DIABETES

Introduction

Type 1 diabetes mellitus (T1DM) is an autoimmune disease in which there is progressive destruction of the β cells in the pancreas.[1] The disease is believed to develop as a result of interaction between susceptibility genes and as yet unidentified environmental factors.[2] The pancreas no longer produces the hormone insulin, which promotes the absorption of glucose from the blood into cells and is essential for life, and so people with T1DM must take exogenous insulin for the rest of their lives to keep their blood sugar levels under control.[1]

Excess blood glucose (hyperglycaemia) leads to diabetic ketoacidosis, the leading cause of morbidity and mortality in children with T1DM. In the long term high blood glucose levels can damage blood vessels and nerves resulting in atherosclerosis, loss of vision, kidney disease and nerve damage. Intensive insulin therapy, which aims to keep blood glucose as close to normal as possible, prevents nerve damage,[3] kidney damage and macrovascular complications such as heart disease and stroke but is associated with an increased risk of severe hypoglycaemia (low blood glucose).[4] Mild hypoglycaemia can produce irritability and inattention while severe hypoglycaemia can produce loss of consciousness and seizures and there is some suggestion that episodes of severe hypoglycaemia in early childhood can have long lasting (although mild) effects on cognitive function.[5]

Type 1 diabetes mellitus is much the most common type of diabetes in children and young people.[6] Most people with T1DM (around 75%) were diagnosed in childhood or young adulthood.[6] The incidence of T1DM has been rising over recent decades, both globally[6] and in New Zealand.[7]

The following section reviews diabetes in children and young people using information from the National Minimum Dataset and New Zealand Health Survey. The section concludes with a brief overview of evidence-based health care for children and young people with diabetes.

Data sources and methods

Indicators

Prevalence of diabetes
Hospitalisations for diabetes

Definitions

Prevalence of diabetes

Diabetes (diagnosed, excluding diabetes during pregnancy) among adults aged 15+ years

Hospitalisations for diabetes

Hospitalisations of 0–24 year olds with a diagnosis of diabetes per 100,000 population

Data sources

Prevalence of diabetes

New Zealand Health Survey (2006/07–2014/15), see Error! Reference source not found.

Hospitalisations for diabetes

Numerator:	National Minimum Dataset
Denominator:	Statistics New Zealand Estimated Resident Population (with linear extrapolation being used to calculate denominators between Census years)

Additional information

Prevalence of diabetes

Adult respondents (aged 15+ years) are defined as having diabetes if they had ever been told by a doctor that they have diabetes. This does not include diabetes during pregnancy (gestational diabetes).
Note that NZHS definition is likely to underestimate the true number of people with diabetes, as some people may not be aware that they have diabetes.

Hospitalisations for diabetes

Diabetes was the principal diagnosis or was documented as one of the first 15 diagnoses.
Codes used for identifying cases are documented in Error! Reference source not found..

National trends and distribution

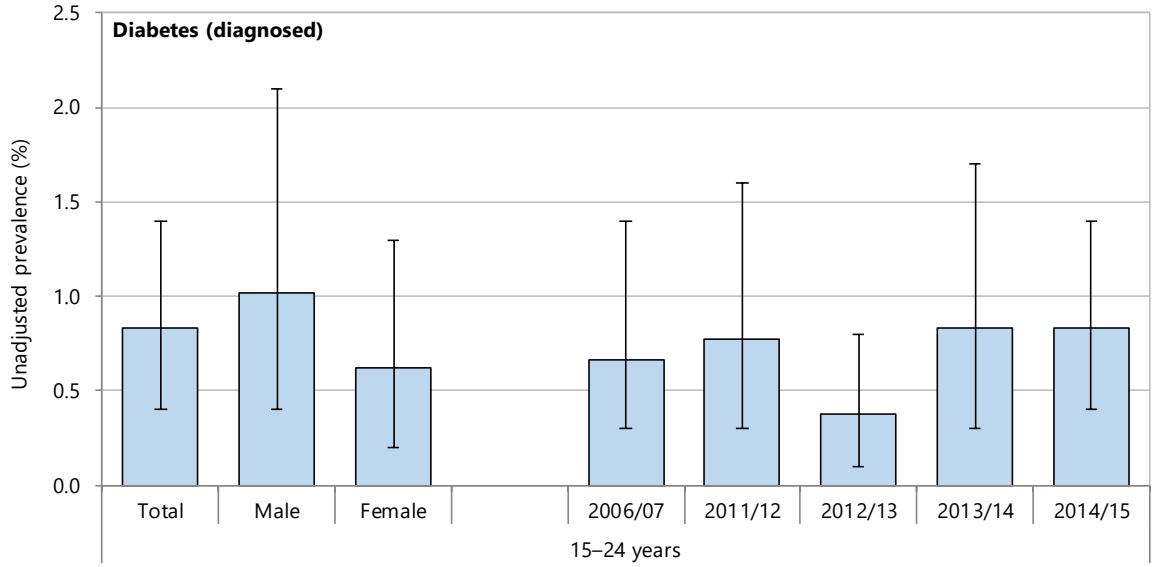
The percentage of those aged 15–24 years diagnosed with diabetes in the New Zealand Health Surveys was similar for the years 2006/07 to 2014/15, with the exception of 2012/13, although this year was not significantly different. The percentage of males diagnosed with diabetes was slightly higher than for females, but not significantly so (**Figure 1**).

There was a total of 19 deaths of 0–24 year olds where diabetes was the underlying cause of death in New Zealand between 2000 and 2013, as documented within the National Mortality Collection. The majority of these deaths were due to type 1 diabetes.

The number of 0–24 year olds hospitalised with diabetes during 2011 to 2015 is presented in **Table 1**. It also presents the number of hospital discharges in which diabetes was documented as the primary diagnosis or as any diagnosis. The majority of hospitalisations were for Type 1 Diabetes.

The rate of hospitalisations for diabetes has increased since 2000, particularly where diabetes was documented within the first 15 diagnoses (**Figure 2**).

Figure 1. Diabetes (diagnosed), by demographic factor, NZ Health Survey 2006/07–2014/15



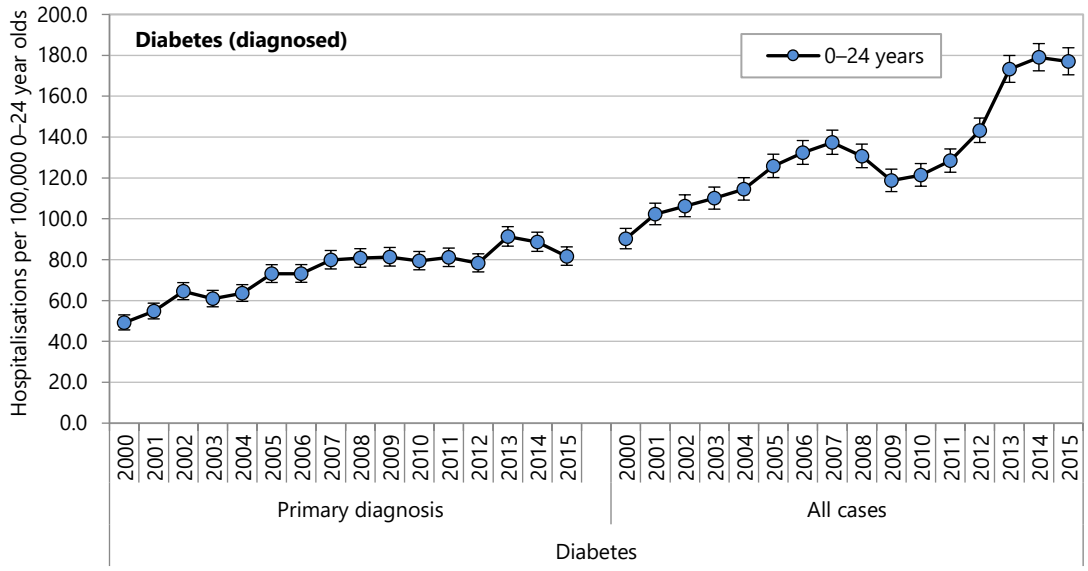
Source: NZ Health Survey

Table 1. Individuals aged 0–24 years hospitalised with diabetes using primary diagnosis compared to all cases, New Zealand 2011–2015

	Unique individuals *(n)*	Hospitalisations *(n)*		Ratio All : Primary
		Primary diagnosis	All cases	
Diabetes				
Hospitalisation				
0–24 years	4,137	6,466	12,308	1.90
0–14 years	1,772	2,771	4,252	1.53
15–24 years	2,614	3,695	8,056	2.18
Diabetes in 0–24 year olds				
Diabetes: Type 1	3,242	6,098	9,796	1.61
Diabetes: Type 2	718	257	1,462	5.69
Diabetes: other	350	111	1,056	9.51

Source: National Minimum Dataset. 'All cases' corresponds to hospitalisations with diabetes listed in any of the first 15 diagnoses; The sum of the age groups or of the diagnoses may total to more than the 0–24 year old total

Figure 2. Hospitalisations for diabetes in 0–24 year olds, New Zealand 2000–2015



Numerator: National Minimum Dataset, Denominator: Statistics NZ Estimated Resident Population. 'All cases' corresponds to hospitalisations with diabetes listed in any of the first 15 diagnoses

Diagnosis

The majority of hospitalisations of 0–24 year olds involving type 1 diabetes had diabetes as the primary reason for hospitalisation within which Type 1 diabetes mellitus with ketoacidosis was the diagnosis with the highest hospitalisation rate (**Table 2**).

Table 2. Hospitalisations involving type 1 diabetes in 0–24 year olds in 0–24 year olds, by primary diagnosis, New Zealand 2011–2015

Primary diagnosis	2011–2015 *(n)*	Annual average	Rate	95% CI	%
Type 1 diabetes* in 0–24 year olds					
New Zealand					
Type 1 diabetes mellitus with ketoacidosis†	3,109	622	40.48	39.08–41.92	31.7
Type 1 diabetes mellitus with poor control	816	163	10.62	9.92–11.38	8.3
Type 1 diabetes mellitus with hypoglycaemia	598	120	7.79	7.19–8.44	6.1
Type 1 diabetes mellitus with ophthalmic complications‡	85	17	1.11	0.90–1.37	0.9
Type 1 diabetes mellitus with other complications	107	21	1.39	1.15–1.68	1.1
Type 1 diabetes mellitus without complication	1,383	277	18.01	17.08–18.98	14.1
Type 1 diabetes mellitus total	6,098	1,220	79.39	77.42–81.41	62.2
Other endocrine, nutritional and metabolic diseases	60	12	0.78	0.61–1.01	0.6
Symptoms and/or abnormal clinical findings NEC	580	116	7.55	6.96–8.19	5.9
Infectious and parasitic diseases	553	111	7.20	6.62–7.83	5.6
Injury and/or poisoning	458	92	5.96	5.44–6.53	4.7
Other diagnoses	2,047	409	26.65	25.52–27.83	20.9
Total	9,796	1,959	127.54	125.04–130.09	100.0

Numerator: National Minimum Dataset, Denominator: Statistics NZ Estimated Resident Population. * Type 1 diabetes in any of the first 15 diagnoses; Rate per 100,000 0–24 year olds; NEC = not elsewhere classified; † Type 1 diabetes mellitus with ketoacidosis includes those hospitalised with/without coma and/or lactic acidosis or where stated as uncontrolled; ‡ Type 1 diabetes mellitus with ophthalmic complications includes those hospitalised with ophthalmic complications stated as uncontrolled, with advanced ophthalmic disease, with other specified ophthalmic complication, with proliferative or other retinopathy, or with diabetic cataract

Demographic distribution

Table 3 presents the demographic distribution of individuals hospitalised with diabetes in New Zealand between 2011 and 2015. There was a social gradient among these individuals with greater prevalence in each successive deprivation quintile, but differences between quintiles were mostly non-significant. Diabetes was significantly

lower among males, and among 0–4 and 5–14 year olds (compared to 15–24 year olds), and significantly lower for Māori and Asian/Indian than for European/Other ethnic groups.

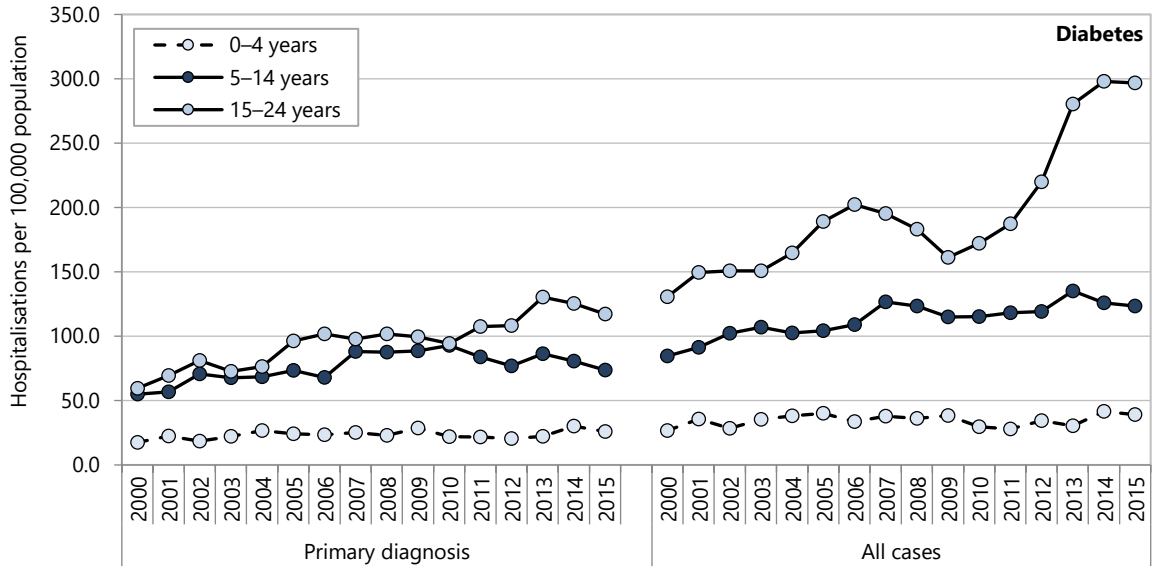
Table 3. Individuals aged 0–24 years hospitalised with diabetes, by demographic factor, New Zealand 2011– 2015

Variable	Unique individuals 2011–2015 *(n)*	Rate per 100,000 population	Rate ratio	95% CI
Diabetes* in 0–24 year olds				
New Zealand				
NZ Deprivation Index quintile				
Deciles 1–2	754	53.13	1.00	
Deciles 3–4	792	59.23	1.11	1.01–1.23
Deciles 5–6	891	61.81	1.16	1.06–1.28
Deciles 7–8	1,103	67.90	1.28	1.16–1.40
Deciles 9–10	1,371	73.79	1.39	1.27–1.52
Prioritised ethnicity				
Māori	857	47.51	0.74	0.69–0.80
Pacific	455	64.21	1.00	0.91–1.11
Asian/Indian	185	19.30	0.30	0.26–0.35
MELAA	50	49.58	0.78	0.59–1.03
European/Other	2,626	63.91	1.00	
Gender				
Female	2,185	58.20	1.00	
Male	1,953	49.74	0.85	0.80–0.91
Age group (years)				
0–4	260	16.67	0.20	0.18–0.23
5–14	1,590	53.28	0.64	0.60–0.68
15–24	2,614	83.33	1.00	

Numerator: National Minimum Dataset, Denominator: Statistics NZ Estimated Resident Population. Diabetes* in any of the first 15 diagnoses; Rate per 100,000 age-specific population; Rate ratios are unadjusted; Ethnicity is Level 1 prioritised; Decile is NZDep2013

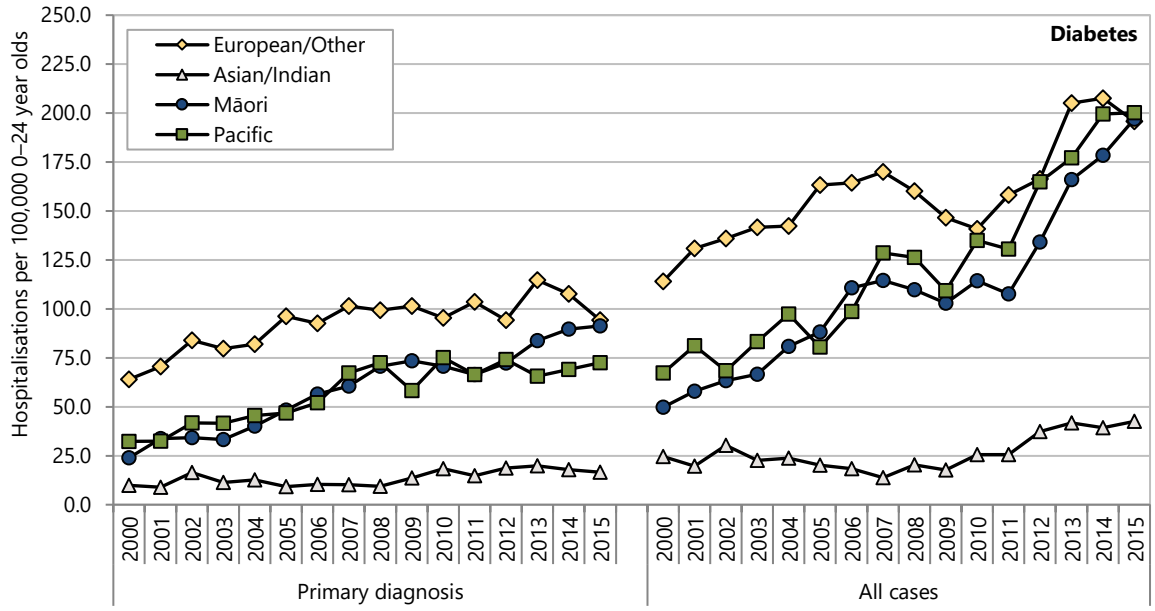
Since 2000, hospitalisations for diabetes had generally increased for each age group (**Figure 3**). The increase was most notable for the 0–4 year olds, for whom rates were consistently higher despite the age specific diabetes rate being lower than those for the other age groups. Over the same period, the primary diagnosis hospitalisation rate had gradually increased for all ethnic groups with notable increases for Māori and Pacific ethnic groups (**Figure 4**).

Figure 3. Hospitalisations involving diabetes in 0–24 year olds, by age group, New Zealand 2000–2015



Numerator: National Minimum Dataset, Denominator: Statistics NZ Estimated Resident Population. 'All cases' corresponds to hospitalisations with diabetes listed in any of the first 15 diagnoses

Figure 4. Hospitalisations involving diabetes in 0–24 year olds, by ethnicity, New Zealand 2000–2015

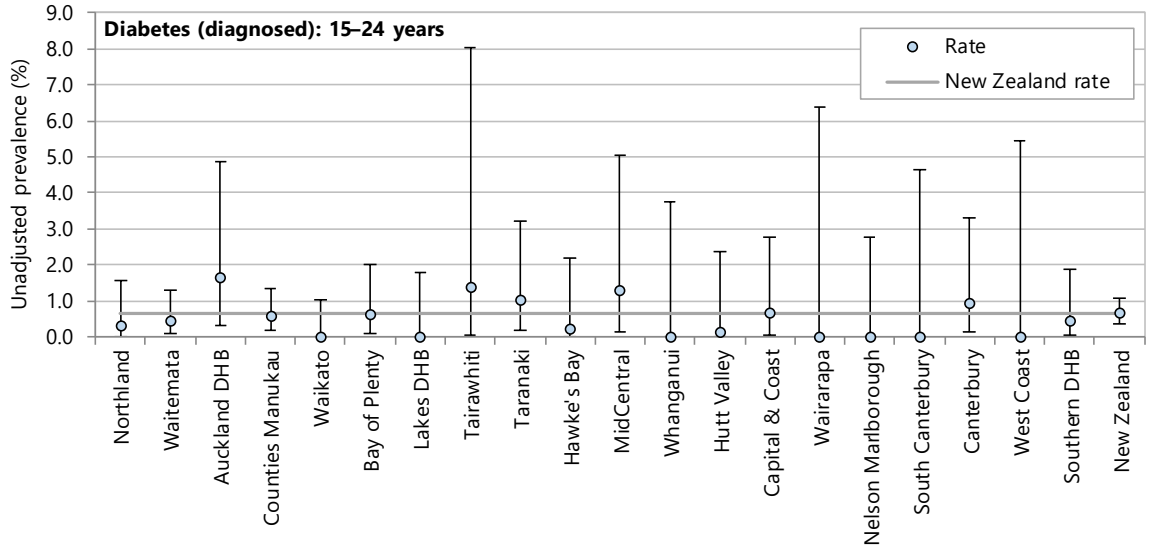


Numerator: National Minimum Dataset, Denominator: Statistics NZ Estimated Resident Population. 'All cases' corresponds to hospitalisations with diabetes listed in any of the first 15 diagnoses

Regional trends and distribution

Figure 5 shows the prevalence of diagnosed diabetes for the district health boards from the 2011/12 to 2013/14 New Zealand Health Surveys. Differences between DHBs should be interpreted with caution due to the relatively small numbers of 0–24 year olds with diabetes in each DHB who were included in the New Zealand Health Surveys.

Figure 5. Diabetes (diagnosed) in 15–24 year olds, by district health board, NZ Health Survey 2011/12–2013/14



Source: NZ Health Survey 2011/12 to 2013/14

Table 4 presents the number of individuals resident in each district health board that had a diagnosis of diabetes during 2011 to 2015. It also presents the number of hospital discharges in which diabetes was documented as the primary diagnosis or any diagnosis. **Table 5** presents the individuals and hospital discharges for the same period by the type of diabetes diagnosed.

The All:Primary diagnosis ratio reflects the extent to which hospitalisations of 0–24 year olds with diabetes occur when this condition is not the primary diagnosis and it provides an indication of the extent to which using only the primary diagnosis undercounts diabetes related hospitalisations. A high ratio may be associated with more thorough documentation and it may also indicate that children with diabetes are often hospitalised for other conditions. For diabetes the All:Primary diagnosis ratio was higher than the national ratio in Canterbury DHB, and lower in Nelson Marlborough, South Canterbury, West Coast, and Southern DHBs (**Table 4**). Within these DHBs, the majority of individuals were diagnosed with type 1 diabetes mellitus.

The rate of hospitalisations for diabetes has generally increased since 2000 in all the South Island DHBs. All DHBs had increases where diabetes was involved but not the primary reason for hospitalisation (**Figure 6**).

Table 4. Hospitalisations for diabetes in 0–24 year olds, South Island DHBs vs New Zealand 2011–2015

DHB	Unique individuals *(n)*	Hospitalisations *(n)*		Ratio All : Primary
		Primary diagnosis	All cases	
Diabetes in 0–24 year olds				
Nelson Marlborough	124	234	427	1.82
South Canterbury	64	167	226	1.35
Canterbury	457	577	1,121	1.94
West Coast	35	49	90	1.84
Southern	338	743	1,187	1.60
New Zealand	4,137	6,466	12,308	1.90

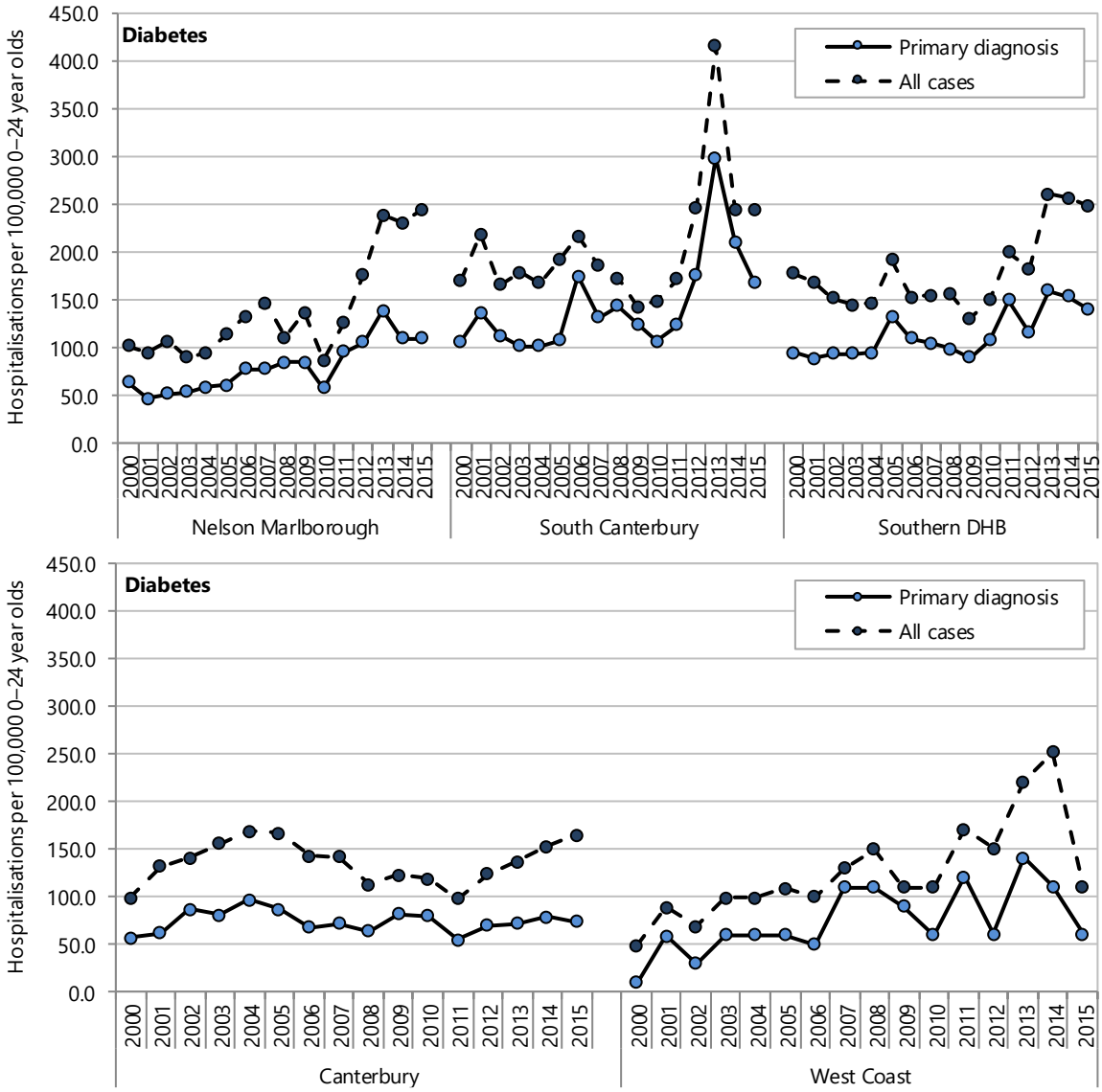
Source: National Minimum Dataset. 'All cases' corresponds to hospitalisations with diabetes listed in any of the first 15 diagnoses

Table 5. Hospitalisations for diabetes in 0–24 year olds, by type, South Island DHBs vs New Zealand 2011–2015

DHB	Unique individuals *(n)*	Hospitalisations *(n)*		Ratio All : Primary
		Primary diagnosis	All cases	
0–24 year olds				
Type 1 Diabetes				
Nelson Marlborough	111	228	363	1.59
South Canterbury	62	167	224	1.34
Canterbury	396	558	981	1.76
West Coast	33	47	87	1.85
Southern	293	713	1,025	1.44
New Zealand	3,242	6,098	9,796	1.61
Type 2 Diabetes				
Nelson Marlborough	11	<5	29	7.25
South Canterbury	<5	0	<5	…
Canterbury	47	15	74	4.93
West Coast	<5	<5	<5	s
Southern	32	12	43	3.58
New Zealand	718	257	1,462	5.69

Source: National Minimum Dataset. 'All cases' corresponds to hospitalisations with diabetes listed in any of the first 15 diagnoses; Due to some cases not having the type of diabetes specified, the sum of type 1 plus type 2 in a DHB may be less than the total number with diabetes in the previous table

Figure 6. Hospitalisations for diabetes in 0–24 year olds, South Island DHBs 2000–2015



Numerator: National Minimum Dataset, Denominator: Statistics NZ Estimated Resident Population. 'All cases' corresponds to hospitalisations with diabetes listed in any of the first 15 diagnoses. Caution rates for the West Coast are based on small numbers

Evidence for good practice

Possibilities for prevention

There are currently no interventions proven to prevent or delay the onset of clinically apparent type 1 diabetes.[1] Primary prevention trials to date have been dietary interventions for infants at increased genetic risk designed to interrupt putative environmental risk factors for T1DM (such as infant formulas free of either cow's milk or bovine insulin, delayed introduction of gluten-containing foods, and vitamin D supplementation) and none of the dietary factors investigated have been shown to be unequivocal risk factors.[1]

Evidence-based health care for children and young people with diabetes

Insulin

From the time of diagnosis children and young people with type 1 diabetes require either multiple daily injections of insulin or continuous subcutaneous insulin infusion (via a pump) to control their blood glucose levels.[8] They (or their parents) also need to plan and monitor their carbohydrate intake so they can adjust their insulin dosage accordingly, and to monitor their blood glucose levels at least five times per day.[8] Intensive glucose control, which requires frequent blood glucose monitoring, has become standard therapy for T1DM

because there is evidence that it lowers the risk of developing microvascular complications (such as eye and kidney disease), particularly in younger patients in the early stages of disease.[9]

Care by a multidisciplinary team

Children and young people with T1DM and their families need ongoing access to a multidisciplinary paediatric diabetes team.[8] Regular clinic attendance (four times per year) is associated with better blood glucose control.[10]

The Ministry of Health's quality standards for diabetes care[11] state that: "young people with diabetes should have access to an experienced multidisciplinary team including developmental expertise, youth health, health psychology and dietetics". However, a 2012 survey which enquired about resourcing for services for children and young people with diabetes in New Zealand secondary care services found that, by international standards, New Zealand services were significantly under-resourced.[12] All centres were below the international recommendations for medical staff, there was wide variation in nurse educator numbers, and most centres did not have dedicated psychologists or dieticians.

Diabetes education

Children and young people with T1DM and their families need on-going education covering insulin therapy, blood glucose monitoring, the effects of diet, physical activity and intercurrent illness on blood glucose control, managing sick days, detecting and managing hypoglycaemia, hyperglycaemia and ketosis, and for adolescents, the effects of alcohol on blood glucose and the particular hazards of smoking, recreational drugs and pregnancy for people with diabetes.[8] The recent (2015) NICE guideline did not identify any RCTs that had evaluated the content of education programmes but noted that there are many discussion papers suggesting appropriate content for such programmes.[8]

Hospital admission

It is common for children and young people to be admitted to hospital soon after diagnosis of T1DM.[13] A significant proportion of children with diabetes have ketoacidosis at diagnosis and moderate to severe ketoacidosis necessitates hospitalisation for intravenous therapy.[13,14] There is some evidence suggesting that it is possible to receive initial management as an outpatient which does not lead to any disadvantages in terms of metabolic control, acute diabetic complications and hospitalisations, psychosocial variables and behaviour, or total costs.[13] Outpatient initial management is unlikely to be suitable for young children, children who live a long way from a hospital or children from families affected by complex social and/or emotional problems.[8]

Management of diabetes is complex. It can be expected that children with T1DM will experience complications of inadequate blood glucose control, such as hypoglycaemia and ketoacidosis, and may then require admission to hospital.[13,15] A recently published Welsh study looking at all-cause hospitalisation rates in a cohort of 1,577 children with newly-diagnosed T1DM (who were followed up for a total of 12,102 person years) found that these children had a rate of hospital admission almost five times higher than control children.[15] Ketoacidosis in children with established T1DM has been reported to be associated with insulin omission or treatment error in around 75% of cases and with inadequate insulin therapy during intercurrent illness in the remainder.[16] It has been suggested that hospital admissions for ketoacidosis could be reduced by better supporting families of children with T1DM, especially those who find diabetes management challenging due to chaotic and dysfunctional family situations[17,18] but there is no good quality evidence to indicate which particular types of support are most effective.[8,19]

Evidence-based health care for children and young people with diabetes

These national and international guidelines, systematic reviews, other publications and websites relevant to the prevention and management of diabetes are provided for further reading.

Ministry of Health Publications and webpages

- Ministry of Health. 2016. Diabetic Retinal Screening, Grading, Monitoring and Referral Guidance. Wellington. http://www.health.govt.nz/system/files/documents/publications/diabetic-retinal-screening-grading-monitoring-referral-guidance-mar16.pdf
- Ministry of Health. 2015. Living well with diabetes: A plan for people at high risk of diabetes 2015−2020. Wellington: Ministry of Health. http://www.health.govt.nz/system/files/documents/publications/living-well-with-diabetes-oct15.pdf
- Ministry of Health. 2014. Quality standards for diabetes care. http://www.health.govt.nz/our-work/diseases-and-conditions/diabetes/quality-standards-diabetes-care

- Ministry of Health. 2014. Quality Standards for Diabetes Care Toolkit 2014. Wellington: Ministry of Health. http://www.health.govt.nz/publication/quality-standards-diabetes-care-toolkit-2014
- Ministry of Health. 2014. National Diabetes Work Programme 2014/15. Wellington: Ministry of Health. http://www.health.govt.nz/publication/national-diabetes-work-programme

International Guidelines

- American Diabetes Association. 2016. Standards of medical care in diabetes—2016. http://professional.diabetes.org/content/clinical-practice-recommendations/?loc=rp-slabnav
- National Institute for Health and Care Excellence. 2015. Diabetes (type 1 and type 2) in children and young people: diagnosis and management. https://www.nice.org.uk/Guidance/NG18
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- Klonoff DC, et al. 2011. Continuous glucose monitoring: an Endocrine Society Clinical Practice Guideline. *Journal of Clinical Endocrinology and Metabolism*, 96(10), 2968-79. http://jcem.endojournals.org/content/96/10/2968.long
- Scottish Intercollegiate Guidelines Network. 2010. Management of Diabetes: A national clinical guideline. Edinburgh: Scottish Intercollegiate Guidelines Network. http://www.sign.ac.uk/guidelines/fulltext/116/index.html

Recent Evidence-Based Medicine Reviews

- The Cochrane Library reviews relevant to diabetes: http://www.cochranelibrary.com/topic/Endocrine%20%26%20metabolic/Diabetes/?per-page=100&stage=review
- Edwards D, Noyes J, Lowes L, et al. 2014. An ongoing struggle: a mixed-method systematic review of interventions, barriers and facilitators to achieving optimal self-care by children and young people with type 1 diabetes in educational settings. *BMC Pediatrics*, 14 228. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4263204/?report=classic
- Hynes L, Byrne M, Dinneen SF, et al. 2014. Barriers and facilitators associated with attendance at hospital diabetes clinics among young adults (15-30 years) with type 1 diabetes mellitus: a systematic review. *Pediatric Diabetes*, 17(7) 509–518. http://dx.doi.org/10.1111/pedi.12198
- Sheehan AM, While AE, Coyne I. 2015. The experiences and impact of transition from child to adult healthcare services for young people with Type 1 diabetes: a systematic review. *Diabetic Medicine*, 32(4), 440-58. http://onlinelibrary.wiley.com/doi/10.1111/dme.12639/abstract

Other Relevant Publications

- Jefferies C, Cutfield SW, Derraik JG, et al. 2015. 15-year incidence of diabetic ketoacidosis at onset of type 1 diabetes in children from a regional setting (Auckland, New Zealand). *Scientific Reports*, 5, 10358
- Jefferies C, Owens N, Wiltshire E. 2015. Care for children and adolescents with diabetes in New Zealand District Health Boards: Is the clinical resourcing ready for the challenge? *New Zealand Medical Journal*,

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- Obaid B, Britt E, Wallace-Bell M, et al. 2012. The demographics and prevalence of youth (15–24 year olds) with type 1 diabetes in the Canterbury District Health Board catchment area in 2010: has the prevalence changed since 2003? *New Zealand Medical Journal*, 125(1363), 22-8. https://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2012/vol-125-no-1363/article-obaid
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Websites

- Health Quality and Safety Commission New Zealand. Diabetes. http://www.hqsc.govt.nz/our-programmes/health-quality-evaluation/projects/atlas-of-healthcare-variation/diabetes/
- Diabetes New Zealand http://www.diabetes.org.nz/home
- Diabetes Youth New Zealand http://www.diabetesyouth.org.nz/
- Australian Diabetes Society https://diabetessociety.com.au/
- British Society for Paediatric Endocrinology and Diabetes https://www.bsped.org.uk/
- Clinical Network for Children and Young People's Diabetes Services https://www.starship.org.nz/for-health-professionals/new-zealand-child-and-youth-clinical-networks/clinical-network-for-children-and-young-peoples-diabetes-services/

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