satisfied SNZ protocols, they were too inaccurate for calculation of adjustment ratios.

Table 14: Number of deaths stratified by age and small area deprivation by: death registration form ethnicity, census sole ethnicity, and census prioritised ethnicity. 45-74 year olds

Decile of NZDep91	Ethnic group	Death reg form	Census sole	Census prioritised	Census sole to death reg ratio
45-64 years					
Deciles 1-4	Maori	135	186	225	1.38
	Pacific People	18	33	42	1.83***
	non-M non-P	4,623	4,557	4,509	0.99
	Total	4,779	4,779	4,779	
Deciles 5-6	Maori	225	279	318	1.24
	Pacific People	24	54	57	2.25***
	non-M non-P	2,451	2,364	2,325	0.96
	Total	2,700	2,700	2,700	
Deciles 7-8	Maori	393	471	525	1.20
	Pacific People	63	105	108	1.67*
	non-M non-P	2,769	2,655	2,589	0.96
	Total	3,225	3,225	3,225	
Deciles 9-10	Maori	960	1,224	1,302	1.28
	Pacific People	165	258	264	1.56
	non-M non-P	3,090	2,733	2,652	0.88
	Total	4,218	4,218	4,218	
65-74 years					
Deciles 1-4	Maori	81	105	123	1.30*
	Pacific People	15	24	21	1.60***
	non-M non-P	6,552	6,525	6,501	1.00
	Total	6,648	6,648	6,648	
Deciles 5-6	Maori	114	120	138	1.05
	Pacific People	12	33	33	2.75****
	non-M non-P	3,789	3,768	3,747	0.99
	Total	3,918	3,918	3,918	
Deciles 7-8	Maori	240	267	321	1.11
	Pacific People	39	69	72	1.77**
	non-M non-P	4,296	4,239	4,179	0.99
	Total	4,572	4,572	4,572	
Deciles 9-10	Maori	438	516	546	1.18
	Pacific People	105	156	159	1.49
	non-M non-P	3,903	3,771	3,741	0.97
	Total	4,449	4,449	4,449	

Unless indicated with an asterix(es), the true ratio (calculated without random rounding due to Statistics New Zealand protocol) was within plus or minus 0.05 of the given ratio.

* Due to Statistics New Zealand random rounding protocol, the true ratio may be as much as 0.1 above or below the given ratio.

** The true ratio may be as much as 0.2 above or below the given ratio.

*** The true ratio may be as much as 0.4 above or below the given ratio.

**** The true ratio may be as much as 0.75 above or below the given ratio.

Table 15: Number of deaths stratified by age and regional health authority by: death registration form ethnicity, census sole ethnicity, and census prioritised ethnicity. 0-44 year olds

RHA	Ethnic group	Death reg form	Census sole	Census prioritised	Census sole to death reg ratio
0-14 years					
Northern	Maori	27	36	48	1.33**
	Pacific People	36	54	60	1.50**
	non-M non-P	198	171	153	0.86
	Total	258	258	258	
Midland	Maori	51	84	105	1.65**
	Pacific People	†	†	†	-
	non-M non-P	156	120	105	0.77
	Total	210	210	210	
Central/Sth.	Maori	24	60	93	2.50***
	Pacific People	†	†	†	-
	non-M non-P	333	285	252	0.86
	Total	363	363	363	
15-24 years					
Northern	Maori	93	111	135	1.19
	Pacific People	27	54	51	2.00***
	non-M non-P	399	357	330	0.89
	Total	519	519	519	
Midland	Maori	75	96	117	1.28*
	Pacific People	†	†	†	-
	non-M non-P	315	291	267	0.92
	Total	393	393	393	
Central/Sth.	Maori	42	111	165	2.64**
	Pacific People	15	24	33	1.60***
	non-M non-P	798	717	657	0.90
	Total	849	849	849	
25-44 years					
Northern	Maori	213	264	303	1.24
	Pacific People	78	153	162	1.96*
	non-M non-P	1,146	1,017	969	0.89
	Total	1,434	1,434	1,434	
Midland	Maori	246	306	333	1.24
	Pacific People	15	15	18	1.00***
	non-M non-P	681	618	591	0.91
	Total	939	939	939	
Central/Sth.	Maori	123	249	276	2.02
	Pacific People	27	48	51	1.78***
	non-M non-P	1,683	1,536	1,509	0.91
	Total	1,833	1,833	1,833	

See footnotes to Table 16.

Table 16: Number of deaths stratified by age and regional health authority by: death registration form ethnicity, census sole ethnicity, and census prioritised ethnicity. 45-74 year olds

RHA	Ethnic group	Death reg form	Census sole	Census prioritised	Census sole to death reg ratio
45-64 years					
Northern	Maori	654	741	810	1.13
	Pacific People	186	306	324	1.65
	non-M non-P	3,765	3,561	3,471	0.95
	Total	4,608	4,608	4,608	
Midland	Maori	741	840	900	1.13
	Pacific People	18	27	27	1.50***
	non-M non-P	2,502	2,394	2,337	0.96
	Total	3,261	3,261	3,261	
Central/Sth.	Maori	318	582	663	1.83
	Pacific People	72	117	120	1.63*
	non-M non-P	6,663	6,354	6,270	0.95
	Total	7,050	7,050	7,050	
65-74 years					
Northern	Maori	300	318	348	1.06
	Pacific People	144	222	228	1.54
	non-M non-P	5,127	5,028	4,992	0.98
	Total	5,568	5,568	5,568	
Midland	Maori	402	438	474	1.09
	Pacific People	†	†	†	-
	non-M non-P	3,564	3,522	3,483	0.99
	Total	3,969	3,969	3,969	
Central/Sth.	Maori	171	249	306	1.46
	Pacific People	27	48	51	1.78***
	non-M non-P	9,852	9,753	9,693	0.99
	Total	10,047	10,047	10,047	

All numbers in table are weighted, and then random rounded to a multiple of three as per Statistics New Zealand protocol. Unless indicated with an asterix(es), the true ratio (calculated without random rounding due to Statistics New Zealand protocol) was within plus or minus 0.05 of the given ratio.

* Due to Statistics New Zealand random rounding protocol, the true ratio may be as much as 0.1 above or below the given ratio.

**The true ratio may be as much as 0.2 above or below the given ratio.

*** The true ratio may be as much as 0.4 above or below the given ratio.

† = whilst the numbers satisfied SNZ protocol, they were too inaccurate for calculation of adjustment ratios.

Chapter 4: Residual bias, and sensitivity analysis

1 Possible residual biases in the numerator-denominator analyses

54.7% of the eligible mortality records overall were available for the numerator-denominator analyses, and the percentage varied by ethnic group (on the NMDS death registration form): 34.5% for Maori, 35.7% for Pacific people and 56.9% for non-Maori non-Pacific. The weighting method described above using multiple strata should mitigate against any systematic biases that could arise in the numerator-denominator analyses. However, there may still be some residual bias such that within the strata used for weighting the distribution of census self-identified ethnicity might differ for the available mortality records (n=22,578) compared to all eligible mortality records (n=41,310).

Procedurally, that residual bias may occur at three different stages that resulted in attrition of the final data set:

1. the failure to link 9,675 (23.4% of 41,310) of the eligible mortality records at all in the NZCMS
2. the exclusion of 6,324 (15.3%) linked mortality records that were not linked in Pass 1 of the linkage ¹
3. and the exclusion of 2,721 (6.5%) linked mortality records from Pass 1 that were not exact matches on sex, DOB, and country of birth.

(There were also an additional 12 mortality records in the n=22,590 data set that had no NZDep91 score, but their impact would have been negligible and is not considered further here.)

For residual bias in the numerator-denominator analyses to occur requires that the exclusion processes above are selective for decedents with characteristics that influence how they would have self-identified their ethnicity on the census, *within the strata used for weighting*. What might plausibly be some of these characteristics? We consider four: residential mobility, rurality, quality of census and mortality data, and socio-economic status (not captured by NZDep91).

Residential mobility

Without doubt, decedents that were excluded from the final data set were more likely to have moved residence between census night and death. However, it is also important to note that for the 9,675 mortality records not linked at all to a census record (i.e. Step 1 above), mobility was *not* the main reason. This finding can be deduced from Figure 10 (page 95) of the linkage Technical Report.¹ This Figure demonstrates that the record linkage success in the first six months was only 79.3%, and that it dropped to 72.8% in the last six-months of follow-up. *A priori*, we were expecting higher linkage success in the first six months, and a more rapid decline over time. Our expectation was based on assuming that residential mobility would be the major limiting factor to the record linkage. However, what this Figure actually suggests is that the major limiting factor to the record linkage was coding errors on one or other of the census and mortality data. Those coding errors could occur at many stages, and would therefore be cumulative. For example, the address on the death registration form might be incorrect, an individual respondent might put their wrong month of birth on the census form, a coder might transcribe a number incorrectly at either SNZ (census) or NZHIS (mortality), or the meshblock for the mortality record might be coded incorrectly.

Residential mobility would have been an influence at Step 2 above as Pass 1 required that people had not moved between census and death, whereas some of the later Passes (Passes 3 and 4) used geocodes for points in time closer to census night. However, only 1,457 mortality records were linked as a result of these two Passes.

Residential mobility would not have been a factor for Step 3 above.

If residential mobility was causing bias in our numerator-denominator analyses, then we would expect residential mobility to be associated with ethnicity. However, 1991 census data demonstrates that this is not the case within age-groups (Table 17 below). Whilst this does not totally remove the possibility of bias in our analyses due to residential mobility (e.g. the data in Table 17 below are for total or prioritised Maori ethnic group, not sole Maori), it does indicate that any bias due to residential mobility is probably minor if not negligible.

Table 17: Years at usual residence according to 1991 census for Maori and all New Zealanders, by three age-groups

		Years at usual address,	
		Less than 1	1 – 5
20-24 year olds	Maori (total or prioritised)	38.0%	31.4%
	All New Zealanders	43.2%	32.7%
40-44 year olds	Maori (total or prioritised)	14.1%	30.5%
	All New Zealanders	13.7%	36.0%
60-64 year olds	Maori (total or prioritised)	7.8%	21.1%
	All New Zealanders	7.8%	26.7%

Rurality

Because of the reliance of the record linkage on geocodes (in particular meshblocks), and the fact that fewer rural decedents were linked to a census record (see Table 20, page 103, Technical Report on record linkage ¹), rurality may cause bias in our numerator-denominator analyses. However, 1991 census data demonstrates that Maori (18%) are only marginally more likely to live in a rural area than non-Maori (15%).³

Socio-economic status (not captured by NZDep91)

The analysis of bias in the record linkage demonstrated that there was a modest association of NZDep91 with the probability of being linked to a census record.^{1 2} Thus, decedents that were living in more deprived small areas were 5-10% less likely to be linked to a census record than decedents living in the least deprived areas, controlling for age, sex, and ethnicity. Whilst we have weighted by strata of NZDep91, it is likely that

there may be residual bias by other socio-economic factors not captured by NZdep91 as to the likelihood of being included in the final data set. This possibility is supported by the finding that NZSEI occupational class was still associated with the probability of being linked to a census record *independently* of NZDep91, although there was only a notably reduced linkage for the lowest occupational class.^{1 2}

Additionally, socio-economic status is associated with ethnicity.

Thus, it seems plausible that socio-economic status might differ between those in the final data set compared to all eligible mortality, and that consequently the census self-identified ethnicity might differ.

Quality of data

Poor quality data for geocodes, sex, DOB, and country of birth on either census or mortality data was the main reason for exclusions from the final data set.

Was the quality of census or mortality data associated with census self-identified ethnicity, *within* strata of NMDS ethnicity, sex, age, RHA and NZDep91 group? Probably. Maori (according to NMDS ethnicity) were much less likely to be in the final data set (34.5%) than non-Maori non-Pacific (56.9%). Given the above discussion, it seems unlikely that rurality, mobility and socio-economic status (and the variables used for weighting) would totally explain this discrepancy.

2 Sensitivity analysis

In this section we present two sensitivity analyses about the numerator-denominator bias adjustment ratio for ‘sole’ Maori.

2.1 Overall sensitivity analysis

Table 18 below shows the distribution of NMDS ethnicity by census sole ethnicity for the raw data (n=22,590), the weighted data (n=41,310), and weighted minus raw data (n=18720). (The cross-classification for the weighted data set was shown previously in Table 1, page 14).

Table 18: Death registration form ethnicity by census sole ethnicity, for 1991-94 mortality records linked to a 1991 census record: raw data, weighted data, difference between weighted and raw data

Census Ethnic group	Death registration form ethnicity			Total	Census to mortality ratio [†]
	Maori	Pacific	Non-M non-P		
<i>Raw data</i>					
Maori	1,086	6	654	1,746	1.46
Pacific People	6	216	231	453	1.94
Non-M non-P	105	12	20,274	20,391	0.96
Total	1197	234	21,159	22,590	
<i>Weighted data</i>					
Maori	3,162	6	1,314	4,482	1.29
Pacific People	12	618	474	1,101	1.68
Non-M non-P	300	30	35,397	35,727	0.96
Total	3,471	654	37,182	41,310	
<i>Weighted minus raw data</i>					
Maori	2,076 (A)	0	660 (C)	2,736	1.20
Pacific People	6	402	243	648	1.54
Non-M non-P	195 (B)	18	15,123 (D)	15,336	0.96
Total	2,277 (A+B+6)	420	16,026 (C+D+243)	18,720	

The cross-classification in the last panel of Table 18 is, essentially, our estimate of the cross-classification for those mortality records (n=18,720) that were excluded from the numerator-denominator analyses. The death registration form column totals for Maori (n=2,277) and non-Maori non-Pacific (n=16,026) are fixed – they are the number of excluded mortality records from the numerator-denominator analyses. If we ignore the Pacific decedents' row, then we are able to conduct a relatively simple sensitivity analysis of the numerator-denominator results by considering plausible alternatives for: the distributions of mortality records between cells A and B; and the distributions of mortality records between cells C and D.

Consider cells C and D. If residual bias by socio-economic status and data quality (and possibly residential mobility and rurality) was affecting the numerator-denominator analyses, what might be the net effect on these two cells? Probably an underestimate of cell C: non-Maori non-Pacific (according to NMDS) that were actually sole Maori by the census would probably be less likely to be included in the numerator-denominator analysis data set (and hence responsible for the weights) than those decedents that were non-Maori non-Pacific on both census and mortality data. For example, the former decedents would probably have on average a lower socio-economic status and hence a lower chance of getting through to the final data set. Likewise, cell A is also probably an underestimate.

The size of these underestimates of cells A and C is probably modest (if at all) due to the many strata used for weighting the numerator-denominator analyses. As a sensitivity analysis, assume that non-Maori non-Pacific people excluded from the final data set were 15% more likely to self-identify as sole Maori on the census than those included in the final data set, *across all strata used for weighting*. Thus, cell C would have actually been 759 (660×1.15) and cell D would have been 15,024. Likewise, assume cell B was overestimated by 15%, and was actually 166, and consequently cell A became 2,105. These changes to the distribution of the excluded decedents, and the affect on the overall distribution, is shown in Table 19 below. Under this sensitivity analysis, the overall numerator-denominator adjustment ratio is **1.33**, 0.04 greater than the ratio of 1.29

estimated using the weighting procedure in our denominator analyses. If rather than 15%, the difference was 7.5%, then the overall adjustment ratio would have been **1.31**. Finally, if it had been 22.5% the overall adjustment ratio would have been **1.35**.

Table 19: Sensitivity analysis, assuming among that among the excluded decedents non-Maori non-Pacific (NMDS) were 15% more likely to be sole Maori on the census, and that Maori (NMDS) were 15% less likely to be non-Maori non-Pacific on the census.

Census Ethnic group	Death registration form ethnicity			Total
	Maori	Pacific	Non-M non-P	
<i>Estimated distribution among excluded decedents</i>				
Maori	2,105 (A)	0	759 (C)	2,736
Pacific People	6	402	243	648
Non-M non-P	166 (B)	18	15,024 (D)	15,336
Total	2,277 (A+B+6)	420	16,026 (C+D+243)	18,720
<i>Raw data (i.e. distribution included decedents)</i>				
Maori	1,086	6	654	1,746
Pacific People	6	216	231	453
Non-M non-P	105	12	20,274	20,391
Total	1197	234	21,159	22,590
<i>Estimated overall distribution</i>				
Maori	3,191	6	1,413	4,610
Pacific People	12	618	474	1,101
Non-M non-P	271	30	35,298	35,599
Total	3,471	654	37,182	41,310

2.2 Sensitivity analysis stratified by age and NZDep91

The above sensitivity analysis requires a guess at the likely percentage variation in census self identified ethnicity for those excluded in the final data set compared to those included. However, we can actually use the data itself to give an upper limit to this percentage variation. 65.5% of Maori were excluded compared to 43.1% of non-Maori

non-Pacific, a ratio of 1.52. Thus, Maori (according to the NMDS ethnicity) were 52% more likely to be excluded from the final analysis data set than non-Maori non-Pacific.

Could it be that this percentage difference also applied *within* non-Maori non-Pacific (according to NMDS ethnicity) with regards to self-identified census ethnicity? That is, within non-Maori non-Pacific (NMDS) maybe those that self-identified as sole Maori on the census were 52% more likely to be excluded from the final data set compared to those that self-identified as non-Maori non-Pacific. This 52% overestimate is almost certainly a substantive overestimate, though:

- It is based on crude data – the 52% estimate varied (but was generally much lower) within strata of age, NZDep91, etc.
- The difference in probability of making the final data set between those that self-identified as Maori or non-Maori non-Pacific on the census *within* the NMDS non-Maori non-Pacific group was probably much less than that *between* the NMDS Maori and non-Maori non-Pacific groups.

These caveats issued, this method does provide an upper limit of the possible effect of residual bias. Sensitivity analyses using this method are shown in Table 20 below. The first two columns are the percentage of Maori (according to NMDS) and non-Maori non-Pacific excluded from the final data set within strata of age and NZDep91. The third column is the excess percentage of Maori excluded from the final data set than non-Maori non-Pacific. For example, for 0-14 year olds 63% divided by 52% gives 1.19, or a 19% excess. The fourth column is simply the adjustment ratios from the weighted numerator-denominator analyses shown in Table 4 and Table 5. The final two columns are the sensitivity analyses. The first of these two columns uses the excess percentages to re-estimate the numerator-denominator adjustment ratio in the same manner as for the sensitivity analyses shown above in Table 19 (workings not shown). However, this column is very likely to overestimate the adjustment ratios:

- the excess percentages used in the sensitivity analyses were not adjusted for other demographic variables (e.g. RHA, NZDep91 (if age) and age (if NZDep91)). The

excess percentage within age and NZDep91 strata further adjusted for the remaining demographic variables would have been less.

- As described above, the difference in probability of making the final data set between those that self-identified as Maori or non-Maori non-Pacific on the census *within* the NMDS non-Maori non-Pacific group was probably much less than that *between* the NMDS Maori and non-Maori non-Pacific groups.

To account for these problems, the final column uses half the excess percentage as a sensitivity analysis.

Table 20: Sensitivity analyses of numerator-denominator ratios for sole Maori by age and NZDep91

	% Maori (NMDS) excluded from final data set	% non-M non-P (NMDS) excluded	% more likely Maori excluded than non-M non-P [% more]	Maori n-d ratio as per weighted analyses	Sensitivity analyses Using [% more] Using [% more] / 2	
<i>Age group</i>						
0-14	63%	52%	19%	1.91	2.00	1.95
15-24	79%	66%	19%	1.50	1.56	1.53
25-44	66%	54%	22%	1.41	1.46	1.43
45-64	63%	42%	49%	1.26	1.31	1.29
65-74	68%	39%	73%	1.15	1.18	1.17
All ages				1.29	1.34	1.31
<i>NZDep91 deciles</i>						
1-4	68%	40%	72%	1.48	1.61	1.54
5-6	64%	42%	51%	1.19	1.22	1.21
7-8	64%	44%	44%	1.25	1.29	1.27
9-10	66%	48%	39%	1.31	1.37	1.34
All deciles				1.29	1.35	1.32

The results shown in Table 20 suggest that the upper limit for the numerator-denominator ratios was not greatly removed from that calculated using our weighting procedure.

2.3 Conclusion

It is plausible, but not certain, that the Maori sole ethnicity adjustment ratios we calculated by our weighted numerator-denominator analyses may still underestimate the true adjustment ratios. However, both sensitivity analyses above suggest that if there was residual bias in our analyses, it was likely to be relatively small.

Chapter 5: Recommendations for future numerator- denominator analyses in the NZCMS

The numerator-denominator analyses conducted for the 1991 census linkage seem robust. However, it may be possible to improve subsequent numerator-denominator analyses for the 1981, 1986 and 1996 census. We recommend that:

- future data sets to determine the numerator-denominator bias be created outside of the probabilistic record linkage process, by simply using merge statements in SAS. Linked mortality records to include in the numerator-denominator analyses would include those agreeing exactly on sex, DOB and country of birth, within either meshblocks or CAUs. Whilst including exact matches within CAUs will increase the percentage of false positive links, the gain in the percentage of Maori and Pacific mortality records will probably off-set this potential problem. Finally, a flag should be retained on the data set indicating whether the linkage was at the meshblock or CAU level to allow comparative numerator-denominator analyses.
- a similar weighting method is used.

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