Diabetes Among Māori and Other Ethnic Groups in New Zealand

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Unique Aspects of Diabetes in New Zealand

New Zealand, known by the indigenous people (Māori) as Aotearoa, is in the South Pacific to the West of Australia. With a land mass of 270,500 km^2 over two major islands (North and South Islands), the population was estimated in 2015 to be 4,637,847. In the 2013 census, 74.0 % identified with one or more European identities, 14.9 % (598,605 people) identified as Māori, 11.8 % identified as Asian and 7.4 % identified as Pacific peoples [1]. European New Zealanders are predominantly of British descent arriving from the mid-nineteenth century. Māori are Polynesians who arrived mainly between 800 and 1200 AD. Pacific peoples largely started arriving in the 1960s and are mainly Polynesians from Samoa, Tonga, Cook Islands, Niue and Tokelau Islands. Asians are from across the continent and first arrived in the nineteenth century, with more rapid increases in immigration in the 1990s. Although Māori and other minority groups are distributed across the country, the ethnic mix differs depending on location, with Auckland (population 1.4 million) recognised as the city with the largest Polynesian population in the world (approximately 32 %).

Māori Perspective on Health and Research

Historically, mainstream health services and research models have not always benefitted indigenous peoples, including Māori [2–5]. The information collected was led by health professionals (including researchers) who may have perpetuated colonial values, while the true complexities of Māori values, belief systems and customs were often not reported accurately [3, 6].

Since the 1960s, in Aotearoa, New Zealand, there has clearly been a shift in the way non-indigenous health professionals, researchers and academics have positioned themselves and their work in relation to working with Māori [2, 4–9]. An important starting point includes bicultural

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strategies developed between Māori and non-Māori. These strategies are unique to Aotearoa, New Zealand, because they are an active response from the Crown (Government) towards the Treaty of Waitangi, signed in 1840 [12]. It is about honouring of the Treaty through the acknowledgement and application of the principles – partnership, participation and protection [5, 9–12]. Evans and Paewai [13] provided definitions of each principle as follows:

(a) *Partnership*. Māori and non-Māori are all citizens of New Zealand; Māori are also afforded tangata whenua (people of the land) status and, as such, might identify with a whānau (extended family), hapu (subtribe) or iwi (tribal group).
(b) *Protection*. This applies to the principle of self-determination and rights to traditional properties or taonga (treasures) such as culture, land, language and all that is deemed important, including self-determination in matters affecting personal well-being such as health, welfare, educational policies and legislation.
(c) *Participation*. The recognition that Māori, as individuals and equal partners, should be afforded equal access and participation in society's benefits.

These principles provide a framework for identifying Māori ethical and practice issues in terms of the rights, roles and responsibilities for health professionals, researchers and Māori communities in Aotearoa, New Zealand.

The dynamics of Māori usually infer whānau (family) or groups to compete, while individuals cooperate within the whānau (extended families). Such dynamics emphasise the sense of inclusiveness where people usually feel part of a whānau (family), hapu (subtribe) or iwi (tribes/people) [14–16]. In contrast, some health professionals, researchers and academics report that mainstream (New Zealand European) perspectives have a bias towards autonomy rather than towards affiliation and a sense of community within a group [7]. Fundamentally, the collaborative and collective methods of learning associated with Māori traditions, values and customs would be useful within learning environments for Māori [2, 4, 17]. The use of kaupapa Māori research concepts may also be helpful for those living with chronic health diseases, such as type 2 diabetes, in acquiring knowledge and understanding and then engaging in activities around health and well-being. For the individual newly diagnosed with type 2 diabetes, managing their blood glucose concentration through increased physical activity and consumption of nutritious food is a priority. The following are concepts often associated with kaupapa Māori styles of learning that encompasses collecting and sharing information with individuals actively involved in education and/or research projects [6, 17]:

- Tino rangatiratanga (relative autonomy/self-determination of Māori culture).
- Taonga tuku iho (cultural aspirations) – the treasures from the ancestors include cultural aspirations Māori hold for their children and messages that guide our/their relationships and interaction patterns.
- Ako (reciprocal learning) literally meaning to teach and to learn – the teacher or health professional does not have to be the fountain of all knowledge.
- Kia piki ake i nga raruraru o te kainga (mediation of socioeconomic and home difficulties).
- Whānau primary concept (a cultural preference) that contains both values (cultural aspirations) and social processes (cultural practices).
- Kaupapa, the collective vision principle.

Māori research ethics guidelines and academic bodies in health (e.g. New Zealand Research Health Council and Nga Pae o te Maramatanga) can now be sourced for learning and sharing information about best practice in the delivery of health services and research with indigenous people, in particular, Māori [5, 16, 19]. Such knowledge advocates for equal sharing of power and control through the processes of reciprocity and feedback as a partnership principle. It also requires consolidation that Māori exist in a cultural dynamic that is collective and/or cooperative [2, 4, 5, 8, 9, 18]. Overall, the goal of the kaupapa Māori research approach is to improve the Hauora (health and well-being) of each individual within and for the whānau

(family), in this instance for those living with type 2 diabetes. Essentially the core of kaupapa Māori is the catch cry 'to be Māori is the norm' where the research approach is for/with/by Māori and it does not exclude or reject mainstream or other indigenous cultures [2, 4, 17, 19].

Diabetes in Aotearoa, New Zealand

The high type 2 diabetes (T2D) prevalence among Māori was first reported in 1962 [20]. Immigrants from the nearby Tokelau Islands were subsequently shown to have an increasing prevalence of T2D compared with those remaining on the Islands [21]. Work was commenced in South Auckland, an area with large Māori, Pacific and Asian communities, in the 1990s [22] to obtain diabetes epidemiological data linked with a range of diabetes preventative strategies to inform a comprehensive diabetes management and prevention strategy. A local plan (the first such plan published globally) was developed and reviewed in 2000, showing progress in some areas but not others [23]. By 2006, subsequent data showed that the national epidemic of diabetes was continuing unabated and now included Asians [24].

Since 2006, a number of new publications have emerged, reporting the prevalence of diabetes and its complications. The impression is that the diabetes epidemic continues to make inroads in spite of a range of policies to reduce the obesity epidemic and improve diabetes care. There remain few studies describing molecular biological differences between Polynesians and Europeans. This chapter will describe an updated review on diabetes and its complications among Māori, Pacific people and Asian vs. European ethnic groups in New Zealand.

Objectives

This review sought to provide an updated report on the epidemiology of diabetes including prevalence, risk factors for complications and severe outcomes (e.g. hospitalisation, death) in Māori and other ethnic groups in New Zealand.

Methods

Eligibility Criteria

Population

This review considered studies in indigenous and underserved ethnic groups (Māori, Pacific [namely, Samoa, Cook Islands, Tonga, Fiji, Niue, Samoa, and Solomon Islands], South Asian [namely, Bangladesh, India, Sri Lanka, and Nepal] and other Asian ethnic groups) with or without comparison with European ethnic groups in New Zealand.

Study Type

This review considered non-experimental (observational) study designs including before and after studies, prospective and retrospective cohort studies, case control studies and cross-sectional studies for inclusion.

Outcomes

This review considered studies that reported on one or more of the following outcomes: incidence or prevalence of any type of diabetes (type 1 diabetes [T1D], T2D or gestational diabetes mellitus [GDM]), biological (namely, pre-diabetes, metabolic syndrome, obesity) and lifestyle (namely, smoking, physical inactivity, and poor diet) risk factors for diabetes; and health (mortality and morbidity (namely, complications)).

Search Strategy and Information Sources

The search strategy aimed to find both peer-reviewed published studies and current reports by the New Zealand Ministry of Health. A two-step search strategy was utilised in this review. An initial search of electronic databases (MEDLINE/PubMed, EMBASE, Scopus and CINAHL) and the New Zealand Ministry of Health website was undertaken using identified keywords and index terms (see Appendix 1). Next, the reference list of all identified reports and articles was searched for additional studies.

Studies in English published after 2004 were considered for inclusion in this review. Where possible, efforts were made to contact authors for missing information.

Data Collection

Data were extracted from papers included in the review independently by two reviewers using data extraction tools developed for this review. The data extracted included specific details about the study design, participants and setting and outcomes.

Data Synthesis

Since statistical pooling was not possible because of the diverse types of studies reviewed, the findings were presented in narrative form, including tables to aid in data presentation where appropriate.

Results

Figure 10.1 presents a flow diagram summarising the identification of studies included for review. Our search strategy identified 292 citations after duplicates were removed. Of these, 246 citations were excluded after the first screening of titles and/or abstracts for inclusion and exclusion criteria, leaving 46 citations for a second full text screening. After further assessment, 12 citations were excluded leaving 34 observational studies for final inclusion in the review.

Descriptive Data Synthesis

Table 10.1 presents study characteristics of 34 studies included for review, which were published in years ranging from 2005 to 2015 [25–60]. Studies were heterogeneous for age, ethnicity and screening/diagnostic characteristics. For instance, case definition of diabetes using HbA1c diagnostic cutoffs was varied across studies between ≥6.5 and >7.0 %, and from 5.7–6.4 % to >6.0 % for pre-diabetes (Table 10.1). Only one study used the oral glucose tolerance test (OGTT) in a population-based sample [57]. Similarly, pre-existing diabetes has been identified through self-report, primary care/general practice records, hospital chart review and data linkage between pharmaceuticals and/or laboratory investigations and hospital admissions/national administrative datasets. Study populations were identified/recruited using various methods including community screening, clinic databases and population based health databases (Table 10.1).

Table 10.2 shows the prevalence of diabetes and pre-diabetes. The prevalence of known diabetes was estimated to be 2.2–5.0 % among Europeans vs. 7.0–12.2 % among Māori, 8.9–38 % among Pacific people and 9.1–37.1 % among Asians. The prevalence of diabetes including known diabetes and undiagnosed diabetes by HbA1c screening ranged from 1.1 to 6.1 % among Europeans but 3.3 to 9.8 % among Māori, 5.3–15.4 % among Pacific peoples and 4.3–9.3 % among Asians. Undiagnosed diabetes alone ranged from 0.4 to 1.1 % among Europeans but 3.6–6.5 % among Māori, 4.6–8.1 % among Pacific people and 7.4–7.5 % among Asians. No consistent gender differences were found.

Three studies (South Auckland, Waikato and Auckland) described the prevalence of diagnosed diabetes [34, 47, 55] in patients who had been hospitalised with an acute cardiovascular event (mean ages 60, 68 and 15+ years, respectively). The prevalence among Māori, Pacific and Asians was approximately double that of European New Zealanders (23.3–39.2 % vs. 11.3–18.1 %). One, a nationwide study among people with a mood and anxiety disorder, aged ≥16 years, again showed the greater prevalence of known diabetes among Māori and Pacific peoples over Europeans (8.0–11.3 % vs. 3.6 %) [38].

A key theme is that within each study, the prevalence of diabetes is generally highest in Pacific people and then Māori, who generally have a prevalence approximately twice that of Europeans. Asians also have a high prevalence generally between (but sometimes below or

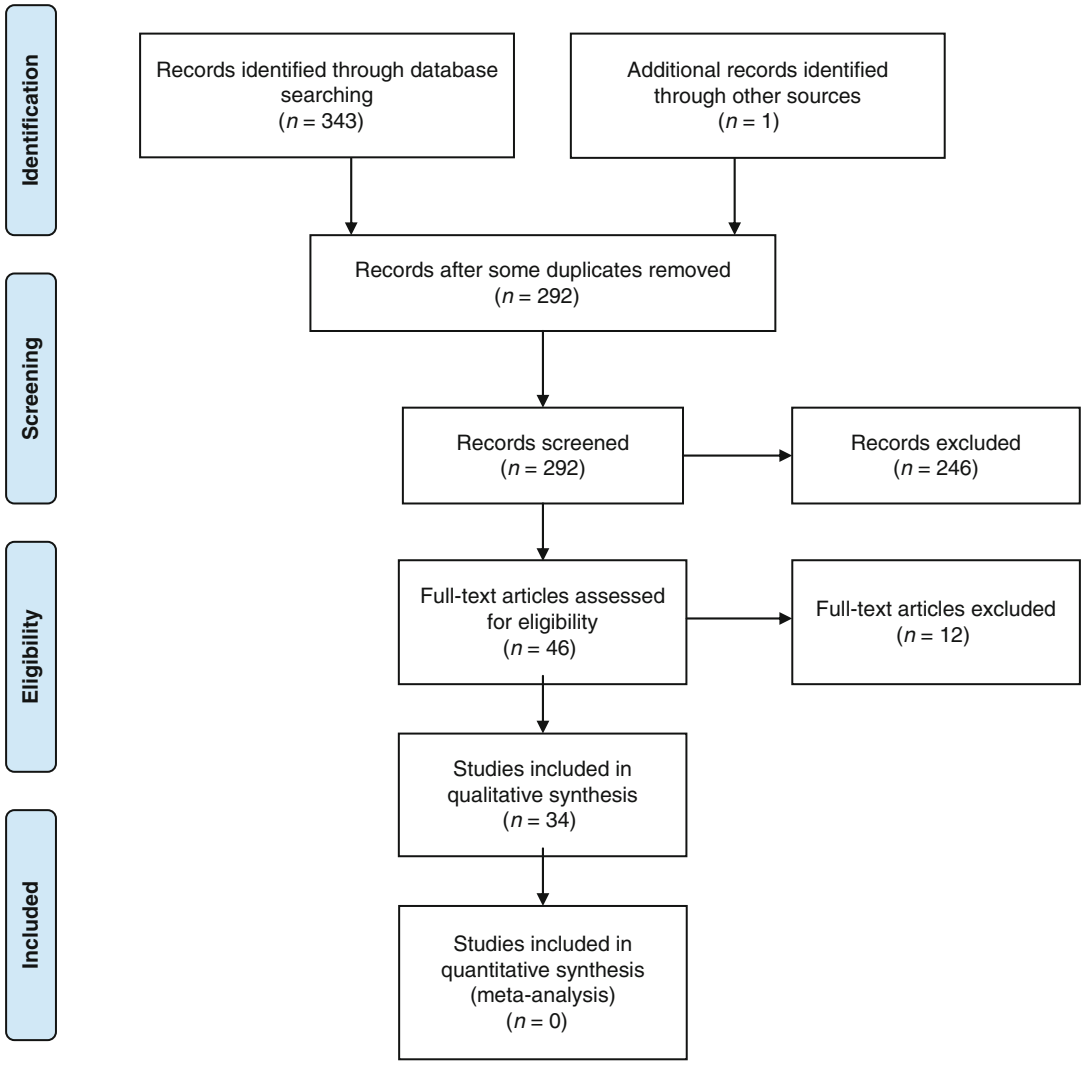

Fig. 10.1 PRISMA 2009 Flow Diagram for systematic review of publications since 2006, when the last review was undertaken

above) Māori and Pacific people. These odds ratios are consistent with the 2013/2014 New Zealand Health Survey.

There are few studies of pre-diabetes. Two, a national study and a South Auckland study [29, 32], using HbA1c of 5.7–6.4 % and 6.1–7.0 % as diagnostic criteria, respectively, found that the prevalence of HbA1c defined pre-diabetes was approximately sixfold higher among non-Europeans than Europeans (12.8–19.9 % vs. 2.1–2.5 %, respectively). Similarly, high prevalence estimates for impaired glucose tolerance and/or impaired fasting glucose were reported among Māori in the Waikato region [57].

Table 10.3 shows the prevalence of risk factors for complications among people with diabetes by ethnic group. Across the data sources from primary care (including the national 'Get Checked' data) to a mixture of primary care and hospitals and from both national, Waikato, South Auckland, West Auckland and South Island studies, Māori, Pacific people and Asians are more likely to have poor glucose control than Europeans. European and Māori patients with type 1 diabetes were more

Table 10.1 Characteristics of observational studies reviewed

Study identification	Study design (follow-up)	Participants and setting	Outcomes (measures, units)
Agban et al. (2008) [25]	Cross-sectional (baseline and 2 years from cohort study)	*Sample size: N* = 7782 *Age (years):* range in mean from 56 to 68 *Gender:* male 42 % *Ethnicity:* European, Māori, Pacific, Asian (Indian), other Asian, Other (Middle Eastern, Latin American/Hispanic and African) *Eligibility criteria*: T2D patients who had undertaken an annual review in 2002 or 2003, and had a follow-up review 2 years later *Setting:* nationwide data from primary health care reviews of patients with T2D collated within 15 primary care organisations or diabetes trusts	*Baseline and 2 years for all outcomes* Poor glycaemic control prevalence (HbA1c >8 %, %) HBP prevalence (>130/80, %) Obesity prevalence (measured BMI ≥30 for European, Asian, Indian and 'Other'; BMI ≥32 for Māori and Pacific, %) Current smoker prevalence (self-report, %),
Brian et al. (2010) [26]	Population-based cross-sectional survey using multistage cluster random sampling	*Sample size: N* = 1381 (73 %) *Age (years):* ≥40 *Gender:* NR *Ethnicity:* Fijian *Eligibility criteria*: HbA1c and visual acuity were measured *Setting:* Diabetic eye disease was assessed using 90-dioptre lens dilated funduscopy	HbA1c and visual acuity measured Mean HbA1c (9.9 ± 2.3 %) Vision threat occurred in at least one eye of 11.5 %. Diabetes (predominantly maculopathy) caused pinhole acuity <6/18, <6/60 and <3/60 for 3.8 %, 1.1 % and 0.7 % of eyes, respectively. No person was bilaterally blind (<6/60) due to diabetes, but 2.3 % (all on oral antiglycaemics alone) were 6/60 bilaterally. Compared with recent diabetes diagnosis, diagnosis >10 years ago was predictive of any (odds ratio [OR] 8.13; 95 % confidence interval [CI] 3.28–20.21; $P < 0.001$) and vision-threatening (OR 5.25; 95 % CI 1.71–16.12; $P = 0.004$) eye disease. Although 80.6 % claimed regular general diabetes checkups, only 36.5 % recalled previous dilated ocular examination. Four eyes had received laser treatment

Table 10.1 (continued)

Study identification	Study design (follow-up)	Participants and setting	Outcomes (measures, units)
Brewer et al. (2008) [27]	Cross-sectional (baseline from cohort study) and prospective cohort and (median 2 years)	*Sample size: N* = 47,904 (408 with prior diagnosis of diabetes) *Age (years)*: ≥0 *Gender*: male 44 % *Ethnicity*: European/other, Māori, Pacific, Asian (unspecified) *Eligibility criteria*: participants in a Hepatitis Foundation screening campaign for hepatitis B (1999–2001) *Setting*: lower half of the North Island of NZ	Diabetes prevalence (HbA1c ≥7 %, %) All-cause mortality (data linkage, HR with 95 % CI)
Chan et al. (2015) [28]	Retrospective cohort (from 2004 to 2010)	*Sample size: N* = 1,475,347 *Age (years)*: ≥0 *Gender*: male 48 % *Ethnicity*: European/other, Māori, Pacific, Asian (Indian), Chinese, other Asian *Eligibility criteria*: residents who had utilised publicly funded health services in NZ and lived in Auckland in 2010 *Setting:* Auckland metropolitan region, linked data between a laboratory repository and national administrative datasets for District Health Boards	Age-standardised diabetes prevalence (dysglycaemia by modified ADA and WHO criteria, %)
Coppell et al. (2013) [29]	Cross-sectional	*Sample size: N* = 4721 *Age (years)*: ≥15 *Gender*: NR *Eligibility criteria*: NR *Ethnicity*: European/Other (Asian, Middle Eastern, Latin American and African), Māori, Pacific *Setting*: nationwide, 2008/2009 New Zealand Adult Nutrition Survey	Diabetes prevalence (self-report diagnosed or HbA1c ≥6.5 %, %) Pre-diabetes prevalence (HbA1c 5.7–6.4 %, %)
Elley et al. (2008) [30]	Cross-sectional	*Sample size: N* = 29,179 *Age (years)*: range in mean from 56 to 68 *Gender*: NR *Eligibility criteria*: T2D *Ethnicity*: European, Māori, Pacific, Asian (Indian), Other Asian, Other *Setting*: nationwide linked hospital records and data obtained from primary health care reviews of patients with T2D	Poor glycaemic control prevalence (HbA1c >8 %, %) HBP prevalence (>130/80, %) Obesity prevalence (measured BMI ≥30, %) Albuminuria prevalence (ACR ≥2.5 for men; ≥3.5 for women, %) Current smoker (self-report, %), 5-year CVD risk prevalence (Framingham risk score ≥15 %, %)

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Table 10.1 (continued)

Study identification	Study design (follow-up)	Participants and setting	Outcomes (measures, units)
Elley et al. (2010) [31]	Prospective cohort (median 3.9 years)	*Sample size: N* = 36,127 *Age (years)*: median 59 *Gender*: male 49 % *Eligibility criteria*: T2D without previous CVD *Ethnicity*: European, Māori, Pacific, Asian (Indian), East Asian, Other (Middle Eastern, Latin American/Hispanic, African, and others) *Setting*: nationwide linked hospital records and data obtained from primary health care reviews of patients with T2D	Fatal or nonfatal CVD incidence (data linkage using ICD-9 and ICD-10 codes, HR with 95 %CI)
Ellison et al. (2005) [32]	Cross-sectional	*Sample size: N* = 50,819 *Age (years):* >20 *Gender:* male 44.6 % *Ethnicity:* European, Māori, Samoan, Cook Island, Asian (Indian), Chinese *Eligibility criteria:* none specified *Setting:* South Auckland. Screening programme to detect elevated fasting hyperglycaemia using HbA1c	Diabetes prevalence (HbA1c >7 %, %) Pre-diabetes or diabetes prevalence (HbA1c >6 %, %)
Faatoese et al. (2011) [33]	Cross-sectional	*Sample size: N* = 252 *Age (years):* range 20–64 *Gender:* male 40 % *Ethnicity:* Māori *Eligibility criteria:* Māori descent *Setting:* community screening for CVD risk factors in Wairoa	T2D prevalence (prior diagnosis by medical records, %)
Feigin et al. (2006) [34]	Cross-sectional	*Sample size: N* = 1423 *Age (years):* ≥15 *Gender:* Male 47 % *Ethnicity:* European, Māori/ Pacific, Asian/other (unspecified) *Eligibility criteria:* first-ever cases of stroke 2002–2003 *Setting:* Auckland population-based register	Diabetes (doctor diagnosed by self-report, %)
Frederikson and Jacobs (2008) [35]	Cross-sectional (baseline from cohort study)	*Sample size: N* = 11,977 *Age (years):* range 7–100 *Gender:* Male 52 % *Ethnicity:* European, Māori, Pacific (Samoan, Cook Island Māori, Tongan, Niuean), Asian (Indian), Chinese, Other *Eligibility criteria:* all records of first screening visits 2002–2005 for people with diabetes *Setting:* Wellington regional retinal screening programme for people with diabetes	Maculopathy prevalence (clinical retinopathy screening, %)

Table 10.1 (continued)

Study identification	Study design (follow-up)	Participants and setting	Outcomes (measures, units)
Grey et al. [36]	Cross-sectional	*Sample size:* $N = 10{,}301$ *Age (years):* range 35–74 *Gender:* male 52% *Ethnicity:* Pacific (Samoans, Tongan, Cook Island Māori, Niuean) Other Pacific (including Tokelauan) *Eligibility criteria:* none specified (Fijian excluded) *Setting:* primary care practices in nine Primary Health Organisations in Auckland and Northland	Diabetes prevalence (electronic medical records, %)
Ihaka et al. (2012) [37]	Cross-sectional	*Sample size:* $N = 53$ *Age (years):* ≥18 *Gender:* men 53% *Ethnicity:* Māori *Eligibility criteria:* Māori with diabetes who had not received a national diabetes assessment for >12 months and had undetected pedal pulses, absence of sensation, previous history of peripheral vascular disease, or ulceration and no below-knee amputation *Setting:* Waitemata district, Auckland 2007–2008	Classification of foot risk status (podiatric practitioners category ≥2, %) Obesity, hypertension, dyslipidaemia and retinopathy prevalence (self-report, %)
Jackson et al. (2009) [38]	Retrospective cohort (from 1996 to 2007)	*Sample size:* $N = 45{,}970$ *Age (years):* ≥0 *Gender:* NR *Ethnicity:* European/other, Māori, Pacific, Asian (Indian), Chinese, Other Asian *Eligibility criteria:* public hospital discharge with any mention of T1D or T2D from 1996 to 2007 *Setting:* counties Manukau National Minimum Dataset, 2007	Hospital admissions for people with diagnosed diabetes (hospital records, %)
Jeffreys et al. (2005) [39]	Prospective cohort (13 years)	*Sample size:* $N = 74{,}847$ *Age (years):* ≥25 *Gender:* male 50% *Ethnicity:* European/other (non-Māori/non-Pacific), Māori, Pacific *Eligibility criteria:* hospital discharge diagnosis of diabetes between 1988 and 2001 *Setting:* record linkage study of national hospital discharge records to death records	All-cause mortality (data linkage hospital discharge to death records, %)

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Table 10.1 (continued)

Study identification	Study design (follow-up)	Participants and setting	Outcomes (measures, units)
Joshy et al. (2009) [40]	Retrospective cohort (from 2003 to 2006)	*Sample size: N* = 7900 *Age (years):* NR *Gender:* male % NR *Ethnicity:* European, Māori *Eligibility criteria:* renal complication-free adult diabetes patients registered with Waikato regional diabetes service, diagnosed with diabetes before 2003 *Setting:* Waikato District Health Board region	Hospital renal admission (hospital records, HR with 95 % CI) Start dialysis or kidney transplantation (hospital records, HR with 95 % CI) Death from renal disease (data linkage to death records, HR with 95 % CI)
Joshy et al. (2009) [41]	Cross-sectional	*Sample size: N* = 45,500 *Age (years):* NR *Gender:* Male % NR *Ethnicity:* European, Māori, Pacific, Asian *Eligibility criteria:* all patients registered with the practices as of 1 July 2007 *Setting:* 10 Rotorua General Practice Group practices	Age-standardised diabetes prevalence (medical records, %)
Joshy et al. (2009) [42]	Cross-sectional	*Sample size: N* = 1819 *Age (years):* ≥18 *Gender:* Male 49 % *Ethnicity:* European, Māori, Pacific, Asian *Eligibility criteria:* all patients with diabetes registered with the practices as of 1 July 2007 *Setting:* 10 Rotorua General Practice Group practices	CKD prevalence (eGFR<60, %) Microalbuminuria prevalence (ACR 2.5–29.9 for men; 3.5–29.9 for women, %) Albuminuria prevalence (ACR ≥30, %)
Joshy et al. (2010) [43]	Retrospective cohort (from 2003 to 2007)	*Sample size: N* = 9043 *Age (years):* ≥18 *Gender:* male 50 % *Ethnicity:* European, Māori *Eligibility criteria:* diabetes patients registered with the Waikato Regional Diabetes Service database before 2008, diagnosed before 2003 and alive as of 2003 *Setting:* Waikato region	Age-standardised, all-cause mortality rate (data linkage,/100,000 person-years)

Table 10.1 (continued)

Study identification	Study design (follow-up)	Participants and setting	Outcomes (measures, units)
Kenealy et al. (2008) [44]	Cross-sectional (baseline from cohort) and prospective cohort (median 2.4 years)	*Sample size:* $N=48{,}444$ *Age (years):* range in mean 53–66 *Gender:* male 49 % *Ethnicity:* European, Māori, Pacific, Asian (Indian), East Asian, Other (Middle Eastern, Latin American/Hispanic, African, others) *Eligibility criteria:* T2D and no previous CVD *Setting:* people with T2D who attended at least one diabetes annual review in primary health care as part of a national programme from 2000 to 2005; forms the NZ Diabetes Cohort Study	Fatal/nonfatal CVD incidence (data linkage to hospital/mortality data, HR with 95 %) Microalbuminuria prevalence (ACR ≥2.5 for men; ≥3.5 for women, %) Macroalbuminuria prevalence (ACR >30, %) Current smoker prevalence (self-report, %) Poor glycaemic control prevalence (HbA1c ≥10 %, %)
Kenealy et al. (2012) [45]	Cross-sectional	*Sample size:* 65,171 *Age (years):* median 65 *Gender:* male 51 % *Ethnicity:* European, Māori, Pacific, Asian (Indian), East Asian, Other (Middle Eastern, Latin American/Hispanic, African, others) *Eligibility criteria:* adults in primary care with T2D, not on renal replacement therapy *Setting:* T2D who had attended at least one diabetes annual review in primary health care as part of a national programme between 2000 and 2006 in New Zealand; forms the NZ Diabetes Cohort Study	Microalbuminuria prevalence (ACR >2.5 men, 3.5 women to <30, %) Macroalbuninuria prevalence (ACR 30–<100, %) Advanced albuminuria prevalence (ACR ≥100, %)
Kerr et al. (2006) [46]	Cross-sectional (baseline from cohort) and prospective cohort (mean 3.8 years)	*Sample size:* $N=4193$ *Age (years):* range in mean 55–60 *Gender:* Male 49 % *Ethnicity:* European, Māori, Pacific, Asian, Other *Eligibility criteria:* T2D Hospital admission for MI or CCF from 1999 to 2001 *Setting:* the study population included 4193 individuals with T2D from South Auckland who participated in a primary care audit from 1994 to 1999	Mortality (data linkage, HR with 95% CI) Smoking prevalence (self-report, %)

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Table 10.1 (continued)

Study identification	Study design (follow-up)	Participants and setting	Outcomes (measures, units)
Kerr et al. (2008) [47]	Cross-sectional	*Sample size: N* = 973 *Age (years):* mean 60 *Gender:* Male 75 % *Ethnicity:* European/other, Māori, Pacific, Asian *Eligibility criteria:* patients admitted for acute CV event *Setting:* patients presenting to Middlemore Hospital Coronary Care Unit with an acute CVD event from July 2004 to June 2006. CVD risk factor data was electronically collected using acute PREDICT	T2D prevalence (diagnosed, %)
Kolt et al. (2007) [48]	Cross-sectional	*Sample size:* 112 *Age (years):* mean 66 *Gender:* male 45 % *Ethnicity:* Asian (India, Sri Lanka, Pakistan, Fiji) *Eligibility criteria:* NR *Setting:* Auckland-based Asian Indian community organisations	Diabetes prevalence (self-report, %)
Lawrenson et al. (2009) [49]	Cross-sectional	*Sample size: N* = 26,096 *Age (years):* ≥20 *Gender:* NR *Ethnicity:* European, Māori, Asian *Eligibility criteria:* aged ≥20 years with T2D *Setting:* Hamilton general practice register linked to Waikato regional diabetes service register	Poor glycaemic control prevalence (HbA1c >8 %, OR with 95% CI)
Lim et al. (2008) [50]	Cross-sectional	*Sample size:* 180 *Age (years):* mean 54 *Gender:* male 44 % *Ethnicity:* Māori *Eligibility criteria:* household members with at least one Māori resident, or Māori with past GDM or aged ≥23 years with 2 parents with known diabetes *Setting:* newly diagnosed with diabetes during a community screening programme, Te Wai o Rona Diabetes Prevention Strategy	Poor glycaemic control prevalence (HbA1c ≥8.0 %, %) HBP prevalence (treated hypertension or ≥130/85, %) Central obesity prevalence (waist circumference >102 cm for men, >88 cm for women, %) Metabolic syndrome prevalence, (ATPIII criteria, %) Current prevalence (self-report, %) Microalbuminuria prevalence (ACR 2.5–29.9 for men, 3.5–29.9 for women, %) Albuminuria prevalence (ACR ≥30, %) CKD prevalence (eGFR <60, %) Retinopathy prevalence (microaneurysms ≥5, %)

Table 10.1 (continued)

Study identification	Study design (follow-up)	Participants and setting	Outcomes (measures, units)
New Zealand Ministry of Health (2013/2014) [51]	Cross-sectional	*Sample size: N* = 13,309 *Age (years)*: ≥15 *Gender*: men and women, the proportion is not noted *Eligibility criteria*: resident population aged ≥15 years living in permanent dwellings, aged-care facilities or student accommodation *Ethnicity*: European/Other, Māori, Pacific, Asian *Setting*: nationwide, New Zealand Health Survey	Diabetes prevalence (self-report, adjusted rate ratios [for age, gender, ethnicity])
Robinson et al. (2006) [52]	Cross-sectional	*Sample size:* 5917 *Age (years):* mean 60 *Gender:* male 50% *Ethnicity:* European, Māori, Pacific, Asian (Indian), Other Asian, Other *Eligibility criteria:* patients with diabetes *Setting:* external audit of general practice diabetes care carried out in South and West Auckland by the Diabetes Care Support Service	Poor glycaemic control prevalence (HbA1c >8.0%, %) Albuminuria prevalence (ACR ≥2.5 for men; ≥3.5 for women, %) Current smoker prevalence (self-report, %) Obesity prevalence (BMI >30, %) HBP prevalence (systolic >140, %) At-risk feet (by clinical review, %) Dyslipidaemia prevalence (TC:HDL ratio>4.5)
Robinson et al. (2015) [53]	Cross-sectional (baseline from cohort) and prospective cohort (median 7.14 years)	*Sample size: N* = 62,002 *Age (years):* range in mean 55–66 *Gender:* male 49% *Ethnicity:* European/other, Māori, Pacific, Asian (Indian subcontinent or Fijian Indians), other Asian (Southeast Asian, Chinese) *Eligibility criteria:* T2D *Setting:* nationwide	Microalbuminuria prevalence (ACR ≥2.5 for men or ≥ 3.5 for women, and < 30 for both, %) Macroalbuminuria prevalence (ACR ≥30, %) Lower limb amputation incidence (linked hospital records ICD codes, rate/1000 person years)
Scott et al. (2006) [54]	Cross-sectional	*Sample size:* 1251 *Age (years):* <26 *Gender:* male 50% *Ethnicity:* Māori/Pacific Islanders, Europeans, Others *Eligibility criteria:* attended a diabetes centre at least once in the previous 3 years, any person with diabetes born after 1 January 1978 *Setting:* 12 paediatric hospital and adult hospitals across NZ and forms the all-NZ young person's diabetes audit, 2003–2004	Microalbuminuria prevalence (ACR >2.5 for males; >3.5 for females, %)

(continued)

Table 10.1 (continued)

Study identification	Study design (follow-up)	Participants and setting	Outcomes (measures, units)
Scott et al. (2007) [55]	Cross-sectional (baseline from retrospective cohort)	*Sample size:* 4408 *Age (years):* mean 68 *Gender:* male 65% *Ethnicity:* European, Māori *Eligibility criteria:* hospital discharge diagnosis of all with acute coronary syndromes from 1999 to 2002 *Setting:* Waikato hospital, Hamilton	Diabetes prevalence (chart review, %)
Scott et al. (2008) [56]	Cross-sectional	*Sample size:* $N = 12{,}992$ *Age (years):* ≥16 *Gender:* male 41% *Ethnicity:* European/other, Māori, Pacific *Eligibility criteria:* subsample with any 12-month mood and anxiety disorder prevalence (CIDI 3.0/DSM-IV) for diabetes prevalence and subsample with diabetes for mental disorder prevalence *Setting:* nationwide	Diabetes prevalence (self-report, %) Any 12-month mood and anxiety disorder prevalence (CIDI 3.0/DSM-IV, %)
Simmons et al. (2009) [57]	Cross-sectional	*Sample size:* 3784 *Age (years):* ≥28 *Gender:* male 36% *Ethnicity:* Māori *Eligibility criteria:* nonpregnant adult Māori *Setting:* all Māori residents within the boundaries of the Waikato District Health Board and the tribal area of Ngati Tuwharetoa in the neighbouring Lakes District Health Board	Undiagnosed diabetes, IGT, and IFG age-standardised prevalence (OGTT 1998 WHO criteria, % with 95%CI)
Smith et al. (2010) [58]	Cross-sectional	*Sample size:* 1.4 million *Age (years):* ≥0 *Gender:* male 46% *Ethnicity:* European/other, Māori, Pacific, Asian *Eligibility criteria:* health events recorded between January 2006 and December 2007 for those alive *Setting:* records of subsidy claims for pharmaceuticals and laboratory investigations were linked to records in a national hospital admissions database to 'reconstruct' populations of four District Health Boards – Counties Manukau, Northland, Waitemata and Auckland	Diabetes age-standardised prevalence (data linkage records ICD-10-AM system, %) Age-standardised proportion of diabetes cases ≥1 medical/surgical hospital admissions in 2007 (data linkage records, %)

Table 10.1 (continued)

Study identification	Study design (follow-up)	Participants and setting	Outcomes (measures, units)
Tomlin et al. (2006) [59]	Cross-sectional	*Sample size:* 13,281 *Age (years):* ≥0 *Gender:* Male 52 % *Ethnicity:* European, Māori/ Pacific *Eligibility criteria:* any diabetes *Setting:* data were collected from all 242 practices participating in the South Link Get Checked programme, every practice in the South Island outside Christchurch city (the main urban centre) and 14 practices within Christchurch	Poor glycaemic control prevalence (HbA1c >9.0 %, %) Microalbuminuria prevalence (ACR >2.5 for males; >3.5 for females, %) High Cholesterol prevalence (≥6.0, %) Smoking prevalence (self-report, %)

T1D type diabetes, *T2D* type 2 diabetes, *HbA1c* glycated haemoglobin, *BMI* body mass index, *NR* not reported, *ADA* American Diabetes Association, *WHO* World Health Organization, *ACR* albumin creatinine ratio, *CVD* cardio vascular disease, *ICD* International Classification of Diseases, *ATPIII* Adult Treatment Panel, *IFG* impaired fasting glucose, *IGT* impaired glucose tolerance, *OGTT* oral glucose tolerance test, *HR* hazard ratio, *OR* odds ratio, *CKD* chronic kidney disease, *eGFR* estimated glomerular filtration rate, *TC* total cholesterol *HDL* high-density lipoprotein, *NZ* New Zealand, *CIDI* Composite International Diagnostic Interview, *DSM* Diagnostic and Statistical Manual of Mental Disorders

Table 10.2 Prevalence of diabetes and pre-diabetes

	Gender	European	Māori	Pacific	Asian
Diabetes prevalence and key features					
Brewer et al. (2008) [27] HbA1c screening/prior diagnosis; age 56–68 years		1.1	3.3	5.3	4.3
Chan et al. (2015) [28][a] Prior diagnosis; age 0+ years	Male	3.0	8.2	11.4	10.8
	Female	2.2	7.0	11.6	9.3
Coppell et al. (2013) [29] HbA1c screening/prior diagnosis; age 15+ years		6.1	9.8	15.4	
Ellison et al. (2005) [32][a] HbA1c screening; age >20 years	Male	1.0	4.8	8.1 (Cook Island Māori) 5.1 (Samoan)	7.5
	Female	0.4	3.6	4.6 (Cook Island Māori) 5.4 (Samoan)	7.4
Faatoese et al. (2011) [33] Prior diagnosis; age 20–64 years	Male		11.8		
	Female		10.0		
Feigin et al. (2006) [34] Prior diagnosis; age 15+ years; post stroke		11.3	31.4		23.3
Grey et al. (2010) [36] Prior diagnosis; age 35–74 years	Male			25–37 26 (Other Pacific)	
	Female			29–38 32 (Other Pacific)	

(continued)

Table 10.2 (continued)

	Gender	European	Māori	Pacific	Asian
Joshy et al. (2009) [41] Prior diagnosis; age not specified		3.1	7.0	8.9	6.7
Kerr et al. (2008) [46] Prior diagnosis; age 60 years; post-acute CVD		18.1	31.5	39.2	33.0
Kolt et al. (2007) [48] Prior diagnosis; age 66 years	Male				34.0
	Female				37.1
New Zealand Ministry of Health (2013/2014) [51] Prior diagnosis; age 15+ years: rate ratio's			2.0 (vs. non-Māori)	2.8 (vs. non-Pacific)	1.8 (vs. non-Asian)
Scott et al. (2007) [55] Prior diagnosis; age 68 years; post-acute CVD		17.5	33.0		
Scott et al. (2008) [56] Prior diagnosis; age 16+ years; mental health		3.6	8.0	11.3	
Simmons et al. (2009) [57] Undiagnosed by OGTT; 28+ years	Male		6.5		
	Female		4.2		
Smith et al. (2010) [58] Prior diagnosis; age 0+ years; subsidy claims	Male	5.0	12.2	13.9	11.3
	Female	4.0	10.6	15.0	9.1
Pre-diabetes prevalence					
Coppell et al. (2013) [29]		18.1	20.5	24.0	
Ellison et al. (2005) [32]	Male	2.5	14.7	19.9 (Cook Island Māori) 12.8 (Samoan)	18.3
	Female	2.1	12.8	15.0 (Cook Island Māori) 13.3 (Samoan)	13.3
Simmons et al. (2009) [57]	Male		5.4 (IFG) 8.5 (IGT)		
	Female		3.0 (IFG) 9.7 (IGT)		

[a]Denotes studies which reported data for additional ethnic minority groups not presented

likely to have poor glucose control than those with type 2 diabetes in the South Island [59].

Other complication risk factors were more variable between ethnic groups. Māori and Pacific people with known diabetes were more likely to be obese (60.7–76%) than Europeans (43.8–46.6%) or Asians (24.9–28.4%). The prevalence of obesity among Māori with newly diagnosed diabetes in a diabetes prevention programme in the Waikato was particularly high (90.0%) [50]. Current smoking was higher among Māori across studies (25.0–34.9%) than Pacific people (15.8–17.8%), Europeans (8.5–19.9%) and Asians (5.8–7.7%). High blood pressure was consistently lowest among Asians (17.5–52%). However, the prevalence of high blood pressure was higher among Māori and Pacific people than Europeans in one national study [25] but lower in

Table 10.3 Prevalence or risk of clinical and lifestyle risk factors for complications and mortality in people with diabetes

	Gender	European	Māori	Pacific	Asian
Poor glycaemic control					
Agban et al. (2008) (baseline) [25][a]		23.6	46.6	68.4	40.2
Agban et al. (2008) [25] (2 years)[a]		23.1	44.4	51.9	31.7
Elley et al. (2008) [30]		23	43	50	36
Kenealy et al. (2012) [45]		6	19	27	12
Lawrenson et al. (2009) [49]		1 (reference)	OR 1.78 (95 %CI: 1.33,2.39)		OR 1.53 (95 %CI: 1.33,1.76)
Lim et al. (2008) [50]			34.4		
Robinson et al. (2006) [52][a]		22.7	49.5	55.7	44.9
Tomlin et al. (2006) [59]		30.7 (T1D) 10.4 (T2D)	51.1 (T1D) 26.0 (T2D)		
High blood pressure					
Agban et al. (2008) [25] (baseline)		27.8	39.8	34.7	27.4
Agban et al. (2008) [25] (2 years)		23.1	30.5	26.2	17.5
Elley et al. (2008) [30]		67	65	61	52
Ihaka et al. (2012) [37]			49		
Lim et al. (2008) [50]			89.4		
Robinson et al., (2006) [52][a]		32.6	27.6	23.7	24.0
CVD risk/poor metabolic control[b]					
Elley et al. (2008) [30]		29.6	30.1	18.5	19.6
Ihaka et al. (2012) [37]			55		
Lim et al. (2008) [50]			89.4		
Robinson et al. (2006) [52][a]		27.3	46.3	35.4	34.8
Tomlin et al. (2006) [59]		19.8 (T1D) 28.9 (T2D)	17.1 (T1D) 31.8 (T2D)		
Obesity					
Agban et al. (2008) [25] (baseline)		45.1	62.2	62.8	28.4
Agban et al. (2008) [25] (2 years)		43.8	60.7	60.8	25.3
Elley et al. (2008) [30]		46	73	73	25
Ihaka et al. (2012) [37]			62		
Lim et al. (2008) [50]			90.0		
Robinson et al. (2006) [52][a]		46.6	76.0	73.7	24.9
Current smoker					
Agban et al. (2008) [25] (baseline)		8.5	28.0	16.5	5.8
Agban et al. (2008) [25] (2 years)		7.8	25.7	14.4	4.2
Elley et al. (2008) [30]		9.6	27.0	16.6	6.1
Ihaka et al. (2012) [37]			25		
Kenealy et al. (2008) [44]		11	31	17	6

(continued)

Table 10.3 (continued)

	Gender	European	Māori	Pacific	Asian
Kenealy et al. (2012) [45]		10.0	28.3	15.8	6.2
Kerr et al. (2006) [46]		11.0	26.9		
Lim et al. (2008) [50]			30.6		
Robinson et al. (2006) [52][a]		13.1	34.9	17.8	7.7
Tomlin et al. (2006) [59]		19.9 (T2D) 10.9 (T2D)	25.5 (T1D) 27.5 (T2D)		
Depression/anxiety					
Scott et al. (2008) [56]		9.3 (depression) 17.5 (anxiety)	16.5 (depression) 23.5 (anxiety)	9.6 (depression) 22.5 (anxiety)	

[a]Denotes studies which reported data for additional ethnic minority groups not presented
[b]Includes metabolic syndrome, dyslipidaemia and CVD risk

one national and one South/West Auckland/study (27.6–65 % vs. 23.7–61 % vs. 23.1–67 % Māori, Pacific, Europeans, respectively [30, 52]. Generally Europeans had lesser CVD risk than Māori, but other inter-ethnic group comparisons were variable. In one study [56], comorbid depression and anxiety in people with diabetes were higher among Māori compared with European or Pacific ethnic groups.

One study compared risk factor prevalence in 2002 and among the same patients 2 years later in primary care [25]. All risk factors improved to a greater or lesser extent, but the degree varied by ethnic group. The greatest improvements in glycaemia occurred in Pacific people and Asians, and the least improvements in blood pressure occurred in the Māori and Europeans. There was limited change in smoking or obesity across ethnic groups. There remained a very high prevalence of risk factors across all ethnic groups.

Table 10.4 shows the prevalence of diabetes complications and mortality in the studies reviewed. One study showed that Māori people had a substantially increased risk (hazard ratio was 25) of starting dialysis or having transplant therapy compared with Europeans [40]. Rates of microalbuminuria (28.4–39.0 %) and macroalbuminura (9–58.2 %) were highest among Māori in primary care, secondary care and in both T1D and T2D compared with Europeans (17–24.9 % and 3.5–6 % respectively), Pacific people (31–32.1 % and 9.1–17.0 %) and Asians (23–24.1 % and 4.1–7.0 %). While the rate of microalbuminuria was similar among Māori who were newly diagnosed as those with known diabetes, albuminuria rates were lower (but already higher at European rates) [50].

Other complications have been less commonly studied. There are only two recent studies of eye disease: one of maculopathy in those with known diabetes, with the highest prevalence among Pacific people and similar prevalence between Europeans, Māori and Asians [35]. The other showed a very low rate of retinopathy at diagnosis among Māori in the Waikato [50]. Foot complications were most common among Māori, followed by Europeans, Pacific people and then Asians [53]. Cardiovascular event rates were 23–30 % higher among Māori than Europeans in two national samples [30, 44], but not significantly higher among Pacific people. Asian cardiovascular event rates were 6 % (nonsignificant) to 29 % higher than Europeans.

Hospitalisation and mortality are integrated measures of a range of diabetes, both comorbid and psychosocial characteristics. Hospitalisation is also substantially higher among Māori than Europeans and Pacific people (who experience roughly similar rates) whose hospitalisation rates are higher than Asians. Standardised mortality rates are significantly higher among Māori than Europeans. However, mortality rates are lower among Pacific people than Europeans. Mortality risk for Asians vs. Europeans was not statistically significant in the three studies reviewed (Table 10.4).

Table 10.4 Prevalence of diabetes-related complications, risk or rate of CVD/mortality

	Gender	European	Māori	Pacific	Asian
Renal complications					
Elley et al. (2008) [30] (albuminuria)[a]		27	49	49	30
Joshy et al. (2009) (start dialysis or transplant)		1 (reference)	HR 25.2 (95 % CI: 10.7,59.7)		
Joshy et al. (2009) (CKD)	Male	25.7	17.9		
	Female	26.2	20.3		
Joshy et al. (2009) (microalbuminuria)	Male	24.1	39.0		
	Female	18.9	28.4		
Joshy et al. (2009) (albuminuria)	Male	5.8	19.2		
	Female	6.0	14.8		
Kenealy et al. (2008) [44] (microalbuminuria)[a]		20	32	31	23
Kenealy et al. (2008) [44] (macroalbuminuria)[a]		4	14	15	5
Kenealy et al. (2012) [45] (microalbuminuria)[a]		22.9	32.8	32.1	24.1
Kenealy et al. (2012) [45] (macroalbuminuria)[a]		3.5	9.0	9.1	4.1
Kenealy et al. (2012) [45] (advanced albuminuria)[a]		1.7	8.1	7.8	2.2
Lim et al. (2008) [50] (microalbuminuria)			29.6		
Lim et al. (2008) [50] (macroalbuminuria)			7.7		
Lim et al. (2008) [50] (CKD)			5.6		
Robinson et al. (2006) [52] (albuminuria)[a]		27.4	55.2	50.4	36.6
Robinson et al., (2015) [53] (microalbuminuria)[a]		23	33	31	23
Robinson et al., (2015) [53] (macroalbuminuria)[a]		5	17	17	7
Scott et al. (2006) [54] (microalbuminuria)[a]		17	43.8 (Māori/Pacific)		
Tomlin et al. (2006) [59]	Male	27.8 (T1D) 35.1 (T2D)	33.3 (T1D) 58.2 (T2D)		
	Female	24.8 (T1D) 26.0 (T2D)	47.6 (T1D) 42.2 (T2D)		
Eye complications					
Frederikson and Jacobs (2008) [35][a]		12	11	16 (Samoan) 14 (Cook Island Māori) 19 (Tongan)	13
Lim et al. (2008) [50]			1.9		
Foot complications					
Ihaka et al. (2012) [37]			100		
Robinson et al. (2015) [53][a]		2.13/1000	3.48/1000	1.70/1000	0.68/1000

(continued)

Table 10.4 (continued)

	Gender	European	Māori	Pacific	Asian
Hospital admissions					
Jackson et al. (2009) [38][a]		19	24	18	13
Joshy et al. (2009)		1 (reference)	HR 7.0 (95 %CI: 4.6,10.6)		
Smith et al. (2010)		27	37	25	21
CVD events/mortality					
Brewer et al. (2008) [27] (ref. HbA1c 4.0–<5.0 %)		HR 2.56 (95 %CI: 0.71,9.19)	HR 2.71 (95 %CI: 1.90,3.85)	HR 0.53 (95 %CI: 0.161.75)	HR 1.70 (95 %CI: 0.10,29.73)
Elley et al. (2010) [31]		1 (reference)	HR 1.23 (95 %CI: 1.14,1.32)	HR 1.07 (95 %CI: 0.99,1.15)	HR 1.29 (95 %CI: 1.14,1.46)
Jeffreys et al. (2005) [33] (ref. not hospitalised diabetes)		SMR 2.99 (95 %CI: 2.93,3.04)	SMR 3.44 (95 %CI: 3.30,3.58)	SMR 2.23 (95 %CI: 2.06,2.41)	
		SMR 2.98 (95 %CI: 2.93,3.04)	SMR 3.80 (95 %CI: 3.64,3.97)	SMR 2.41 (95 %CI: 2.21,2.61)	
Joshy et al. (2009)		1 (reference)	HR 4.1 (95 %CI: 1.5,11.4)		
Joshy et al. (2010)	Male	551/100,000	1012/100,000		
	Female	491/100,000	808/100,000		
Kenealy et al. [44]		1 (reference)	HR 1.30 (95 %CI: 1.19,1.41)	HR 1.04 (95 %CI: 0.95,1.13)	HR 1.06 (95 %CI: 0.91,1.24)

[a]Denotes studies which reported data for additional ethnic minority groups not presented

Discussion

The results of this review show that the burden of diabetes and related complications remains greater among Māori and other non-European ethnic groups as shown in our previous reviews in 2000 and 2006 [22, 24]. The prevalence of known diabetes among those aged ≥30 years in South Auckland in the early 1990s was 4.2 % in Europeans, 7.9 % among Māori and 5.5 % among Pacific people [42] with approximately 33–50 % undiagnosed [6, 43, 61]. Decades later, these rates have approximately doubled. Glycaemic control remains poorer among non-European groups and many of the other complications and risk factors are especially common among Māori. Renal complications rates, particularly microalbuminuria and macroalbuminuria, remain substantially higher among Māori. Conversely, the low prevalence of retinopathy at diagnosis among Waikato Māori [32] suggests that screening for diabetes in that area may have had a positive impact on early case finding and management for prevention of diabetes-related complications. Despite this, the increased burden of diabetes among Māori/Pacific rates and Asians compared with Europeans has continued to rise and is now one of New Zealand's most serious health issues, which should inform the new national diabetes plan in New Zealand.

Diabetes-Related Policy

Since the last review [24], diabetes-related policy has positively changed for quality of care, screening and prevention. For those with diabetes, the Ministry of Health funded a national programme ('Get Checked') in 2001 that paid general practitioners to undertake a diabetes annual review that could provide the clinical assessments to inform

the next steps in the management plan of each participating patient. An evaluation in 2007 [62] reported that many Primary Health Organisations (PHOs), especially those with larger Māori and Pacific Island people's populations, had identified barriers to these population groups using the programme and had put in place initiatives to address these barriers. From the numbers and coverage rates reported by DHBs, it appears that these initiatives were more successful with Pacific peoples. Although the numbers of Māori accessing the programme were increasing, the coverage rates continued to fall short of the target rate set by District Health Boards (DHBs). In 2008, poor retention in Get Checked was shown [63] such that in 2005/2006, only 6100 (57 %) of the estimated 10,600 diabetes patients enrolled in the Waikato utilised the free check. Younger patients aged <40 years, those of Māori or Asian origin, and those with type 1 diabetes were less likely to be retained in the programme with regular checks. A further review in 2011 [64] demonstrated that the Get Checked programme did not systematically result in improved management or outcomes for people with diabetes. As a result, from July 2012, the 'Get Checked' programme was shelved and was replaced by the 'Diabetes Care Improvement Package' [65]. A key change under the new package was placing the responsibility for coordination of diabetes care in the hands of each DHB, thus allowing DHBs to tailor diabetes care towards their population structure, as opposed to a standard national plan under the 'Get Checked' programme.

Wider guidance for quality care were released by the Ministry of Health in 2014 [66] to complement work from the New Zealand Guidelines Group. A Virtual Diabetes Register (VDR) created from six major databases was established by the Ministry of Health in 2013 [67]. The six data sources were: hospital admissions coded for diabetes, outpatient attendees for diabetes and diabetes retinal screening, prescriptions of specific antidiabetic therapies, laboratory orders for measuring diabetes management and primary health (general practitioner) enrolments. There are no special guidelines for the use of antidiabetes medications among Polynesians.

In 2015, a 5-year plan 'Living Well with Diabetes' [68] was proposed to ensure that all New Zealanders with diabetes, or at risk of developing T2D, had access to high-quality, people-centred health services.

Diabetes Screening

As non-European populations are at greater risk of diabetes, they are theoretically more likely to be screened under the DHB managed health targets programme [69]. This programme was introduced in 2007 but reduced in 2009. One of the targets was that 90 % of the eligible population would have had their cardiovascular risk assessed within the last 5 years (this would include a diabetes test).

Diabetes Prevention and Prevention Research

Strategies to prevent diabetes include the Green Prescription [70] where a prescription of physical activity to a patient is provided. A recent randomised controlled trial among Māori and Europeans with diabetes found that both face-to-face and telephone delivery of the Green Prescription are associated with improvements in both weight and HbA1c [71]. Generally, fewer Māori have participated in the GRx programme [72]. This lower participation may have been due to lower referrals from primary care even when fees, administrative and other barriers have been removed [70].

Wider family-based [73] healthy eating and activity guidelines [73] are also in place. A comprehensive plan for [74] includes 22 initiatives that target interventions for those who are obese, increase support for those at risk of becoming obese and introduce broad strategies to make healthier choices easier. A limited review of obesity (as the main risk factor for type 2 diabetes) prevention strategies over the past 20 years have indicated that key strategies have largely been unimplemented [75]. A key success over these 20 years has been the Energize programme in the

Waikato [76], associated with reductions in childhood obesity. The sister study, Te Wai o Rona: Diabetes Prevention Strategy [77], was associated with reductions in weight among Māori with and without pre-diabetes in a vanguard study, but research funding was not continued after 3 years. The coach-supported structured approach to lifestyle change has recently been shown to successfully limit gestational weight gain across nine European countries [78]. Other prevention studies among Māori (e.g. Ngāti and Healthy) showing initial promise [79] have not progressed.

Future Directions: Unmet Needs, Unanswered Questions, Unquestioned Answers

The focus of this chapter has been the epidemiology of diabetes among Māori and other ethnic communities in New Zealand. In spite of substantial policy initiatives, the prevalence of diabetes, the risk factors for complications, especially poor blood glucose control, and the rates of complications remain substantially higher in these ethnic populations groups compared with European New Zealanders. There have been successful initiatives such as Project Energize, the school based lifestyle programme, with its high acceptability among Māori and Pacific people and has not been extended to too many other areas in the country. The early promise from Te Wai o Rona: Diabetes Prevention Strategy has not been followed up, and diabetes metabolic targets are frequently not met based upon primary care data. Diabetes among all ethnic groups, particularly Māori, remains a major public health menace.

There clearly needs to be more research as to why the gap remains between current diabetes outcomes and what should be possible with a national organisational structure that includes a single payer across primary and secondary care, well-developed primary care including Māori and Pacific health services, a well-trained workforce and a raft of policy initiatives to prevent diabetes and its complications and their wider social determinants. Specific research into the excess renal disease among Māori is urgently needed. Current research into the genetic, intrauterine/foetal determinants of diabetes and its complications should be broadened within a culturally safe framework. More research into appropriate behavioural and self-management interventions, building upon global research but tailoring to local cultural needs, are also crucial for those with diabetes. However, the real need is for more large scale intervention studies, developed to go to scale, that can transform the current diabetes healthcare landscape.

We call on the New Zealand's Ministry of Health to make diabetes prevention and management among ethnic minority groups a national health priority area for urgent action in both diabetes health services development and rollout, and both outcomes and translational research.

Appendix: Database Searching Strategies

Search Outline

Concept	Search terms
Diabetes	Diabetes mellitus, type 1
	Diabetes, gestational
	Diabetes mellitus, type 2
	Diabetes mellitus
New Zealand	New Zealand
Native and unserved ethnic groups	Pacific Islander
	Māori
	Samoa
	Cook Islands
	Polynesia (MESH)
	Tonga
	Fiji
	Niue
	Solomon Islands
	Melanesia (MESH)
	Oceanic Ancestry Group (MESH)
	Southeast Asian
	Bangladesh
	India
	Sri Lanka
	Nepal

Medline Search -8/10/15

1	Diabetes mellitus, type 1 or diabetes, gestational/ or diabetes mellitus, type 2 or diabetes mellitus	158,509
2	Diabetes.ab,ti.	243,850
3	1 or 2	274,256
4	New Zealand	20,180
5	New Zealand.ab,ti.	26,249
6	4 or 5	35,119
7	'Pacific Islander'.ab, ti.	1069
8	Māori.ab, ti.	1680
9	Samoa	220
10	Polynesia	695
11	'Cook Islands'.ab, ti.	88
12	Tonga	141
13	Fiji	437
14	Niue.ab, ti.	26
15	Melanesia	357
16	Solomon Islands.ab, ti.	282
17	Oceanic Ancestry Group	5709
18	Bangladesh	5328
19	India	50,204
20	Sri Lanka	2620
21	Nepal	4202
22	7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21	70,730
23	3 and 6 and 22	220
24	*Limit 23 to yr = '2005 -Current'*	*156*

NB: search terms with/are MESH terms

Scopus Search

TITLE-ABS-KEY (‘diabetes’) AND TITLE-ABS-KEY (‘New Zealand’) AND TITLE-ABS-KEY (‘Pacific Islander’ OR ‘Māori’ OR ‘Samoa’ OR ‘Cook Islands’ OR ‘Polynesia’ OR ‘Tonga’ OR ‘Fiji’ OR ‘Niue’ OR ‘Solomon Islands’ OR ‘Melanesia’ OR ‘Ocean Ancestry Group’ OR ‘Southeast Asian’ OR ‘Bangladesh’ OR ‘India’ OR ‘Sri Lanka’ OR ‘Nepal’) AND PUBYEAR > 2004 AND NOT ALL (‘trials’) OR (‘RCT’) OR ALL (‘intervention’)

Total results: 98

Search date: 12/10/2015

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