2022

Summary of diabetes among Aboriginal and Torres Strait Islander people

Australian Indigenous HealthInfoNet

Kathy Ride
Edith Cowan University

Australian Indigenous HealthInfoNet

Summary of diabetes among Aboriginal and Torres Strait Islander people

Core funding is provided by the Australian Government Department of Health

AUSTRALIA ECU EDITH COWAN UNIVERSITY

Australian Indigenous Health*InfoNet*

The mandate of the Australian Indigenous Health*InfoNet* (Health*InfoNet*) is to contribute to improvements in both Aboriginal and Torres Strait Islander peoples' health by making relevant, high quality knowledge and information easily accessible to policy makers, health service providers, program managers, clinicians and other health professionals (including Aboriginal and Torres Strait Islander Health Workers) and researchers. The Health*InfoNet* also provides easy-to-read and summarised material for students and the general community.

The Health*InfoNet* achieves its commitment by undertaking research into various aspects of Aboriginal and Torres Strait Islander peoples' health and disseminating the results (and other relevant knowledge and information) mainly via the Australian Indigenous Health*InfoNet* website (**https://healthinfonet.ecu.edu.au**), the Alcohol and Other Drugs Knowledge Centre (**https://aodknowledgecentre.ecu.edu.au**), Tackling Indigenous Smoking (**https://tacklingsmoking.org.au**) and WellMob (**https://wellmob.org.au**). The research involves analysis and synthesis of data and other information obtained from academic, professional, government and other sources. The Health*InfoNet*'s work in knowledge exchange aims to facilitate the transfer of pure and applied research into policy and practice to address the needs of a wide range of users.

Recognition statement

The Health*InfoNet* recognises and acknowledges the sovereignty of Aboriginal and Torres Strait Islander people as the original custodians of the country. Aboriginal and Torres Strait Islander cultures are (in the main) persistent and enduring, continuing unbroken from the past to the present, characterised by resilience and a strong sense of purpose and identity despite the undeniably negative impacts of colonisation and dispossession. Aboriginal and Torres Strait Islander people throughout the country represent a diverse range of people, communities and groups, each with unique identities, cultural practices and spiritualities. We recognise that the current health status of mainland Aboriginal and Torres Strait Islander people has been significantly impacted by past and present practices and policies.

We acknowledge and pay our deepest respects to Elders past and present throughout the country. In particular, we pay our respects to the Whadjuk Noongar peoples of Western Australia on whose Country our offices are located.

Contact details

Professor Neil Drew (Director)
Australian Indigenous Health*InfoNet*
Edith Cowan University
2 Bradford Street
Mount Lawley, Western Australia 6050

Phone: (08) 9370 6336
Email: **healthinfonet@ecu.edu.au**
Website: **healthinfonet.ecu.edu.au**

Tell us what you think

We welcome and value your feedback as part of our post-publication peer review process. Please let us know if you have any suggestions for improving this Summary.

ISBN Web: 978-0-6454385-1-2
ISBN Hard copy: 978-0-6454385-0-5

Summary of diabetes among Aboriginal and Torres Strait Islander people

Publication team

Kathy Ride
Christine Potter
Ashleigh Parnell

Publication layout
Michelle Pierre

Executive editor
Professor Neil Drew

Acknowledgements

Special thanks are extended to the staff at the Australian Indigenous Health*InfoNet* for their support and guidance around the content of this *Summary*.

Suggested citation:

Ride K (2022) *Summary of diabetes among Aboriginal and Torres Strait Islander people.* Australian Indigenous Health*InfoNet.*

Based on:

Ride, K., & Burrow, S. (2022). Review of diabetes among Aboriginal and Torres Strait Islander people. *Journal of the Australian Indigenous HealthInfoNet, 3*(2).
Retrieved from https://ro.ecu.edu.au/aihjournal/vol3/iss2/1

This *Summary* is part of a resource package including the full review, a fact sheet and a short video. These resources and more information about diabetes can be viewed on the Australian Indigenous Health*InfoNet's* Diabetes Portal:
https://healthinfonet.ecu.edu.au/diabetes

Cover artwork

Janganpa Jukurrpa (Brush-tailed Possum Dreaming)
by Phyllis Napurrurla Williams

Featured icon artwork

by Frances Belle Parker

The Health*InfoNet* commissioned Frances Belle Parker, a proud Yaegl woman, mother and artist, to produce a suite of illustrated icons for use in our knowledge exchange products. Frances translates biomedical and statistically based information into culturally sensitive visual representations, to provide support to the Aboriginal and Torres Strait Islander workforce and those participating in research and working with Aboriginal and Torres Strait Islander people and their communities. Frances came to prominence winning the Blake Prize in 2000, making her the youngest winner and the first Indigenous recipient over the 65 year history of the prize.

"Biirrinba is the Yaygirr name for the mighty Clarence River (NSW). It is this river that is the life giving vein for the Yaegl people. And it is this river which inspires much of my artwork. I am deeply inspired by my Mother's land (Yaegl land) and the Island in the Clarence River that my Mother grew up on, Ulgundahi Island. The stories which are contained within this landscape have shaped me as a person as an artist and most recently as a Mother. This is my history, my story and it will always… be my responsibility to share this knowledge with my family and my children."

Contents

Introduction

Diabetes is the fastest growing chronic condition in the world, and type 2 diabetes is now considered an epidemic [1] [2]. It was estimated that 463 million people had diabetes in 2019 [3]. Experts have calculated that this will increase to more than 578 million by 2030 (a 25% increase), and 700 million (a 50% increase by 2045 [2]). Socially disadvantaged members of society and indigenous peoples are at greatest risk of developing diabetes worldwide [4].

In Australia:

- Aboriginal and Torres Strait Islander people are almost three times more likely to have diabetes than non-Indigenous people [5].
- Aboriginal and Torres Strait Islander women who are pregnant are more likely to have pre-existing diabetes than non-Indigenous women [6], but they are no more likely to develop gestational diabetes mellitus (GDM) than non-Indigenous women [7].
- Aboriginal and Torres Strait Islander children (younger than 17 years of age) are between 6 and 20 times more likely to develop type 2 diabetes than non-Indigenous children [8, 9].
- Aboriginal and Torres Strait Islander people are four times more likely to die from diabetes than non-Indigenous people [7].

The high level of diabetes among Aboriginal and Torres Strait Islander people is caused by many factors [10-12]. There are the lifestyle risk factors of poor nutrition, too much alcohol, smoking, not enough exercise and being overweight or obese. As well as these, are the social and emotional factors that include education, employment, income, housing, access to services, connection with land, racism and incarceration [13, 14].

Addressing these factors should reduce the impact of diabetes on Aboriginal and Torres Strait Islander people but this will require a range of culturally appropriate prevention and management programs that are tailored specifically to Aboriginal and Torres Strait Islander people. It will require broader action beyond the health service sector [10, 12, 15, 16].

To reduce the impact of diabetes on Aboriginal and Torres Strait Islander people, it is critical to introduce interventions and strategies at all stages of the journey – strategies that address prevention, early detection and management of diabetes. It is important that programs for Aboriginal and Torres Strait Islander people are culturally sensitive, meet community needs and are not seen as being forced upon communities [10]. To ensure cultural sensitivity and acceptance by the wider community, it is essential to involve Aboriginal and Torres Strait Islander community members and Aboriginal and Torres Strait Islander Health Practitioners in the design of any programs [17].

The background story of Aboriginal and Torres Strait Islander people and diabetes

The risk of developing diabetes is influenced not only by a person's behaviour, but also by historical, social, cultural, geographical, economic and community factors, and government health policies and services [2, 16]. British settlement and British culture as the dominant culture in Australia has had a long-lasting effect on these factors and as a result has affected access to health services for other cultural groups [18]. This is because health service programs and health-care practices are mostly based on the leading cultural group values, principles and beliefs. This can lead to racism within these systems when dealing with minority groups. New evidence suggests that external factors that can change gene expression (epigenetic factors), the environment within the womb (intrauterine environment) and other early life factors may also influence the development of diabetes in the next generations [4, 19].

Several behavioural and biomedical factors are known to increase the risk of developing diabetes, particularly type 2 diabetes [20]. However, improvements in these factors can reduce the risk of type 2 diabetes and become protective in nature. The main health risk factors are discussed below.

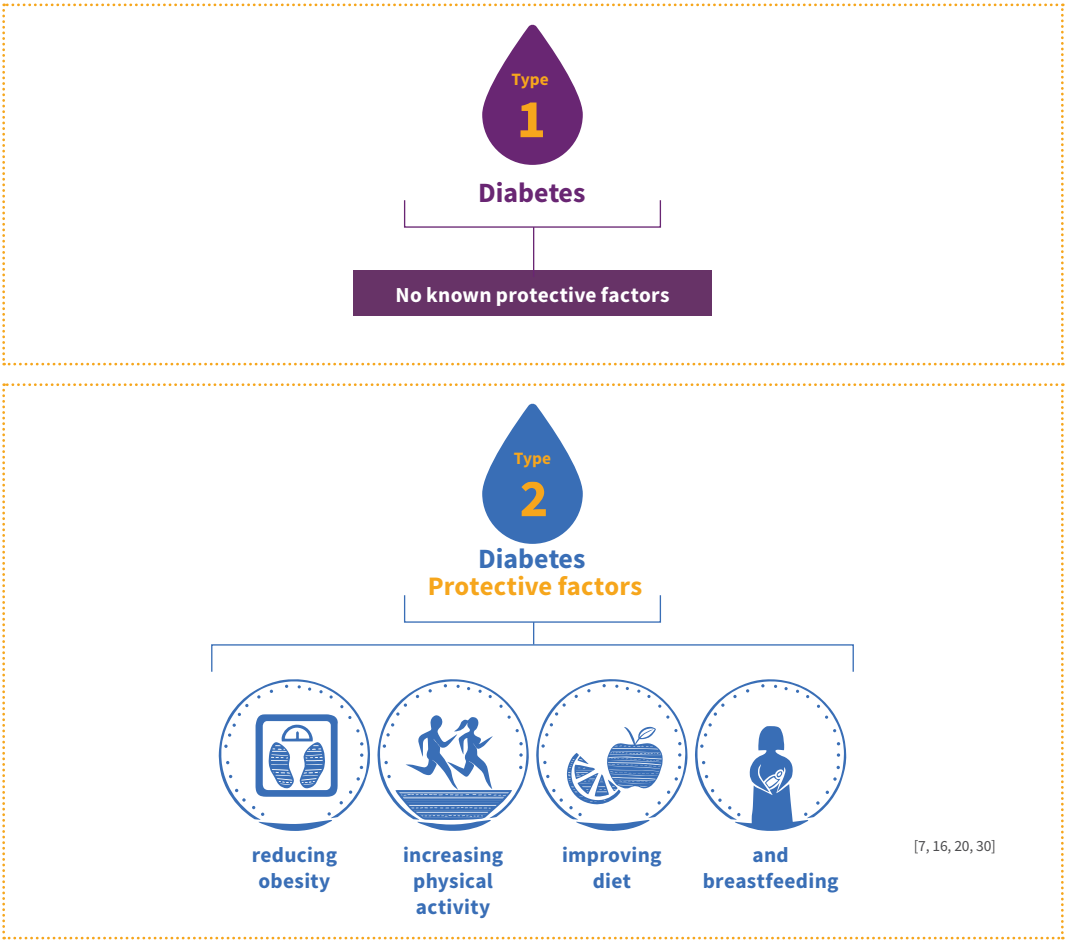
Box 1

What is diabetes?

When a person has diabetes their body is not able to produce and/or use insulin properly, which leads to high levels of sugar in the blood [21]. It can lead to sickness, disability, reduced quality of life and early death [21-23]. Diabetes can affect the entire body and requires lifelong management [22, 23]. New research has shown it is possible for some people with type 2 diabetes to reduce their average blood sugar level to that which is considered 'normal' (achieve an HbA1c of under 6.5% or 48mmol/mol). If they can keep it at that level for at least three months without the need for glucose lowering medication this is referred to as type 2 diabetes 'remission' [24-26].

If undiagnosed or poorly managed, diabetes can lead to a range of complications and death [27]. Complications include diseases of the large blood vessels (macrovascular disease), such as heart disease and stroke, and diseases of the small blood vessels (microvascular disease), such as kidney disease, eye disease and nerve disease [28]. Type 2 diabetes is the most common form of diabetes, traditionally affecting older people but increasingly occurring in young people and children [4, 23, 41]. Type 1 diabetes and GDM are the other main types of diabetes [29]. Other types of diabetes are fairly uncommon and are caused by certain conditions or syndromes that result in problems in insulin secretion, insulin action, or both, such as diabetes caused by pancreatitis.

What are the risks and protective factors for diabetes?



Breastfeeding can be protective against the development of type 2 diabetes for both the mother and baby. Many studies have shown that breastfeeding can reduce the risk of maternal type 2 diabetes in later life [30] and reduce the rate of progression from GDM to type 2 diabetes [31]. Breastfeeding may also reduce the risk of babies becoming overweight [10].

Risk factors

- **Non-modifiable risk factors** – family history and age.
- **Behavioural risk factors** – tobacco smoking, low levels of physical activity, poor diet and being overweight or obese [7, 20].
- **Biomedical risk factors** – impaired glucose regulation, high blood pressure (hypertension), high blood cholesterol (dyslipidaemia).
- **Social and economic risk factors** – education, employment, income, housing, access to services, connection with land, racism and imprisonment [13, 14, 32].

Aboriginal and Torres Strait Islander people are more likely to have these risk factors for diabetes than non-Indigenous Australians [33] and many who already have diabetes have multiple risk factors and other related health problems [34-36].

Epigenetics and the intrauterine environment

Increasing evidence now suggests that external factors that can change gene expression (epigenetics) and the environment within the mother's womb (intrauterine) can have a big influence on the development of diabetes. We know that mothers who have type 2 diabetes before they get pregnant (pre-existing diabetes) and mothers with GDM are more likely to have babies who develop diabetes [2]. Factors such as maternal malnutrition, maternal psychological stress, smoking, alcohol use and high blood sugar levels during critical periods of fetal development in pregnancy may cause the child to develop poor physical and mental health [2, 19, 37]. This may partly explain the higher rates of diabetes in this population [19]. This then creates an inter-generational cycle where mothers pass on diabetes to their offspring, and thus the epidemic continues to grow [2].

Box 2

Types of diabetes

Pre-diabetes describes a condition in which blood sugar levels are higher than normal, although not high enough to be diagnosed as type 2 diabetes (between 5.5 and 6.9 mmol/l) [38]. Pre-diabetes has no signs or symptoms. People with pre-diabetes have a higher risk of developing type 2 diabetes and cardiovascular disease. Pre-diabetes can often be prevented from progressing to diabetes through lifestyle changes and weight loss (if overweight or obese). There are two pre-diabetes conditions: impaired glucose tolerance (IGT) and impaired fasting glucose (IFG) [38]

Type 1 diabetes is most frequently diagnosed in children and adolescents [34, 39, 40]. The body is not able to produce insulin and this leads to hyperglycaemia (high blood sugar levels). Type 1 diabetes requires insulin treatment for life.

Type 2 diabetes was previously considered a disease of adults, but it is increasingly being diagnosed in child and adolescent populations, reflecting the increase in childhood obesity [41]. It is characterised by hyperglycaemia due to insulin resistance and/or low insulin production. Type 2 diabetes can usually be controlled through lifestyle modifications, but may require insulin treatment over time.

Gestational diabetes mellitus (GDM) is a form of diabetes that develops during pregnancy in some women [34, 39, 40]. This type of diabetes is short-term and usually develops in the second or third trimester of pregnancy. Both mother and baby are at risk of complications during the pregnancy and birth [34, 39]. GDM usually disappears after the baby is born, although it puts the mother and child at increased risk of developing type 2 diabetes later in life [42]. GDM can recur in later pregnancies.

Diabetes in pregnancy (DIP or *Overt diabetes*) is pre-existing type 2 diabetes that is not diagnosed before pregnancy [43]. It is important to detect DIP as early as possible, so blood sugar levels can be brought down to normal levels, to support the best posssible pregnancy outcome. Evidence suggests that Aboriginal and Torres Strait Islander women with DIP are at high risk of progression to type 2 diabetes within a short timeframe after birth [44].

How many Aboriginal and Torres Strait Islander people have diabetes?

There are various ways to measure the level of diabetes in a population, including prevalence, incidence, health service utilisation, mortality and burden of disease (see Box 3 for information on these measurements). This summary focuses mainly on national data that provide an overall picture of the impact of diabetes on Aboriginal and Torres Strait Islander people. Much of the published data are for type 2 diabetes, but numbers for type 1 diabetes and GDM are reported where available. If the type of diabetes is not specified it can be assumed to be type 2 diabetes. Separate data for Torres Strait Islander people is limited, but is also provided where available. It should be noted that:

- the availability and quality of data varies
- there are data limitations associated with each of the measures of diabetes
- statistics about diabetes for Aboriginal and Torres Strait Islander people are often underestimated.

Box 3

Measuring diabetes

Incidence is the number of new cases of diabetes that occur during a certain period of time [45].

Prevalence is the number or proportion of cases of diabetes in a population at a specific period of time [45].

Age-standardised rates enable comparisons of rates of diabetes between populations that have different age structures [46]. Age-standardisation is often used when comparing Aboriginal and Torres Strait Islander people and non-Indigenous people because the Aboriginal and Torres Strait Islander population has a younger age structure than the non-Indigenous population.

Rate ratio is the rate of Aboriginal and Torres Strait Islander people affected by diabetes divided by the rate of non-Indigenous people affected by diabetes [46].

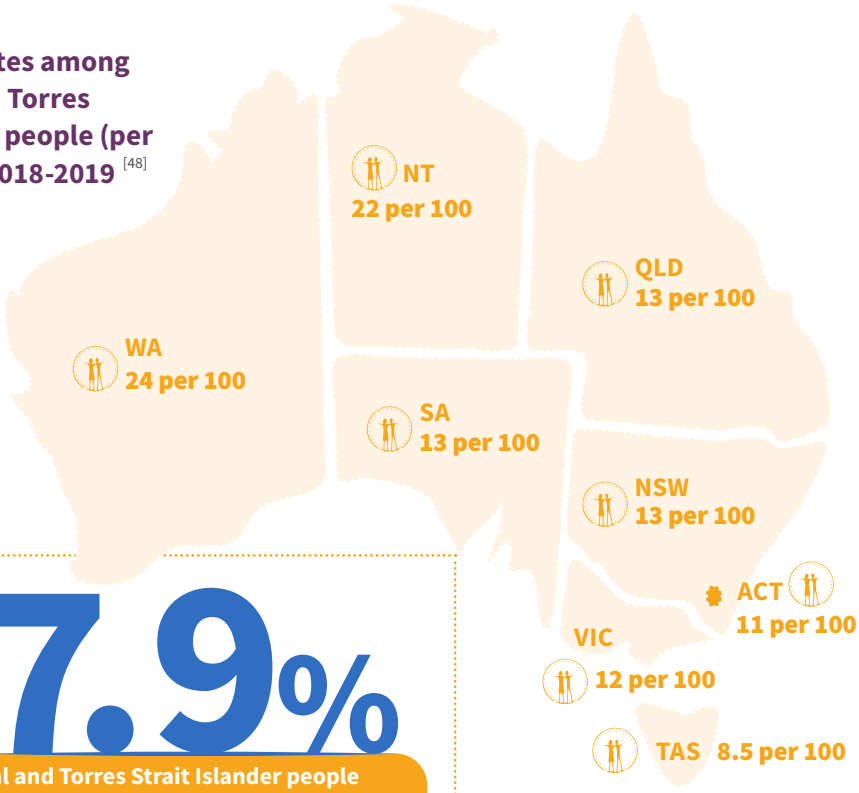
Ratio is the proportion of Aboriginal and Torres Strait Islander people affected by diabetes divided by the proportion of non-Indigenous people affected by diabetes.

Potentially preventable hospitalisations are hospital admissions for conditions (including diabetes) that may have been avoided through appropriate preventive measures and early disease management, usually given in primary care and community based care settings [46].

Potentially avoidable deaths are deaths among people aged less than 75 years from conditions (including diabetes) that should be preventable and treatable [46]. Potentially avoidable deaths can be reduced through lifestyle improvements and appropriate primary prevention, early intervention and medical treatment.

Burden of disease is measured in disability-adjusted life years (DALYs). It provides a estimate of years of life lost due to premature mortality caused by diabetes and years of life lost due to disability or ill health caused by diabetes [47].

Rates of diabetes among Aboriginal and Torres Strait Islander people (per 100 persons) 2018-2019 [48]



7.9%

of Aboriginal and Torres Strait Islander people self-reported that they had diabetes in 2018-19.

Prevalence

In 2018, after adjusting for age, Aboriginal and Torres Strait Islander children and young adults were less likely to have type 1 diabetes than non-Indigenous people (197 per 100,000 people compared with 232 per 100,000 people) [7].

In 2018-19:

- around 7.9% of Aboriginal and Torres Strait Islander people self-reported that they had diabetes [5]. After adjusting for age, Aboriginal and Torres Strait Islander people were 2.9 times as likely to have diabetes as non-Indigenous people (13% compared with 4.3%) [5]
- after adjusting for age, the proportion was similar in males (13) and females (12%)
- the prevalence of diabetes increased with age, [5] ranging from 2.5% for Aboriginal and Torres Strait Islander people aged 25-35 years to 11% for those aged 35-44 years, 19% for those aged 45-54 years and 35% for those aged 55 years and over
- the rate of diabetes/high sugar levels was higher for both Aboriginal and Torres Strait Islander males (2.5 times higher) and females (3.2 times higher) than non-Indigenous males and females
- the rate of diabetes/high sugar levels was lower among Aboriginal and Torres Strait Islander people living in non-remote areas (15 per 100 persons) than among those living in remote areas (24 per 100 persons) (see Table 1)

Pre-diabetes

In 2012-13, based on fasting plasma glucose results:

- 4.7% of Aboriginal and Torres Strait Islander adults had pre-diabetes
- the proportion of Aboriginal and Torres Strait Islander adults with pre-diabetes did not differ significantly by sex or between remote and non-remote areas
- Aboriginal and Torres Strait Islander adults were 1.8 times as likely to have pre-diabetes than non-Indigenous adults (based on age-standardised rates) [49].

Table 1. Rates[1] of people reporting diabetes/high sugar levels as a long-term health condition, by Indigenous status, age, gender and remoteness, and Indigenous:non-Indigenous rate ratios, Australia, 2017-2018 and 2018-2019

	Aboriginal and Torres Strait Islander people[2] (Rate)	Non-Indigenous people[3] (Rate)	Rate Ratio[4]
Age (years)			
18-24	0.8	0.9	0.9
25-34	3.0	1.2	2.5
35-44	11	2.5	4.4
45-54	21	5.2	4.0
55+	36	15	2.4
Gender			
Male	18	7.0	2.5
Female	17	5.3	3.2
Remoteness			
Non-remote	15	6.1	2.5
Remote[5]	24	8.6	2.8

Notes:
1. Rates are expressed as number per 100 persons.
2. Data for Aboriginal and Torres Strait Islander people is from National Aboriginal and Torres Strait Islander Health Survey (NATSIHS) 2018-19.
3. Data for non-Indigenous Australians is from National Health Survey (NHS) 2017-18.
4. Rate ratio is calculated by dividing the Indigenous rate by the non-Indigenous rate.
5. The NHS 2017-18 excludes Very Remote areas of Australia and discrete Aboriginal communities.

Source: AIHW, 2020 (derived from Table D1.09.2) [48]

Incidence

Type 1 diabetes

National incidence data for type 1 diabetes is obtained from the *National (insulin-treated) diabetes register* (NDR).

In 2019, after adjusting for age, the rate was 16 per 100,000 population for males and 9.8 per 100,000 population for females. The incidence rate for Aboriginal and Torres Strait Islander people was similar to that for non-Indigenous people (13 per 100,000 population compared with 12 per 100,000 population) [50].

Gestational diabetes

In 2017-18, 13% of Aboriginal and Torres Strait Islander mothers who gave birth were diagnosed with GDM. After adjusting for age, the incidence rate among Aboriginal and Torres Strait Islander mothers was similar to the rate for non-Indigenous mothers (17% and 16% respectively) [7].

In 2016-17, the incidence of GDM increased with age (6.6% in the 15-19 year age-group, 8.8% in the 20-24 year age-group and 32% in the 40 years and over age group) [51].

Morbidity

General practice attendances

General practitioners (GPs) are usually the first point of contact with health services for people with diabetes. They often play a key role in coordinating the other specialised services and health professionals who are needed to manage the condition [52].

From April 2010 to March 2015:

- 5.5% of problems managed by GPs among Indigenous patients were diabetes-related
- 92% of diabetes-related problems were for non-insulin dependent type 2 diabetes
- the rate of diabetes problems managed by GPs was three times as high among Indigenous Australians as among other Australians (3 times higher for type 2 diabetes and 2.3 times higher for type 1 diabetes) [7].

Hospitalisation

Hospital services are typically required to treat the advanced stages of complications of diabetes or acute episodes of poor blood sugar (glycaemic) control [34].

Type 1

In 2017-18 [7]:

- there were around 3,000 hospitalisations with a principal and/or additional diagnosis of type 1 diabetes among Aboriginal and Torres Strait Islander people (361 per 100,000 population)
- after adjusting for age, the hospitalisation rate was almost twice as high among Aboriginal and Torres Straight Islander people (446 per 100,000 population) compared with non-Indigenous people (233 per 100,000 population)
- the age-standardised rate of hospitalisations for type 1 diabetes increased from 362 hospitalisations per 100,000 population to 446 hospitalisations per 100,000 population between 2015-16 and 2017-18
- the age-standardised hospitalisation rate was higher among Aboriginal and Torres Strait Islander males (525 hospitalisations per 100,000 population) than females (381 hospitalisations per 100,000 population)
- age-specific hospitalisation rates were highest in those aged 55–64 years (905 hospitalisations per 100,000 population)
- hospitalisation rates for type 1 diabetes were around three times as high among Aboriginal and Torres Strait Islander Australians living in major cities (482 per 100,000 population) and regional areas (528 per 100,000 population) as those living in remote and very remote areas (175 hospitalisations per 100,000 population)
- hospitalisation rates were highest in Vic (575 per 100,000 population) and lowest in the NT (147 per 100,000 population). Other states had rates ranging from 322 per 100,000 population to 562 per 100,000 population.

Type 2

In 2017-18 [7]:

- there were around 69,000 hospitalisations with a principal and/or additional diagnosis of type 2 diabetes among Aboriginal and Torres Strait Islander adults
- after adjusting for age, the hospitalisation rate was almost five times as high among Aboriginal and Torres Strait Islander adults as non-Indigenous adults (19,000 per 100,000 and 4,500 per 100,000 respectively)
- the age-standardised rate of hospitalisations increased from 12,100 per 100,000 population to 14,300 hospitalisations per 100,000 population between 2015-16 and 2017-18
- the hospitalisation rate was higher among Aboriginal and Torres Strait Islander females (all ages) compared to Indigenous males (15,500 per 100,000 population and 13,100 per 100,000 population respectively)
- type 2 diabetes hospitalisation rates increased with age, peaking in those aged 65 years and over (45,800 hospitalisations per 100,000 population)
- hospitalisations were 3.3 times as high among Aboriginal and Torres Strait Islander Australians living in remote and very remote areas (30,800 per 100,000 population) than those living in major cities (9,200 per 100,000 population)
- hospitalisation rates were highest in WA (35,000 per 100,000 population) and lowest in Tas (4,100 per 100,000 population). Other states and territories had rates ranging from 6,200 per 100,000 population to 21,800 per 100,000 population.

Deaths

In 2020:

- the rate of deaths from diabetes for Aboriginal and Torres Strait Islander people was 75 per 100,000 population
- the death rate was 4.9 times higher for Aboriginal and Torres Strait Islander people than for non-Indigenous people [53]
- the death rate was higher for Aboriginal and Torres Strait Islander males (82 per 100,000 population) than females (71 per 100,000 population)
- diabetes was the fourth leading cause of death for males and the second leading cause of death for females
- the rate of Aboriginal and Torres Strait Islander people who died from diabetes decreased from 81 deaths per 100,000 population to 75 per 100,000 population between 2011-2015 and 2016-2020 [53]
- Aboriginal and Torres Strait Islander people in the 45-54 year age-group were 11 times more likely to die from diabetes than non-Indigenous people in that age-group (rate ratios were 16.6 for females and 8.1 for males) [53].

In 2014-2018:

- after adjusting for age, the rate of avoidable and preventable deaths[1] from diabetes was 44 per 100,000 population among Aboriginal and Torres Strait Islander Australians (46 per 100,000 population for males and 42 per 100,000 population for females)
- the rate of avoidable and preventable deaths from diabetes increased with age for both Aboriginal and Torres Strait Islander males and females
- the NT had the highest rate of avoidable and preventable deaths (108 per 100,000 population), followed by WA (66 per 100,000 population), Qld and SA (both 43 per 100,000 population) and NSW (21 per 100,000 population).

Burden of disease

Every year in Australia, many years of healthy life are lost because of injury, illness or early (premature) deaths in the population. This loss of healthy life is called the 'burden of disease' [54].

The *Australian burden of disease study* (ABDS) measures the impact of living with illness and injury and dying prematurely. Disability-adjusted life years, or DALY measures the years of healthy life lost from death and illness.

In 2018, type 2 diabetes was the fourth leading specific cause of total burden of disease among Aboriginal and Torres Strait Islander people, with an age-standardised rate of 15 DALY per 1,000 people [54].

1 Avoidable and preventable mortality refers to deaths from conditions that are considered avoidable given timely and effective health care (including disease prevention and population health initiatives) [48]

Special populations

Children and adolescents

Type 2 diabetes is becoming more common among Aboriginal and Torres Strait Islander children and adolescents, which is causing concern among experts because it is mostly preventable [4]. Type 2 diabetes now accounts for the most new cases of diabetes in this population where previously there was a greater incidence of type 1 diabetes. Type 2 diabetes occurs more frequently among Aboriginal and Torres Strait Islander adolescents than non-Indigenous adolescents [8, 9, 55] [56] [57].

Nationally, between 2006 and 2011, for Aboriginal and Torres Strait Islander youth aged 10-19 years:

- 55% of new cases were type 2 diabetes
- 43% of new cases were type 1 diabetes [58].

In the Top End, between 2016 and 2017, among Aboriginal and Torres Strait Islander youth (less than 25 years of age):

- the prevalence of type 2 diabetes was 6.7 per 1,000 population
- the youngest reported age of diagnosis was 4.4 years of age
- the prevalence was higher for those aged 15-24 years (14 per 1,000 population) than those 15 years or younger (1.4 per 1,000 population)
- the prevalence was higher for females (9.4 per 1,000 population) than males (4.2 per 1,000 population) [59].

In WA, between 1990 and 2012, among Aboriginal and Torres Strait Islander children:

- they were 20 times more likely to be diagnosed with type 2 diabetes than non-Indigenous children (13 per 100,000 person-years compared with 0.6 per 100,000 person-years)
- the mean age at diagnosis was 13.3 years [8]
- 12% were classified as overweight and 61% obese.

In NSW, Aboriginal and Torres Strait Islander youth:

- were over six times more likely to be diagnosed with type 2 diabetes than non-Indigenous youth
- the median age at diagnosis was 13.5 years to 14.5 years [57] [9]
- 90% of the youth were classified as overweight or obese.

Early onset of type 2 diabetes brings an increased risk of comorbidities (other diseases occuring alongside diabetes, such as heart disease), diabetes complications (such as problems with the eyes, nervous system and kidneys) and early death [55] [60, 61] [62]. Kidney disease, high blood pressure (hypertension), abnormal blood lipids (dyslipidaemia) and depressive symptoms are among the most common comorbidities and complications [62]. Blood sugar level control (glycaemic control) usually gets worse over time in people with type 2 diabetes, however, this happens faster in adolescents than in adults due to greater insulin resistance in the cells and a decreased sensitivity to glucose in the pancreas (β-cell dysfunction) [61].

In 2020, the Australian Paediatric Endocrine Group published guidelines on paediatric (childhood) type 2 diabetes [61]. The guidelines provide recommendations on screening, diagnosis, diabetes education, monitoring including targets, healthy lifestyles, treatment using drugs (pharmacotherapy), assessment and management of complications and comorbidities and transition. There is also a section on considerations of care for children and adolescents from indigenous backgrounds in Australia and New Zealand. Previous to this, health professionals had to refer to adult guidelines, or international guidelines that did not address care for patients from indigenous backgrounds.

Pregnant women (diabetes in pregnancy)

Diabetes in pregnancy refers to GDM and pre-existing diabetes (type 1 and type 2), both of which can lead to a range of complications for the mother and child (see Box 4) [63].

Among Aboriginal and Torres Strait Islander mothers who gave birth in Australia in 2019:

- 86% did not have diabetes
- 12% had GDM
- 2.2% had pre-existing diabetes.

How many Aboriginal and Torres Strait Islander females are hospitalised for a principal and/or additional diagnosis of diabetes during pregnancy?

In 2017-18:

- Aboriginal and Torres Strait Islander females aged 10-54 years with a pregnancy outcome were admitted to hospital at a rate of 24,700 per 100,000 females
- after adjusting for age, the hospitalisation rates were 1.8 times as high among Aboriginal and Torres Strait Islander females as non-Indigenous females [7].

Between 2015-16 and 2016-17:

- the hospitalisation rate was more than two times as high among those living in remote and very remote areas (44,100 per 100,000 females) as those living in major cities (20,600 per 100,000 females)
- hospitalisation rates were highest in the NT (42,300 per 100,000 population) and lowest in Tas (15,500 per 100,000 population). Other states had rates ranging from 16,100 per 100,000 to 31,300 per 100,000 population [7].

Box 4

Risks associated with diabetes in pregnancy

Risks for the child include: being born early (pre-term birth), stillbirth, low and high birthweight, longer stay in hospital, low Apgar score, admission to neonatal intensive care units and resuscitation. There is also increased risk of obesity, impaired glucose tolerance and type 2 diabetes in early adulthood. Babies of mothers with pre-existing diabetes are at higher risk of complications than those with GDM [39, 63].

Risks for the mother include: pre-existing and gestational high blood pressure (hypertension), pre-eclampsia, induced labour, pre-term birth, caesarean section, longer stays in hospital both before and after birth (antenatal and postnatal) and first appearance or progression of complications including those associated with kidney, eye and cardiovascular diseases [39, 63]. Mothers with GDM are less likely to have complications than mothers with pre-existing diabetes. For mothers with GDM there is also a risk of GDM occurring in later pregnancies and of the development of type 2 diabetes.

Complications with diabetes in pregnancy

Among Australian women who have diabetes during pregnancy, Aboriginal and Torres Strait Islander mothers and babies are more likely to experience negative effects during pregnancy, labour and delivery, than non-Indigenous mothers and babies [63, 64]. People living in a remote region also appear to have an increased risk of a negative outcome [64].

In 2016-2018 [6]:

- Aboriginal and Torres Strait Islander mothers who had pre-existing diabetes were 2.3 times more likely to have a stillborn baby, and 1.9 times more likely to experience a death before or after the birth (perinatal) than those without diabetes.
- Aboriginal and Torres Strait Islander women who had pre-existing diabetes were about 3.3 times as likely to have a pre-term birth as Aboriginal and Torres Strait Islander women who did not have pre-existing diabetes before the onset of pregnancy.
- Aboriginal and Torres Strait Islander women who had GDM were about 1.2 times as likely to have a pre-term birth as Aboriginal and Torres Strait Islander women who did not have GDM.
- Pre-existing diabetes and GDM both increased the risk of Aboriginal and Torres Strait Islander women having a low birthweight baby (0.8 and 0.5 respectively) compared with women who did not have diabetes.

National figures regarding complications of diabetes in pregnancy for Aboriginal and Torres Strait Islander mothers and babies for the period 2014-2015 are presented in Table 2.

Table 2. Selected maternal and infant complications of diabetes among Aboriginal and Torres Strait Islander women who gave birth, by diabetes in pregnancy status, Australia, 2014-2015 (age-standardised percent and ratio)

Complication	Pre-existing diabetes		GDM		No diabetes
Maternal	*%[1]*	*Ratio[2]*	*%[1]*	*Ratio[2]*	*%[1]*
Pre-existing (chronic) hypertension[3]	9.1	7.1	2.9	2.2	1.3
Gestational hypertension[3]	7.1	1.9	5.7	1.5	3.8
Pre-eclampsia[3]	8.2	3.4	4.1	1.7	2.4
Pre-term induction[4]	40	1.5	42	1.6	27
Antenatal hospital stay 5 or more days[5]	14	7.8	4.7	2.8	1.7
Postnatal hospital stay 5 or more days[6]	31	3.0	13	1.3	10
Infant	*%[1]*	*Ratio[2]*	*%[1]*	*Ratio[2]*	*%[1]*
Pre-term birth[7]	36	2.5	16	1.1	14
Caesarean section	62	2.2	43	1.5	29
Low birthweight[8]	17	1.3	9.5	0.7	14
High birthweight[9]	5.1	4.1	2.4	2.0	1.2
Low Apgar score[10]	5.6	1.9	2.9	1.0	2.9
Resuscitation[11]	37	1.8	22	1.1	20
Special Care Nursery (SCN)/Neonatal Intensive Care Unit (NICU) admission	67	3.0	33	1.5	23
Hospital stay 7 – 13 days[12]	16.1	2.9	7.8	1.4	5.6
Hospital stay 14 days or more[12]	13.6	2.8	4.6	1.0	4.8

Notes:

1. Data are directly age-standardised to the Australian female population aged 15–44 as at 30 June 2001.
2. Ratio is calculated by dividing the percent of women with pre-existing diabetes or GDM by the percent of women with no diabetes for each group.
3. Due to differences in definitions and methods used for data collections between jurisdictions, care should be taken when interpreting this data.
4. Labour induced at less than 37 weeks.
5. Women who gave birth in hospital only. Excludes women who gave birth in centres attached to hospitals.
6. Only includes women who were discharged home. Women who gave birth in hospital only. Excludes women who gave birth in centres attached to hospitals.
7. Gestational age of live born babies from 20-36 weeks (4 babies of less than 20 weeks gestational age were also included).
8. Less than 2,500 grams.
9. 4,500 grams and over.
10. Apgar score (at five minutes) of 0-6.
11. Only includes where active resuscitation was undertaken.
12. Only babies who were discharged home are included. Excludes babies who were born in birth centres attached to hospitals.

Source: Derived from [65]

How does COVID-19 affect people with diabetes?

People with diabetes and other non-communicable chronic diseases are at greater risk of being infected by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus and contracting coronavirus disease (COVID-19) [66, 12]. Among those hospitalised with COVID-19, patients with diabetes appear to be among the most severely affected. According to national data [67], people with diabetes are more likely to require intensive care unit stays and to die due to COVID-19. There is also emerging evidence that long-term health consequences and complications of diabetes are made worse by COVID-19, and that COVID-19 may bring on the onset of diabetes [68].

Aboriginal and Torres Strait Islander people and people living in remote communities are at greater risk of contracting COVID-19 than the general population due to [69]:

- higher rates of other health issues in these communities
- greater difficulties in accessing health care
- the high rate of travel often undertaken by people in the community
- more of a reliance on outreach services by those in remote places
- living in large and/or intergenerational households
- crowded or insecure housing
- higher rates of chronic disease than the general population (this has also been observed in indigenous populations in the United States of America (USA)[70, 66, 69].

During the 'first wave' of the pandemic in early 2020, the Australian Government, following advice from the National Aboriginal Community Controlled Health Organisation (NACCHO), ordered the closure of remote communities to prevent visitors entering and bringing the virus to vulnerable community members [71]. Telehealth was used for checkups and to ensure the Aboriginal and Torres Strait Islander community members were following their medical plans. In regional and urban areas, Aboriginal Medical Services continued to visit their Elders.

In July 2020, the Australian Government released an emergency response plan for COVID-19 specifically for Aboriginal and Torres Strait Islander people [72].

A COVID-19 outbreak in remote and very remote communities can lead to reduced numbers of medical staff (due to infection and the need to isolate), which increases the risk of a rise in

deaths from existing chronic diseases, including diabetes. [73]. For these reasons, it is important that people with diabetes are educated in self-management of their condition during acute illness, including medication changes. It is also critical that there is no reduction in the medical management of blood sugar levels (glycaemia) and other complications of diabetes, as this could result in increased illness and death. Telehealth is one solution for enabling continued care for patients in rural and remote areas, or during lockdowns.

In the healthcare system in the USA, the need to maintain blood sugar level (glycemic) control while reducing patient contact has resulted in the implementation of strategies that promote more self-management [66].

Prevention and management of diabetes

The prevention and management of diabetes is vital to the current and future health of Aboriginal and Torres Strait Islander people [15].

Effective diabetes prevention and management programs need:

- evidence-based health promotion measures, public health interventions and clinical services [10]
- to be delivered sensitively, tailored to community needs, and not perceived as being forced upon communities [10]
- to involve Aboriginal and Torres Strait Islander community members and Aboriginal and Torres Strait Islander Health Practitioners in their design to ensure cultural acceptability to the wider community [17].

In addition, interventions that improve cultural safety for Indigenous people living with diabetes can also have positive effects on medical outcomes [18].

Most primary health care services in Australia (such as GP clinics or Aboriginal Medical Services) play a critical role in the early detection of diabetes [74]. Early detection, early intervention and management lead to better outcomes.

Interventions for diabetes management need to occur both within and outside the health system (including policy action, education, employment and nutrition), through government and non-government agencies, and need to commence as early as possible in the life course [15, 17, 75, 76].

How can diabetes be prevented?

There is currently no known way to prevent type 1 diabetes or GDM [77] [78]. Type 2 diabetes is related to social disadvantage [76] so prevention requires action that also addresses the social determinants of Aboriginal and Torres Strait Islander health such as poverty, culture, racism, employment and education [10, 15, 76]. Food security, healthier choices and lifestyle changes need to be encouraged and made easier to adopt, and family and child health needs to be improved through pregnancy and early years programs [79].

The standard approach to primary prevention that can prevent or delay the onset of type 2 diabetes in high risk individuals includes:

- identifying those at high risk through the use of risk assessment tools
- delivering education programs
- promoting lifestyle modifications that focus on increased physical activity, dietary change and weight loss [12].

Risk assessment and screening

The *Australian type 2 diabetes risk assessment tool* (AUSDRISK) has been developed to identify people who are at risk of developing type 2 diabetes [80-82].

While simple and practical, the Royal Australian College of General Practitioners (RACGP) suggests that AUSDRISK has limited use as a screening tool for Aboriginal and Torres Strait Islander people due to the high background level of undiagnosed type 2 diabetes. To identify diabetes earlier and reduce the risk of complications, they recommend direct screening for diabetes through blood testing combined with other screening that is being performed (such as a cardiovascular risk assessment) [83].

Testing for diabetes in remote Aboriginal primary health care settings needs to be simple and practical. Marley and colleagues [84] suggest that a combination of point-of-care and laboratory glycated haemoglobin A (HbA1C) testing is more effective than the standard impaired glucose tolerance (IGT) and/or impaired fasting glucose (IFG tests). Not only is this method appropriate for use with adults and adolescents [85], it could simplify diabetes testing in remote areas, provide quicker diagnoses, and increase the number of cases detected.

Another diabetes prediction model and tool was tested in the Kimberley region of WA and published in 2015 [86]. It claims to predict the 10-year absolute risk of type 2 diabetes for Aboriginal people based on waist circumference and age. This work has not yet been repeated, so it is unknown whether it would work for Aboriginal and Torres Strait Islander communities in other areas.

Education

Education in diabetes prevention needs to be carried out in a culturally appropriate manner [10]. Awareness programs and education programs (including school education programs) need to be community-wide, and culturally relevant [12]. Education should be culturally appropriate and in the patient's native language, which may include using an interpreter [17] and translating materials and services [12].

Diabetes education should stress that diabetes can be prevented and that diabetes is not 'normal' (as many people in Aboriginal and Torres Strait Islander communities believe) [17].

Deadly Choices is a social marketing initiative that was started in 2010 in South East Qld by the Institute for Urban Indigenous Health (IUIH). The Deadly Choices program conducts school-based chronic disease education initiatives for young Aboriginal and Torres Strait Islander students (years 7 to 12) in Brisbane, Qld [87, 88]. It aims to empower Aboriginal and Torres Strait Islander people to make healthy choices for themselves and their families, such as quitting smoking, eating good food and exercising daily. It also encourages people to access their local health service and complete a 715 Health Check every 9-12 months - encouraging people to see a doctor not just when they are sick, but to help them remain healthy, to access support, and prevent or manage their chronic disease better. An evaluation of the program found that participants showed significant improvements over time in knowledge, attitudes and belief in themselves in relation to their understanding of types of chronic disease, chronic disease risk factors, prevention and health checks [89]. The students who took part in the program showed a significant improvement in their knowledge of chronic disease and associated risk factors.

Lifestyle modifications

Overweight and obesity, poor nutrition and physical inactivity (lifestyle factors) are risk factors that contribute to the unreasonably high levels of diabetes seen in Aboriginal and Torres Strait Islander communities [10].

A review of healthy lifestyle programs targeting physical activity and nutrition among Aboriginal and Torres Strait Islander people found that:

- programs can have positive health effects for up to two years, and are more likely to be effective if they are started by the community [16]
- very few healthy lifestyle programs have continued beyond five years due to a lack of long term funding and the existence of many social and economic problems in communities [10, 16, 90]
- programs that achieved short-term successful outcomes tended to be run by Aboriginal people or an Aboriginal organisation and have Aboriginal input into the design
- they all required longer term funding to maintain the programs.

Examples of lifestyle intervention programs

The Life! Program offers a course specifically for Aboriginal people and their families, which is called the Road to Good Health [91]. Funded by the Victorian Government, managed by Diabetes Australia - Victoria, and run by Aboriginal Health Workers and other health professionals, this course supports participants to make long-term lifestyle changes, such as adopting a healthier diet and becoming more physically active [92, 93]. Unofficial feedback suggests the course is culturally relevant, valuable to users and popular (https://lifeprogram.org.au/learn-about-life/for-aboriginal-communities/), but published evaluations are not available.

Various other programs have used sport to promote healthy lifestyles among Aboriginal and Torres Strait Islander children and adults, but their long-term success has not been evaluated [16]. Some short-term programs have demonstrated positive results, such as some 12-week exercise programs for Aboriginal and Torres Strait Islander males [94] and females [95]. The 10-week Too Deadly for Diabetes program conducted in an urban Aboriginal community used diet and exercise to help participants achieve positive health outcomes [96]. Much of the value of the program was because it was run by an Aboriginal person, for Aboriginal people and in an Aboriginal organisation.

In the regional location of Derby, WA, the Derby Aboriginal Health Service ran a lifestyle intervention program for young people aged 15-25 years. The aim was to prevent type 2 diabetes in those people who were at high risk of developing diabetes [90]. The program included education sessions and separate male and female physical activity sessions. The evaluation suggested that programs that have community input into the creation, a dedicated local person involved, supportive organisers and relevant and enjoyable activities are most likely to be useful. However, long-term funding for prevention is essential if we are to see any changes.

What other lifestyle modifications can help?

Other interventions outside the health sector that could help reduce the incidence of type 2 diabetes in the Aboriginal and Torres Strait Islander population include [10, 97]:

- making healthy food and drinks more available, affordable and accessible (e.g. in stores and through community gardens and traditional food projects)
- restricting advertising of unhealthy food and drinks
- providing clearer food labelling and education on the nutritional value of foods
- providing a clean community water supply and water bubblers
- using a tax on sugary drinks (e.g. soft drinks) to reduce intake
- encouraging physical activity through partnerships with local councils
- improving housing.

How is diabetes managed?

Suitable and effective diabetes management for Aboriginal and Torres Strait Islander people depends on two main factors:

i. access to a broad range of health services in a broad range of settings [10]
ii. opportunities and assistance for patients to interact with the necessary healthcare providers and the healthcare system [81].

Diabetes management for Aboriginal and Torres Strait Islander people can be improved through:

- earlier detection of undiagnosed diabetes
- access to good quality primary health care
- access to medications
- education on self-management of diabetes
- availability of tertiary specialist treatment when complications develop.

The following sections refer mainly to the management of type 2 diabetes for Aboriginal and Torres Strait Islander people. Some information about managing diabetes in pregnancy is also provided.

Managing diabetes in the primary health care setting

Strategies that can help to improve diabetes management for Aboriginal and Torres Strait Islander people in the primary care setting include:

- involvement of an Aboriginal and Torres Strait Islander Health Worker, liaison officer, outreach worker or care coordinator
- access to a choice of culturally appropriate care [10, 81, 98]
- empowering patients to take the lead in managing their chronic condition through education and active participation [17, 99]
- up-skilling GPs to help them manage patients with more complex conditions
- providing access to local services that offer specialised treatment (such as renal dialysis) for those with diabetes-related complications [10]
- early diagnosis, a suitable management plan and the best available clinical treatment [99].

Whyatt and colleagues (2017) suggest that better management of patients in the primary care setting for diabetes would improve their preventive care, encourage regular monitoring, improve crisis intervention and continuity of care, and reduce emergency department presentations [100].

Previous research in the NT showed that Aboriginal and Torres Strait Islander people with diabetes in remote communities tend to go to hospital rather than visit their primary care provider for treatment [101]. However, another study found that introducing a suitable diabetes care plan led to better short-term blood glucose control and fewer diabetes-related hospital admissions [99].

The use of shared electronic health records and telemedicine can also help enable diabetes management in the primary care setting:

- shared electronic health records can reduce the risk of hospital admission for diabetes because a patient's medical history including current medications and results of recent tests are available at any health centre [99]
- telemedicine enables even those in remote communities to consult with doctors and specialists without either the patient or the specialist needing to travel [17].

Access to medicines

Newer diabetes medications are rarely made available for Australians living in lower socioeconomic areas and in remote areas and this may contribute to poorer health outcomes for people living in those areas [102]. Other potential barriers to access and use of medicines by Aboriginal and Torres Strait Islander people include:

- lack of transport and access to services
- inability to afford medication and services
- difficulty with storing medications such as insulin that require refrigeration
- difficulty interpreting labelling and consumer medicine information
- client beliefs and behaviours about filling scripts, taking medication, sharing medication and side effects
- lack of interpreters or culturally appropriate explanation of medications.

Self-management

Factors that contribute to the success of chronic disease self-management programs for Aboriginal and Torres Strait Islander people include [74, 103]:

- culturally appropriate self-management support led by Aboriginal and Torres Strait Islander Health Workers
- a flexible manner that prioritises relationships
- a social view of health that sees individual health as embedded in socio-cultural contexts
- recognition of, and a value for, the cultural knowledge and connections of many participants
- empowerment and support for self-management and ownership of one's own health.

Examples of culturally appropriate self-management support programs include the Aunty Jean's Good Health Team program [104], the Wurli-Wurlinjang Diabetes Day program [105] and the Work It Out program [103].

Tertiary care

Aboriginal people with chronic disease use health services in a different manner to non-Aboriginal people [100]. Affordable and timely access to specialist services is required to treat and manage diabetes complications [10, 100]. However, studies show that Aboriginal people attend hospitals not only for specialist services for diabetes complications, but also for general diabetes care (primary and secondary care). High rates of hospital use may be related to poor access to primary care services and a lack of doctor-patient relationships for chronic disease care. Strategies that may reduce hospital admissions include:

- creation of chronic disease management teams
- outreach services by health professionals to local primary health services
- telehealth services [100].

Managing diabetes in pregnancy and after birth

The early detection and management of diabetes during pregnancy (including pre-existing type 1 and type 2 diabetes and GDM) is important to reduce complications in both mothers and babies [10].

GDM detection and management in pregnancy and after birth are important strategies for preventing or delaying the development of type 2 diabetes in the longer term [106]. However, barriers to screening that have been identified by Aboriginal and Torres Strait Islander patients include:

- lack of awareness and forgetting about the need for a test
- the inconvenience of doing the test (a two-hour test that requires the subject to fast before doing the test)
- the unpleasant nature of the test and the fear of results
- poor communication from health professionals
- being too busy to do the test
- psychological barriers (such as denial, fear, tiredness, shame, stress and worry)
- lack of motivation due to feelings that diabetes is inevitable, feelings that they (the women) lack control over choices, lack of belief in themselves and putting their own health last.
- The Northern Territory Diabetes in Pregnancy Partnership Project, which commenced in 2012, [107] [10, 108] has three key elements [107]:
    - a review of current models of care in the NT to improve health service delivery for women with diabetes in pregnancy
    - development of a NT clinical register of referred patients for use by health professionals
    - a detailed research project to assess rates and outcomes of diabetes in pregnancy in the NT (Pregnancy and Adverse Neonatal Outcomes in Remote Australia, PANDORA).

The PANDORA project aims to contribute to the development of policy and planning for the management of diabetes in pregnancy, and the follow-up of mother and baby, in urban, rural and remote regions throughout Australia [107, 108].

What programs and services are available for people with diabetes?

A range of mainstream and Indigenous-specific Australian Government Department of Health programs contribute to the prevention and management of diabetes and other chronic conditions among Aboriginal and Torres Strait Islander people at a national level [109, 110]. These programs include:

- **the Medicare Benefits Schedule (MBS)** - The Medicare health assessment for Aboriginal and Torres Strait Islander people (more commonly known as the health check) must be performed by a medical practitioner and includes risk assessments, diagnosis and intervention for common and treatable conditions such as diabetes [111]
- **the Practice Incentives Payment - Indigenous Health Incentive (PIP IHI)** - was reviewed and updated as part of the 2021-22 Federal Budget. It provides incentive payments for general practices that register for the IHI and agree to undertake certain activities to improve the provision of care to their Aboriginal and/or Torres Strait Islander patients with a chronic disease [112]
- **the Pharmaceutical Benefits Scheme (PBS)** - provides subsidies for medicines used in the treatment of diabetes (PBS medicine co-payments)
- **the National Diabetes Services Scheme (NDSS)** - provides subsidised diabetes products and services to persons with diagnosed diabetes who are registered with the scheme
- **healthy lifestyle promotion programs including those that tackle smoking**
- **GP, specialist** and allied **health outreach services** including the **Indigenous Australians' Health Programme** and **Medical Outreach Indigenous Chronic Disease Program**
- funding for **research into diabetes prevention among Aboriginal and Torres Strait Islander people** [7]
- the establishment of **Primary Health Networks** which **work directly with GPs, other primary care providers** (including **Aboriginal Community Controlled Health Organisations**), secondary care providers and hospitals to better coordinate care across the local health system [7]
- the **Insulin Pump Program** which provides fully subsidised insulin pumps to eligible, low income families who have children (up to 18 years of age) with type 1 diabetes and do not have access to other means of reimbursement, such as private health insurance [113]
- **funding for the Australian Institute of Health and Welfare (AIHW)** to support national surveillance and monitoring of vascular diseases including diabetes.

Back on Track is a recent collaboration between **Diabetes Australia and the NDSS.** During 2020, many Aboriginal and Torres Strait Islander people became less strict about their routine diabetes and health care management plans. The primary reasons for this were due to social distancing, fear of exposure to COVID-19, and a focus on other priorities. Back on Track encourages Aboriginal and Torres Strait Islander people to get 'back on track' with their diabetes self-care [114]. The campaign encourages patients to undergo routine, regular checkups with their doctor, health worker or nurse.

Primary health care services

To meet the needs of Aboriginal and Torres Strait Islander people, primary health care services need to provide both expert and culturally appropriate chronic disease care [115]. The involvement of Aboriginal and Torres Strait Islander Health Workers and Practitioners has been identified by health professionals and patients as an important factor in the delivery of good diabetes care to Aboriginal and Torres Strait Islander people [74, 98]. Aboriginal and Torres Strait Islander Health Workers have been shown to help patients feel comfortable, help break down communication and cultural barriers that may exist between patients and non-Indigenous health staff [74], and provide culturally appropriate self-management support [98].

Aboriginal and Torres Strait Islander community controlled primary health care services play a major role in delivering essential primary health care services to Aboriginal and Torres Strait Islander people in a culturally secure manner [116].

Box 5

Aboriginal and Torres Strait Islander community controlled primary health care services

Aboriginal and Torres Strait Islander community controlled primary health care services are located in all states and territories and funded by the federal, state and territory governments and other sources [117]. They are planned and governed by local Aboriginal and Torres Strait Islander communities and aim to deliver holistic and culturally appropriate health and health-related services. Aboriginal and Torres Strait Islander community controlled primary health care services vary in the primary health care activities they offer. Possible activities include: diagnosis and treatment of illness or disease, management of chronic illness, transportation to medical appointments, outreach clinic services, immunisations, dental services and dialysis services.

What policies and strategies relate to diabetes?

The Australian Government has recently released the Australian National Diabetes Strategy 2021-2030 [12]. The *Strategy* outlines public health issues including COVID-19, aged and disability care, mental health and Aboriginal and Torres Strait Islander health. Development of the *Strategy* has been guided by an Expert Advisory Group and a Jurisdictional Advisory Group, and endorsed by Australian Health Ministers.

The *Strategy* includes seven high-level goals with areas for action and measures of progress. The goals cover the important issues of prevention, awareness, early detection and management of diabetes, as well as highlighting specific vulnerable populations and the research agenda. Goal 5 is specific for reducing the impact of diabetes among Aboriginal and Torres Strait Islander peoples, however actions relating to all the goals will impact positively on this population (see Table 3).

Table 3. Components of the Australian national diabetes strategy 2021-2030

Vision
Strengthen, integrate and coordinate all sectors to improve health outcomes and reduce the social and economic impact of diabetes in Australia
Principles
1. Facilitation of person-centred care and self-management throughout life
2. Reduction in health inequities
3. Collaboration and cooperation to improve health outcomes
4. Coordination and integration of diabetes care across services, settings, technology and sectors
5. Measurement of health behaviours and outcomes
Goals
1. Prevent people developing type 2 diabetes
2. Promote awareness and earlier detection of type 1 and type 2 diabetes
3. Reduce the burden of diabetes and its complications and improve quality of life
4. Reduce the impact of pre-existing diabetes and GDM in pregnancy
5. Reduce the impact of diabetes among Aboriginal and Torres Strait Islander peoples
6. Reduce the impact of diabetes among other priority groups
7. Strengthen prevention and care through research, evidence and data

Figure 1: Selected national policy developments relevant to addressing diabetes among Aboriginal and Torres Strait Islander people

1987	• **National Diabetes Service Scheme (NDSS)** is established
1996	• Diabetes becomes a **National Health Priority Area (NHPA)** • **Ministerial Advisory Committee on Diabetes** is established
1998	• **National Diabetes Strategy and Implementation Plan** report is published
1999	• **National (insulin-treated) Diabetes Register (NDR)** is established
2000	• **National Diabetes Strategy 2000-2004** is signed
2002	• **Australian Health Ministers' Advisory Council (AHMAC)** agreed to the development of a national policy approach to chronic disease prevention and care
2006	• **National Service Improvement Framework For Diabetes** is released • **National Chronic Disease Strategy** is released • **Australian Better Health Initiative** is announced
2007	• Diabetes is included in the **National Reform Agenda** • A national package to prevent type 2 diabetes is announced
2008	• **Australian Type 2 Diabetes Risk Assessment Tool (AUSDRISK)** is introduced • New Medicare item introduced to develop a **Diabetes Risk Plan** for high risk individuals • **Close The Gap Statement Of Intent** is signed • **National Partnership Agreement On Closing The Gap In Indigenous Health Outcomes** is established • **Indigenous Chronic Disease Package** is announced
2010	• **Practice Incentives Program** – Indigenous Health Incentive receives funding
2011	• **NDSS introduces National Development Programs** that include initiatives for Aboriginal and Torres Strait Islander people
2013	• **Aboriginal And Torres Strait Islanders And Diabetes Action Plan** is released • **National Aboriginal and Torres Strait Islander Health Plan 2013-2023** is released • **Medical Outreach Indigenous Chronic Disease Program** is established
2014	• **Indigenous Australians' Health Programme** is established
2015	• **National Diabetes Strategy 2016-2020** is released
2017	• **Diabetes In Australia: Focus on the Future** is published
2019	• **National Agreement on Closing The Gap** is developed
2021	• **National Diabetes Strategy 2021-2030** is released

Where to next?

Aboriginal and Torres Strait Islander Health Workers and Practitioners are important members of primary health care teams in Aboriginal and Torres Strait Islander communities in Australia. Their knowledge of community and culture are valuable, and when trained in diabetes care and management, they are able to provide regular health checks and education about health risks and self-management. Increased support and training opportunities for Aboriginal and Torres Strait Islander Health Workers and Practitioners, and the workforce working with and within Aboriginal and Torres Strait Islander primary care settings is essential. However, the use of skilled and dedicated Aboriginal and Torres Strait Islander Health Workers and Practitioners cannot improve chronic disease outcomes without a supportive and efficient system to deliver the services.

The Australian National Diabetes Strategy 2021-2030 highlights key issues that require special attention including diabetes in aged care, prevention of type 2 diabetes and diabetes in vulnerable communities including Aboriginal and Torres Strait Islander communities. However, the gap between Aboriginal and Torres Strait Islander people and non-Indigenous people is not closing. Experts are calling for a National Type 2 Diabetes Prevention Program with collaboration from all levels of government [118].

Conclusion

The high levels of diabetes in many Aboriginal and Torres Strait Islander communities are the result of historical, social and cultural factors, as well as lifestyle and other health risk factors [10, 15, 16]. New evidence suggests that epigenetic factors, the environment within the womb, and other early life factors may also influence the development of diabetes [4, 19].

Type 2 diabetes is becoming more common in Aboriginal and Torres Strait Islander children and adolescents [4] who are at increased risk of developing associated diseases, diabetes complications and early death [55, 60, 61, 62].

The emergence of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus and the resulting COVID-19 pandemic [66] has highlighted the susceptibility of people with diabetes and other non-communicable chronic diseases [12]. The Australian Government advises that Aboriginal and Torres Strait Islander people may be at a greater risk of severe illness from COVID-19 [70] than the general population.

The Australian Government has recently released the Australian National Diabetes Strategy 2021-2030 [12]. It is hoped that the Strategy will provide a long-term commitment by all political parties to culturally appropriate prevention and management of diabetes across the lifespan for Aboriginal and Torres Strait Islander people.

References

1. Diabetes Australia. (2015). *About diabetes.* Retrieved 23 September 2015 from https://www.diabetesaustralia.com.au/about-diabetes
2. Zimmet, P. Z. (2017). Diabetes and its drivers: the largest epidemic in human history? *Clinical Diabetes and Endocrinology, 3*. Retrieved from: https://doi.org/10.1186/s40842-016-0039-3
3. International Diabetes Federation. (2019). *IDF diabetes atlas: Ninth edition* (9th ed.). Brussels, Belgium: International Diabetes Federation.
4. Zimmet, P. Z., Magliano, D. J., Herman, W. H., Shaw, J. E., & (2014). Diabetes: a 21st century challenge. *The Lancet Diabetes & Endocrinology, 2*(1), 56 - 64.
5. Australian Bureau of Statistics. (2019). *National Aboriginal and Torres Strait Islander Health Survey, 2018-19*. Canberra: Australian Bureau of Statistics.
6. Australian Institute of Health and Welfare. (2021). *Pregnancy and birth outcomes for Aboriginal and Torres Strait Islander women: 2016–2018*. Canberra: Australian Institute of Health and Welfare.
7. Australian Institute of Health and Welfare. (2020). *Indicators for the Australian National Diabetes Strategy 2016-2020: data update.* Retrieved 9 December 2020 from https://www.aihw.gov.au/reports/diabetes/diabetes-indicators-strategy-2016-2020/contents/summary
8. Haynes, A., Kalic, R., Cooper, M., Hewitt, J. K., & Davis, E. A. (2016). Increasing incidence of type 2 diabetes in Indigenous and non-Indigenous children in Western Australia, 1990-2012. *Medical Journal of Australia, 204*(8), 303.
9. Craig, M. E., Femia, G., Broyda, V., Lloyd, M., & Howards, N. J. (2007). Type 2 diabetes in Indigenous and non-Indigenous children and adolescents in New South Wales. *Medical Journal of Australia, 186*(10), 497-499.
10. Diabetes Australia. (2013). *Aboriginal and Torres Strait Islanders and diabetes action plan*. Canberra: Diabetes Australia.
11. Australian Institute of Health and Welfare. (2015). *Cardiovascular disease, diabetes and chronic kidney disease - Australian facts: Aboriginal and Torres Strait Islander people*. Canberra: Australian Institute of Health and Welfare.
12. Australian Government Department of Health. (2021). *Australian national diabetes strategy 2021-2030*. Canberra: Australian Government Department of Health.
13. Carson, B., Dunbar, T., Chenhall, R. D., & Bailie, R. (Eds.). (2007). *Social determinants of Indigenous health*. Crows Nest, NSW: Allen and Unwin.
14. Marmot, M. (2004). *The status syndrome: how social standing affects our health and longevity*. New York: Holt Paperbacks.
15. O'Dea, K., Rowley, K. G., & Brown, A. (2007). Diabetes in Indigenous Australians: possible ways forward. *Medical Journal of Australia, 186*(10), 494-495.
16. Closing the Gap Clearinghouse. (2012). *Healthy lifestyle programs for physical activity and nutrition* (Closing the Gap Clearinghouse resource sheet no. 9). Canberra: Closing the Gap Clearinghouse.
17. Nguyen, H. D., Chitturi, S., & Maple-Brown, L. J. (2016). Management of diabetes in Indigenous communities: lessons from the Australian Aboriginal population. *Internal Medicine Journal, 46*(11), 1252-1259.
18. Tremblay, M.-C., Graham, J., Porgo, T. V., Dogba, M. J., Paquette, J.-S., Careau, E., & Witteman, H. O. (2020). Improving cultural safety of diabetes care in Indigenous populations of Canada, Australia, New Zealand and the United States: a systematic rapid review. *Canadian Journal of Diabetes, 44*(7), 670-678.
19. McEwen, E. C., Boulton, T. J., & Smith, R. (2019). Can the gap in Aboriginal outcomes be explained by DOHaD. *Journal of Developmental Origins of Health and Disease, 10*(1), 5-16.
20. Australian Institute of Health and Welfare. (2015). *Cardiovascular disease, diabetes and chronic kidney disease - Australian facts: risk factors* (AIHW Catalogue no CDK 004, cardiovascular, diabetes and chronic kidney disease series no 4). Canberra: Australian Institute of Health and Welfare.
21. Australian Institute of Health and Welfare. (2014). *Incidence of insulin-treated diabetes in Australia 2000-2011* (AIHW Catalogue no CVD 66, diabetes series no 22). Canberra: Australian Institute of Health and Welfare.
22. Diabetes Australia. (2011). *What is diabetes?* Retrieved September 2011 from http://www.diabetesaustralia.com.au/Understanding-Diabetes/What-is-Diabetes/
23. Shaw, J., & Tanamas, S. (2012). *Diabetes: the silent pandemic and its impact on Australia*. Canberra: Diabetes Australia.
24. Riddle, M. C., Cefalu, W. T., Evans, P. H., Gerstein, H. C., Nauck, M. A., Oh, W. K., . . . Twenefour, D. (2021). Consensus report: definition and interpretation of remission in type 2 diabetes. *Diabetes Care, Early view*(https://doi.org/10.2337/dci21-0034).
25. Diabetes Australia. (2021). *Position statement: type 2 diabetes remission*. Canberra: Diabetes Australia.

26. Diabetes UK. (2021). *Remission in adults with type 2 diabetes: position statement*. London, United Kingdom: Diabetes UK.

27. Australian Bureau of Statistics. (2014). *Australian Aboriginal and Torres Strait Islander health survey: biomedical results, 2012-13* (ABS Catalogue no 4727.0.55.003). Canberra: Australian Bureau of Statistics.

28. Diabetes Australia. (2015). *About diabetes: complications of diabetes.* Retrieved 15 September 2015 from http://www.who.int/diabetes/action_online/basics/en/index3.html

29. Australian Institute of Health and Welfare. (2020). *Diabetes.* Retrieved 15 July 2020 from https://www.aihw.gov.au/reports/diabetes/diabetes/contents/what-is-diabetes

30. Horta, B. L., & de Lima, N. P. (2019). Breastfeeding and type 2 diabetes: systematic review and meta-analysis. *Current Diabetes Reports, 19*. Retrieved from: https://doi.org/10.1007/s11892-019-1121-x

31. Chamberlain, C. R., Oldenburg, B., Wilson, A. N., Eades, S., O'Dea, K., Oats, J., & Wolfe, R. (2016). Type 2 diabetes after gestational diabetes: greater than fourfold risk among Indigenous compared to non-Indigenous Australian women. *Diabetes/Metabolism Research and Reviews, 32*(2), 217-227.

32. Wilkinson, R., & Marmot, M. (2003). *Social determinants of health: the solid facts* (2nd ed). Denmark: World Health Organization.

33. Australian Bureau of Statistics. (2014). *Australian Aboriginal and Torres Strait Islander health survey: updated results, 2012–13* (ABS Catalogue no. 4727.0.55.006). Canberra: Australian Bureau of Statistics.

34. Australian Institute of Health and Welfare. (2014). *Cardiovascular disease, diabetes and chronic kidney disease: Australian facts: morbidity - hospital care* (AIHW Catalogue no CDK 003, cardiovascular, diabetes and chronic kidney disease series no 3). Canberra: Australian Institute of Health and Welfare.

35. Australian Bureau of Statistics. (2014). *Australian Aboriginal and Torres Strait Islander health survey: biomedical results, 2012-13 - Australia: table 5.3 [data cube].* Retrieved 10 September 2014 from http://www.abs.gov.au/AUSSTATS/subscriber.nsf/log?openagent&4727.0.55.003_5.xls&4727.0.55.003&Data%20Cubes&76FB2FC429853BA3CA257D4E001702E1&0&2012-13&10.09.2014&Latest

36. Australian Bureau of Statistics. (2014). *Australian Aboriginal and Torres Strait Islander health survey: biomedical results, 2012-13 - Australia: table 6.3 [data cube].* Retrieved 10 September 2014 from http://www.abs.gov.au/AUSSTATS/subscriber.nsf/log?openagent&4727.0.55.003_6.xls&4727.0.55.003&Data%20Cubes&F653985C855EA253CA257D4E00170316&0&2012-13&10.09.2014&Latest

37. Ling, C., & Rönn, T. (2019). Epigenetics in human obesity and Type 2 Diabetes. *Cell Metabolism, 29*(5), 1028-1044.

38. Diabetes Australia. (2016). Understanding pre-diabetes (pp. 2). Canberra: Diabetes Australia.

39. Australian Institute of Health and Welfare. (2010). *Diabetes in pregnancy: its impact on Australian women and their babies* (AIHW Catalogue no CVD 52, diabetes series no. 14). Canberra: Australian Institute of Health and Welfare.

40. World Health Organization. (2021). *Diabetes.* Retrieved 10 November 2021 from https://www.who.int/news-room/fact-sheets/detail/diabetes

41. Kao, K., & Sabin, M. A. (2016). Type 2 diabetes mellitus in children and adolescents. *Australian Family Physician, 45*(6), 401-406.

42. Whitbread, C., Kirkham, R., Cheng, E., Thorbjornsen, E., & Maple-Brown, L. (2017). Diabetes in pregnancy in the Northern Territory. *Australian Diabetes Educator, 20*(1), 25-29.

43. International Association of Diabetes and Pregnancy Study Groups Consensus Panel. (2010). International Association of Diabetes and Pregnancy Study Groups recommendations on the diagnosis and classification of hyperglycemia in pregnancy. *Diabetes Care, 33*(3), 676-682.

44. Wood, A. J., Boyle, J. A., Barr, E. L. M., Barzi, F., Hare, M. J. L., Titmuss, A., . . . Maple-Brown, L. J. (2021). Type 2 diabetes after a pregnancy with gestational diabetes among First Nations women in Australia: the PANDORA study. *Diabetes Research and Clinical Practice, 181*. Retrieved from:

45. Lee-Koo, C., Henry, E., & Mathur, S. (2014). *Cardiovascular disease, diabetes and chronic kidney disease: Australian facts: prevalence and incidence* (AIHW Catalogue no CDK 2, cardiovascular, diabetes and chronic kidney disease series no 2). Canberra: Australian Institute of Health and Welfare.

46. Steering Committee for the Review of Government Service Provision. (2014). *Overcoming Indigenous disadvantage: key indicators 2014*. Canberra: Productivity Commission.

47. Australian Institute of Health and Welfare. (2015). *Australian Burden of Disease Study: fatal burden of disease in Aboriginal and Torres Strait Islander people 2010* (Australian Burden of Disease Study series 2. Cat. no. BOD 02). Canberra: Australian Institute of Health and Welfare.

48. Australian Institute of Health and Welfare, & National Indigenous Australians Agency. (2020). *Aboriginal and Torres Strait Islander Health Performance Framework report.* Retrieved 9/12/2020 from https://www.indigenoushpf.gov.au/

49. Australian Institute of Health and Welfare. (2015). *The health and welfare of Australia's Aboriginal and Torres Strait Islander peoples 2015* (AIHW Catalogue no IHW 147). Canberra: Australian Institute of Health and Welfare.

50. Australian Institute of Health and Welfare. (2020). *Incidence of insulin-treated diabetes in Australia.* Retrieved 9 December 2020 from https://www.aihw.gov.au/reports/diabetes/incidence-of-insulin-treated-diabetes/contents/incidence-of-insulin-treated-diabetes-in-australia

51. Australian Institute of Health and Welfare. (2019). *Incidence of gestational diabetes in Australia [web report].* Retrieved 4 September 2019 from https://www.aihw.gov.au/reports/diabetes/incidence-of-gestational-diabetes-in-australia/data

52. Australian Institute of Health and Welfare. (2008). *Diabetes: Australian facts 2008* (Diabetes series no. 8. Cat. no. CVD 40). Canberra: Australian Institute of Health and Welfare.

53. Australian Bureau of Statistics. (2021). *Causes of death, Australia 2020.* from https://www.abs.gov.au/statistics/health/causes-death/causes-death-australia/2020

54. Australian Institute of Health and Welfare. (2021). *Australian Burden of Disease Study 2018: key findings for Aboriginal and Torres Strait Islander people* (Cat. no: BOD 28). Canberra: Australian Institute of Health and Welfare.

55. Titmuss, A., Davis, E. A., Brown, A., & Maple-Brown, L. J. (2019). Emerging diabetes and metabolic conditions among Aboriginal and Torres Strait Islander young people. *Medical Journal of Australia, 210*(3), 111-113.

56. Stone, M., Baker, A., & Maple Brown, L. (2013). Diabetes in young people in the Top End of the Northern Territory. *Journal of Paediatrics and Child Health, 49*(11), 976-979.

57. Tran, F., Stone, M., Huang, C. Y., Lloyd, M., Woodhead, H. J., Elliott, K. D., . . . Craig, M. E. (2014). Population-based incidence of diabetes in Australian youth aged 10-18 yr: increase in type 1 diabetes but not type 2 diabetes. *Pediatric Diabetes, 15*(8), 585-590.

58. Australian Institute of Health and Welfare. (2014). *Type 2 diabetes in Australia's children and young people: a working paper* (AIHW Catalogue no CVD 64, diabetes series no 21). Canberra: Australian Institute of Health and Welfare.

59. Titmuss, A., Davis, E. A., O'Donnell, V., Wenitong, M., Maple-Brown, L. J., & Haynes, A. (2022). Youth-onset type 2 diabetes among First Nations young people in northern Australia: a retrospective, cross-sectional study. *The Lancet, 10*(1), 11-13.

60. Maple-Brown, L. J., Sinha, A. K., & Davis, E. A. (2010). Type 2 diabetes in Indigenous Australian children and adolescents. *Journal of Paediatrics and Child Health, 46*(9), 487-490.

61. Peña, A. S., Curran, J. A., Fuery, M., George, C., Jefferies, C. A., Lobley, K., . . . Dahiya, R. (2020). Screening, assessment and management of type 2 diabetes mellitus in children and adolescents: Australasian Paediatric Endocrine Group guidelines. *The Medical Journal of Australia, 213*(1), 30-43.

62. Viner, R., White, B., & Christie, D. (2017). Type 2 diabetes in adolescents: a severe phenotype posing major clinical challenges and public health burden. *The Lancet, 389*(10085), 2252-2260.

63. Australian Institute of Health and Welfare. (2019). *Diabetes in Pregnancy 2014-2015*. Canberra: Australian Institute of Health and Welfare.

64. Duong, V., Davis, B., & Falhammar, H. (2015). Pregnancy and neonatal outcomes in Indigenous Australians with diabetes in pregnancy. *World Journal of Diabetes, 6*(6), 880-888.

65. Australian Institute of Health and Welfare. (2019). *Australia's mothers and babies: Data tables: National Perinatal Data Collection annual update 2019.* Retrieved 18 November 2021 from https://www.aihw.gov.au/reports/mothers-babies/australias-mothers-babies/data

66. Gujral, U. P., Johnson, L., Nielsen, J., Vellanki, P., Haw, J. S., Davis, G. M., . . . Pasquel, F. J. (2020). Preparedness cycle to address transitions in diabetes care during the COVID-19 pandemic and future outbreaks. *BMJ Open Diabetes Research & Care, 8*. Retrieved from: https://doi.org/10.1136/bmjdrc-2020-001520

67. COVID-19 National Incident Room Surveillance Team. (2020). COVID-19 Australia: epidemiology report 28 - fortnightly reporting period ending 25 October 2020. *Communicable Diseases Intelligence, 44*. Retrieved from: https://doi.org/10.33321/cdi.2020.44.84

68. Khunti, K., Del Prato, S., Mathieu, C., Kahn, S. E., Gabbay, R. A., & Buse, J. B. (2021). COVID-19, hyperglycemia, and new-onset diabetes. *Diabetes Care, 44*(12), 2645.

69. Communicable Disease Network Australia. (2020). *CDNA national guidance for urban and regional Aboriginal and Torres Strait Islander communities for COVID-19*. Canberra: Australian Government Department of Health.

70. Australian Government Department of Health. (2021). *Coronavirus (COVID-19) advice for Aboriginal and Torres Strait Islander peoples and remote communities.* Retrieved 23 December 2021 from https://www.health.gov.au/health-alerts/covid-19/advice-for-groups-at-risk/aboriginal-and-torres-strait-islander-people-and-remote-communities

71. Power, J. (2020). *When it came to COVID-19, Indigenous Australians sent it packing.* Retrieved 13 November 2020 from https://www.smh.com.au/national/when-it-came-to-covid-19-indigenous-australians-sent-it-packing-20201112-p56e5u.html

72. Australian Government Department of Health. (2020). *Australian health sector emergency response plan for Novel Coronavirus (COVID-19): Management plan for Aboriginal and Torres Strait Islander populations*. Canberra: Australian Government Department of Health.

73. Scott, E. S., Jenkins, A. J., & Fulcher, G. R. (2020). Challenges of diabetes management during the COVID-19 pandemic. *Medical Journal of Australia, 213*(2), 56-57.e51.

74. Stoneman, A., Atkinson, D., Davey, M., & Marley, J. V. (2014). Quality improvement in practice: improving diabetes care and patient outcomes in Aboriginal Community Controlled Health Services. *BMC Health Services Research, 14*. Retrieved from: https://doi.org/10.1186/1472-6963-14-481

75. Seear, K. H., Atkinson, D. N., Henderson-Yates, L. M., Lelievre, M. P., & Marley, J. V. (2020). Maboo wirriya, be healthy: community-directed development of an evidence-based diabetes prevention program for young Aboriginal people in a remote Australian town. *Evaluation and Program Planning, 81*. Retrieved from: https://doi.org/10.1016/j.evalprogplan.2020.101818

76. Frier, A., Devine, S., McBain-Rigg, K. E., Barnett, F., Cassady, Z. A., Dunning, T., & Reese, R. L. (2021). Indigenous Australian perspectives on incorporating the social determinants of health into the clinical management of type 2 diabetes. *Rural and Remote Health, 21*(2). Retrieved from:

77. Diabetes Australia. (2015). *Type 1 Diabetes.* Retrieved 2015 from http://www.diabetesaustralia.com.au/Living-with-Diabetes/Type-1-Diabetes/

78. Mayo Clinic. (2015). *Diseases and conditions: gestational diabetes.* Retrieved 2015 from https://www.mayoclinic.org/diseases-conditions/gestational-diabetes/symptoms-causes/syc-20355339

79. Australian Department of Health. (2015). *Australian National Diabetes Strategy 2016-2020*. Canberra: Australian Department of Health.

80. Colagiuri, R., Girgis, S., Gomez, M., Walker, K., Colagiuri, S., & O'Dea, K. (2009). *National evidence based guideline for the primary prevention of type 2 diabetes*. Canberra: National Health and Medical Research Council.

81. Royal Australian College of General Practitioners. (2014). *General practice management of type 2 diabetes: 2014-2015*. Melbourne: Royal Australian College of General Practitioners.

82. Department of Health (2020). *Australian type 2 diabetes risk assessment tool (AUSDRISK).* https://www.health.gov.au/resources/apps-and-tools/the-australian-type-2-diabetes-risk-assessment-tool-ausdrisk

83. National Aboriginal Community Controlled Health Organisation, & Royal Australian College of General Practitioners. (2018). *National guide to a preventive health assessment for Aboriginal and Torres Strait Islander people: 3rd edition*. East Melbourne: Royal Australian College of General Practitioners.

84. Marley, J. V., Oh, M. S., Hadgraft, N. T., Singleton, S. L., Isaacs, K., & Atkinson, D. N. (2015). Using glycated haemoglobin testing to simplify diabetes screening in remote Aboriginal Australian health care settings. *Medical Journal of Australia, 203*(1), 28-32.

85. Manifold, A., Atkinson, D., Marley, J. V., Scott, L., Cleland, G., Edgill, P., & Singleton, S. (2019). Complex diabetes screening guidelines for high-risk adolescent Aboriginal Australians: a barrier to implementation in primary health care. *Australian Journal of Primary Health, 25*(5), 501-508.

86. Adegbija, O., Hoy, W., & Wang, Z. (2015). Predicting absolute risk of type 2 diabetes using age and waist circumference values in an Aboriginal Australian community. *PLOS ONE, 10*(4), 1-10.

87. Institute for Urban Indigenous Health. (2021). *What is Deadly Choices?* Retrieved 2021 from https://deadlychoices.com.au/about/what-is-deadly-choices/

88. Malseed, C., Nelson, A., & Ware, R. (2014). Evaluation of a school-based health education program for urban Indigenous young people in Australia. *Scientific Research, 6*(7), 587 - 597.

89. Malseed, C., Nelson, A., & Ware, R. (2014). Evaluation of a school-based health education program for urban Indigenous young people in Australia. *Scientific Research, 6*(7), 587-597.

90. Seear, K. H., Atkinson, D. N., Lelievre, M. P., Henderson-Yates, L. M., & Marley, J. V. (2019). Piloting a culturally appropriate, localised diabetes prevention program for young Aboriginal people in a remote town. *Australian Journal of Primary Health, 25*(5), 495-500.

91. The Life! Program. (2021). Road to Good Health program case study (pp. 2). Melbourne: The Life! Program.

92. Life! (2015). *About the Life! program.* Retrieved 2015 from http://www.lifeprogram.org.au/about-the-life-program/about-the-program

93. Diabetes Victoria. (2021). *About the Life! program.* Retrieved 2021 from https://lifeprogram.org.au/learn-about-life/

94. Mendham, A. E., Duffield, R., Marino, F., & Coutts, A. J. (2015). A 12-week sports-based exercise programme for inactive Indigenous Australian men improved clinical risk factors associated with type 2 diabetes mellitus. *Journal of Science and Medicine in Sport, 18*(4), 438–443.

95. Canuto, K., Cargo, M., Li, M., D'Onise, K., Esterman, A., & McDermott, R. (2012). Pragmatic randomised trial of a 12-week exercise and nutrition program for Aboriginal and Torres Strait Islander women: clinical results immediate post and 3 months follow-up. *BMC Public Health, 12*. Retrieved from: https://doi.org/10.1186/1471-2458-12-933

96. Power, T., East, L., Gao, Y., Usher, K., & Jackson, D. (2021). A mixed- methods evaluation of an urban Aboriginal diabetes lifestyle program. *Australian and New Zealand Journal of Public Health, 45*(2), 143-149.

97. Pan, F., Owen, N., & Oddy, W. H. (2021). Sugar sweetened beverages and increasing prevalence of type 2 diabetes in the Indigenous community of Australia. *Nutrition, Metabolism and Cardiovascular Diseases, 31*(10), 2825-2830.

98. McDermott, R. A., Schmidt, B., Preece, C., Owens, V., Taylor, S., Li, M., & Esterman, A. (2015). Community health workers improve diabetes care in remote Australian Indigenous communities: results of a pragmatic cluster randomized controlled trial. *BMC Health Services Research, 15*. Retrieved from: https://doi.org/10.1186/s12913-015-0695-5

99. Li, S. Q., Guthridge, S., Lawton, P., & Burgess, P. (2019). Does delay in planned diabetes care influence outcomes for aboriginal Australians? A study of quality in health care. *BMC Health Services Research, 19*. Retrieved from: https://doi.org/10.1186/s12913-019-4404-7

100. Whyatt, D., Yap, M., Tenneti, R., Pearson, G., & Vickery, A. (2017). Hospital use in Aboriginal and non-Aboriginal patients with chronic disease. *Emergency Medicine Australasia, 29*(5), 516-523.

101. Thomas, S. L., Zhao, Y., Guthridge, S. L., & Wakeman, J. (2014). The cost-effectiveness of primary care for Indigenous Australians with diabetes living in remote Northern Territory communities. *Medical Journal of Australia, 200*(11), 658-662.

102. Hamrosi, K., Taylor, S. J., & Aslani, P. (2006). Issues with prescribed medications in Aboriginal communities: Aboriginal Health Workers' perspectives. *Rural and Remote Health, 6*. Retrieved from: http://www.rrh.org.au/publishedarticles/article_print_557.pdf

103. Parmenter, J., Basit, T., Nelson, A., Crawford, E., & Kitter, B. (2020). Chronic disease self- management programs for Aboriginal and Torres Strait Islanders: factors influencing participation in an urban setting. *Health Promotion Journal of Australia, 31*(1), 104-111.

104. Illawarra Health. (2004). *Aunty Jean's Good Health Team: listening to the voices of the Elders to create an Aboriginal chronic and complex care program*. Unanderra, NSW: Illawarra Health.

105. Entwistle, P., Entwistle, D., & Stothers, K. (2011). *Wurli-Wurlinjang Diabetes Day Program: evaluation report*. Katherine, NT: Centre for Remote Health, Flinders University and Charles Darwin University.

106. Campbell, S., Roux, N., Preece, C., Rafter, E., Davis, B., Mein, J., . . . Chamberlain, C. (2017). Paths to improving care of Australian Aboriginal and Torres Strait Islander women following gestational diabetes. *Primary Health Care Research & Development, 18*(6), 549-562.

107. Menzies School of Health Research. (2015). *NT Diabetes in Pregnancy Partnership Project.* Retrieved 2015 from http://www.menzies.edu.au/page/Research/Projects/Diabetes/The_Northern_Territory_Diabetes_in_Pregnancy_Partnership_Project/

108. Maple-Brown, L. J., Brown, A., Lee, I. L., Connors, C., Oats, J., McIntyre, H. D., . . . O'Dea, K. (2013). Pregnancy and neonatal diabetes outcomes in remote Australia (PANDORA) study. *BMC Pregnancy and Childbirth, 13*. Retrieved from: https://doi.org/10.1186/1471-2393-13-221

109. Department of Health. (2015). *Chronic disease health programmes.* Retrieved 3 February 2015 from http://www.health.gov.au/internet/main/publishing.nsf/Content/irhd-chronic-disease

110. Department of Health. (2015). *Diabetes.* Retrieved 11 February 2015 from http://www.health.gov.au/internet/main/publishing.nsf/content/chronic-diabetes

111. Australian Government Department of Health. (2021). *Annual health assessment for Aboriginal and Torres Strait Islander people.* Retrieved 24 June 2021 from https://www1.health.gov.au/internet/main/publishing.nsf/Content/mbsprimarycare_ATSI_MBSitem715

112. Services Australia. (2021). *Indigenous Health Incentive guidelines.* Retrieved 10 December 20201 from https://www.servicesaustralia.gov.au/indigenous-health-incentive-for-practice-incentives-program?context=23046

113. Diabetes Australia. (2021). *Insulin pumps.* Retrieved 2021 from https://www.diabetesaustralia.com.au/living-with-diabetes/managing-your-diabetes/diabetes-technology/insulin-pumps/

114. Diabetes Australia. (2021). *Aboriginal and Torres Strait Islander people.* Retrieved 28 October 2021 from https://www.diabetesaustralia.com.au/living-with-diabetes/aboriginal-and-torres-strait-islanders/

115. Liaw, S. T., Lau, P., Pyett, P., Furler, J., Burchill, M., Rowley, K., & Kelaher, M. (2011). Successful chronic disease care for Aboriginal Australians requires cultural competence. *Australian and New Zealand Journal of Public Health, 35*(3), 238-248.

116. Australian Institute of Health and Welfare. (2013). *Healthy for Life: Aboriginal Community Controlled Health Services: report card* (AIHW Catalogue no IHW 97). Canberra: Australian Institute of Health and Welfare.

117. Steering Committee for the Review of Government Service Provision. (2014). *Report on government services 2014: Indigenous compendium*. Canberra: Productivity Commission.

118. Diabetes Australia. (2021). *Australian diabetes sector welcomes the release of new National Diabetes Strategy.* Retrieved 14 November 2021 from https://www.diabetesaustralia.com.au/mediarelease/australian-diabetes-sector-welcomes-the-release-of-new-national-diabetes-strategy/

Core funding
is provided by the
Australian Government
Department of Health

AUSTRALIA
ECU
EDITH COWAN
UNIVERSITY