



## Indigenous disparities in disease-specific mortality, a cross-country comparison: New Zealand, Australia, Canada, and the United States

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### Abstract

**Aims** To compare the disease-specific mortality rates of the indigenous populations of New Zealand, Australia, Canada, and the United States with the non-indigenous populations in each country.

**Methods** For New Zealand, Australia, Canada, and the United States, we compiled and calculated (from crude data) ethnic-specific mortality rates by primary cause of death in 1999 for the indigenous and non-indigenous populations in each country. We calculated age-adjusted mortality rates, using direct standardisation and weights based on the World Health Organization world population.

**Results** Australia experienced the largest relative and absolute disparities in life expectancy between indigenous and non-indigenous populations. For specific causes of death, New Zealand Maori, and Australian Aboriginals and Torres Strait Islanders experienced the highest levels of disparities when compared to their respective non-indigenous population group. Large disparities exist for indigenous peoples in all four countries for diabetes mortality.

**Conclusion** The indigenous peoples of New Zealand and Australia suffer from high disease-specific mortality rates. The relative size of indigenous/non-indigenous mortality disparities are highest in New Zealand and Australia. There appears to be a number of common issues that adversely affect the quality of the mortality data that is available in the four countries. Action is required to address indigenous health disparities and to improve the quality of indigenous mortality data.

### Background

Disparities in health status for the indigenous peoples of New Zealand, Australia, Canada, and the United States (US) have been well documented.<sup>1-6</sup> In each of these 'rich' countries, the indigenous peoples invariably suffer from poorer health, with an excess of early mortality and lower life expectancy when compared to the non-indigenous population.

Numerically, the indigenous populations of each country represent a small proportion of the total population. Maori represent approximately 15% of the New Zealand population, Aboriginals and Torres Strait Islanders represent 2-3% of the Australian population, American Indians and Alaskan Natives represent 1-1.5% of the US population, and Aboriginal Canadians represent 4% of the Canadian population.<sup>7-10</sup>

Although gains in health status have been made for all the indigenous peoples of these four countries, large disparities remain. In New Zealand, a recent report has highlighted that although life expectancy has improved dramatically for non-Maori

non-Pacific people, Maori life expectancy has remained largely static, leading to a relative increase in the life expectancy disparity experienced by Maori.<sup>11</sup> In particular, Maori disease specific mortality disparities have increased for cardiovascular disease and cancer when compared to non-Maori.<sup>11</sup>

The aim of the research is to compare the disease specific mortality rates of the indigenous population of New Zealand, Australia, Canada, and the US with the non-indigenous population in each country. The New Zealand population is the reference population for which all comparisons are made. The size of the relative disparities (indigenous/non-indigenous) in disease-specific mortality rates, within and between countries are compared.

## Method

Life expectancy at birth data for New Zealand (2000-2002) was obtained from Statistics New Zealand.<sup>12</sup> Life expectancy data for the US (2001) was obtained from the Centers for Disease Control and Prevention (CDC).<sup>13</sup> Life expectancy data for Australia (2000) was obtained from the Australian Institute of Health and Welfare.<sup>14</sup> Life expectancy data for Canada (2000) was obtained from Health Canada.<sup>4</sup> Mortality risk ratios for comparison are those accounting for the leading causes of death in New Zealand and the US in 1999.<sup>15,16</sup> These included malignant neoplasms of the lung, bowel, cervix, female breast, and prostate; ischaemic heart disease; cerebrovascular disease; chronic obstructive pulmonary disease (COPD); intentional self harm; diabetes; human immunodeficiency virus (HIV); assault; pneumonia and influenza.

Mortality data for New Zealand are compiled by the New Zealand Health Information Service (NZHIS).<sup>15</sup> Cause of death in 1999 was defined by International Disease Classification–9th edition (ICD–9) codes (Appendix 1). Crude mortality data (1999) for this study was obtained from the NZHIS. The national mortality dataset in New Zealand contains ethnicity information. Since 1996, the ethnicity question recorded on death registration certificates has been the same as that asked in the 1996 national census of population and dwellings.<sup>15</sup> Mortality data for the US are compiled by the National Center for Health Statistics of the US CDC.<sup>17</sup> Cause of death in 1999 was defined by ICD-10 codes (Appendix 1). Crude mortality data for this study was obtained from the CDC. The national mortality dataset in the US contains race information.<sup>18</sup>

Mortality data for Australia is compiled by the Australian Bureau of Statistics.<sup>19</sup> Currently, there is incomplete coverage of indigenous deaths in some state and territory registration systems in Australia. Therefore, the mortality data used for this study was from those jurisdictions assessed by the Australian Bureau of Statistics as having a sufficient level of coverage to enable statistics on Aboriginal and Torres Strait Islanders to be produced. These states and jurisdictions include Queensland, South Australia, Western Australia, and the Northern Territory.<sup>8</sup> The Australian Institute of Health and Welfare supplied crude mortality data (1999) for this study.<sup>20</sup> Cause of death in 1999 was defined by ICD–10 codes. The Australian population denominator values used in this study were derived from the 2001 census.<sup>20</sup>

Statistics Canada supplied mortality data for Canada, for the population group ‘all Canadians’. The national mortality dataset held by Statistics Canada does not contain ethnicity data. At present there is no mortality data available for off-reserve indigenous Canadians. Indigenous mortality data (1999) was only available for First Nation on-reserve indigenous Canadians.<sup>21</sup> Crude mortality data for First Nation on-reserve indigenous Canadians was obtained from Health Canada (First Nations and Inuit Health Branch).<sup>22</sup> Cause of death in 1999 was defined by ICD–9 codes. For New Zealand, Australia, Canada, and the US, we compiled and calculated from crude data ethnic specific mortality rates by primary cause of death in 1999 for the indigenous and non-indigenous populations. We calculated age-adjusted mortality rates, using direct standardization<sup>23</sup> and weights based on the WHO world standard population.<sup>24</sup> We also used New Zealand, Australian, Canadian, and US-based weights; and Segi standard population-based weights<sup>15</sup>—and found results similar to those presented here.

## Results

Life expectancy overall for males (76.6 years) and females (82.1 years) was highest in Australia (see Table 1). Male indigenous life expectancy was highest in New Zealand (69.0 years) and female indigenous life expectancy was highest in Canada (76.6 years). The lowest life expectancy for indigenous peoples for both males (56 years) and females (63 years) was in Australia. Australian Aboriginals and Torres Strait Islanders, therefore, experienced the greatest disparity in life expectancy, when compared to the non-indigenous population.

Maori had the highest mortality rates among all population groups (see Table 2), for ischaemic heart disease, COPD, total malignant neoplasms and malignant neoplasm of the lung, female breast, prostate, and cervix. Non-Maori New Zealanders had the highest mortality rate for malignant neoplasm of the bowel among all population groups. The only three disease-specific mortality rates measured where Maori mortality was lower than non-Maori mortality occurred in malignant neoplasm of the bowel, pneumonia and influenza, and intentional self-harm.

Australian Aboriginals and Torres Strait Islanders had the highest mortality rates among all population groups for cerebrovascular disease and diabetes. When indigenous mortality rates were compared with non-indigenous mortality rates in Australia, Aboriginal and Torres Strait Islander mortality rates were higher for every disease-specific mortality rate measured, except for malignant neoplasm of the bowel.

Canadian First Nation peoples had the highest mortality rate among all population groups for intentional self-harm and, pneumonia and influenza. Indigenous mortality rates were lower than non-indigenous mortality rates in Canada for total malignant neoplasms, malignant neoplasm of the lung and female breast, ischaemic heart disease, cerebrovascular disease, and COPD.

American Indians and Alaskan Natives had the highest mortality rate among all the population groups for assault. Indigenous mortality rates were lower than non-indigenous mortality rates in the US for total malignant neoplasms and each of the individual neoplasms reported (lung, bowel, female breast, cervix, and prostate), ischaemic heart disease, cerebrovascular disease, HIV and COPD.

In terms of the size of the relative disparities that exist between population groups within a country, New Zealand Maori and Australian Aboriginals and Torres Strait Islanders experienced the highest levels of disparities when compared to their respective non-indigenous population groups (Figures 1–3).

The size of mortality risk ratio for indigenous/non-indigenous populations groups (Table 2) across all four countries was highest in New Zealand for total malignant neoplasms (risk ratio [RR] 1.6) of the lung (RR 2.9), breast (RR 1.5), cervix (4.5), and prostate (RR 1.5); HIV (2.0) and ischaemic heart disease (RR of 1.9, which was the same as the Australian indigenous/non-indigenous RR). In Australia, the size of mortality risk ratio for indigenous/non-indigenous populations groups was the highest for all four countries for: cerebrovascular disease (RR 2.1), COPD (RR 2.5), pneumonia and influenza (RR 2.1), diabetes (RR 9.8), ischaemic heart disease (RR 1.9), and assault (RR 5.6).

**Table 1. Life expectancy at birth (years)**

Sex	New Zealand			Australia			Canada			United States		
	Relative Difference	Maori	All	Relative Difference	Aboriginal	All	Relative Difference	First Nation	All	Relative Difference	AIAN	All
Males	0.9	69.0	76.3	0.73	56	76.6	0.9	68.9	76.3	0.91	67.4	74.1
Females	0.9	73.2	81.1	0.77	63	82.1	0.94	76.6	81.8	0.93	74.2	79.5

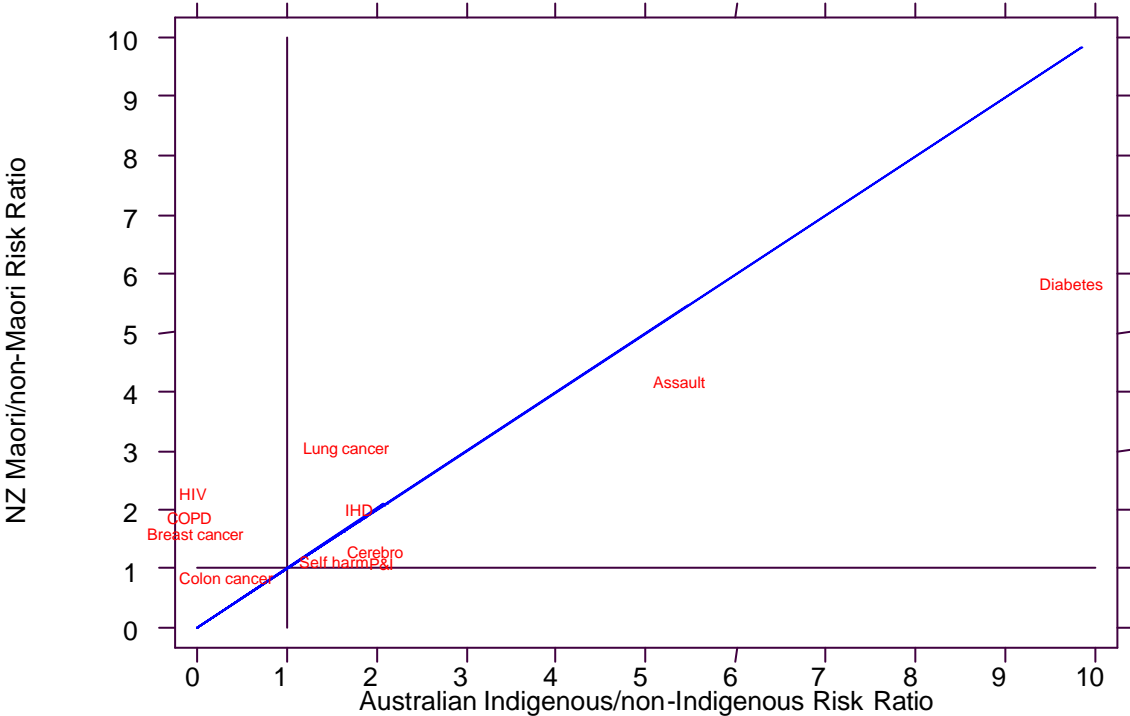
AIAN=American Indian and Alaskan Native.

**Table 2. Age standardised mortality rates (per 100,000 population)**

Disease	New Zealand			Australia			Canada			United States		
	I	NI	RR	I	NI	RR	I	NI	RR	I	NI	RR
Total malignant neoplasms	228.2	146.1	1.6	149.9	124.3	1.2	98.9	143.0	0.7	91.3	142.0	0.6
Malignant neoplasm of trachea, bronchus, and lung	74.6	25.6	2.9	45.4	25.3	1.8	29.3	39.6	0.7	25.7	40.3	0.6
Malignant neoplasm of breast (female)	18.9	12.9	1.5	12.0	9.0	1.3	9.6	11.3	0.8	6.5	11.1	0.6
Malignant neoplasm of the prostate	14.8	9.6	1.5	NA	NA	NA	8.8	7.4	1.2	2.9	7.0	0.4
Malignant neoplasm of the cervix uteri	5.4	1.2	4.5	NA	NA	NA	2.1	1.1	1.9	0.9	1.2	0.8
Malignant neoplasm of colon, rectum, and anus	16.2	22.6	0.7	7.6	16.2	0.5	13.1	11.4	1.1	8.2	14.1	0.6
Ischaemic heart diseases	206.1	110.2	1.9	162.6	87.1	1.9	83.8	89.6	0.9	83.1	118.9	0.7
Cerebrovascular diseases	55.2	47.2	1.2	73.8	35.5	2.1	28.1	30.9	0.9	25.3	35.6	0.7
Other chronic obstructive pulmonary disease	34.0	19.6	1.7	33.7	13.7	2.5	10.8	16.1	0.7	15.8	22.7	0.7
Intentional self-harm	12.9	13.1	1.0	19.4	11.9	1.6	27.8	12.2	2.3	12.0	9.8	1.2
Pneumonia and influenza	9.9	10.3	1.0	13.2	6.2	2.1	24.4	17.7	1.4	14.0	13.2	1.1
Diabetes mellitus	62.5	11.0	5.7	85.4	8.7	9.8	19.5	13.3	1.5	36.2	16.7	2.2
Human immunodeficiency virus	1.0	0.5	2.0	NA	NA	NA	NA	1.2	NA	2.9	5.0	0.6
Assault	3.9	1.0	3.9	7.8	1.4	5.6	8.1	1.5	5.4	10.6	6.4	1.7

I=indigenous; NI=non-indigenous; RR= risk ratio.

**Figure 1. Maori/non-Maori mortality risk ratio versus Australian Indigenous/non-Indigenous risk ratio in New Zealand and Australia respectively**



**Figure 2. Maori/non-Maori mortality risk ratio versus Canadian Indigenous/non-Indigenous risk ratio in New Zealand and Canada respectively**

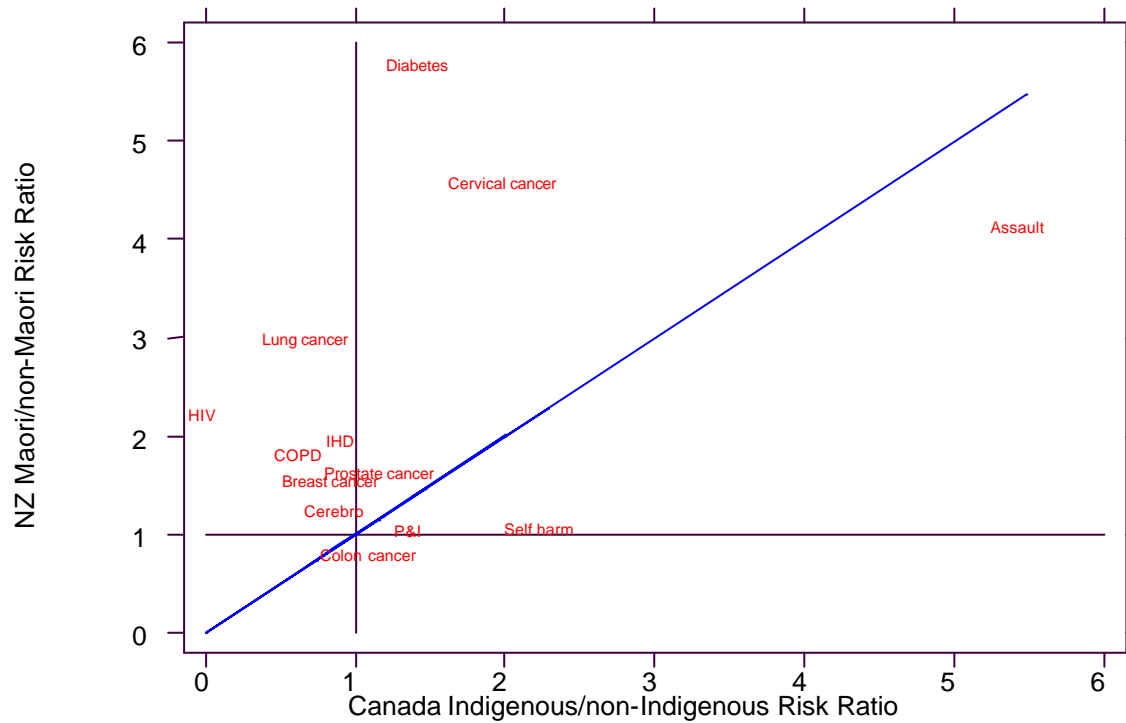
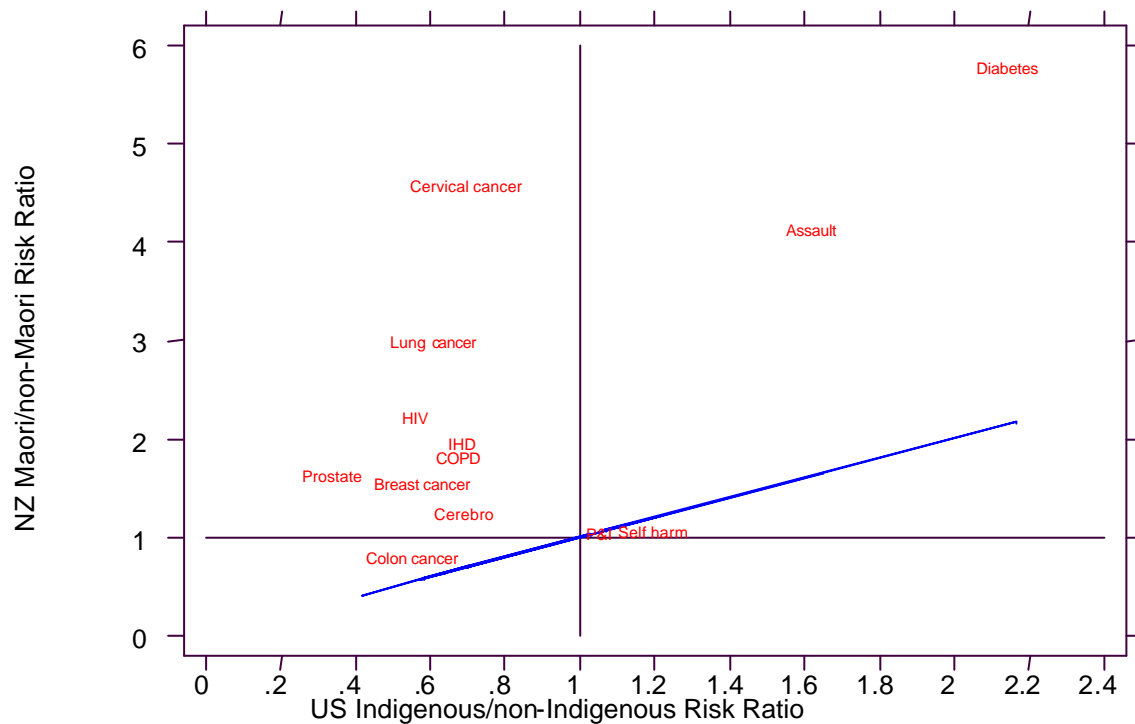


Figure 3. Maori/non-Maori mortality risk ratio versus US Indigenous/non-Indigenous risk ratio in New Zealand and the US respectively





**Appendix 1. International Classification of Disease (ICD) codes used for defining major causes of death**

ICD-10 DESCRIPTION	ICD-9 CODES	ICD-10 CODES
Malignant neoplasms	140-208	C00-C97
Malignant neoplasm of trachea, bronchus, and lung	162	C33-C34
Malignant neoplasm of the female breast	174	C50
Malignant neoplasm of prostate	185	C61
Malignant neoplasm of cervix uteri	180	C53
Malignant neoplasm of colon, rectum, and anus	153-154	C18-C21
Ischaemic heart diseases	410-414	I20-I25
Cerebrovascular diseases	430-434, 436-438	I60-I69
Other chronic obstructive pulmonary disease	496	J44
Intentional self-harm	E950-E959	X60-X84, Y87.0
Diabetes mellitus	250	E10-E14
Human immunodeficiency virus disease	042-044	B20-B24
Assault	E960-E969	X85-Y09, Y87.1

Across all four countries (New Zealand, Australia, Canada, and the US) the indigenous peoples had higher mortality rates for diabetes and assault when compared to their non-indigenous populations.

## Discussion

This paper compares indigenous and non-indigenous disease-specific mortality rates and risk ratios (in New Zealand, Australia, Canada, and the US) for the leading causes of death in New Zealand. There have been a limited number of academic papers published comparing indigenous disparities in mortality among rich countries.<sup>25–28</sup> In 1992, Hogg attempted to place Australian Aboriginal mortality within the broader context of other countries. Hogg found that Australian Aboriginals had higher age and cause-specific death rates, and a strikingly different mortality profile overall compared to indigenous peoples in New Zealand, the US, and Canada.<sup>25</sup>

The main findings of this research are that:

Life expectancy in all four countries was lower for the indigenous peoples—with Australian Aboriginals and Torres Strait Islanders having the lowest life expectancy of all population groups and the greatest relative disparity when compared to the non-indigenous population.

The highest disease-specific mortality rates for ischaemic heart disease and malignant neoplasms are found in New Zealand Maori (except for malignant neoplasm of the bowel where New Zealand non-Maori have the highest rate). Canadian First Nation peoples have the highest mortality rates of all population groups for intentional self-harm and pneumonia/influenza. American Indians and Alaskan Natives have the highest mortality rates of all population groups for assault. Non-indigenous Americans have the highest mortality rate for HIV.

In terms of the size of the relative disparities that exist for disease-specific mortality, New Zealand Maori, Australian Aboriginals and Torres Strait Islanders have the highest levels of disparities when compared to their non-indigenous population groups.

Diabetes is a powerful determinant of health outcome and for indigenous peoples across the four countries, diabetes related mortality is high. Australian Aboriginals and Torres Strait Islanders, in particular, have very high mortality rates associated with diabetes—and the indigenous/non-indigenous risk ratio of 9.8 was the highest reported. The prevalence of diagnosed diabetes has in recent years been increasing in all four indigenous populations.<sup>29–32</sup> Also, the prevalence of obesity is increasing in some indigenous populations,<sup>30,32</sup> this will result in a rise in diabetes related mortality in the near future.

The current high levels of indigenous mortality and disparities that exist in New Zealand and Australia are not acceptable. In comparison, indigenous mortality in Canada and the US is lower in many of the disease-specific areas reported in this study when compared to their non-indigenous counterparts.

There are several cross-country and country-specific lessons that should be explored following these analyses. For example, cancer deaths in indigenous Americans (and to a lesser extent, cancer deaths in indigenous Canadians) are very low—these findings are consistent with other published reports. Low indigenous mortality rates for lung

cancer in the US may be partially explained by the rarity of habitual cigarette smoking among Southwest tribes but reasons for the low rates of other cancers are not so evident.<sup>33</sup> Cobb, in a recent report on indigenous cancer deaths in the US, stated that further research is required to elucidate why American Indians have low cancer mortality. This research may have significant implications for cancer prevention in other ethnic groups.<sup>33</sup>

Although disparities are large in New Zealand for death from assault, the absolute rates are lower than in the US. For example, the Maori age-standardised mortality rate from assault is 3.9 per 100,000 (RR of 3.9 compared to non-Maori) compared to the non-indigenous rate of 6.4 per 100,000 in the US. Further research should be undertaken to explore how the national response to violence differs between countries. A review of factors that have been successful in keeping death related to assault comparatively low in New Zealand may have implications for policy development in the US.

New Zealand has a low annual incidence of new HIV infections and subsequent low mortality rates as reflected in the study findings (although new infections have been increasing in recent years). The New Zealand response to the HIV epidemic has been viewed as a public health success story. The New Zealand response was characterised by law change (the Homosexual Law Reform Act was passed), national coordination of a policy response (the National Council on AIDS and a medical advisory committee were formed), and empowerment of affected communities (groups such as the AIDS Foundations, Injecting Drug User Community Groups, and the New Zealand Prostitutes Collective were formed).<sup>34</sup> Such a public health approach could be undertaken to protect the health of indigenous and non-indigenous populations in other countries.

The publication of comparative data such as this should stimulate increased cross-country learning, research, and policy development.

### **The quality of indigenous mortality data**

There are several common issues that adversely affect the quality of indigenous mortality data. These include the lack of an accurate denominator value for the indigenous population concerned (mainly due to undercounting) and the lack of agreement over which population denominator values to use if they do exist (e.g., whether to use single ethnic response groups as the denominator value vs the multiple ethnic response groups).

Denominator values for the indigenous population in all four countries are usually derived from census data. However, in Australia, estimating the size of the Aboriginal and Torres Strait Islander population has proved difficult due to uncertainties attached to interpreting indigenous population counts from the 5-yearly census.<sup>8</sup>

Between 1996 and 2001, the Australian indigenous population increased 16 %, however the expected increase based on natural increase (births minus deaths) was 12%.<sup>8</sup> This variance is in part due to the increased propensity of indigenous people to self-identify as indigenous on the census forms. As it is not possible to estimate how these factors may change over time, it is therefore problematic to estimate the inter-census population denominator counts that are needed to calculate annual death rates.

There is a lack of agreement as to how official agencies define indigenous status and the way in which ethnic specific mortality data is recorded. In New Zealand (as in other countries), there has been frequent modification of the ethnicity question recorded in the censuses and it was not until 1991 census that the biological concept of ethnic origin was replaced with that of self-identified ethnicity.<sup>35</sup> These frequent changes in the census ethnicity question has led to difficulty comparing mortality trends over time and have also produced difficulties in estimating inter-census population denominator counts.

Perhaps the most important issue in regards to the quality of indigenous mortality data is the undercounting of deaths (the numerator for mortality data). In each of the four countries, the undercounting of indigenous deaths is likely to lead to an underestimation of the relative size of disparities that exist between indigenous and non-indigenous populations. In Australia, for example, the Australian Bureau of Statistics (which administers the national mortality database), recommends that the coverage of indigenous mortality data is of sufficient quality to be used for research purposes only from the jurisdictions of Queensland, South Australia, Western Australia, and the Northern Territory.<sup>8</sup> This is primarily due to the fact that indigenous ethnicity status on death certificates is not always recorded, or recorded incorrectly, leading to an undercounting of the number of indigenous deaths.<sup>8</sup>

In New Zealand, research has been undertaken that attempts to adjust for this undercounting by a process of probabilistic record linkage of death registration data with census data. This research has produced estimates of the considerable extent of the undercounting of Maori deaths.<sup>36,37</sup> Unfortunately, this data could not be used for this study as there was no similar 'corrected' mortality data available from the US, Australia, or Canada.

An issue that is unique to Canada is that the national mortality database administered by Statistics Canada does not contain ethnicity data. The regional offices of Health Canada collect mortality data for the indigenous, on-reserve, First Nations population. Via a series of partnerships with each provincial vital statistics registrar, First Nations specific death certificate information is sent to the regional First Nations and Inuit Health Branch regional office. However, in a number of areas no such relationships exist (for example the Atlantic, Ontario, and Quebec regions), and therefore data is obtained directly from the local communities, or not at all.<sup>21</sup> The availability of indigenous mortality data in Canada is further limited by the lack of information that is available for off-reserve, or non-status, indigenous peoples.

## **Methodological considerations**

The varying degrees of completeness and accuracy of the indigenous mortality databases that exist within the four countries are likely to affect these findings. For example research by Ajwani (2003), has reported that during 1996-1999, 7% more decedents identified Maori as one of their ethnic groups on the 1996 census compared with mortality data.<sup>38</sup> Therefore the accuracy of the Maori deaths rates used in this study is relatively high. This level of accuracy is unlikely to be present in the three other countries.

In the US, some estimates of the under-reporting of American Indian deaths have ranged from 11% to 25%.<sup>39,40</sup> In Canada, it is difficult to determine an accurate

overview of indigenous mortality for the reasons reported already, and due to the fact that only limited information is available regarding indigenous people that reside in urban areas.

The implication of these findings may therefore be that when New Zealand indigenous/non-indigenous mortality risk ratios are compared with indigenous/non-indigenous mortality risk ratios from these countries (Figures 1–3), the results may be somewhat improved to that described.

Although it is impossible to quantify the exact amount of the measurement bias that may exist in our calculations, the data presented here is the most reliable currently available. Differences in the calculation of life expectancy and in ICD coding practices between countries could bias the findings, but this is likely to have a minimal effect on the relative differences in mortality between indigenous and non-indigenous populations within a country, which is the main focus of this paper. It should also be noted that grouping of data for indigenous peoples may obscure important differences that may exist between large tribal grouping, an issue that may be particularly important in North America where mortality and other health status indicators vary widely between tribal and geographical indigenous populations. Further, this analysis was for a 1-year period, if a longer period were available for analysis, this could increase the consistency of the rates reported.

## Conclusion

The indigenous peoples of New Zealand and Australia suffer from high disease-specific mortality rates. The relative size of indigenous/non-indigenous mortality disparities are highest in New Zealand and Australia. There appears to be a number of common issues that adversely affect the quality of the mortality data that is available in the four countries. Action is required to address indigenous health disparities and to improve the quality of indigenous mortality data

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## References:

1. Ministry of Health. Priorities for Maori and Pacific Health: Evidence from epidemiology. Public Health Intelligence. Occasional Bulletin 2001;No 3. Available online. URL:

- <http://www.moh.govt.nz/moh.nsf/ea6005dc347e7bd44c2566a40079ae6f/427d66f8922e2fa2cc256a540078bd80?OpenDocument> Accessed December 2004.
2. Ministry of Health. Reducing inequalities in health. Wellington: Ministry of Health; 2002. Available online. URL: <http://www.moh.govt.nz/moh.nsf/0/523077dddeed012dcc256c550003938b?OpenDocument> Accessed December 2004.
  3. Ring I, Brown N. Indigenous health: chronically inadequate responses to damning statistics. *Med J Aust.* 2002;177:629–31.
  4. Health Canada. A federal report on comparable health indicators 2002. Ottawa: Health Canada; 2002. Available online. URL: <http://www.hc-sc.gc.ca/iacb-dgiac/arad-draa/english/accountability/indicators.html> Accessed December 2004.
  5. Zuckerman S, Haley J, Roubideaux Y, Lillie-Blanton M. Health service access, use and insurance coverage among American Indians/Alaska Natives and Whites: What role does the Indian Health Service play? *American Journal of Public Health.* 2004;94:53–9.
  6. Paisano R, Cobb N, Espey D. Cancer mortality among American Indians and Alaska Natives - United States, 1994 -1998. *Mortality Morbidity Weekly Reports.* 2003;52(30):704–7. Available online. URL: <http://www.cdc.gov/mmwr/PDF/wk/mm5230.pdf> Accessed December 2004.
  7. Statistics New Zealand. 2001 New Zealand Census Results: Statistics New Zealand; 2001.
  8. Australian Bureau of Statistics. The health and welfare of Australia's Aboriginal and Torres Strait Islander peoples. Canberra: Australian Bureau of Statistics; 2003.
  9. Statistics Canada. Aboriginal peoples of Canada. Ottawa: Statistics Canada; 2002.
  10. US Census Bureau. The American Indian and Alaska Native population 2000. Washington DC: US census bureau; 2000.
  11. Ministry of Health. Decades of disparity: ethnic mortality trends in New Zealand 1980-1999. Wellington: Ministry of Health; 2003. Available online. URL: <http://www.moh.govt.nz/moh.nsf/ea6005dc347e7bd44c2566a40079ae6f/febdcf2d4baae173cc256d5c00137cae?OpenDocument> Accessed December 2004.
  12. Statistics New Zealand. New Zealand life tables 2000-2002. Wellington: Statistics New Zealand; 2004.
  13. National Center for Health Statistics. National vital statistics reports. Atlanta: Centers for Disease Control; 2002.
  14. Australian Institute of Health and Welfare. Life expectancy overview. Canberra: Australian Institute of Health and Welfare; 2002.
  15. New Zealand Health Information Service. Mortality and demographic data 1999. Wellington: Ministry of Health; 2003. Available online. URL: <http://www.nzhis.govt.nz/publications/mortality99.pdf> Accessed December 2004.
  16. Centers for Disease Control. 1999 United States Mortality File. Atlanta: Centers for Disease Control; 1999.
  17. Hoyert D, Arias E, Smith B, Murphy S, Kochanek K. Deaths: Final data for 1999. Hyattsville, Maryland: National Center for Health Statistics; 2001.
  18. Centers for Disease Control and Prevention. U.S. standard death certificate, 1989 revision. Atlanta: Centers for disease control and prevention; 1989.
  19. Australian Bureau of Statistics. Causes of death, Australia. Canberra: Australian Bureau of Statistics; 2003.
  20. Al-Yaman F. Australian mortality data by ethnicity and age group, 1999. Canberra: Australian Institute of Health and Welfare; 2003.

21. First Nation and Inuit Health Branch. A statistical profile on the health of First Nations in Canada. Ottawa: Health Canada; 2002.
22. Probert A. First Nation on reserve mortality data, 1999. Ottawa: First Nation and Inuit Health Branch, Health Canada; 2003.
23. Fleiss J. Statistical methods for rates and proportions. Second ed. New York: John Wiley and Sons; 1981.
24. Ahmad O, Boschi-Pinto C, Lopez A, Murray C, Lozano R, Inoue M. Age standardisation of rates: a new WHO standard. Geneva: World Health Organization; 2003.
25. Hogg R. Indigenous mortality: placing Australian aboriginal mortality within a broader context. *Social Science Medicine*. 1992;35:335–46.
26. Ring I, Firman D. Reducing indigenous mortality in Australia: lessons from other countries. *Med J Aust*. 1998;170:190–1.
27. Paradies Y, Cunningham J. Placing Aboriginal and Torres Strait Islander mortality in an international context. *Australia New Zealand Journal of Public Health*. 2002;26:11–6.
28. Michael J, Michael M. Health status of the Australian aboriginal people and the native Americans - a summary comparison. *Asia Pacific Journal of Public Health*. 1994;7:132–6.
29. Statistics Canada. Aboriginal People Survey, 2001. Initial release supporting tables. Ottawa: Statistics Canada; 2001.
30. Ministry of Health. A snapshot of health. Provisional results of the 2002/03 New Zealand Health Survey. Wellington: New Zealand Ministry of Health; 2003. Available online. URL: <http://www.moh.govt.nz/moh.nsf/ea6005dc347e7bd44c2566a40079ae6f/9ad4668e36fecf37cc256deb007c38b8?OpenDocument> Accessed December 2004.
31. Acton K, Burrows N, Thompson T. Diabetes prevalence among American Indians and Alaska Natives and the overall population — United States, 1994--2002. *Mortality Morbidity Weekly Reports*. 2003;52:702–4. Available online. URL: <http://www.cdc.gov/mmwr/PDF/wk/mm5230.pdf> Accessed December 2004.
32. Australian Bureau of Statistics. National Health Survey: Aboriginal and Torres Strait Islanders results. Canberra: Australian Bureau of Statistics; 2002.
33. Cobb N, Paisano R. Patterns of cancer mortality among Native Americans. *Cancer* 1998;83:2377–83.
34. Davis P, editor. Intimate details and vital statistics: AIDS, sexuality and the social order in New Zealand. Auckland: University Press; 1996.
35. Ministry of Health. Monitoring ethnic inequalities in health. *Public Health Intelligence* 2001; Occasional Bulletin Number 4. Available online. URL: [http://www.moh.govt.nz/moh.nsf/ea6005dc347e7bd44c2566a40079ae6f/a4bceba4fe65795bcc256a7700839825/\\$FILE/ATTDJSLT/MonitoringEthnicInequalities.pdf](http://www.moh.govt.nz/moh.nsf/ea6005dc347e7bd44c2566a40079ae6f/a4bceba4fe65795bcc256a7700839825/$FILE/ATTDJSLT/MonitoringEthnicInequalities.pdf) Accessed December 2004.
36. Blakely T, Kiro C, Woodward A. Unlocking the numerator-denominator bias II: adjustment ratios by ethnicity and deprivation 1991-94. *The New Zealand census mortality study*. *N Z Med J*. 2002;115:43–8.
37. Blakely T, Robson B, et al. Unlocking the numerator-denominator bias I: adjustment ratios by ethnicity for 1991-1994 mortality data. *The New Zealand census mortality study*. *N Z Med J*. 2002;115:39–43.
38. Ajwani S, Blakely T, Robson T, et al. Unlocking the numerator-denominator bias III: adjustment ratios by ethnicity for 1981-1999 mortality data. *The New Zealand census-mortality study*. *N Z Med J*. 2003;116(1175). URL: <http://www.nzma.org.nz/journal/116-1175/456>

39. U.S. Census Bureau. Methodology and assumptions for the population projections of the United States: 1999-2100. Washington DC: Population Division of the U.S. Census bureau; 2000.
40. Indian Health Service. Trends in Indian Health. Washington DC: Indian Health Service; 1997.