



## Ethnic disparities in causes of death among diabetes patients in the Waikato region of New Zealand

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**Aim** Assist health service planning by: (1) estimating the causes and disparities in mortality among people with diabetes in Waikato and (2) examining the differences in recording of diabetes.

**Method** A retrospective cohort study of diabetes patients registered with the Waikato Regional Diabetes Service. Deaths from 2003-2007 were identified among patients diagnosed with diabetes before 2003. Causes of death were obtained from the NZHIS. Mortality rates were compared with the general New Zealand population. Cox's proportional-hazards-model was used to estimate the all-cause and cause-specific mortality risk.

**Results** 921 deaths were observed among 9043 diabetes patients. Compared with Europeans, Māori had nearly double the age-adjusted mortality rates. SMRs for male-Europeans, female-Europeans, male-Māori and female-Māori aged 25+ were 1.16 (1.05-1.28), 1.10 (0.98-1.24), 2.49 (2.06-3.01), 3.12 (2.56-3.80) respectively. Of the 441 deaths with causes available, 268 (61%) had diabetes mentioned on the NZHIS-coding. Māori were more likely than Europeans to have diabetes reported on NZHIS-coding. They were more likely to die from cardiovascular disease, cancer and renal disease [Hazard-ratios 2.31 (1.6-3.3), 1.83 (1.1-3), and 11.74 (4.8-29) respectively].

**Conclusion** Māori diabetes patients experienced significantly higher risk of mortality compared with Europeans. Studies on diabetes related mortality using the national mortality database needs to take the increased recognition of diabetes on NZHIS coding for Māori into account.

Diabetes is associated with increased mortality rates, when compared to people without diabetes.<sup>1-3</sup> Some studies have suggested a reduction in excess mortality.<sup>4</sup> In New Zealand, Māori have been shown to have excess mortality associated with diabetes.<sup>5</sup> Health service planners use official mortality statistics as an indicator of health needs. NZHIS mortality records are routinely analysed, looking at deaths coded with diabetes as the primary cause of death. This approach has been shown to be missing out important information on deaths due to comorbidities among diabetes patients.

Routine mortality analysis is further limited by the under-coding of diabetes on death certificates.<sup>6-8</sup> Waikato DHB's Health Needs Analysis Report 2008 highlighted disparities in mortality for diabetes patients.<sup>9</sup> This could be biased if ethnic differences in the level of under coding differed, an issue not previously studied. To overcome coding biases, a comprehensive analysis of mortality in people with diabetes is best undertaken using a population based diabetes register.

The Waikato Regional Diabetes Service (WRDS) provides specialist diabetes services and performs retinal screening for people living within the Waikato DHB region. Patients are referred to the service by their general practitioner and the WRDS diabetes register is compiled from the retinal screening register and those referred for other complications. The register is thought to be almost 90% complete for Waikato.<sup>10</sup>

The aims of this study are

- (1) To estimate the causes of death and disparities in mortality among people with diabetes in Waikato by ethnicity and gender on the WRDS diabetes register.
- (2) To examine the ethnic differences in the recording of diabetes on NZHIS coding.

## Method

The WRDS database was established in 1997, to record secondary diabetes service utilisation. This is a retrospective cohort study of diabetes patients registered with the WRDS database before 2008. Patients diagnosed before 2003, and alive as of 1.Jan.2003, were identified and retrospectively followed for 5 years until death or end of 2007. The National Health Information Service (NZHIS) Mortality Collection classifies the underlying cause of death for all deaths registered in New Zealand, using the ICD-10-AM 2nd Edition and the WHO Rules and Guidelines for Mortality Coding.

Deaths registered in New Zealand from 1988 onwards are held in this national mortality database. Loss of follow-up due to within country migration was not an issue in this study, due to the availability of national mortality data. It was not possible to track migration out of New Zealand. The (NZHIS) Mortality Collection had causes of deaths available for deaths until 2005 at the time of the study in 2008. The unique National Health Index (NHI) number in New Zealand allows linkage between health information systems. Causes of death information for deaths from 2003–2005 was obtained from the NZHIS using NHI linkage. Patient status information (alive/deceased) is also available from WRDS database. In case of mismatch between national mortality data and WRDS data, deaths were verified by manually reviewing patient records and then by contacting the diabetes educators and general practitioners.

Causes of death were classified into cardiovascular disease (CVD), cancer, renal, cerebrovascular, gastrointestinal, respiratory, diabetes/complications and other. Two people coded the data independently and the two sets of codes were compared to minimise coding errors. The concordance between single ethnicity on WRDS database and prioritised ethnicity recorded on hospital patient management system was examined.

Crude mortality rates per 1000 person-years were calculated by ethnicity and gender. Segi world population, used in national mortality reports, was used to standardise mortality rates. The 95% confidence intervals for age-standardised mortality rates have been calculated using the Keyfitz method.<sup>11</sup> Mortality rates for Type 1 and Type 2 diabetes patients were age-adjusted using direct standardisation to the corresponding study population structure.

Standardised mortality ratios (SMRs) in relation to the national death rates were calculated using the 2004 national data from the Ministry of Health.<sup>12</sup> SMR is the ratio of observed number of deaths in the diabetic population to the expected number of deaths. Expected deaths were calculated by applying the age (5-year group) and gender specific mortality rates of the general population applied to the number of person-years of follow-up in each group. National ethnicity specific death rates were available for Māori population. SMRs for Māori diabetes patients in relation to national age and gender specific rates for Māori have been calculated.

Confidence intervals for SMRs were calculated using the Boice-Monson method.<sup>13</sup> Fisher's exact test was used to determine whether diabetes was more likely to be recorded on NZHIS coding for Māori compared with Europeans. Cox proportional hazards model was employed to identify the risk factors for all cause and cause-specific mortality. Data were analysed using SAS® version 9.

## Results

9043 diabetes patients diagnosed with diabetes before 2003 were identified. Patients were of mean age  $59 \pm 16$  years, 69% Europeans, 21% Māori, 8% Other and 2% Unknown. The majority (7,501) had Type 2 diabetes and 1,391 had Type 1 diabetes. A small proportion of patients [151 (1.7%)] did not have type of diabetes recorded. Duration of diabetes at start of follow-up could be calculated for 8664 (95.8%) who had year of diagnosis of diabetes recorded.

8485 (94%) of patients had demographic information available on the hospital system due to secondary service contact. Of these 7575 (89%) had only a single ethnicity recorded, even though the hospital system can store up to three ethnicities. 568 (7%) had two ethnicities recorded, 7 (0.1%) had 3 ethnicities and 335 (4%) did not have any ethnicity recorded. While 91% of the 1915 people identifying themselves as Māori on the WRDS database had the same prioritised ethnicity on the hospital system, 129 (7.6%) were recorded as non-Māori. Similarly 120 people recorded as non-Māori on the WRDS database had prioritised Māori ethnicity on the hospital system. Ethnicity recorded on the WRDS database has been used for further analysis.

921 deaths were observed during the 5-year follow-up period with 46261 person-years of follow-up (Table 1). Compared with European diabetes patients, Māori had nearly double the age-adjusted mortality rates (Table 2). SMRs in relation to national general population rates for male-Europeans, female-Europeans, male-Māori and female-Māori aged 25+ were 1.16(1.05–1.28), 1.10(0.98–1.24), 2.49(2.06–3.01), 3.12(2.56–3.80) respectively. Age, gender and ethnicity specific SMRs have been calculated diabetes patients in general as well as for people with Type 2 diabetes (Table 3). Age-specific SMRs decreased with age among all subgroups of ethnicity and gender.

Of the 921 observed deaths, 441 deaths until end of 2005 (26581 person-years of follow-up) had cause of death information available. 268/441 (61%) had diabetes mentioned on the death certificate. Among the 441 deceased patients, 98% of patients recorded as Māori on the WRDS database had a matching ethnicity on NZHIS mortality database, where as 96% had the same prioritised ethnicity on the hospital system. Māori are more likely than Europeans to have diabetes reported on NZHIS coding (p value 0.0098), but cause specific differences were not statistically significant (p value 0.0760 and 0.6414 for cardio vascular disease and cancer respectively).

Due to the small number of observed deaths among Pacific Islands people and Asians (18 and 12 respectively), they are not analysed as separate ethnicity categories but are included in the total.

Among both Europeans and Māori, nearly half the deaths were due to cardiovascular disease and quarter of deaths due to cancer (Table 4). Among those dying due to cardiovascular disease, Māori were more likely to have renal comorbidity than Europeans. [13/46 (28%) vs 6 /141 (4%), Chi-squared p value<0.0001].

**Table 1. Patient characteristics at start of follow-up by ethnicity**

<b>Variables</b>	<b>European</b>	<b>Māori</b>	<b>Total</b>
<b>N</b>	6236	1915	9043
<b>Age at start of follow-up (mean±SD)</b>	61±16	54±13	59±16
<b>Male</b>	3246 (52%)	924 (48%)	4649 (51%)
<b>Type of diabetes*</b>			
Type 2	4948 (80%)	1749 (94%)	7501 (84%)
Type 1	1202 (20%)	115 (6%)	1391 (16%)
<b>Age at diagnosis of diabetes, years* (mean±SD)</b>			
Type 2 (n=7276)	57.7±12.6	46.5±12.4	54.3±13.4
Type 1 (n=1361)	24.8±16.9	27.1±15.1	25.3±16.8
<b>Duration of diabetes at start of follow-up, years</b>			
Type 2	7.8±6.9	8.8±7.9	7.9±7.1
Type 1	16.9±11.7	13.0±9.6	16.4±11.5

\* Patients with missing data have been excluded. Data are (mean±SD) or n (%).

**Table 2. Crude and age-adjusted death rates for diabetes patients by gender and ethnicity**

Variables	European		Māori		Total	
	Male	Female	Male	Female	Male	Female
<b>All diabetes patients (person-years)</b>	3246 (15,409)	2990 (14,376)	924 (4397)	991 (4745)	4649 (22,135)	4394 (21,126)
Observed deaths	380	276	108	98	520	401
Crude mortality per 1000 person years	24.7	19.2	24.6	20.7	23.5	18.9
Age-standardised <sup>‡</sup> to Segi world population, rate/100,000 person-years (95% CI)	551 (496–606)	491 (433–549)	1,012 (821–1203)	808 (648–968)	632 (578–686)	569 (513–625)
<b>Type 2 diabetes patients (person-years)</b>	2608 (7612)	2340 (6910)	843 ( 2475)	906 (2665)	3880 (11,359)	3621 (10,681)
Observed deaths (Male/ Female)	340	230	94	86	463	340
Age-adjusted* mortality rate/1000 person-years	24.8	16.6	33.5	34.6	27.0	27.0
Age-standardised <sup>‡</sup> to Segi world population, rate/100,000 person-years (95% CI)	458 (409–506)	353 (308–399)	960 (766–1154)	724 (571–877)	570 (518–622)	459 (411–508)
<b>Type 1 diabetes patients (person-years)</b>	596 (1761)	606 (1682)	55 (160)	60 (168)	694 (2049)	697 ( 2041)
Observed deaths (Male/ Female)	41	29	12	10	41	52
Age-adjusted <sup>†</sup> mortality rate/1000 person-years	10.9	14.3	65.7	66.0	12.2	15.6

\*Direct standardisation to Type 2 diabetes population in the study.

<sup>†</sup> Direct standardisation to Type 1 diabetes population in the study.

<sup>‡</sup> Direct standardisation using Segi world population.

**Table 3. Age-specific all cause standardised mortality ratios (SMRs) after 5 years of follow-up for European and Māori diabetes patients by gender**

Variables	Age group	All diabetes patients		Type 2 diabetes patients	
		Deaths	SMR (95% CI)	Deaths	SMR (95% CI)
<b>European Female</b>	40–49	10	4.32 (2.33–8.03)*	4	2.64 (0.99–7.04)
	50–59	17	1.76 (1.09–2.83)*	16	2.02 (1.24–3.30)*
	60–69	50	1.44 (1.09–1.90)*	41	1.30 (0.96–1.77)
	70–79	94	1.07 (0.88–1.31)	78	0.97 (0.77–1.21)
	80+	102	0.90 (0.74–1.09)	91	0.87 (0.71–1.07)
<b>European Male</b>	40–49	6	1.64 (0.74–3.65)	2	0.82 (0.21–3.28)
	50–59	25	1.55 (1.05–2.29)*	18	1.29 (0.81–2.04)
	60–69	72	1.21 (0.96–1.52)	66	1.20 (0.95–1.53)
	70–79	189	1.29 (1.12–1.49)*	176	1.29 (1.11–1.49)*
	80+	86	0.85 (0.69–1.05)	78	0.84 (0.67–1.05)
<b>Māori Female</b>	40–49	16	9.32 (5.71–15.2)*	14	8.48 (5.02–14.3)*
	50–59	16	3.05 (1.87–4.97)*	14	2.82 (1.67–4.75)*
	60–69	36	3.64 (2.63–5.05)*	31	3.29 (2.31–4.67)*
	70–79	23	1.94 (1.29–2.91)*	21	1.86 (1.21–2.85)*
	80+	5	2.20 (0.91–5.27)	5	2.20 (0.91–5.27)
<b>Māori Male</b>	40–49	12	5.50 (3.12–9.69)*	10	4.96 (2.67–9.21)*
	50–59	29	4.10 (2.85–5.90)*	26	3.92 (2.67–5.75)*
	60–69	41	2.79 (2.05–3.79)*	33	2.39 (1.70–3.36)*
	70–79	21	1.51 (0.98–2.31)	20	1.47 (0.95–2.28)
	80+	4	0.82 (0.31–2.18)	4	0.82 (0.31–2.18)
<b>Māori Female*</b>	40–49	16	3.99 (2.44–6.51)*	14	3.63 (2.15–6.12)*
	50–59	16	1.27 (0.78–2.08)	14	1.18 (0.70–1.99)
	60–69	36	1.55 (1.12–2.15)*	31	1.40 (0.99–1.99)
	70–79	23	0.96 (0.64–1.44)	21	0.92 (0.60–1.41)
	80+	5	1.74 (0.72–4.18)	5	1.74 (0.72–4.18)
<b>Māori Male*</b>	40–49	12	2.30 (1.31–4.05)*	10	2.07 (1.12–3.86)*
	50–59	29	1.60 (1.11–2.31)*	26	1.53 (1.04–2.25)*
	60–69	41	1.32 (0.97–1.79)	33	1.13 (0.80–1.59)
	70–79	21	0.87 (0.57–1.34)	20	0.85 (0.55–1.31)
	80+	4	0.62 (0.23–1.66)	4	0.62 (0.23–1.66)

\* In relation to national Māori population rates. SMR is the ratio of observed number of deaths in the diabetic population to the expected number of deaths. Expected deaths were calculated by applying the age (5-year group) and gender specific mortality rates of the general population applied to the number of person-years of follow-up in each group. Numbers for Type 1 diabetes were too small by age group.

**Table 4. Primary causes of death and the extent of recognition of diabetes on NZHIS coding**

Variables	Causes of deaths			Mention of diabetes		
	European	Māori	Total	European	Māori	Total
Cancer	71 (22.7%)	25 (24.5%)	103 (23.4%)	48%	40%	44%
Renal	9 (2.9%)	14 (13.7%)	25 (5.6%)	100%	100%	100%
Cardiovascular disease	141 (45.1%)	46 (45.1%)	197 (44.7%)	61%	76%	64%
Diabetes/complications	25 (8.0%)	5 (4.9%)	31 (7.0%)	96%	100%	97%
Cerebrovascular	21 (6.7%)	1 (1.0%)	23 (5.2%)	43%	0%	39%
Gastrointestinal	9 (2.9%)	3 (2.9%)	14 (3.1%)	22%	67%	29%
Respiratory	17 (5.4%)	5 (4.9%)	23 (5.2%)	59%	100%	70%
Other	20 (6.4%)	3 (2.9%)	25 (5.7%)	35%	100%	48%
All Cause	313	102	441	58%	73%	61%

**Table 5. Cox's proportional hazards ratios (95% CI) for all cause, cardiovascular, cancer related and renal mortality among European and Māori diabetes patients**

	All cause mortality by diabetes type		Cause specific mortality†		
	Type 2	Type 1	CVD	Cancer	Renal
No. of deaths	750	92	185	96	23
Age (years)	1.08 (1.07–1.09)*	1.08 (1.06–1.09)*	1.09 (1.07–1.1)*	1.06 (1.04–1.1)*	1.06 (1.03–1.1)*
Māori (vs European)	1.92 (1.61–2.30)*	5.43 (3.31–8.92)*	2.31 (1.6–3.3)*	1.83 (1.1–3)*	11.74 (4.8–29)*
Male (vs Female)	1.44 (1.25–1.68)*	0.83 (0.56–1.25)	1.99 (1.47–2.7)*	1.25 (0.8–1.9)	0.93 (0.4–2.1)
Type 1 (vs Type2)	–	–	2.96 (1.94–4.5)*	0.91 (0.3–2.2)	13.16 (5.3–33)*

European and Māori patients only. Variables are mutually adjusted; \* Significant at 5% level;

† Only those events with cause of death information available.

Compared with European diabetes patients, Māori diabetes patients are more likely to die from cardiovascular disease, cancer and renal disease (Table 5). Māori and Type 1 diabetes patients have significantly higher risk of death due to renal disease.

## Discussion

Results of the present study indicate that Māori continue to have nearly double the age adjusted mortality rates than Europeans.

Age-specific SMRs decreased with age among all subgroups of ethnicity and gender. Convergence of SMRs with age is expected with the mortality rates in the general population rising exponentially with age. SMRs were higher among females (both European and Māori) compared with males. Gender differences in SMRs were higher in the younger age groups (forties and fifties), especially among Type 2 diabetes patients, but the differences diminished with age. Similar results of excess mortality among women in the younger age groups were observed in the Swedish linkage study, due to significant interaction between index age and gender.<sup>14</sup>

The observed all cause SMRs, especially in the older age groups, were lower than that found in previous New Zealand studies in the 1990s looking at mortality among people with diabetes.<sup>5 6 15</sup> This could be due to a range of factors including increased screening resulting in earlier detection of diabetes before the onset of complications,<sup>16</sup> the introduction of evidence based guidelines in 2003, improvements in the management of risk factors for diabetes complications (example: blood pressure and lipids).<sup>17,18</sup>

Mortality rates have been estimated based on a cohort of diabetes patients registered with the Waikato Regional Diabetes Service. WRDS register is estimated to cover almost 90% of the diabetes patients in the Waikato<sup>10</sup>, with the exemption of newly diagnosed diabetes patients who are yet to attend their first retinal screening, those with established eye disease and those who are too frail to attend retinal screening.<sup>19</sup>

Observed mortality rates may be underestimated since deaths among older diabetes patients not needing retinal screening would not be captured. As opposed to the prioritised ethnicity used commonly in New Zealand, a single ethnicity is stored in the WRDS database. But results of the hospital system audit indicate that multiple ethnicities are not commonly recorded and the use of prioritised ethnicity is unlikely to make a huge difference.

Reductions in all-cause mortality among women and men with diabetes mellitus have occurred over time in the U.S,<sup>4 20</sup> but mortality rates among individuals with diabetes mellitus remain 2-fold higher compared with individuals without diabetes. Although overall mortality rates in the New Zealand general population decreased over time,<sup>21</sup> such trends are not available separately for people with and without diabetes.

National estimates of mortality burden due to diabetes (compared with people without diabetes) in New Zealand, derived from multi-state life tables,<sup>22</sup> are constrained by data uncertainties in the estimates of prevalence of diabetes and in the estimates of relative risk of all-cause mortality conditional on diabetes. Previous studies in New Zealand have looked at mortality among diabetes patients in relation to that in the national general population. Māori Type 2 diabetes patients in aged 40–59 in South

Auckland<sup>6</sup> experienced 7 times excess mortality, in relation to the national total population rates.

A record linkage study using hospital discharges, comparing the mortality patterns of patients with diabetes to the general population of the same ethnic group, found that Māori with diabetes have nearly four times excess mortality, while Pacific have slightly over 2 times and non-Māori/non-Pacific have nearly 3 times excess mortality in the 25+ age-group.<sup>5</sup> Studies based on patients with diabetes identified through hospital records report higher SMRs,<sup>14</sup> probably due to of the selective inclusion of more patients in more advanced stages of diabetes and its complications.

With high prevalence of diabetes among middle aged Māori in the general population,<sup>23</sup> SMRs may not be indicative of the true burden due to diabetes. Mortality attributable to diabetes would be better estimated using studies involving people with and without diabetes. Such studies may be feasible using general practice information systems, as in the U.K.<sup>2,3</sup> The choice of population standard affects the magnitude of mortality rates and standardised mortality ratios<sup>24</sup>, as evident from the Māori rates standardised using two different populations.

The results suggest that the under-coding of diabetes on death certificates has not improved and continues to be a major limitation for routine mortality analysis solely based on these codes. Māori are more likely to have diabetes reported on death certificates due to higher proportion having renal comorbidities, for which diabetes coding is higher. This would introduce significant bias to mortality analysis using diabetes coding on national mortality data.

Current findings are in agreement with the higher risk of death from nephropathy for Māori with Type 2 diabetes compared with Europeans with Type 2 diabetes observed in South Auckland (adjusted hazard-ratio of 15).<sup>6</sup> Present results indicate that Māori diabetes patients experienced significantly higher mortality due to cardiovascular disease and cancer as well. Excess mortality risk among Type 1 patients may be partly due to the longer duration of diabetes.

Māori in general have high prevalence of cardiovascular disease independent of social deprivation.<sup>25</sup> They are also at increased risk of first cardiovascular event in the presence of Type 2 diabetes.<sup>26</sup> Māori with diabetes experience significant excess mortality compared to the Māori general population.<sup>5,6</sup> Disparities in cancer survival are reported to be partly attributed to late presentation among Māori<sup>27</sup>, as well as differences in exposure to risk factors and access to screening and treatment. Ethnic mortality gradients are influenced by socioeconomic factors<sup>28,29</sup> and smoking.<sup>30</sup> Socio economic deprivation, which may be a proximal cause of excess diabetes mortality among Māori, was not available in this study. Māori with diabetes face a range of barriers to self care.<sup>31</sup>

In conclusion, Māori diabetes patients experience significantly higher mortality than Europeans. The data yet again demonstrates the shortcomings of diabetes coding on death certificates. Studies on diabetes related mortality using national mortality database needs to take the increased recognition of diabetes on NZHIS coding for Māori into account. Mortality among diabetes patients in New Zealand would need to be compared with that among people without known diabetes, to estimate the true burden due to diabetes.

**Competing interests:** None known.

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