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Type 2 diabetes in youth

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TYPE 2 DIABETES IN YOUTH
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MedicineToday
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FOREWORD FROM THE SUPPLEMENT EDITOR

Type 2 diabetes in children and adolescents is no longer a rare condition. Once considered almost exclusively an adult disease, it has become one of the most significant chronic health challenges affecting young people worldwide. In Australia, its incidence continues to rise, driven by increasing rates of obesity and compounded by social and environmental factors that contribute to health inequities. Aboriginal and Torres Strait Islander children and adolescents are disproportionately affected, highlighting the need for culturally safe and equitable models of care.

Youth-onset type 2 diabetes is characterised by more rapid progression, earlier complications and greater long-term morbidity than adult-onset disease. Early diagnosis, timely intervention and co-ordinated multidisciplinary care are therefore essential, with GPs playing a pivotal role in recognising at-risk young people and supporting their ongoing management.

This supplement provides a practical overview of contemporary care for youth-onset type 2 diabetes. It includes an overview of the epidemiology, diagnosis and management of the condition, alongside articles exploring the disproportionate burden of disease among Aboriginal and Torres Strait Islander young people, advances in pharmacotherapy, the expanding role of diabetes technologies and digital health, and the management of obesity as a key driver of youth-onset type 2 diabetes.

Together, these articles provide practical, evidence-based guidance to support GPs and other clinicians caring for young people with type 2 diabetes. As our understanding of this rapidly evolving condition continues to grow, so too does our ability to intervene earlier, individualise treatment and improve long-term outcomes.

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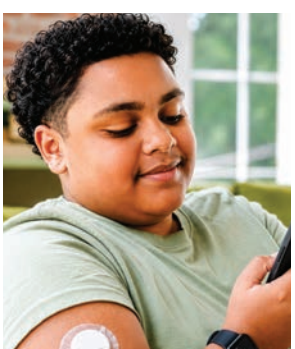

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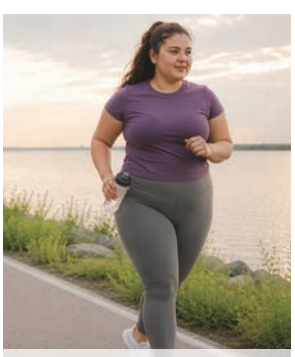

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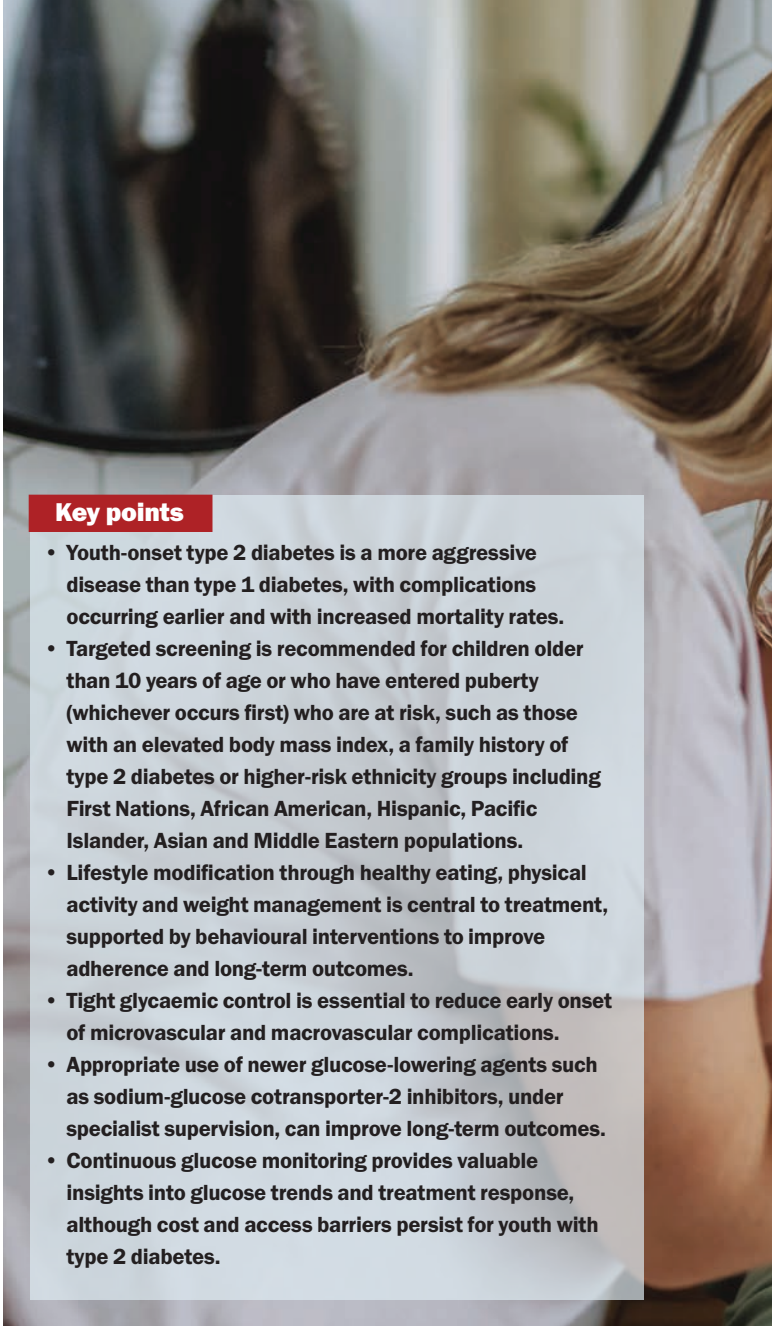
Type 2 diabetes in youth
A growing concern

UMA GANTI MB BS, DCH, FRACP

Type 2 diabetes in children and adolescents is an increasingly prevalent and aggressive condition with early onset of complications. Early recognition and comprehensive, multidisciplinary management are key to improving long-term outcomes. Ongoing research and equitable access to new therapies are essential to curb its growing impact.

Type 2 diabetes is increasingly recognised as a significant public health concern among children and adolescents. Once predominantly observed in adults, the incidence of type 2 diabetes in younger populations has surged in recent decades, paralleling the global rise in obesity rates. This article explores the epidemiology, risk factors, diagnosis, disease burden, treatment options, long-term complications and prevention strategies associated with type 2 diabetes in children and adolescents, with particular attention to the challenges faced by Aboriginal and Torres Strait Islander Australians.



Key points

- **Youth-onset type 2 diabetes is a more aggressive disease than type 1 diabetes, with complications occurring earlier and with increased mortality rates.**
- **Targeted screening is recommended for children older than 10 years of age or who have entered puberty (whichever occurs first) who are at risk, such as those with an elevated body mass index, a family history of type 2 diabetes or higher-risk ethnicity groups including First Nations, African American, Hispanic, Pacific Islander, Asian and Middle Eastern populations.**
- **Lifestyle modification through healthy eating, physical activity and weight management is central to treatment, supported by behavioural interventions to improve adherence and long-term outcomes.**
- **Tight glycaemic control is essential to reduce early onset of microvascular and macrovascular complications.**
- **Appropriate use of newer glucose-lowering agents such as sodium-glucose cotransporter-2 inhibitors, under specialist supervision, can improve long-term outcomes.**
- **Continuous glucose monitoring provides valuable insights into glucose trends and treatment response, although cost and access barriers persist for youth with type 2 diabetes.**

Epidemiology and incidence

The prevalence of type 2 diabetes among children and adolescents has escalated alarmingly. Recent estimates suggest that about 41,600 young people (younger than 20 years of age) were newly diagnosed with type 2 diabetes globally, although the incidence varies by region.[1] Certain groups, such as Aboriginal and Torres Strait Islander, African American, Hispanic, Pacific Islander, Asian and Middle Eastern populations, are considered high-risk ethnicities.[2] Studies show that the incidence of type 2 diabetes in children is closely linked to rising obesity rates, with the condition being diagnosed more frequently in youth with overweight and obesity.[3]

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Pathophysiology

The underlying mechanisms leading to youth-onset type 2 diabetes are not completely understood and are continually evolving. It is a condition of insulin resistance in the liver, adipose and peripheral tissues, leading to pancreatic beta cell dysfunction and eventual failure. The pathophysiology of type 2 diabetes in youth is heterogenous, with insulin deficiency a key driver and insulin resistance with obesity a prominent feature among young people.[2]

Pancreatic or diabetes autoantibodies – glutamic acid decarboxylase, islet antigen 2, zinc transporter 8 and insulin antibody – are the four antibodies tested for the diagnosis of type 1 diabetes. They are also recommended in the diagnostic evaluation of youth-onset type 2 diabetes, to screen for the presence of type 1 diabetes.[4] A small

proportion of young people with type 2 diabetes also show autoimmune antibodies, with an early requirement for insulin noted.[4]

The Restoring Insulin SEcretion (RISE) study has been instrumental in improving our understanding of these mechanisms, and how they differ between youth and adults with prediabetes and recently diagnosed type 2 diabetes.[5] Pubertal insulin resistance is also thought to be contributory factor in the development of the condition, and this could explain why type 2 diabetes is uncommon before puberty, as well as why onset tends to occur earlier in girls, who typically enter puberty at a younger age.[2]

Risk factors

The risk factors for developing type 2 diabetes in children and adolescents are multifaceted and include genetic, environmental and behavioural components.

- **Obesity:** the most significant risk factor, particularly central obesity, which is characterised by excess abdominal fat. Obesity worsens insulin resistance and accelerates beta cell failure. The prevalence of obesity among children has increased dramatically, with about 18.5% of children in the USA aged 2 to 19 years classified as obese.[6]
- **In utero environment:** in utero exposure to hyperglycaemia, maternal obesity and nutritional imbalance are significant risk factors for obesity and diabetes among offspring, contributing to the intergenerational cycle of type 2 diabetes seen in high-risk groups. Studies among the Pima people have demonstrated the impact of hyperglycaemia in pregnancy.[7]
- **Family history:** a family history of diabetes increases the risk of developing type 2 diabetes. Genetic predisposition plays a crucial role in the aetiology of the disease.[8]
- **Physical inactivity:** sedentary lifestyles, driven by increased screen time and reduced physical activity, contribute to obesity and insulin resistance.
- **Dietary patterns:** particular dietary habits, including high consumption of sugar-sweetened beverages and low intake of fruits and vegetables, are associated with an elevated risk of type 2 diabetes.

1. Diagnosing type 2 diabetes in children and adolescents[9]*

Features

- Overweight or obesity (BMI >85th percentile)
- Signs of insulin resistance (e.g. acanthosis nigricans)
- Associated metabolic comorbidities (e.g. dyslipidaemia, metabolic dysfunction-associated steatotic liver disease, hypertension, polycystic ovary syndrome)
- Family history of type 2 diabetes
- Negative pancreatic antibodies (e.g. glutamic acid decarboxylase antibodies, islet antigen 2 antibodies)

Criteria

- Classic symptoms of diabetes or hyperglycaemic crisis and random plasma glucose ≥11.1 mmol/L, or
- Fasting plasma glucose ≥7.0 mmol/L,† or
- 2-hour plasma glucose ≥11.1 mmol during an OGTT,† or
- HbA_{1c} level ≥48 mmol/mol (≥6.5%)

Other investigations

- Consider screening for type 1 diabetes with autoantibody testing (e.g. glutamic acid decarboxylase antibodies, islet antigen 2 antibodies) in all paediatric patients with the clinical phenotype of type 2 diabetes, given the higher prevalence of the former condition. If these are negative but type 1 diabetes is still suspected, consider testing for insulin antibodies and ZnT8 antibodies
- Measurement of insulin and C-peptide levels is not recommended, as glucotoxicity and lipotoxicity can acutely affect insulin secretion

Abbreviations: BMI = body mass index; HbA_{1c} = glycated haemoglobin; OGTT = oral glucose tolerance test.

* For further information, refer to the *International Society for Pediatric and Adolescent Diabetes Clinical Practice Consensus Guidelines 2024: Type 2 Diabetes in Children and Adolescents*.

† Type 2 diabetes is often detected incidentally during the evaluation of obesity and may not always present with symptoms of polyuria or polydipsia. Repeat testing can be requested if indicated, in the absence of classic symptoms of diabetes.

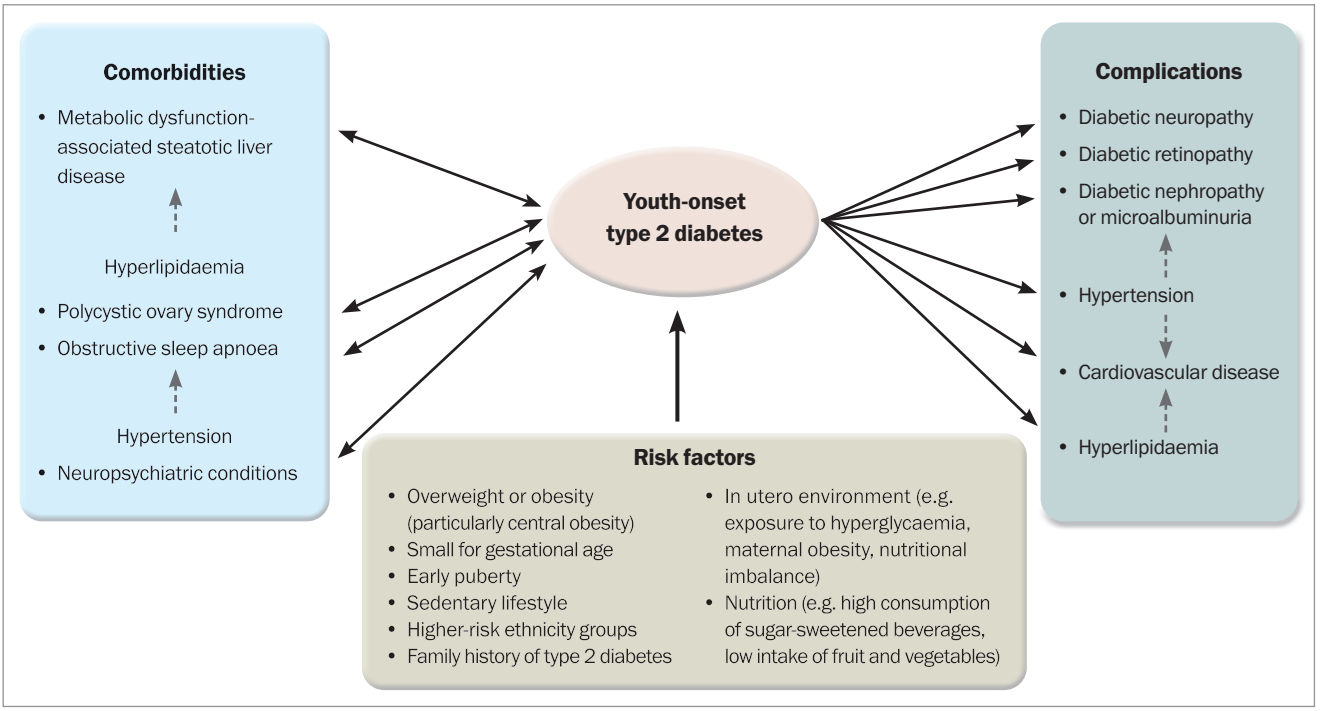


Figure. Comorbidities, risk factors and complications of youth-onset type 2 diabetes.
Adapted from: Savic Hitt TA, Katz LEL. Pediatric type 2 diabetes: not a mini version of adult type 2 diabetes. Endocrinol Metab Clin North Am 2020; 49: 679-693.

- **Ethnicity:** certain ethnic groups, including African American, Hispanic, Asian and Middle Eastern, are at a higher risk for type 2 diabetes. In Australasia, a high proportion of affected youth are of Aboriginal and Torres Strait Islander, Māori or Pacific Islander descent.

There is a complex interplay between the comorbidities, risk factors and complications seen in type 2 diabetes (Figure).

Diagnosis

Insulin resistance, characterised by the body's inability to effectively utilise insulin, is a hallmark of type 2 diabetes. In children and adolescents, the diagnosis of type 2 diabetes is based primarily on the presence of hyperglycaemia, which can be evaluated through various methods (Box 1).[9] Early diagnosis is crucial to prevent the onset of long-term complications.

Features supporting the diagnosis of type 2 diabetes include:

- overweight or obesity, defined as body mass index at the 85th percentile or above
- signs of insulin resistance (e.g. acanthosis nigricans)
- associated metabolic comorbidities (e.g. dyslipidaemia, metabolic dysfunction-associated steatotic liver disease, hypertension, polycystic ovary syndrome)
- family history of type 2 diabetes
- negative pancreatic antibodies (e.g. glutamic acid decarboxylase antibodies, islet antigen 2 antibodies).

Targeted screening for type 2 diabetes in children over 10 years of age or who have entered puberty (whichever occurs first), with an oral glucose tolerance test or measurement of glycated haemoglobin (HbA_{1c}) levels, is recommended in certain groups every two to three years, or earlier if there is excessive weight gain (Box 2).[9] The differential diagnoses for paediatric type 2 diabetes includes type 1 diabetes and monogenic forms such as maturity-onset diabetes of the young (Box 3).[9]

Disease burden and long-term complications

The burden of type 2 diabetes in children and adolescents is substantial, affecting individuals, their families and healthcare systems.[3] Major studies over the past two decades – including the SEARCH for Diabetes in Youth (SEARCH) study, the Treatment Options for Type 2 Diabetes in Adolescents and Youth (TODAY) study and the RISE study – have been pivotal in understanding youth-onset type 2 diabetes.

The 20-year SEARCH surveillance study described the epidemiology of type 2 diabetes and identified risk factors for complications, finding that the risk is substantially higher than in type 1 diabetes.[10]

The TODAY study, conducted in the USA, was the first multiethnic, multicentre randomised trial comparing three treatment approaches in youth with obesity and new-onset type 2 diabetes (n = 699; ages 10 to 17 years): metformin monotherapy, metformin plus rosiglitazone and metformin plus intensive lifestyle intervention. The primary outcome was glycaemic control, although diabetes-related complications and cardiovascular risk factors were also assessed.[11] Overall, 50% of participants of the TODAY study were unable to maintain glycaemic control with metformin alone. Combination therapy with metformin plus rosiglitazone resulted in longer duration of glycaemic control,

2. Screening recommendations for youth-onset type 2 diabetes[9]

For non-Aboriginal and Torres Strait Islander populations

Children over 10 years of age or who have entered puberty (whichever occurs first) should be screened for type 2 diabetes if they are overweight or obese (BMI ≥85th or 95th percentile, respectively), and have at least one of the following:

- maternal history of diabetes or gestational diabetes mellitus
- type 2 diabetes in a first-degree relative
- South Asian, South East Asian, Middle Eastern, North African or Latino heritage
- signs of insulin resistance (e.g. acanthosis nigricans)
- conditions associated with obesity or metabolic syndrome (e.g. dyslipidaemia, metabolic dysfunction-associated steatotic liver disease, hypertension, polycystic ovary syndrome)
- use of antipsychotic medication

For Aboriginal and Torres Strait Islander populations

Children over 10 years of age or who have entered puberty (whichever occurs first) should be screened for type 2 diabetes with point-of-care HbA_{1c} if they have at least one of the following:

- overweight or obese (BMI ≥85th or 95th percentile, respectively) and/or waist circumference to height ratio >0.5
- maternal history of diabetes or gestational diabetes mellitus
- type 2 diabetes in a first-degree relative
- signs of insulin resistance (e.g. acanthosis nigricans)
- conditions associated with obesity or metabolic syndrome (e.g. dyslipidaemia, metabolic dysfunction-associated steatotic liver disease, hypertension, polycystic ovary syndrome)
- use of antipsychotic medication

Abbreviations: BMI = body mass index; HbA_{1c} = glycated haemoglobin.

whereas metformin plus intensive lifestyle intervention produced intermediate results but was not superior to metformin alone.[11] After 3.9 years, 33.8% of participants had hypertension, 16.6% had microalbuminuria and 55.9% of the participants showed normal lipid profiles.[11] Retinopathy was observed in 13.7% of participants.[11] This landmark trial highlighted the aggressive nature of youth-onset type 2 diabetes. Follow-up data from the TODAY study showed that at about 15 years postdiagnosis, 60% of participants had developed at least one microvascular complication, with retinopathy affecting about half and peripheral neuropathy a third of the cohort.[12]

Diabetic kidney disease, defined by albuminuria (>30 mcg/mg) or an estimated glomerular filtration rate less than 60 mL/min/1.73 m^2, was far more common in youth-onset type 2 diabetes than in type 1 diabetes.[13,14] In a separate retrospective cohort study, youth-onset type 2 diabetes was found to be associated with a 23-fold higher risk of renal failure and a 39-fold higher risk of requiring dialysis compared with youth without diabetes.[13]

The RISE consortium studies compared the pathophysiology and treatment outcomes of youth-onset and adult-onset type 2 diabetes. These studies showed that youth with type 2 diabetes exhibited significantly greater insulin resistance than those with adult-onset type 2 diabetes.[5]

3. Differential diagnoses of youth-onset type 2 diabetes[9]

Type 1 diabetes

- Most common cause of diabetes in white children from Australia or New Zealand
- Features include:
  - obesity rates similar to the general population
  - acanthosis nigricans, with or without other characteristics of metabolic syndrome
  - ketosis or diabetic ketoacidosis at diagnosis in ≥25% of cases
  - positive type 1 diabetes autoantibodies in >90%; however, between 10 and 20% of children with a phenotypic type 2 diabetes presentation may have one positive autoantibody
  - family history of type 1 diabetes in up to 4%, and more than 15% of children diagnosed with type 1 diabetes have a positive family history of type 2 diabetes
- Autoantibodies:
  - GAD and IA2 antibodies are the most easily measurable
  - insulin antibodies and znT8 antibodies can also be measured

MODY

- About 8% of children with a type 2 diabetes phenotype have monogenic diabetes
- Autosomal dominant inheritance
- Features include:
  - obesity rates similar to the general population
  - absence of acanthosis nigricans, with or without other characteristics of metabolic syndrome
  - ketosis in neonatal diabetes (rare in other forms)
  - negative diabetes autoantibodies
  - family history of diabetes in 90% of individuals
  - mild fasting hyperglycaemia occurs in some forms (e.g. MODY 2)
- Paired C-peptide and glucose testing two to five years after diagnosis may be useful to distinguish MODY from type 1 diabetes and type 2 diabetes

Other considerations

- Uncommon differential causes of type 2 diabetes include diseases of the exocrine pancreas (e.g. cystic fibrosis, haemochromatosis, pancreatitis), endocrinopathies and drug-induced diabetes
- Genetic testing is indicated for all children diagnosed under 6 months of age, or those diagnosed between 6 and 12 months of age with negative autoantibodies, to assess for neonatal diabetes

Abbreviations: GAD = glutamic acid decarboxylase; IA2 = islet tyrosine phosphatase 2; MODY = maturity-onset diabetes of the young; ZnT8 = zinc transporter 8.

Screening for complications in youth-onset type 2 diabetes should follow a structured approach, including evaluation, treatment and monitoring of common comorbidities (Table 1).[9] Overall, the key long-term complications of type 2 diabetes include:

- cardiovascular disease – youth with type 2 diabetes are at increased risk of developing cardiovascular disease at an earlier age
- nephropathy – diabetic kidney disease can develop, leading to chronic kidney disease and potential end-stage renal failure
- retinopathy – diabetic retinopathy may progress to vision impairment or blindness

Table 1. Complications in youth-onset type 2 diabetes: evaluation and treatment[9]

Complication/ comorbidity	Evaluation at diagnosis and annually	Recommended treatment	Treatment goals	Comments
Retinopathy	• Comprehensive eye examination with dilated pupils or retinal photography by an optometrist or ophthalmologist • Often asymptomatic in early stages	• Management guided by ophthalmologist based on retinal findings	• Prevent progression of proliferative retinopathy • Preserve vision	• Optimise blood glucose levels and weight, as well as management of dyslipidaemia or hypertension, if present
Nephropathy or microalbuminuria	• Collect three early-morning urine samples for uACR ratio (random samples if early morning not feasible) • Consider factors affecting accuracy (e.g. contamination, menstruation, recent exercise, orthostatic proteinuria, infection) • Assess renal function using eGFR • Often asymptomatic in early stages	• Initiate ACE inhibitors if two samples show uACR >30 mg/g (microalbuminuria) • Refer to nephrologist if albuminuria >300 mg/g (macroalbuminuria) or hypertension present	• Maintain normal kidney function, uACR and blood pressure	• Optimise blood glucose levels and weight, as well as management of dyslipidaemia or hypertension, if present
Peripheral neuropathy	• Foot examination including ankle reflexes, vibration sensation (with a 128 Hz tuning fork), pinprick sensation and 10 g monofilament pressure (on distal plantar areas)	• Provide foot care education • Refer to neurologist for abnormal findings	• Tailor management to individual symptoms and findings	• Optimise blood glucose levels and weight, as well as management of dyslipidaemia or hypertension, if present
Overweight and obesity	• Assess family history of excess weight and other modifiable risk factors • Plot BMI by age and sex (overweight: ≥85th to <95th percentile; obesity ≥95th percentile) • Identify obesity-related comorbidities	• Encourage a healthy lifestyle and family involvement • Advise metformin adherence, if prescribed • Adjust insulin to avoid weight gain • Manage obesity-related comorbidities	• Achieve BMI closer to healthy range	• Even modest reductions in BMI can improve comorbidities, and are easier for the patient to achieve

Abbreviations: ALT = alanine aminotransferase; AST = aspartate aminotransferase; BMI = body mass index; BP = blood pressure; eGFR = estimated glomerular filtration rate; GLP-1 = glucagon-like peptide 1; SGLT-2 = sodium-glucose cotransporter-2; uACR: urinary albumin-to-creatinine ratio.

- neuropathy – peripheral neuropathy can lead to complications such as foot ulcers and infections
- psychosocial issues – the diagnosis of type 2 diabetes can lead to psychosocial challenges, including depression and anxiety, which can further complicate management.

Management strategies

Management of type 2 diabetes in children and adolescents typically involves a multifaceted approach, including lifestyle modification, pharmacotherapy and ongoing monitoring. However, the most effective and enduring intervention strategies remain unclear. The Flowchart illustrates an approach to managing newly diagnosed youth-onset type 2 diabetes in individuals with overweight or obesity.

Lifestyle modification

The cornerstone of treatment involves promoting a healthy diet, increasing physical activity and encouraging weight loss. Behavioural interventions, such as counselling and support groups, can enhance adherence to lifestyle changes and improve long-term outcomes.

Pharmacotherapy

Pharmacological agents used in adults with type 2 diabetes, including sulfonylureas, thiazolidinediones and dipeptidyl peptidase-4 inhibitors, have been investigated in youth-onset type 2 diabetes but with limited success because of side effects such as hypoglycaemia and weight gain. Some drugs, such as thiazolidinediones, have not been approved in Australia for use in youth because of safety concerns identified in adults.

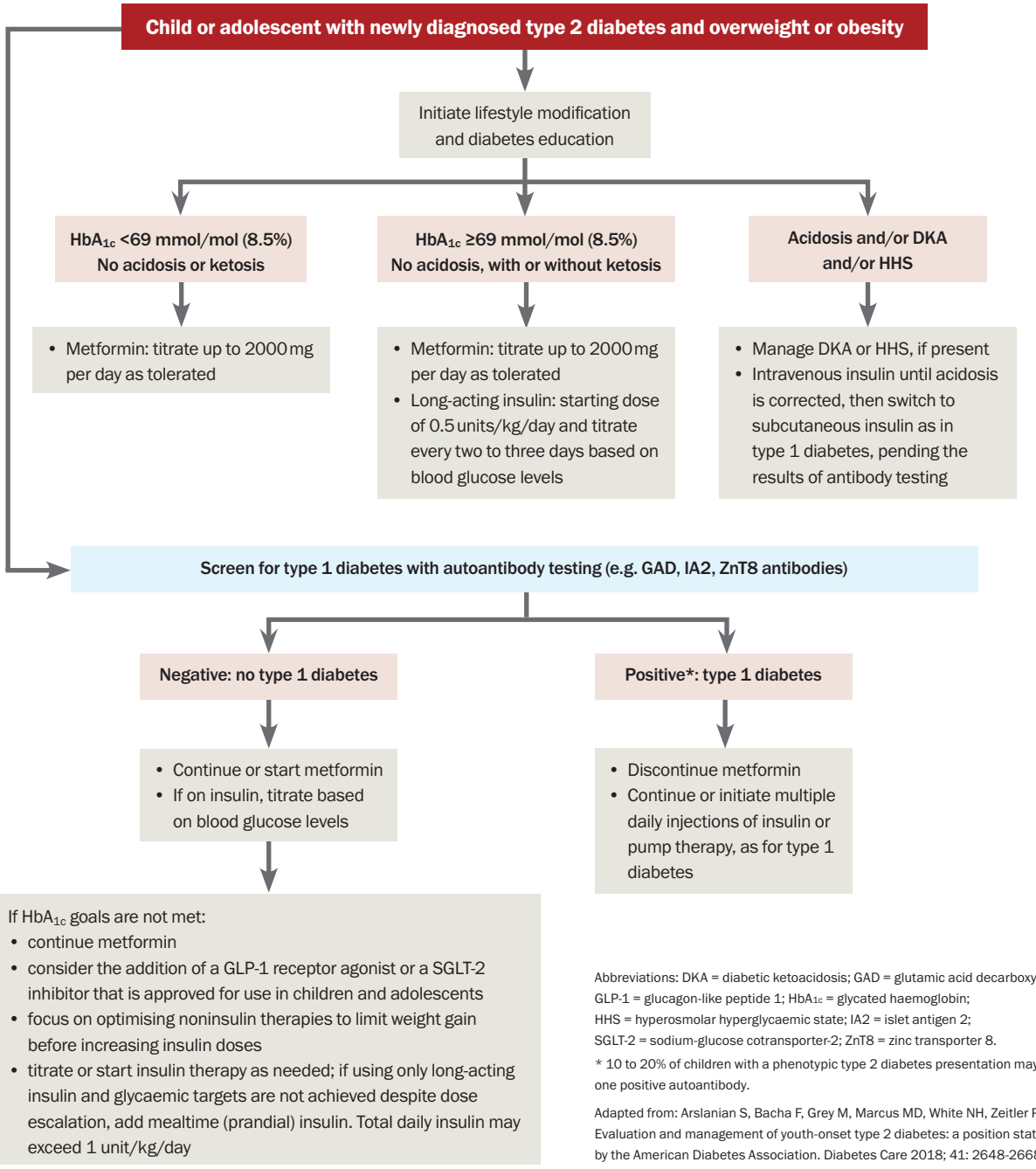
If lifestyle modifications are insufficient, pharmacological therapy may be required.

Table 1. Complications in youth-onset type 2 diabetes: evaluation and treatment[9] *continued*

Complication/ comorbidity	Evaluation at diagnosis and annually	Recommended treatment	Treatment goals	Comments
Reproductive health or menstrual cycle irregularities (e.g. polycystic ovary syndrome)	• Monitor menstrual cycle regularity • Assess for hyperandrogenism: hirsutism, moderate-to-severe acne, androgenic alopecia • Measure testosterone levels, free androgen index and sex hormone binding globulin if irregular menstrual cycles present	• Treat according to symptoms and recent guidelines for polycystic ovary syndrome • Prescribe combined oral contraceptive if irregular menstrual cycles and/or hirsutism • Utilise cosmetic therapies for treating hirsutism	• Individualised according to predominant symptom	• Discuss contraception, especially if sexually active and glycated haemoglobin is above target, because of the risk of hyperglycaemia in unplanned pregnancies • Contraception is also required if taking teratogenic medications (ACE inhibitors, statins, SGLT-2 inhibitors and GLP-1 receptor agonists) • Weight management support
Obstructive sleep apnoea	• Evaluate for snoring, morning sleepiness or witnessed apnoeic episodes • Consider weight status	• Refer to a pulmonary physician for oximetry or sleep study	• Individualised according to sleep study results	• Weight management is important • Sleep apnoea often coexists with dyslipidaemia, hypertension and insulin resistance
Hypertension	• Measure BP using appropriate cuff • Plot result in percentiles charts for age, gender and height • pre-hypertension: BP ≥90th percentile or 120/80 mmHg • hypertension: BP ≥95th percentile or 130/80 mmHg • 24-hour ambulatory BP monitoring, if available	• Lifestyle modification with family involvement • ACE inhibitor if BP remains >95th percentile or 130/80 mmHg after five months of lifestyle modification	• Maintain BP <90th percentile for age and sex	• Address weight management • Refer to nephrologist if secondary causes suspected or targets not achieved
Metabolic dysfunction-associated steatotic liver disease	• Assess ALT and AST levels at diagnosis, and annually • Evaluate for coexisting metabolic syndrome and family history of liver disease	• Optimise glycaemic control, lipid profile and weight management • Encourage lifestyle modification • Refer to a paediatric gastroenterologist if liver enzymes remain above three times upper limit of normal after six months	• Normalise liver enzymes • Prevent progression to steatohepatitis and fibrosis	• Consider hepatic ultrasound if persistent elevation of liver enzymes • Optimise management of comorbidities (e.g. dyslipidaemia, hypertension)
Mental health or impact of chronic disease on quality of life	• Assess as clinically indicated	• Promote healthy lifestyle • Offer counselling and psychosocial support, if needed	• Support overall wellbeing	• Medical management if required for mental health conditions

Abbreviations: ALT = alanine aminotransferase; AST = aspartate aminotransferase; BMI = body mass index; BP = blood pressure; eGFR = estimated glomerular filtration rate; GLP-1 = glucagon-like peptide-1; SGLT-2 = sodium-glucose cotransporter-2; uACR: urinary albumin-to-creatinine ratio.

AN APPROACH TO MANAGING YOUTH-ONSET TYPE 2 DIABETES



Abbreviations: DKA = diabetic ketoacidosis; GAD = glutamic acid decarboxylase; GLP-1 = glucagon-like peptide 1; HbA_{1c} = glycated haemoglobin; HHS = hyperosmolar hyperglycaemic state; IA2 = islet antigen 2; SGLT-2 = sodium-glucose cotransporter-2; ZnT8 = zinc transporter 8.

* 10 to 20% of children with a phenotypic type 2 diabetes presentation may have one positive autoantibody.

Adapted from: Arslanian S, Bacha F, Grey M, Marcus MD, White NH, Zeitler P. Evaluation and management of youth-onset type 2 diabetes: a position statement by the American Diabetes Association. Diabetes Care 2018; 41: 2648-2668.

Current pharmacotherapy options approved for use in children include insulin, metformin (for children from 10 years of age) and empagliflozin (a sodium-glucose cotransporter-2 [SGLT-2] inhibitor; for children 10 years of age and older). Metformin remains the first-line medication for type 2 diabetes in children and adolescents, as it improves glycaemic control and supports modest weight reduction.[4]

Symptomatic patients (e.g. those with polyuria, polydipsia, recurrent skin infections or weight loss) or those with an HbA_{1c} level above 69 mmol/mol (8.5%) should also be treated with insulin, which can be tapered over two to six weeks once glucose targets are achieved. An HbA_{1c} level of 45 mmol/mol (6.3%) and above after metformin therapy predicts sustained hyperglycaemia after 48 months.[15]

The American Diabetes Association 2025 guidelines now recommend an HbA_{1c} goal

Table 2. Monitoring diabetes management and target range in youth-onset type 2 diabetes[9]

Measurement	Target range	Monitoring frequency
Glycated haemoglobin	• ≤48 mmol/mol (≤6.5%)	• Check every three months to assess long-term glycaemic control
Self-monitoring of capillary blood glucose levels	• Fasting: 4 to 6 mmol/L • 2-hour postprandial: 4 to 8 mmol/L	The frequency of self-monitoring should be individualised according to the patient's management plan and the presence of any concurrent illness • Lifestyle modification and/or metformin: check before and two hours after a main meal, two to three times a week, unless glycated haemoglobin measurement is unreliable or above target • Basal insulin or oral medications with hypoglycaemia risk: check fasting and bedtime blood glucose levels • Multiple daily injections, at treatment initiation or adjustment or suboptimal blood glucose control: check at least three times a day (fasting, before and two hours after a main meal) • During illness: two to four times a day (fasting, before and two hours after a main meal, and overnight) • Whenever signs of hyper- or hypoglycaemia are present
Ketones	• No detectable ketones in urine or blood	• Check during periods of illness, when signs of ketosis or diabetic ketoacidosis are present or if there is a history of diabetic ketoacidosis at diagnosis

of less than 48 mmol/mol (6.5%) for youth-onset type 2 diabetes.[16] This reflects the need for early and aggressive treatment escalation. Glycaemic targets should be individualised; however, since youth with type 2 diabetes have a lower risk of hypoglycaemia but a higher risk of complications, a stricter HbA_{1c} goal of less than 48 mmol/mol (6.5%) is recommended, compared with less than 53 mmol/mol (7%) in type 1 diabetes.[12,17,18]

Newer therapies and noninsulin agents, such as glucagon-like peptide-1 (GLP-1) receptor agonists and SGLT-2 inhibitors, are emerging as promising options. Randomised controlled trials in youth have demonstrated that GLP-1 receptor agonists are safe and effective in lowering HbA_{1c} levels and promoting weight loss, particularly at higher doses approved for obesity.[19-21]

The Efficacy and Safety of the SGLT2 Inhibitor Empagliflozin versus Placebo and the Dipeptidyl Peptidase-4 Inhibitor Linagliptin versus Placebo in Young People with Type 2 Diabetes (DINAMO) study, a recent multicentre, double-blind, placebo-controlled trial in 158 youth aged 10 to 17 years, showed that participants in the empagliflozin pooled group had a statistically significant HbA_{1c} reduction of 9.2 mmol/mol (0.84%).[22] Longer-term trials are required to strengthen evidence for improved therapeutic decision-making.

Various national and international guidelines also recommend tighter glycaemic targets (HbA_{1c} level of 48 mmol/mol [6.5%] or less) in youth-onset type 2 diabetes to prevent end-organ complications. They endorse the use of SGLT-2 inhibitors in children, provided they are managed by a specialised diabetes service, including an endocrinologist.

Although the TGA has not approved dapagliflozin for use in children and adolescents (because of limited paediatric data), small pharmacokinetic and pharmacodynamic studies in youth suggest characteristics similar to adults.[23] Safety and tolerability data are reassuring, but larger and longer-term paediatric studies remain needed.[23] Recent PBS changes have introduced new prescribing criteria for the GLP-1 analogues semaglutide and dulaglutide, including a trial of an alternative hypoglycaemic agent (such as an SGLT-2 inhibitor), resulting in tightly regulated access for paediatric patients. Where possible, diabetes teams caring for children with type 2 diabetes aim to follow PBS guidelines to ensure equitable management of the condition.

Currently, SGLT-2 inhibitors are available on the national paediatric formulary. Given the evidence provided by the DINAMO study, which has shown empagliflozin has efficacy in reducing hyperglycaemia in youth, consistent with adult data and with a similar safety profile,[22] empagliflozin and its formulations being added to the paediatric formulary can help prevent delays in treatment for youth inadequately managed by metformin monotherapy.

Monitoring

Regular monitoring of blood glucose and HbA_{1c} levels is essential to assess treatment efficacy and guide ongoing management (Table 2).[6] The benefits of real-time continuous glucose monitoring and intermittently scanned continuous glucose monitoring are well established, as these technologies provide detailed information on glucose trends and variability, support self-management and enable clinicians to make timely treatment adjustments.[24]

Findings from a pilot study involving nine adolescents and young adults with type 2 diabetes using real-time continuous glucose monitoring demonstrated modest improvements in quality of life.[20] Participants also reported greater motivation to change their diet

and lifestyle based on glucose trends, indicating that real-time continuous glucose monitoring was both feasible and acceptable in this population.[25] Similarly, a recent study examined outcomes from a 10-day trial of intermittently scanned continuous glucose monitoring use in youth with type 2 diabetes. Although no significant improvements in glycaemic outcomes were observed, participants were receptive to the technology and motivated to make lifestyle modifications.[26] However, literature exploring perspectives of youth with type 2 diabetes and their parents on intermittently scanned continuous glucose monitoring remains limited.[25]

Although continuous glucose monitoring is now considered standard of care and subsidised for individuals with type 1 diabetes in most developed countries, it remains unsubsidised for youth and adults with type 2 diabetes in Australia and some other high-income countries. This creates a significant cost barrier, limiting access to this valuable technology. Government or insurance support could greatly improve accessibility and outcomes for people living with type 2 diabetes.

Metabolic and bariatric surgery

Weight loss surgery may be considered for the treatment of youth with type 2 diabetes who have a body mass index greater than 35 kg/m^2 and persistently elevated HbA_{1c} levels despite lifestyle modification and pharmacotherapy. Findings from the Teen-Longitudinal Assessment of Bariatric Surgery and TODAY studies suggest that surgical treatment for adolescents with severe obesity and type 2 diabetes is associated with superior glycaemic control compared with medical therapy alone.[11,27]

Vertical sleeve gastrectomy is the most performed metabolic and bariatric procedure in adolescents. However, evidence directly comparing the efficacy of conventional treatment options with surgical therapy remains limited.[28] Long-term data on metabolic outcomes and postoperative complications are also needed to guide clinical decision-making.

Prevention strategies

Preventive measures are crucial in addressing the rising incidence of type 2 diabetes among children and adolescents. Effective strategies include:

- public health campaigns – initiatives promoting healthy eating and physical activity can raise awareness and encourage sustainable lifestyle changes
- school-based programs – implementing health education programs within schools can help foster healthy habits early in life
- family involvement – engaging families in prevention and management efforts enhances the effectiveness of interventions and supports long-term behaviour change
- community resources – improving access to recreational facilities and affordable healthy food options within communities supports healthier lifestyles and reduces barriers to change.

Transition and GP-based care

GPs play a key role in the early detection and long-term management of type 2 diabetes in children and adolescents. Regular health check-ups, obesity screening and monitoring of metabolic parameters facilitate early intervention. GPs can also co-ordinate care with paediatric endocrinologists, dietitians, diabetes educators and mental health professionals to provide comprehensive, individualised management. Effective transition planning from paediatric to adult services is essential to maintain continuity of care and prevent deterioration in glycaemic control.

Type 2 diabetes in Aboriginal and Torres Strait Islander children

Aboriginal and Torres Strait Islander populations face unique challenges regarding type 2 diabetes, with significantly higher prevalence rates observed in these communities. Western Australian data highlight an incidence of type 2 diabetes of 12.6 per 100,000 person-years in Aboriginal and Torres Strait Islander youth, compared with 0.6 per 100,000 in non-Aboriginal and Torres Strait Islander youth. Higher rates have also been reported in New South Wales and the Northern Territory. These young people experience higher rates of comorbidities, such as hypertension and obesity, which contribute to a significant disease burden.[29]

Contributing factors include socioeconomic disadvantage, limited access to healthcare, cultural differences in dietary practices and the intergenerational impacts of historical trauma. Tailored interventions that respect cultural values and prioritise community involvement are essential for the effective prevention and management of type 2 diabetes among Aboriginal and Torres Strait Islander children and adolescents. Recommendations for screening for type 2 diabetes in Aboriginal and Torres Strait Islander populations differ from those for other groups of individuals (Box 2).[9]

Conclusion

Type 2 diabetes in children and adolescents is a complex and rapidly growing public health concern that necessitates a multifaceted approach encompassing prevention, early diagnosis and effective management. Addressing the rising incidence of type 2 diabetes requires co-ordinated efforts from healthcare providers, policymakers, educators and communities to promote healthy behaviours and ensure equitable access to high-quality care. As understanding of the condition evolves, ongoing research and innovation in treatment options will be essential to reduce its long-term impact and improve outcomes for young people living with type 2 diabetes. **ET**

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A list of references is included in the online version of this article (https://medicinetoday.com.au/mt/2026/july/supplements/type-2-diabetes-in-youth).

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Type 2 diabetes in youth

A growing concern

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Type 2 diabetes in Aboriginal and Torres Strait Islander youth

Inequity and intergenerational risk

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Aboriginal and Torres Strait Islander young people are at high risk of developing type 2 diabetes. The condition reflects inequity in the social determinants of health and carries significant intergenerational risk. Supportive, holistic and strengths-based healthcare provides the basis for effective primary management.

KEY POINTS

- Youth-onset type 2 diabetes (YOT2D), diagnosed before 25 years of age, progresses more rapidly and is associated with increased cardiometabolic complications compared with later-onset type 2 diabetes.
- In recent years, Aboriginal and Torres Strait Islander young people have experienced the highest reported prevalence of YOT2D worldwide.
- Intergenerational transmission of cardiometabolic risk plays a key role in the high prevalence, particularly through in utero exposure.
- Aboriginal and Torres Strait Islander young people living with YOT2D report stigma and distress at the diagnosis.
- GPs are central to the holistic and multidisciplinary care required to adequately and appropriately support young people living with YOT2D.
- Annual screening for YOT2D using glycated haemoglobin should be undertaken in all Aboriginal and Torres Strait Islander young people with any risk factor.

The prevalence of type 2 diabetes among children and adolescents is increasing worldwide, including in Australia.[1] Youth-onset type 2 diabetes (YOT2D), defined as type 2 diabetes diagnosed before the age of 25 years, disproportionately affects young people from high-risk ethnic groups, particularly First Nations communities.[2,3] This pattern is also seen in Australia, although data for Aboriginal and Torres Strait Islander youth remain limited in some areas, and the risk is likely to vary substantially across language groups and regions. Aboriginal and Torres Strait Islander youth have the highest reported prevalence of type 2 diabetes in the world, at 14.4 per 1000 (95% confidence interval, 12.2–17.0) in the Central Australian region and 6.7 per 1000 (95% confidence interval, 6.0–7.4) across Northern Australia.[4] In Western Australia, the incidence of type 2 diabetes in young people aged less than 16 years is 18.3 times higher in Aboriginal and Torres Strait Islander youth compared with non-Indigenous Australians.[5] Aboriginal and Torres Strait Islander adolescents across Australia also have a 10 times higher likelihood of hospitalisation for type 2 diabetes than non-Indigenous adolescents.[6] In addition, Aboriginal and Torres Strait Islander youth tend to be affected by type 2 diabetes at a younger age than non-Indigenous youth, with cases reported in early childhood.[7]

Although an increase in the prevalence of type 2 diabetes has been seen among all Australian youth over the past 20 years,

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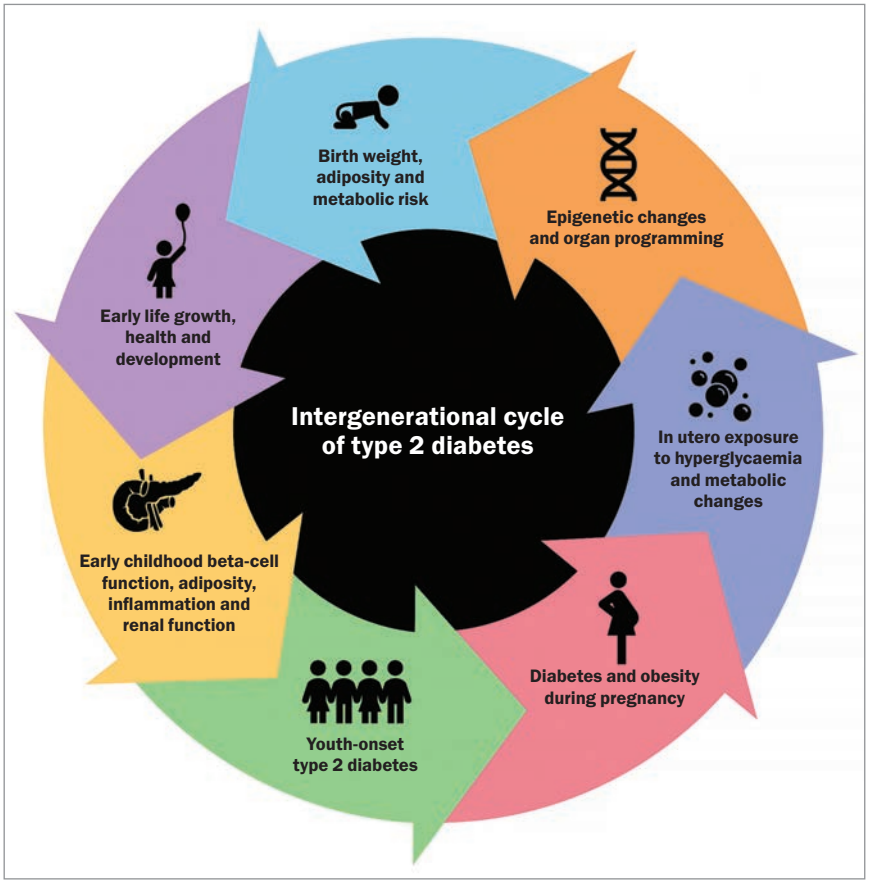

Figure. Intergenerational transmission of risk in youth-onset type 2 diabetes.[11]
Reproduced with permission from Titmuss A, Korula S, Wicklow B, Nadeau KJ. Curr Diab Rep 2024; 24: 183-195.

Aboriginal and Torres Strait Islander youth have experienced a much greater rise in new diagnosis rates.[8] Data from Western Australia indicate a high burden of comorbidity in Aboriginal and Torres Strait Islander children with type 2 diabetes, with 59% affected by hypertension, 24% by dyslipidaemia and 61% by obesity.[5] These findings have significant implications for future morbidity and mortality.

However, new phenotypes of type 2 diabetes are emerging in Aboriginal and Torres Strait Islander young people, in which obesity is less prominent. Risk factors for diabetes and metabolic syndrome have been reported at a significantly earlier age and at much higher frequency among Aboriginal and Torres Strait Islander people, suggesting that the prevalence of YOT2D will continue to increase in the future.[9]

Youth-onset type 2 diabetes is a condition of inequity

YOT2D is recognised internationally as a 'disease of poverty' and the condition reflects underlying structural and social inequities.[10,11] These inequities contribute to an increased risk of YOT2D and diabetes- related complications, limit access to culturally safe healthcare and effective clinical management, and exacerbate food insecurity. The social determinants of health underpin these inequities by shaping both diabetes risk and the extent to which health systems enable equitable access to care and support effective lifestyle change.[12,13] These social determinants of health have impacts at the individual, family and community level. For Aboriginal and Torres Strait Islander young people, these determinants include education, income, food and housing security, psychological trauma, and structural, commercial and political forces, including the ongoing experience of racism and discrimination.[14] The influence of these factors extends beyond individual behaviours or healthcare quality, accounting for up to 55% of health outcomes.[15] Current models of healthcare often do not adequately address these issues or holistically consider the sociopolitical inequity a young person faces.

A further issue is the limited data on pharmaceutical options for type 2 diabetes in children and adolescents. Globally, it is estimated that only 2% of youth with type 2 diabetes are eligible and able to participate in randomised controlled trials, despite YOT2D being a high-risk condition for poor outcomes.[16] In the limited trials taking place, First Nations youth are particularly under-represented.[16]

Intergenerational transmission of type 2 diabetes

Intergenerational transmission of type 2 diabetes has been described as an epidemic affecting Aboriginal and Torres Strait Islander youth (Figure).[11,17] YOT2D is associated with exposure to maternal hyperglycaemia during pregnancy, compounding any underlying genetic susceptibility to diabetes. This is likely an important factor in the intergenerational transmission of cardiometabolic conditions at successively younger ages, a pattern that has been observed in other First Nations populations worldwide.[18,19] Among First Nations peoples of Canada, 43% of children born to mothers diagnosed with type 2 diabetes in adolescence developed diabetes themselves by 10 to 19 years of age and 25% developed diabetes by 7 years of age.[20]

Offspring exposed to maternal type 2 diabetes during pregnancy are at greater risk of adverse outcomes than those exposed to gestational diabetes mellitus,

1. RISK FACTORS FOR YOUTH-ONSET TYPE 2 DIABETES

- Overweight or obesity (body mass index Z score ≥1 with or without waist-to-height ratio >0.5)
- *In utero* exposure to maternal diabetes, including gestational diabetes
- First-degree relative with type 2 diabetes
- Signs of insulin resistance (e.g. acanthosis nigricans)
- Other conditions associated with obesity or metabolic syndrome (e.g. hypertension, dyslipidaemia, hepatic steatosis, polyendocrine metabolic ovarian syndrome, obstructive sleep apnoea)
- Use of psychotropic medications

potentially reflecting sustained hyperglycaemia preconception and throughout pregnancy.[18] The mechanism of increased cardiometabolic risk may relate to epigenetic changes and in utero organ programming in offspring.[11] This highlights the importance of optimising cardiometabolic health in adolescence and preconception, enhancing the health of any future offspring.

In utero exposures may also influence the diabetes phenotype. The classic phenotype for type 2 diabetes includes a high body mass index, central adiposity and clinical evidence of insulin resistance. However, young people exposed to maternal hyperglycaemia in pregnancy may have less overweight or obesity, lower insulin secretion, milder but evident insulin resistance and earlier onset of type 2 diabetes.[21,22] Aboriginal youth diagnosed with type 2 diabetes before 15 years of age have a lower prevalence of overweight or obesity (87%), compared with those diagnosed between 15 and 24 years of age (97%).[4]

These differing phenotypes are still poorly understood, but in utero organ programming likely affects pancreatic beta-cell function, potentially reducing the age of diagnosis and resulting in altered adiposity to that seen in the past. Waist-to-height ratio, as a marker of central adiposity, may be more clinically useful than body mass index in Aboriginal and Torres Strait Islander youth, using a ratio of greater than 0.5 as a marker of increased cardiometabolic risk.[23,24] The Pregnancy and Neonatal Diabetes Outcomes in Remote Australia (PANDORA) birth cohort study in the Northern Territory, in which 175 women (15%) had type 2 diabetes in pregnancy, is expected to provide further insights into intergenerational risk in Aboriginal and Torres Strait Islander communities as the offspring reach adolescence.[25]

Screening for youth-onset type 2 diabetes

Active screening for type 2 diabetes is recommended in all Aboriginal and Torres Strait Islander young people with any risk factor, even if they are asymptomatic, from 10 years of age or earlier if puberty occurs before this age (Box 1).[24] Upcoming Australian and New Zealand consensus guidelines will lower the recommended age of screening to 8 years. Annual screening can be carried out using glycated haemoglobin (HbA_{1c}), including point-of-care testing. An HbA_{1c} level of 6.5% (48 mmol/mol) or more is consistent with a diagnosis of diabetes. Complication screening for cardiometabolic comorbidities should begin at the time of diagnosis.

Concerning future trajectories

The concerning trajectory of YOT2D represents an equity issue. The pathophysiology, phenotype, comorbidities, complications and treatment response of YOT2D all appear significantly worse than later-onset diabetes.[2,11] Glycaemic control is chronically suboptimal in YOT2D, with only 14% of Aboriginal and Torres Strait Islander young people living in Northern Australia meeting glycaemic targets.[4] Very limited data are available for non-Indigenous Australian youth. These glycaemic control outcomes are consistent with the situation worldwide; 34% of youth with type 2 diabetes are reported to have HbA_{1c} levels greater than 10% (86 mmol/mol), and 80% to have at least one microvascular or macrovascular complication, at 15 years after diagnosis.[12] Canadian data suggest that almost 50% of youth will have end-stage renal failure by 20 years after diagnosis with type 2 diabetes.[26] YOT2D is associated with a 23 times higher risk of kidney failure and a 39 times higher risk of requiring dialysis compared with young people without diabetes.[26]

The implications for Aboriginal and Torres Strait Islander families and communities are substantial if young people diagnosed with diabetes in adolescence progress to requiring dialysis by 30 years of age. Data from Far North Queensland demonstrate worse outcomes for young people with type 2 diabetes compared with type 1 diabetes, even with shorter diabetes duration and lower median HbA_{1c} levels.[27]

Young people with type 2 diabetes appear to respond differently to pharmacological management, with a higher rate of treatment failure compared with adult cohorts.[16,28,29] In light of these concerns, YOT2D has been described as a 'severe

2. FIVE MAIN THEMES IN THE EXPERIENCES OF ABORIGINAL AND TORRES STRAIT ISLANDER YOUNG PEOPLE LIVING WITH TYPE 2 DIABETES[32]

- Shock, shame and distress at the diagnosis and a sense of isolation from other youth, which can cause disengagement from healthcare
- A normalisation–shame paradox, where stigma exists despite a high diabetes prevalence among family members, contributing to a sense of powerlessness to change their health trajectory
- Complex behaviours relating to the diagnosis, including resentment, denial and avoidance, which affect diabetes self-management
- A lack of understanding of diabetes and recognition that current diabetes education styles and content are not culturally or age appropriate
- Social complexities and competing priorities for youth, including carer responsibilities, which can create challenges in diabetes management

TABLE. ENHANCING ENGAGEMENT OF ABORIGINAL AND TORRES STRAIT ISLANDER YOUNG PEOPLE IN DIABETES CARE – WHAT YOUNG PEOPLE WANT YOU TO KNOW[32,33,39]

Focus	Possible strategies	Young people's voices
Be prepared for the shock of diagnosis and subsequent complex emotions	• Consider the young person's priorities and motivators • Share more information at the next appointment if the young person appears to be overwhelmed • Identify supports for the young person	• 'I was full-on crying' • 'I just wanted to get out of there, I didn't want to believe it. It was horrible. Horrible, when I found out' • 'I thought [...] just old people [got it] ... I didn't know younger people get it as well' • 'It's like your second nightmare, you're running away from it'
Provide hope, acknowledging that the normalisation–shame paradox can lead to a sense of powerlessness	• Support the young person to decide on achievable goals • Explore how everyone's diabetes story is different • Use strengths-based language and carefully consider terminology • Talk about shame and avoid language that blames the individual for their diagnosis	• 'I was a bit scared because my sister's got diabetes, my mum, my grandmother, sort of runs in the blood' • '...before, I wouldn't want to like tell you my story at all because I was pretty much, at first, I was ashamed of it'
Opportunities to improve understanding of type 2 diabetes	• Use simple explanations, diagrams, pictures and videos where possible • Check understanding and health literacy • Ensure consistency of key messages, goals and diabetes education among the healthcare team • Ensure age-appropriate and culturally safe education • Recognise and prioritise Aboriginal and Torres Strait Islander ways of knowing and being	• '[They have] explained it to me heaps of times; I still can't get [it] right' • 'It was the first time I heard "diabetes". I didn't really understand it so I didn't really listen' • 'And 'cause every time I used to research type 2 diabetes it was like – yeah, the information was there, but it wasn't, you might as well say broken down, where it'd be explained simple, just like how we're talking now, just simple'
Importance of psychological and social supports	• Identify key support people in the young person's life, and the role of family • Discuss mental and emotional wellbeing and refer to other services when needed • Link the young person in with other young people living with type 2 diabetes • Consider support beyond the health sector • Screen for psychosocial health. Use the HEEADSSS framework approach exploring the many domains of young people's lives • Engage family members with lived experience of diabetes and explore beliefs and perceptions, acknowledging that these may support or hinder the young person	• 'But it's hard you know. You think you're alone' • 'Confused about what it meant and [...] where I could go from there [...] but there was hardly any help' • 'It'd be good [to be] around people the same age and stuff you know. Be good to hear their side of the story and how they got it and what they're doing'
Prioritise the therapeutic relationship	• Be flexible with where and when healthcare is provided (i.e. a young person may feel more comfortable to talk outside the clinic) • Focus on building rapport first and find common ground • Prioritise continuity of care • Identify achievable goals • Involve an Aboriginal health or community practitioner where possible • Recognise that young people live in many different environments and are more likely to engage with flexible approaches to healthcare and with trusted people in their lives • Develop processes and structures to facilitate continuity of care when young people move locations or between services	• 'Because the doctor there, she's really good; supportive and she really understands and is concerned' • 'Aboriginal health workers provide "help like family"' • 'I wouldn't listen to the diabetes educator, I'd just be very disrespectful – because I despised her for giving me the diagnosis' • 'It's not easy – you've already got other stuff going through your mind and diabetes is just a thing that just tops it off, you know, takes the cake' • 'Mum would argue with me to go to doctor's appointments and I'd say, "No, I don't want to go," because I wouldn't want the doctor to tell me that ... because I haven't taken my medication'

Abbreviation: HEEADSSS = Home; Education and employment; Eating; Activities; Drugs; Sexuality; Suicide and depression; Safety.

aggressive phenotype' and must be considered and managed differently from later-onset type 2 diabetes.[30] Guidelines suggest focused and intensive clinical management, active treatment to tight glycaemic targets, and collaborative shared care between primary healthcare and paediatricians or endocrinologists from the time of diagnosis.[31]

Models of care

Pharmaceutical treatments provide a limited solution in the context of such inequity in social determinants of health and access to services. Research with Aboriginal and Torres Strait Islander young people living with type 2 diabetes has highlighted some key experiences and perceptions that influence their lives.[32,33] Five main themes emerged (Box 2).[32]

Type 2 diabetes is associated with a greater risk of mental health concerns, potentially further isolating affected young people.[34,35] Addressing the social and emotional wellbeing needs of young people is an essential first priority, with ongoing engagement and effective clinical care possible only once this has been achieved.

This research has highlighted the voices of Aboriginal and Torres Strait Islander youth and what they need from health services and health professionals. Current models of care use individual patient education and management approaches that are incongruent with the needs or world views of Aboriginal and Torres Strait Islander youth. Persistent barriers to care include insufficient cultural safety, intergenerational trauma, stigma and shame, structural inequities, and limited understanding by health professionals of young people's priorities and perceptions.[32,33]

There are significant differences in access to health services and multidisciplinary diabetes teams across Australia. Primary healthcare services, particularly community-controlled health services, are crucial in providing culturally safe, contextually relevant and holistic care that addresses the social determinants of health. Effective communication and a collaborative approach between primary care and diabetes services are essential. This includes integrating specialist diabetes outreach services into primary care and acknowledging the fundamental importance of continuity of care and the therapeutic relationship that is developed between the young person and their primary care service.

Aboriginal and Torres Strait Islander young people are facing an intergenerational epidemic of type 2 diabetes

Innovative strategies are urgently required to alter the trajectories for those at risk and to ensure strengths-based models of care. One such strategy is to incorporate peers with lived experience of type 2 diabetes to provide peer support and peer-led diabetes education from the time of diagnosis. This strengths-based approach of engaging peers to support youth affected by YOT2D has been shown in other First Nations populations to be culturally appropriate, strengthen health systems, improve health outcomes and enhance wellbeing, building capacity, connection and support.[36-38] Peers can support continuity of care and facilitate navigation of the health system in a way that is person-centred and enhances cultural safety.

Aboriginal and Torres Strait Islander young people have provided some clear messages to health professionals regarding optimal models of care (Table).[32,33,39] They have called for health professionals to actively explore holistic support that is strengths-based, reduces stigma, and enhances wellbeing and social connections. They have also highlighted the crucial role of Aboriginal health practitioners and community-based workers in providing culturally tailored and contextually appropriate healthcare, acknowledging the unique differences in Aboriginal and Torres Strait Islander communities across Australia.

Young people have called for intersectoral responses to provide wraparound support. Codesign of support strategies with Aboriginal and Torres Strait Islander youth living with YOT2D has highlighted the importance of schools in enhancing diabetes management and capacity building for diabetes self-care.[39] This has also highlighted the need for community awareness of YOT2D to reduce stigma and isolation.[32,39]

Conclusion

Aboriginal and Torres Strait Islander young people are facing an intergenerational epidemic of type 2 diabetes, a condition reflecting inequity and social determinants of health. The condition is associated with a high risk of cardiometabolic complications at an early age. Effective primary healthcare needs to be community-led, person-centred, culturally safe, strengths-based and holistic, aimed at enhancing support, maintaining connection and building capacity. Current evidence gaps in terms of emerging phenotypes, reducing intergenerational risk, effective treatment and enhanced models of care require research that is conducted in true partnership with Aboriginal and Torres Strait Islander communities and reconsiders the existing paradigm. Meaningful progress will depend on ensuring that the voices of Aboriginal and Torres Strait Islander young people, families and communities are central to service design, research priorities and models of care. MT

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A list of references is included in the online version of this article (https://medicinetoday.com.au/mt/2026/july/supplements/type-2-diabetes-in-youth).

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Type 2 diabetes in Aboriginal and Torres Strait Islander youth

Inequity and intergenerational risk

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PEER REVIEWED FEATURE

Youth-onset type 2 diabetes

The ever-changing face of pharmacotherapy

JACQUELINE CURRAN BSc, MB ChB, FRACP

Youth-onset type 2 diabetes follows a more aggressive course than adult-onset disease, with earlier complications and faster decline in beta-cell function. Improved understanding of its pathophysiology and expanding pharmacotherapy options are changing the approach to personalised management.

KEY POINTS

- Youth-onset type 2 diabetes (YOT2D) follows a more aggressive course than adult-onset type 2 diabetes, with earlier complications and more rapid decline in beta-cell function.
- Lifestyle intervention remains the cornerstone of management, but pharmacotherapy should be intensified promptly to achieve and maintain glycaemic targets.
- Metformin remains first-line therapy for most young people with YOT2D, with insulin used during metabolic decompensation and as rescue therapy when required.
- Sodium-glucose cotransporter-2 inhibitors, glucagon-like peptide-1 receptor agonists and tirzepatide are expanding treatment options and improving glycaemic control in YOT2D.
- Treatment should be individualised according to the patient's clinical presentation, comorbidities, treatment goals and preferences.

Youth-onset type 2 diabetes (YOT2D) is increasing globally, with the highest burden occurring in First Nations populations. Aboriginal and Torres Strait Islander children have an 18-fold higher risk of developing YOT2D than non-Indigenous children.[1] The US SEARCH for Diabetes in Youth Study predicts a sixfold increase in YOT2D by 2050.[2]

YOT2D follows a more aggressive course than adult-onset type 2 diabetes (T2D), with earlier onset of complications and a more rapid decline in beta-cell function.[2] It remains uncertain whether newer pharmacotherapies will alter this trajectory, as earlier cohorts treated with a limited range of agents experienced consistently poor outcomes. Growing evidence has improved our understanding of the complex pathophysiology of T2D and highlighted important differences between YOT2D and adult-onset T2D, including responses to pharmacotherapy. Many drug classes well established in adult-onset T2D management have now been evaluated in young people with YOT2D for pharmacokinetics, pharmacodynamics, glycaemic efficacy and safety, expanding the range of potential treatment options.

This article reviews the unique pathophysiology of YOT2D, current treatment targets and the evolving glycaemic-lowering pharmacotherapy options available to support individualised care.

The complex pathophysiology of T2D

A detailed understanding of the pathophysiology of T2D enables rational selection of combination therapies that target the multiple organs and tissues involved. Reduced insulin sensitivity in the liver, skeletal muscle and adipose tissue initially leads to compensatory hyperinsulinaemia. As pancreatic beta-cell function progressively declines, insulin secretion becomes inadequate, resulting in hyperglycaemia, the hallmark of T2D (Figure 1). Insulin resistance is driven by genetic factors, reflected by the clustering of T2D within families, as well as elevated

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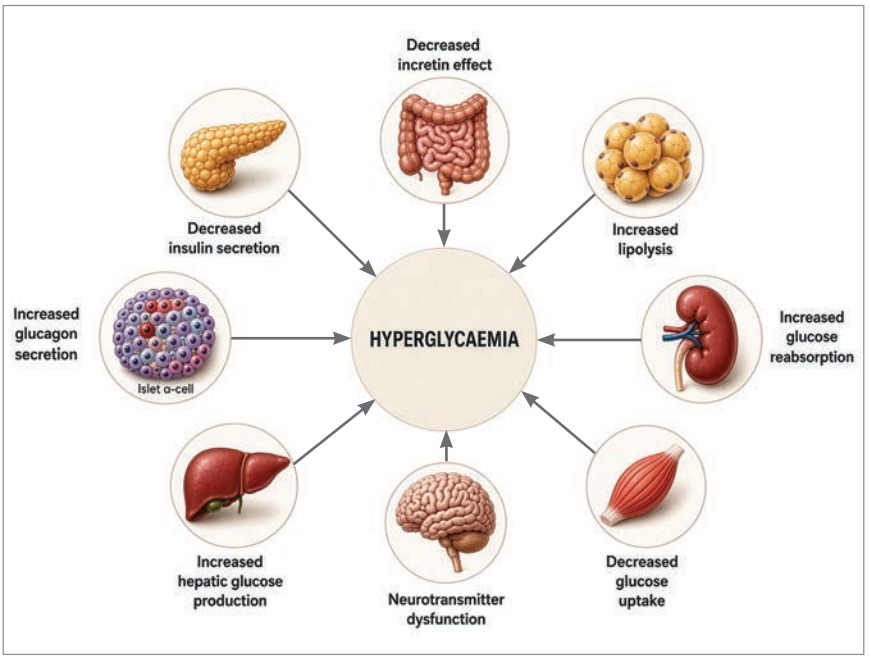

Figure 1. Hyperglycaemia: the result of eight pathophysiological defects.

1. KEY PATHOPHYSIOLOGICAL DEFECTS IN TYPE 2 DIABETES

Excess body fat
Adipose tissue becomes resistant to insulin's antilipolytic effects, resulting in elevated FFA levels. FFAs stimulate gluconeogenesis, promote hepatic and skeletal muscle insulin resistance, and impair insulin secretion, a process known as lipotoxicity. Dysfunctional adipose tissue also produces excessive amounts of inflammatory and atherogenic cytokines that further worsen insulin resistance.

Skeletal muscle
Skeletal muscle is the primary site of exogenous glucose disposal. GLUT4 is the major transporter involved. Insulin and exercise stimulate translocation of GLUT4 to the muscle cell membrane, facilitating glucose uptake. In T2D, skeletal muscle insulin resistance impairs glucose uptake, contributing to hyperglycaemia.

Liver
Hepatic IR is characterised by excessive basal hepatic glucose production despite elevated fasting insulin levels and inadequate suppression of glucose output after meals due to reduced hepatic responsiveness to insulin.

Incretins
GLP-1 and GIP account for most of the incretin effect following food intake by stimulating insulin secretion. In T2D, GLP-1 secretion is reduced and resistance to the actions of GIP develops.

Pancreas
In the setting of insulin resistance, beta cells initially increase insulin production, resulting in compensatory hyperinsulinaemia. As beta-cell capacity declines, postprandial and subsequently fasting hyperglycaemia develop, with up to 80% of beta-cell function lost by the time of diagnosis. The exact mechanisms underlying beta-cell failure remain uncertain, but several processes are thought to contribute, including excess deposition of lipids within beta cells and elevated FFA levels (lipotoxicity), which impair insulin secretion and accelerate beta-cell failure, and chronic hyperglycaemia (glucotoxicity), which further impairs beta-cell function and reduces insulin production. In addition, suppression of postprandial glucagon secretion from pancreatic alpha cells is impaired in T2D.

Kidneys
About 90% of filtered glucose is reabsorbed in the proximal convoluted tubule via sodium-glucose cotransporter-2. Renal glucose reabsorptive capacity is increased in people with T2D compared with matched healthy controls.[3]

Brain
The brain contributes to T2D through central insulin resistance and impaired regulation of appetite and energy balance.

Abbreviations: FFA = free fatty acid; GLUT4 = glucose transporter 4; GIP = glucose-dependent insulinotropic polypeptide; GLP-1 = glucagon-like peptide-1; T2D = type 2 diabetes.

adiposity, ectopic fat deposition, sedentary behaviour and the physiological insulin resistance associated with puberty. The major organs and tissues involved in T2D pathophysiology are outlined in Box 1.[3]

How does YOT2D differ from adult-onset T2D?

Although YOT2D and adult-onset T2D share many core pathophysiological defects, important differences exist (Figure 2). Young people have greater insulin resistance than adults with the same body mass index (BMI), body fat percentage, ethnicity and sex.[4,5] They also have lower insulin clearance and a greater beta-cell insulin secretory response after adjustment for insulin resistance. YOT2D occurs more commonly in females, likely because of the physiological insulin resistance associated with the additional growth hormone secretion seen during puberty, whereas adult-onset T2D is more common in males. Alpha-cell dysfunction also appears to be less pronounced in YOT2D.[6]

The Restoring Insulin Secretion (RISE) study examined whether early treatment could preserve or restore beta-cell function in people with glucose intolerance or newly diagnosed T2D. Neither metformin nor basal insulin preserved beta-cell function in youth, whereas beta-cell function was maintained in adults.[7] Durable glycaemic control is therefore more difficult to achieve in YOT2D, as many therapies are less effective in the setting of severe insulin resistance.[8]

The phenotypes of YOT2D

YOT2D is a heterogeneous condition with distinct metabolic subtypes that require personalised approaches to management. Clustering analyses of routine clinical measures have identified three main subtypes: obesity-related YOT2D, insulin-deficient YOT2D and insulin-resistant YOT2D. The insulin-deficient and insulin-resistant subtypes together account for about half of all cases and are associated with greater disease severity and higher

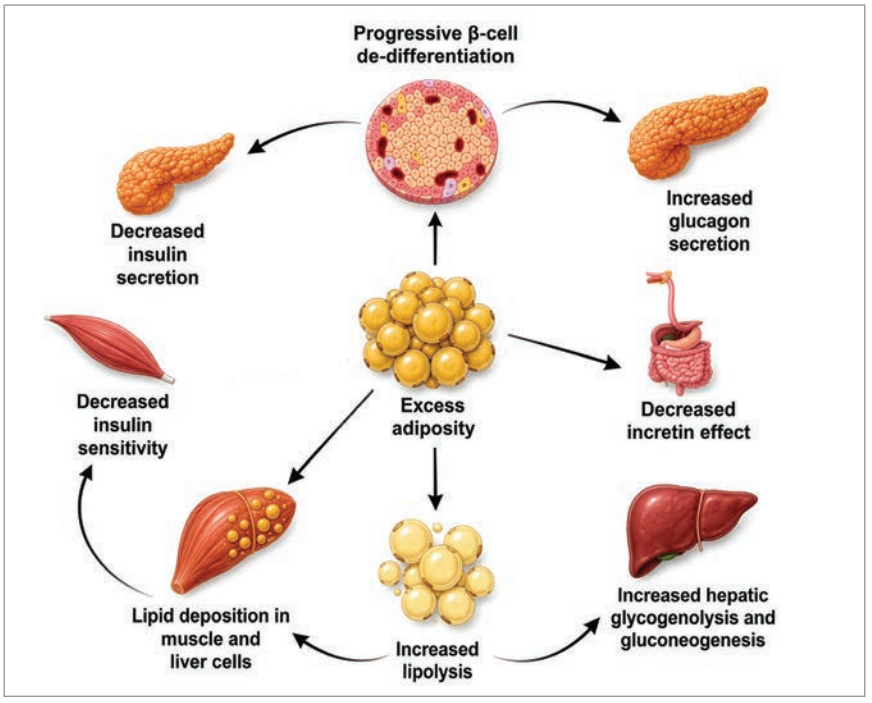

Figure 2. Pathophysiology of youth-onset type 2 diabetes. Multiple mechanisms involving pancreatic beta-cells and liver, muscle and adipose tissue contribute to hyperglycaemia and the development of type 2 diabetes. Youth with type 2 diabetes exhibit greater insulin resistance, more aggressive beta-cell failure and more rapid glycaemic deterioration than adults with type 2 diabetes.

rates of treatment failure.[9,10] Beta-cell decline varies widely (6 to 30% per year) and is influenced by age at diagnosis, ethnicity, genetics, glycated haemoglobin (HbA_{1c}) level, BMI and the presence of islet autoantibodies.[11,12]

Glycaemic targets

A target HbA_{1c} level of 6.5% or less is recommended for young people with YOT2D. HbA_{1c} level should be measured every three months and therapy intensified as needed to maintain the target (a treat-to-target approach), rather than waiting for glycaemic control to deteriorate before escalating treatment (a treat-to-failure approach). This target reflects the accelerated rate of complications and higher mortality associated with YOT2D compared with adult-onset T2D and childhood type 1 diabetes.

To achieve this target, recommended glucose levels are 4 to 6 mmol/L fasting and 4 to 8 mmol/L two hours postprandially. Self-monitoring of blood glucose should be individualised, and continuous glucose monitoring can be a useful adjunct in YOT2D, improving the proportion of time spent within the target glucose range.[13]

Choosing pharmacotherapy in YOT2D

When add-on therapy is required to achieve glycaemic targets, the patient's engagement and adherence should first be assessed. Additional factors must then be considered, and each medication change should be accompanied by education regarding administration, expected glycaemic effects, adverse effects, safety considerations, follow up and stopping criteria. Several medications have minimum approved ages because of limited research data or TGA approval requirements; however, off-label use may sometimes be appropriate with careful monitoring. Key factors influencing treatment selection are outlined in Box 2. The choice of pharmacotherapy at diagnosis depends on the clinical presentation and should follow current International Society for Pediatric and Adolescent Diabetes recommendations (Figure 3).[14] The key characteristics of currently available pharmacotherapies for YOT2D are summarised in the Table.[15-55]

Pharmacotherapy should complement lifestyle modification and support reversal of the underlying disease mechanisms. Improvements in body composition,

2. FACTORS TO CONSIDER IN INDIVIDUALISING ANTIHYPERGLYCAEMIC THERAPY

Patient-specific clinical factors
- Age
- Sex
- Pubertal status
- Comorbidities
- Chronic diseases (renal, liver, cardiac)
- Baseline investigations required
- Contraindications
- Allergies
- Potential drug interactions
- Ongoing surveillance required

Medication-specific factors
- Glycated haemoglobin-lowering efficacy
- Mechanism of action
- Impact on weight
- Side-effect profile
- Hypoglycaemia risk
- Blood glucose monitoring requirements
- Route of administration
- Dosing schedule
- Storage requirements

Patient, family and treatment goals
- Patient and family preferences
- Ability to adhere to treatment
- Education and support needs
- Level of supervision required
- Cost and access
- Sexual activity and contraception counselling
- Treatment goals (glycaemia, weight, comorbidity targets)
- Duration of therapy

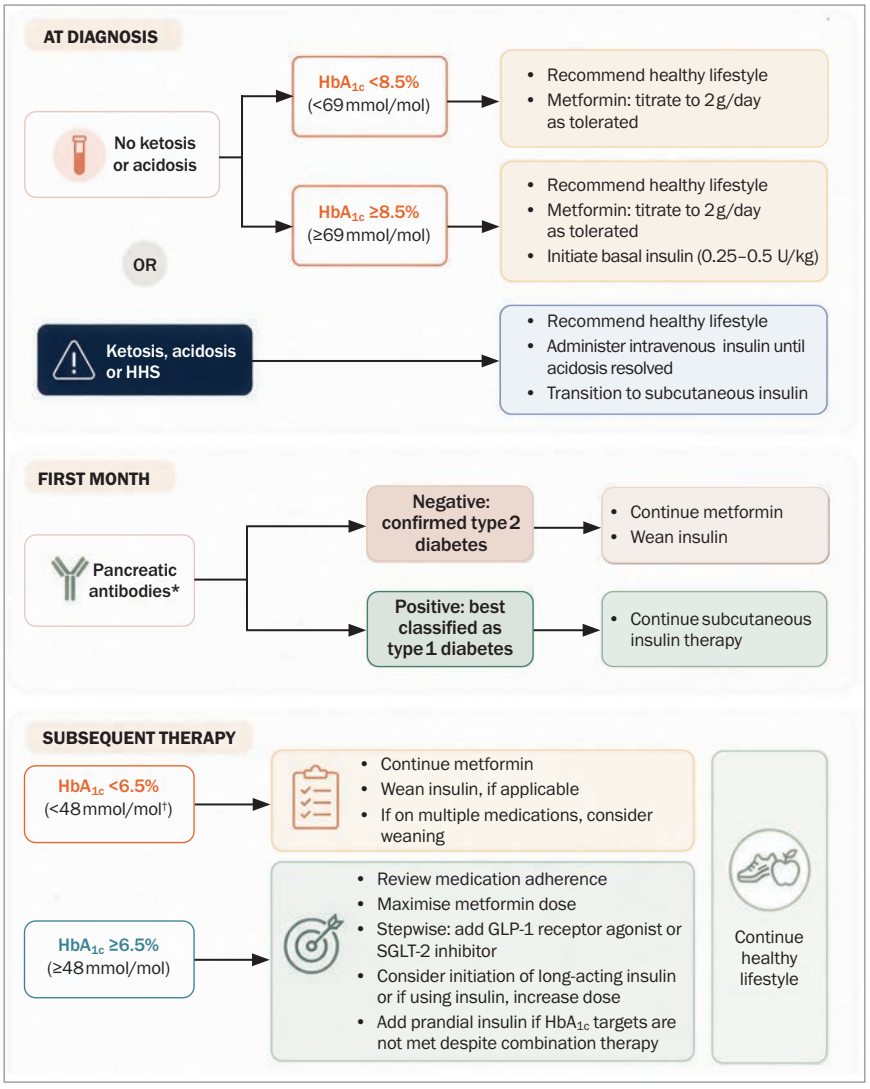

Figure 3. Evaluation and management of new-onset type 2 diabetes.

Abbreviations: HbA_{1c} = glycated haemoglobin; HHS = hyperosmolar hyperglycaemic state; GLP-1 = glucagon-like peptide-1; SGLT-2 = sodium-glucose cotransporter-2.

* If pancreatic autoantibodies are not available, use family history, response to treatment, clinical progression and associated metabolic comorbidities to establish diabetes type.

† HbA_{1c} target may be ≥6.5% in specific circumstances (significant hypoglycaemia).

Modified from 2024 International Society for Pediatric and Adolescent Diabetes (ISPAD) Clinical Practice Consensus Guidelines.

achieved through reducing excess body fat while maintaining or increasing skeletal muscle mass, can substantially reduce insulin resistance. Adequate sleep, regular moderate- to vigorous-intensity physical activity, reduced sedentary behaviour and a nutrient-rich diet are all essential components of management. Ongoing support is required to help young people maintain these lifestyle measures, and involvement of a multidisciplinary team experienced in managing YOT2D is recommended.

Biguanides

Metformin is first-line therapy for most young people with YOT2D and is generally well tolerated. It should only be initiated after resolution of ketosis or a hyperosmolar hyperglycaemic state.[14] When combined with insulin at diagnosis, metformin may facilitate more rapid insulin withdrawal over the following weeks. About half of adolescents with YOT2D can maintain long-term glycaemic control with metformin monotherapy compared with more than 80% of adults, who achieve glycaemic targets with metformin alone.[20,56] Metformin should be avoided in young people with intolerable adverse effects, known allergy to biguanides or significant renal impairment.

The recommended starting dose is metformin extended-release 500 mg with the evening meal or metformin immediate-release 250 mg once daily in younger children to improve tolerability.[14] The dose should be titrated over three to four weeks as tolerated to a maximum dose of 2 g daily. Metformin should be discontinued 48 hours before elective surgery, radiological studies involving iodinated contrast media and during significant gastrointestinal illness. Gastrointestinal adverse effects are common when commencing metformin; gradual dose escalation, administration with food and good adherence may help minimise these symptoms.[22]

Insulin

Insulin is used to manage hyperglycaemia associated with metabolic decompensation at diagnosis and may also be required later in the disease course. It often functions as a short-term 'rescue' therapy and should be discontinued as soon as clinical stabilisation permits. Insulin therapy can rapidly improve glycaemic control and is associated with low rates of symptomatic hypoglycaemia in YOT2D. Long-acting basal insulin is commenced first, with prandial insulin added if glycaemic targets are not achieved.

Where possible, insulin doses should be reduced by 30 to 50% each week and ceased once glycaemic targets are maintained, transitioning to metformin monotherapy in newly diagnosed patients or when another glucose-lowering agent is introduced. Discontinuing insulin where appropriate may help minimise weight gain. The Treatment Options for Type 2 Diabetes in Adolescents and Youth

TABLE. PHARMACOTHERAPIES FOR YOUTH-ONSET TYPE 2 DIABETES

Drug class*	Medication	Mechanism of action	Usual dose	Common adverse effects	HbA_{1c} reduction versus placebo	Weight and cardiometabolic effects	Clinical role in YOT2D	TGA approval/ pregnancy category
Biguanide[15-30]	Metformin, immediate release/ extended release	Suppresses hepatic glucose production and lipogenesis; increases glucose uptake and fat oxidation in muscle and adipose tissue; slows intestinal glucose absorption	250–2000 mg/ day orally	Abdominal pain, nausea, diarrhoea, reduced appetite, headache, vitamin B12 deficiency. Rare lactic acidosis during acute illness or dehydration	0.7–1.2%	Improved lipid profile; reduced BMI and adiposity	First-line therapy; can be combined with all other drug classes	Approved for age ≥10 years; pregnancy category C
Insulin[31-34]	Basal, bolus and premixed	Increases peripheral glucose uptake and suppresses hepatic glucose production	Variable dose and frequency; SC injection	Hypoglycaemia, weight gain. Rare: severe hypoglycaemia, hypersensitivity reactions	0.6–5.2%	Increased BMI	Initial treatment in DKA and HHS; rescue therapy during metabolic decompensation; long-term therapy in insulin-deficient YOT2D	Most preparations approved for YOT2D; pregnancy category A or B
SGLT-2 inhibitor[35-43]	Empagliflozin	Inhibits renal glucose reabsorption in the proximal tubule, increasing urinary glucose excretion; undergos biotransformation in the liver and excreted renally	5–25 mg daily orally	Genitourinary infections, dehydration, headache, nasopharyngitis; hypoglycaemia when combined with insulin; rare: euglycaemic DKA	0.84% (26 weeks)	No significant BMI reduction in YOT2D; cardiovascular and renal benefits have been demonstrated in adults	Second-line therapy	Approved for age ≥10 years; pregnancy category D
	Dapagliflozin		5–10 mg daily orally		0.75% (24 weeks; NS)			Approved for age ≥18 years; pregnancy category D
GLP-1 receptor agonist[44-54]	Dulaglutide	Enhances glucose-dependent insulin secretion, suppresses glucagon secretion, delays gastric emptying and increases satiety	0.75–1.5 mg weekly; SC injection	Nausea, vomiting, diarrhoea. Rare: pancreatitis, gallstones, cholecystitis, gastroparesis, bowel obstruction	1.4% (26 weeks)	No BMI reduction at diabetes doses; BMI reduction seen in youth obesity, not YOT2D; improved lipid profile	Second-line therapy; do not combine with DPP-4 inhibitors	Approved in T2D for adults aged ≥18 years; pregnancy category D
	Liraglutide		0.6–1.8 mg daily; SC injection		1.1% (26 weeks)			
Dual GIP/ GLP-1 receptor agonist[55]	Tirzepatide	Enhances insulin secretion, suppresses glucagon secretion and promotes satiety	2.5–10 mg weekly; SC injection	Similar to GLP-1 receptor agonists	2.28% (30 weeks)	BMI reduction 7.4% (5 mg) and 11.2% (10 mg) (30 weeks)	Second- or third-line therapy; do not combine with DPP-4 inhibitors	Approved for adults aged ≥18 years; pregnancy category D

Abbreviations: BMI = body mass index; DKA = diabetic ketoacidosis; DPP-4 = dipeptidyl peptidase-4; GIP = glucose-dependent insulinotropic polypeptide; GLP-1 = glucagon-like peptide-1; HHS = hyperosmolar hyperglycaemic state; NS = nonsignificant; SC = subcutaneous; SGLT-2 = sodium-glucose cotransporter 2; T2D = type 2 diabetes; YOT2D = youth-onset type 2 diabetes.
*Pharmacokinetic data are available for metformin, insulin, dulaglutide, empagliflozin and dapagliflozin in YOT2D. Tirzepatide dosing is based on physiologically based pharmacokinetic modelling.

(TODAY) study found that more than half of young people receiving metformin monotherapy required insulin within five years. An HbA_{1c} level of 6.3% or greater at three months predicted subsequent loss of glycaemic control across all treatment groups. With additional drug classes now available, other agents are increasingly being used to reduce the need for rescue insulin.[20,57]

Sodium-glucose cotransporter-2 inhibitors

Sodium-glucose cotransporter-2 inhibitors (SGLT-2) inhibitors, including empagliflozin and dapagliflozin, are effective in YOT2D. Empagliflozin is TGA approved for children aged 10 years and older, whereas dapagliflozin is currently TGA approved only for adults aged 18 years and older. They are administered orally once daily and combination tablets with metformin are available. Additional renal and cardiovascular benefits have been demonstrated in adults; making these agents particularly appropriate for young people with renal impairment.[14]

A meta-analysis of three randomised controlled trials in YOT2D demonstrated significant reductions in HbA_{1c} levels compared with placebo (short-term mean difference, −0.94%; 95% confidence interval [CI], −1.27 to −0.61; long-term mean difference, −0.93%; 95% CI, −1.36 to −0.49).[58] Fewer participants required rescue therapy or discontinued treatment because of a lack of efficacy. Rates of adverse and serious adverse events were similar to those observed with placebo. These findings support SGLT-2 inhibitors as an effective add-on therapy in YOT2D.[59]

Glucagon-like peptide-1 receptor agonists

Glucagon-like peptide-1 (GLP-1) receptor agonists have strong evidence for weight reduction, and their ability to increase insulin secretion, suppress glucagon secretion and enhance satiety makes them an attractive option for young people with diabetes and obesity. However, in YOT2D, daily liraglutide and weekly dulaglutide lowered HbA_{1c} levels but did not reduce BMI at the doses studied. Currently, GLP-1 receptor agonists are only TGA approved for use in adults aged 18 years and older with T2D.

Higher-dose liraglutide and semaglutide are effective treatments for adolescent obesity; however, conclusions regarding their efficacy in YOT2D remain limited because few participants with diabetes have been included in these studies. In the Semaglutide Treatment Effect in People with Obesity (STEP) TEENS trial, semaglutide 2.4 mg once weekly reduced BMI by 16.1% in adolescents with obesity. Semaglutide 2.4 mg may therefore be considered in young people with YOT2D and obesity that is refractory to lifestyle intervention.[59]

The adverse-effect profile of GLP-1 receptor agonists in YOT2D is similar to that observed in adults, with gastrointestinal symptoms being the most common adverse effects.[59]

Dual GIP/GLP-1 receptor agonist

To date, meaningful improvements in both adiposity and glycaemia in YOT2D have been demonstrated only with the dual incretin tirzepatide; however, current TGA approval in T2D is for use in adults aged 18 years and older. Tirzepatide lowers HbA_{1c} levels by 1.5 to 2.5%, depending on dose, and produces weight loss of 10 to 15%, offering substantially greater dual metabolic benefits than existing therapies for YOT2D.[55]

The long-term durability and safety of SGLT-2 inhibitors, GLP-1 receptor agonists and tirzepatide in YOT2D remain uncertain. However, extensive safety data from adults are reassuring, and these agents represent promising treatment options, either alone or in combination. Longer-term studies of incretin-based therapies are underway and are likely to further expand treatment options.

Medications not recommended in YOT2D

Sulfonylureas are currently not recommended in YOT2D because of the risk of hypoglycaemia, weight gain and potential beta-cell decline. Thiazolidinediones are not used because of the increased risk of fracture, heart failure and macular oedema reported in adults. Dipeptidyl peptidase-4 inhibitors are not efficacious in reducing HbA_{1c} in YOT2D.[60]

Summary

Understanding the complex pathophysiology of YOT2D and recognising its distinct subtypes can help clinicians develop personalised treatment plans for young people. Targeting weight loss remains central to reducing insulin resistance and may now involve the use of agents such as semaglutide or tirzepatide alongside lifestyle interventions to reduce adiposity. Expanding pharmacotherapy options, including SGLT-2 inhibitors, GLP-1 receptor agonists and the dual GIP/GLP-1 receptor agonist tirzepatide, provide meaningful improvements in glycaemic control and offer a more optimistic outlook for young people with YOT2D. Although many traditional therapies have shown limited long-term effectiveness in YOT2D, newer incretin-based therapies provide the first substantial dual benefits for both HbA_{1c} and adiposity. Cardiometabolic and renal complications commonly seen in YOT2D should be screened for and managed as part of holistic care in addition to adiposity and glycaemic management.

Building strong relationships with young people and their families, and involving them in shared decision making, can improve adherence, minimise adverse effects and optimise outcomes in this rapidly evolving therapeutic landscape. MT

References

A list of references is included in the online version of this article (https://medicinetoday.com.au/mt/2026/july/supplements/type-2-diabetes-in-youth).

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Technology and tools in youth-onset type 2 diabetes

Evidence, care and clinical practice

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Young people with type 2 diabetes present distinct challenges compared with adults with the disease and young people with type 1 diabetes. The use of digital health technologies and tools for this group requires careful attention to developmental stage, family context, school environment and equity, as well as ongoing involvement of the diabetes multidisciplinary care team.

Youth-onset type 2 diabetes (YOT2D) has a unique biology. Compared with adult-onset type 2 diabetes, it progresses more rapidly and is associated with a poorer prognosis, including earlier development of comorbidities such as hypertension, metabolic dysfunction-associated fatty liver disease, and psychological comorbidities, as well as earlier onset of vascular complications and premature mortality.[1,2] However, guidance specific to support the care of young people with YOT2D is limited. Evidence gaps are significant; most data are derived from adults with type 1 diabetes or type 2 diabetes, requiring cautious extrapolation to YOT2D. Poor adherence to treatment, inconsistent clinic attendance and loss to follow up, particularly after transition to adult care, are significant impediments to supporting care in YOT2D. As this is an aggressive condition, lack of engagement with the care team or GP may have an adverse impact on clinical outcomes. Models of care that include technology may help improve engagement and outcomes, as has been demonstrated in young people with obesity.[3]

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KEY POINTS

- Youth-onset type 2 diabetes (YOT2D) shares the biology of young-adult type 2 diabetes, with a more aggressive disease course, but developmental differences dictate how technology must be used.
- Technology and digital tools lack specific evidence for YOT2D, requiring evidence from adults with type 2 diabetes, or young people with type 1 diabetes or obesity, to be carefully adapted.
- Continuous glucose monitoring in YOT2D has possible benefits in family oversight and behaviour change, but it is not currently funded under the National Diabetes Services Scheme.
- Digital health tools – such as continuous glucose monitoring systems, wearable monitors, lifestyle apps and messaging support – require embedding into a structured framework with involvement from the young person, family and multidisciplinary team.
- Addressing social media health misinformation within the consultation is the youth-preferred and recommended method of preventing adverse health effects.
- Transitioning to adult care is a high-risk time for young people with diabetes. Technology can help, provided it is part of a structured framework that is commenced well before the transition.

Continuous glucose monitoring

The Royal Australian College of General Practitioners recommends that continuous glucose monitoring (CGM) should be considered for continual or intermittent use in all individuals with type 2 diabetes on intensive insulin therapy (multiple daily injections or insulin pumps), subject to individual factors and the availability of resources. Given that many young people with YOT2D require intensive insulin therapy, CGM is recommended. It may also be beneficial in specific groups not receiving intensive insulin therapy, including those who:

- do not perform adequate finger-prick blood glucose level monitoring for safe diabetes management
- have suboptimal diabetes management

- have suspected hypoglycaemia
- are undergoing treatment changes.[4]

Use of CGM and other technologies should account for school environments, varying self-management abilities and psychosocial factors (e.g. stigma, peer differences). Many schools do not permit students to carry mobile phones in the classroom, creating practical challenges for the use of smartphone-linked CGM devices and other digital apps. Acceptance of these digital tools by the young person and their peers, families and schools is as important as their clinical usefulness.

The evidence base for the benefits of CGM is overwhelmingly drawn from adults with type 2 diabetes, where modest benefits have been demonstrated in randomised controlled trials, particularly in insulin-treated patients compared with non-insulin-treated patients.[5] In Australia, CGM is not currently funded under the National Diabetes Services Scheme (NDSS) for type 2 diabetes in people of any age. Current private pricing for TGA-approved sensors are available on the manufacturers' websites.

The emerging evidence for CGM in young people with type 2 diabetes is discussed in a previous article by Middleton and Wong in the May 2026 issue of *Endocrinology Today*, and is briefly summarised here.[6] In YOT2D, studies have shown acceptability of CGM and improved quality of life, but it is too early to conclude any significant glycaemic benefit. Chesser and colleagues' 12-week pilot (n = 9; median age, 19.1 years; baseline glycated haemoglobin, 11.9%) found no glycaemic change, but the participants' quality of life improved and all those who completed the pilot wished to continue using CGM.[7] A subsequent pilot randomised controlled trial involving young adolescents (mean age, 15 years; glycated haemoglobin, 7.4%) found CGM to be feasible and well tolerated, but the study was not sufficiently powered to demonstrate an effect on glycaemia.[8] Wear time decreased from 71% to 38% by month 3 because of skin adhesion issues. The most common reason for declining participation was reluctance to wear the device.

There may be an opportunity to use CGM intermittently in young people with YOT2D to support family or individual behaviour change, with emerging evidence in the area. A practical takeaway is to set expectations with patients and family; CGM in this age group should be framed as a tool for engagement and behavioural insight.

A particular paediatric advantage of CGM is remote monitoring. In children with type 1 diabetes, parents can track glucose levels remotely during school, sport, excursions and camps, as well as overnight, which can meaningfully reduce parental anxiety.[9] This benefit, however, is built around hypoglycaemia avoidance and insulin titration. In non-insulin-treated YOT2D, the anticipated mechanism of benefit is behavioural rather than safety-driven, and so the same rationale does not transfer in whole. Remote monitoring may still reassure parents, but the clinical justification is weaker.

One further practical point is that not every CGM device on the market meets the accuracy standards GPs would assume. The December 2025 Australian Diabetes Society/Australian Diabetes Educators Association/Australasian Diabetes in Pregnancy Society/Australian and New Zealand Society for Paediatric Endocrinology and Diabetes/New Zealand Society for the Study of Diabetes consensus statement on CGM performance notes that regulatory oversight has eased in Australia and that unapproved devices can enter the New Zealand market without meeting recommended standards.[10] Clinicians should advise patients to use TGA-approved, NDSS-eligible systems and remain cautious about cheaper, direct-to-consumer sensors. With any sensor, accuracy can drift with sensor age, site of insertion, hydration status and glycaemia – finger-prick blood glucose levels should be favoured over CGM readings with any discrepancy. Furthermore, high-dose vitamin C (more than 500–1000 mg), paracetamol (above the recommended dose of 1000 mg every 6 hours), salicylic acid and hydroxyurea have been noted by various manufacturers to interfere with CGM readings; users and clinicians should check manufacturer user manuals for specific details.

Insulin pumps and automated insulin delivery

Evidence for insulin pump therapy and automated insulin delivery in type 2 diabetes remains limited across all age groups, and in children and adolescents with type 2 diabetes, the data are essentially absent. Family capacity to support insulin pump therapy is an additional prerequisite beyond individual patient suitability. Current expert opinion supports reserving these technologies for carefully selected patients with significant insulin deficiency or refractory hyperglycaemia, within specialist multidisciplinary settings.

Digital self-management tools

Children and adolescents with YOT2D share substantial clinical overlap with those managed in paediatric obesity programs: high rates of overweight and obesity, similar lifestyle goals and comparable psychosocial pressures. The digital health intervention evidence in paediatric obesity, although not directly applicable, offers several insights that translate meaningfully to this context.[3]

Tool selection should track developmental stage. Younger children should access parent-led, simple-interface programs, whereas adolescents can take on more self-directed tracking with gradually reduced parental oversight (Table).

Systematic reviews and meta-analyses of technology-based obesity interventions in children and adolescents consistently find that digital tools are the most effective as adjuncts to conventional care.[11,12] Parental involvement is among the strongest predictors of digital intervention success, particularly in younger children. One meta-analysis found that family engagement is specifically associated with improved outcomes in children younger than 12 years.[11] A rapid review of family-based digital interventions in primary school-aged children found meaningful improvements in dietary behaviour and

TABLE. ADAPTING DIGITAL TOOL SELECTION TO DEVELOPMENTAL STAGE IN YOUTH-ONSET TYPE 2 DIABETES

Developmental stage	Self-management capacity	Technology approach	Family or carer role	Key considerations
Young childhood (about 8–12 years of age)	• Limited • Parent-led	• CGM with remote parental monitoring • Simple family-facing apps	• Primary technology user • Plan for gradual handover	• Written diabetes management plan for school • Staff training required
Early adolescence (about 13–15 years of age)	• Developing • Shared	• CGM with shared access • Lifestyle apps chosen with young person	• Provide collaborative oversight • Negotiate data sharing	• Peer stigma risk • Discussion of discreet sensor placement • School nurse communication
Later adolescence (about 16–17 years of age)	• Increasing autonomy	• Adolescent-directed tools • Messaging-based support • Telehealth	• Step back without withdrawing • Begin transition preparation	• Identification of digital tools to continue in adult services

Abbreviation: CGM = continuous glucose monitoring.

physical activity when the family unit, rather than the child alone, was the target of the intervention.[12]

Engagement with digital health tools in adolescents is higher when the content is goal-directed, personalised and interactive; passive information delivery alone is consistently ineffective across this age group. App selection for YOT2D should be guided by these engagement principles, favouring tools that support goal-setting, provide immediate behavioural feedback and allow for clinician review of data.

Wearable activity monitors and lifestyle apps have an established evidence base extrapolated from paediatric obesity and physical activity data, rather than YOT2D specifically. Some notable examples were covered by Middleton and Wong in their article, noting that access and usage should be guided by appropriate clinician and family supervision.[6] Wearable wrist accelerometers provide real-time feedback on activity, sedentary time and sleep, whereas diet- and lifestyle-tracking apps can support food literacy and habit formation. Their main value lies in translating nonspecific lifestyle advice into measurable, achievable goals that can be reviewed regularly. As with CGM, engagement tends to decline without structured clinician review; therefore, these tools work best as an adjunct rather than a standalone intervention and should be introduced incrementally to avoid digital overload. Moreover, their clinical utility is heavily determined by the structured support framework in which they are embedded, rather than by the technology itself.

School integration: lessons from type 1 diabetes

Schools are key care environments for young people with diabetes, and written diabetes management plans are essential.[13] Although these plans are standard practice for young people with type 1 diabetes, management plans also need to be individualised for young people with YOT2D depending on their therapeutic and monitoring regimens. School staff should also be educated that type 1 diabetes and YOT2D are distinct conditions with different management needs.

School diabetes management plans are usually organised by the diabetes care team and include details of the treatment regimen (particularly if the young person is receiving insulin therapy), glucose targets and the use of technology, as well as an emergency plan with clear information on what to do and who to call when urgent action is needed. The plans are essential to ensure the student's wellbeing and ability to participate in school activities, without discrimination. The plans should be reviewed and revised as needed annually, particularly as treatment for YOT2D typically evolves over time.

It is now standard practice for healthcare teams to collaborate proactively with schools rather than leaving the responsibility to families. Parents and carers should not be expected to attend school regularly to support the student. Accordingly, school plans should clearly describe the young person's use of diabetes technologies and the responsibilities of school staff.

CGM use can reduce classroom disruption and enable external parental monitoring during school hours. Technical issues can arise with CGM (e.g. sensor dislodgement or error messages), but these are generally outweighed by the benefits of continuous glucose levels over finger-prick glucose testing. Peer support and peer-led education for young people with YOT2D likely have a role in improving care, with notable programs underway already among young Aboriginal and Torres Strait Islander people (such as those organised by the Menzies School of Health Research, available here: https://diabeteslifecourse.org.au/youth-diabetes/). Evidence from young people with type 1 diabetes suggests positive clinical, behavioural and psychosocial outcomes with peer-based interventions; however, the quality of the evidence is imprecise and may not be directly translatable to YOT2D.[14]

Technology-supported models of care

In paediatric practice, diabetes technologies must be implemented with the family as a primary participant. Shared access to CGM data by family members should be negotiated explicitly with the young person, with increasing adolescent autonomy over data sharing supported as they mature.

Multidisciplinary telehealth case conferencing offers a complementary and actionable mechanism for GPs. In adult cases of type 2 diabetes, structured multidisciplinary telehealth case conferencing has produced sustained reductions in glycated haemoglobin levels and cardiometabolic risk factors over three years of follow up in a multiethnic South Western Sydney population.[15] Given the high prevalence of psychological comorbidities in young people with YOT2D, embedding mental health review within the

same case conferencing structure could improve both engagement and continuity. Of note, Medicare rebates are provided for GPs and other healthcare professionals to organise, co-ordinate and participate in multidisciplinary case conferences.

As discussed in the review by Middleton and Wong in the May 2026 issue of *Endocrinology Today*, nurse-led telemedicine surveillance models are particularly well suited to paediatric settings, where the clinical complexity of managing diabetes during normal growth and development requires regular, low-intensity contact rather than infrequent specialist reviews.[6] These models are intended to extend, rather than replace, specialist paediatric and GP care, and their applicability to paediatric diabetes nursing teams warrants further investigation.

Social media is now a primary source of health information for adolescents with chronic disease. In one study involving young people with chronic conditions, nearly 95% of participants searched online for information and peer support, and 99% did not want clinicians present in those spaces.[16] Moreover, diabetes and nutrition content on platforms such as TikTok is frequently inaccurate, commercially driven and poorly sourced. The American Academy of Pediatrics recommends that clinicians proactively ask adolescents what health information they have seen on social media and whether they have questions about it, framing this as an opportunity to identify and correct misinformation within the consultation rather than outside it.[17]

A particularly high-risk manifestation of social media health misinformation in the context of YOT2D is the promotion of unregulated injectable peptides, such as counterfeit versions of approved glucagon-like peptide-1 receptor agonists and experimental agents such as retatrutide for weight loss and metabolic management. Clinicians managing young people with obesity or YOT2D should be aware of this phenomenon and its clinical risks, and their role in proactive patient counselling.

Transition to adult services

Transition to adult diabetes care, typically around the age of 16 to 18 years is a high-risk period for YOT2D, with a risk of loss to follow up and worsening glycaemia.[18] However, evidence specific to YOT2D transition is lacking, as structured transition programs are limited and underdeveloped. Ideally, transition should be to a multidisciplinary team with expertise in YOT2D, in close collaboration with the primary healthcare team. When a young person with YOT2D is transitioned to adult services, technology can be supportive to maximise engagement and minimise loss to follow up. This includes the young person providing the adult team with access to their CGM account (there are various programs depending on the CGM device). This enables the multidisciplinary clinic team to review the young person's CGM data. Simple measures include ensuring the young person provides the adult team with their mobile number and email address (not their parents' contact details). The young person should also know their Medicare details, NDSS number and MyGov account details.

Digital tools, such as text messaging reminders, can provide continuity across services and reduce disruption, while joint clinical or telehealth appointments and messaging support can ease transition. Social support from family members, support figures or peer support programs (which may be web-based) should complement this process.

Future directions

There are several priorities for future research and policy in the use of technology for YOT2D. Randomised controlled trials of digital health interventions specifically in children and adolescents with type 2 diabetes are the highest priority, as the evidence base currently relies on extrapolation from studies in adults or young people with other chronic conditions such as type 1 diabetes. Co-design with young people with YOT2D and their families is largely absent from existing research and should be a priority to more consistently produce interventions with greater engagement and perceived relevance than developer-led approaches.

Advocacy for NDSS funding of CGM in YOT2D is warranted. The Diabetes Australia 2024 Equitable Access to Diabetes Technology position statement recommends extending subsidies to people younger than 21 years and, specifically, young Aboriginal and Torres Strait Islander people with type 2 diabetes, a group with a 20-fold higher incidence than non-Indigenous young people.[19,20] Finally, culturally appropriate digital health interventions for Aboriginal and Torres Strait Islander young people with type 2 diabetes are an urgent and underserved research and policy priority.

Conclusion

YOT2D presents clinical and technological challenges that are distinct from those of adult type 2 diabetes and paediatric type 1 diabetes and cannot be adequately addressed by extrapolation from either evidence base. For clinicians, the central principle is that digital health tools such as CGM, wearable monitors, lifestyle apps and messaging support, derive their value from the structured framework in which they are embedded; without family engagement and clinician data review, they consistently underperform. CGM is currently a tool for behavioural insight and family oversight rather than a glycaemic intervention, and GPs should set expectations accordingly while advocating for NDSS funding that would make access more equitable. Across all domains, the evidence base is nascent; randomised controlled trials conducted specifically in children and adolescents with type 2 diabetes, co-designed with young people and families, are urgently needed, as are culturally grounded digital health tools for Aboriginal and Torres Strait Islander young people, who carry a disproportionate burden of this disease. MT

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A list of references is included in the online version of this article (https://medicinetoday.com.au/mt/2026/july/supplements/type-2-diabetes-in-youth).

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Adolescent obesity

Tailoring interventions to address hormonal and metabolic considerations

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Adolescent obesity is a chronic, biologically driven condition. Understanding hormonal and neuroendocrine mechanisms allows GPs to deliver tailored, effective care incorporating behavioural strategies, multidisciplinary care, pharmacotherapy and dietitian referral.

Adolescent obesity, defined as a body mass index (BMI) adjusted for age and sex that is at or above the 95th percentile, is recognised as a chronic disease of energy regulation rather than a simple behavioural issue.[1] The prevalence remains high, with overweight and obesity affecting at least one in four adolescents in Australia, including 8% living with obesity.[2] Public health campaigns and community-based healthy lifestyle programs (e.g. Go4Fun in New South Wales and similar initiatives) play an important role in supporting obesity prevention and early intervention. Early-onset complications, including type 2 diabetes, metabolic dysfunction-associated steatotic liver disease (MASLD) and cardiovascular risk factors, are commonly encountered in general practice during adolescence.[3] Importantly, cardiometabolic risks may be reversed if obesity is resolved before adulthood.[4]

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KEY POINTS

- Adolescent obesity is a chronic, biologically regulated disease that requires long-term, patient-centred management rather than a sole focus on weight loss.
- GPs play a key role in identifying obesity-related comorbidities early and providing ongoing, family-based behavioural support tailored to the adolescent's developmental stage.
- Behavioural interventions remain the foundation of treatment, with dietitian-led care and more intensive interventions considered when first-line management is insufficient.
- Glucagon-like peptide-1 receptor agonists may be appropriate for selected adolescents with persistent or severe obesity, but these should be used as part of a comprehensive multidisciplinary management plan.
- Regular follow up, attention to weight stigma and realistic goal-setting are essential to improving engagement and supporting sustainable long-term health outcomes.

Advances in understanding the neuroendocrine regulation of appetite, metabolism and energy expenditure have reframed obesity as a biologically defended condition, shaped by hormonal signalling, environmental exposure and developmental stage.[3] This helps explain a common clinical challenge: adolescents who appear motivated and engaged but struggle to sustain weight loss.

For GPs, this shift has practical implications. Management should move beyond short-term weight reduction towards longitudinal, individualised care that targets the underlying drivers of obesity. A recommended approach for adolescent obesity management is discussed in this article and outlined in the Flowchart.

How and why do adolescents present?

Adolescents usually do not present with obesity as the primary complaint. More often, weight gain is identified incidentally or in the context of related concerns such as fatigue, low mood, sleep disturbance or menstrual irregularity.

Puberty is a crucial window. Hormonal changes, including increased levels of growth hormone, sex steroids and insulin-like growth factor, may alter appetite, body composition and metabolism.[5] At the same time, insulin sensitivity declines physiologically. In adolescents with obesity, this decline is greater and may persist, contributing to ongoing weight gain and metabolic risk.

Behavioural changes compound these effects. Common features include:

- irregular eating patterns and increased autonomy over food choices
- reduced sleep duration and disrupted circadian rhythms
- increased sedentary, screen-based activity
- decreased physical activity
- mood changes, low self-esteem, bullying and peer pressure.

These biological and behavioural changes interact, accelerating weight gain and reinforcing the need for early intervention.

Hormonal and metabolic drivers: what GPs need to understand

Obesity reflects dysregulation of a complex neuroendocrine system controlling appetite and energy balance.

At a central level, hypothalamic pathways integrate signals from:

- leptin (largely secreted by adipose tissue)
- insulin
- gut-derived incretin hormones, such as glucagon-like peptide-1 (GLP-1) and glucose-dependent insulinotropic polypeptide.

These systems regulate hunger and energy expenditure but also defend a biological set point. When weight is reduced, compensatory responses are triggered, including increased appetite and decreased metabolic rate.[3]

Adipose tissue further contributes as an active endocrine organ, releasing adipokines and inflammatory mediators that impair insulin signalling and drive metabolic dysfunction.[6] Over time, this promotes insulin resistance, dyslipidaemia and MASLD.

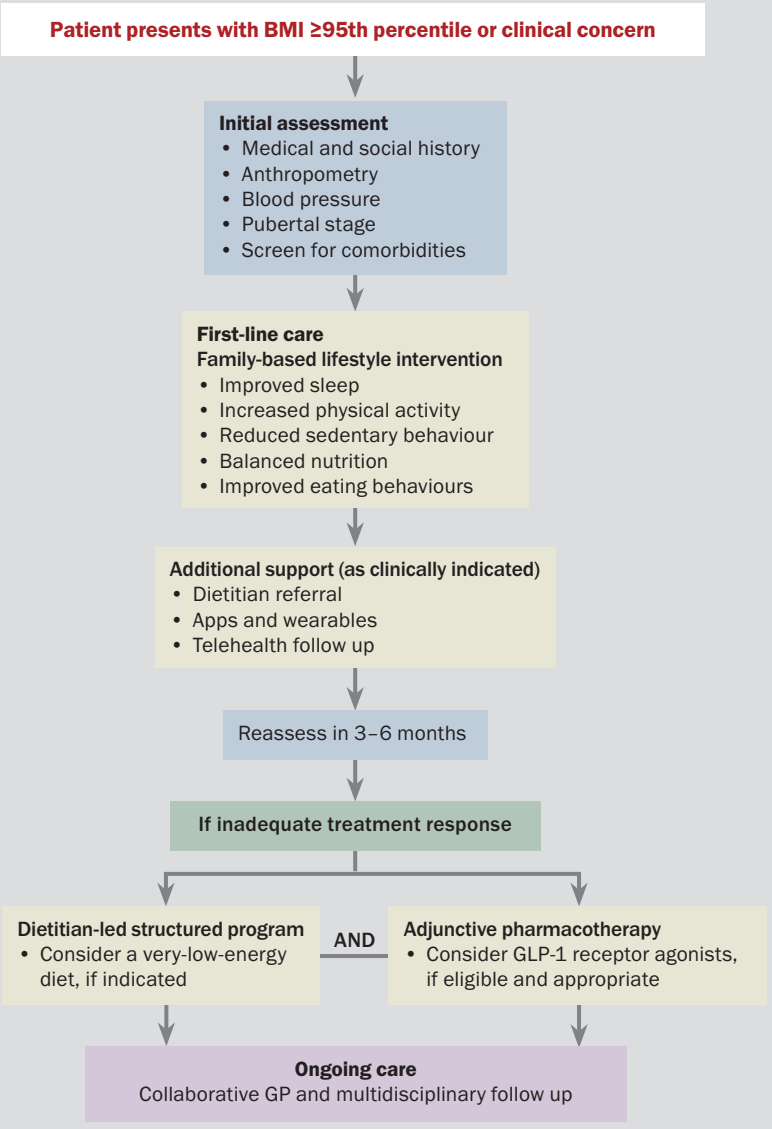
Puberty amplifies these processes through transient insulin resistance.[5] In adolescents with obesity, this physiological change becomes exaggerated and may not fully resolve.

Sleep is a key but often overlooked factor. Short or irregular sleep is associated with:

- increased levels of ghrelin (the 'hunger hormone')
- reduced leptin signalling
- worsening insulin sensitivity
- increased risk of mental health problems and low motivation
- reduced physical activity.

Addressing sleep is therefore a practical intervention that aligns directly with underlying hormonal pathways.

RECOMMENDED TREATMENT ALGORITHM FOR ADOLESCENTS WITH OBESITY



Abbreviations: BMI = body mass index; GLP-1 = glucagon-like peptide-1.

1. COMMON COMORBIDITIES OF ADOLESCENT OBESITY

- Type 2 diabetes and prediabetes
- Dyslipidaemia
- Metabolic dysfunction-associated steatotic liver disease
- Obstructive sleep apnoea
- Hypertension
- Polyendocrine metabolic ovarian syndrome
- Mental health disorders (e.g. depression, anxiety, disordered eating)

What must not be missed

Although most adolescent obesity is multifactorial, secondary causes should be excluded when clinically indicated, including hypothyroidism, Cushing's syndrome or rarer genetic causes of obesity. Clinical features suggestive of pathological causes of obesity may include poor linear growth, developmental delay, dysmorphic features, severe hyperphagia, early-onset obesity (<5 years of age) or pubertal abnormalities.

More commonly, GPs should actively identify comorbidities, which are often under-recognised. Common comorbidities of adolescent obesity are outlined in Box 1. Particular attention should be given to coexisting mental health disorders; depression, anxiety and disordered eating frequently coexist and may significantly impact engagement with treatment.

Initial assessment

A collaborative, nonjudgmental approach to an initial assessment (and on an ongoing basis) is crucial. Weight stigma can be a barrier to care and may reduce engagement, trust and follow up. GPs should use respectful, person-centred language and provide a safe, nonjudgmental clinical environment.

Assessment should be structured but pragmatic. The BMI percentile should be assessed.[7] Clinicians should also assess for clinical obesity, including evaluation of blood pressure, pubertal stage, sleep patterns, family environment and eating behaviours, and mental health.[1]

Suggested investigations include:

- glycated haemoglobin
- fasting glucose
- lipid profile
- liver function tests.

Assessment should be repeated over time rather than viewed as a one-off screen. Fasting insulin levels should not be routinely measured to screen or diagnose insulin resistance in adolescents with obesity, as they do not reliably differentiate between adolescents with normal versus impaired glucose tolerance. Other investigations may be indicated depending on the clinical scenario.

Practical management: tailoring the intensity of intervention

Management of adolescent obesity is most effective when delivered using a stepped-care approach, with progression in intensity based on severity, comorbidities and response to treatment. This is particularly important given that many adolescents may not be appropriate candidates for pharmacotherapy because of age, access or preference.

First-line: structured behavioural and family-based intervention

Initial management should focus on sustainable changes within a family-based behavioural approach, as evidence is strongest for interventions that actively involve caregivers. Adolescent engagement is crucial, with evidence showing that management is more effective when goals are realistic and negotiated.[8] Key components include:

- establishing regular, culturally appropriate meal patterns and reducing grazing
- improving sleep consistency and duration
- reducing the intake of energy-dense, nutrient-poor foods
- increasing physical activity through enjoyable, achievable activities.

Escalation: intensive dietary interventions

For adolescents who do not respond adequately to first-line care, escalation to more structured, intensive dietary intervention is appropriate. Escalation may be appropriate for:

- adolescents who cannot access GLP-1 receptor agonist therapy because of cost
- patients with moderate to severe obesity
- patients with emerging metabolic complications.

Dietitian-led interventions allow for individualised, developmentally appropriate care, addressing both nutritional intake and eating behaviours. Common evidence-based approaches include:

- structured meal plans with defined portions and macronutrient balance
- a reduction in the intake of ultra-processed foods, targeting energy density and satiety
- family-based behavioural programs, through which caregivers implement environmental change
- very-low-energy diets in selected adolescents with severe obesity, under specialist multidisciplinary supervision.

More intensive, individualised approaches can produce meaningful short-term reductions in weight and metabolic risk, particularly when combined with behavioural support. However, they require careful monitoring to ensure nutritional adequacy and to support adherence.

Other possible referrals

Bariatric surgery may be an appropriate treatment option for selected adolescents with severe obesity when delivered within a multidisciplinary, stepped-care model. However, access remains very limited in Australia, with procedures performed infrequently and very limited availability within the public health system.

Referral to mental health services, social work, exercise physiology, physiotherapy, sleep medicine or other specialist services may also be indicated based on the adolescent's clinical, psychosocial and family needs.

The role of the dietitian

Dietitians play a central role in adolescent obesity management and should be involved early in care, particularly if more intensive intervention is required. Dietitians can:

- tailor dietary strategies to developmental stage and family context
- address maladaptive eating patterns (e.g. binge eating, irregular meals, grazing)
- support the implementation of structured diets
- monitor nutritional adequacy and eating disorder risk during intensive interventions, particularly during pharmacotherapy
- support the management of side effects of pharmacotherapy (e.g. gastrointestinal upset, dehydration)
- provide ongoing behavioural support.

A GP may refer an adolescent to a dietitian through:

- Medicare-funded allied health visits under a chronic disease management plan
- private referral, if appropriate
- multidisciplinary paediatric weight management services.

Integrating treatment pathways in general practice

In practice, management often involves combining approaches rather than progressing linearly. A typical pathway may involve:

- initial GP-led assessment and brief intervention
- early referral to a dietitian for structured dietary support
- use of digital tools to improve engagement
- escalation to more intensive dietary approaches if progress is limited
- referral to other allied health professionals, such as a clinical psychologist, exercise physiologist, social worker, sleep specialist or paediatrician
- consideration of pharmacotherapy, if appropriate.

This flexible, patient-centred approach allows care to be tailored to the individual adolescent, while recognising obesity as a chronic, relapsing condition.

Pharmacotherapy in adolescent obesity: where it fits

Pharmacotherapy is best understood as part of a stepped-care model. It may be considered for adolescents with persistent obesity despite structured behavioural intervention, particularly when obesity-related comorbidities are present (Box 2). It may also be considered in adolescents with severe obesity or significant comorbidities, if earlier treatment is clinically indicated, and need not be deferred until behavioural intervention alone has been shown to be insufficient. Decisions should be individualised and made within a broader multidisciplinary plan.

Among the available options, incretin therapies such as GLP-1 receptor agonists are the main emerging therapy in adolescent obesity because they target the neuroendocrine pathways that regulate appetite.[9] Metformin may be considered, primarily for the management of clinical insulin resistance, prediabetes or polyendocrine metabolic ovarian syndrome.

In adolescents, these agents are typically considered in those with:

- severe obesity, defined as a BMI 120% or greater of the age- and sex-specific 95th percentile, indicating a BMI substantially above the standard obesity threshold
- obesity with significant weight-related comorbidities, such as prediabetes, type 2 diabetes, MASLD, obstructive sleep apnoea or hypertension
- persistent obesity despite structured behavioural and dietitian-led intervention.

Evidence of glucagon-like peptide-1 receptor agonists in adolescents

The strongest evidence comes from the Semaglutide Treatment Effect in People with Obesity (STEP) TEENS trial, in which once-weekly semaglutide 2.4 mg delivered subcutaneously, combined with behavioural intervention, resulted in an average BMI reduction of about 16% over 68 weeks, compared with minimal change with placebo.[10] Improvements in cardiometabolic risk markers were also observed. The effects of GLP-1 receptor agonists include enhanced satiety, reduced hunger and improved insulin sensitivity, which are particularly relevant in adolescence, when puberty-related

2. PHARMACOTHERAPY IN ADOLESCENT OBESITY: WHEN TO CONSIDER IT

Consider pharmacotherapy when:

- obesity persists despite structured behavioural and dietitian-led care
- severe obesity is present, particularly body mass index ≥120% of the 95th percentile
- significant weight-related comorbidities are present (e.g. type 2 diabetes, metabolic dysfunction-associated steatotic liver disease, obstructive sleep apnoea, hypertension)
- earlier escalation is needed because of clinical severity
- biochemical evidence of prediabetes (HbA_{1c} 6.0–6.4% or impaired fasting glucose 5.6–6.9 mmol/L)

Do not use pharmacotherapy:

- as a substitute for behavioural, nutritional and family-based care
- when age, developmental context or family preference make treatment unsuitable
- when access or cost barriers preclude treatment

Before and during treatment:

- confirm goals, comorbidities and readiness for long-term therapy
- discuss adverse effects and titrate treatment gradually to improve tolerability
- arrange screening blood tests before commencement (fasting glucose; HbA_{1c}; electrolytes, urea and creatinine; estimated glomerular filtration rate; liver function tests; lipids; thyroid function tests)
- monitor nutritional adequacy, hydration, growth and psychological wellbeing
- review adherence, injection burden and family capacity to support treatment
- set realistic expectations, including variable response and the possibility of weight regain after stopping

Abbreviation: HbA_{1c} = glycated haemoglobin

hyperphagia and disrupted satiety signalling can drive ongoing weight gain.

In practice, GLP-1 receptor agonists are:

- used within a multidisciplinary framework
- combined with behavioural and family-based interventions
- framed as long-term therapy rather than a short-term solution.

Findings from a recent systematic review and network meta-analysis of 42 randomised clinical trials, including 3835 participants, found that the most effective treatment for weight management in children and adolescents was a combined pharmacotherapy and behavioural treatment approach, superior to pharmacotherapy monotherapies.[11] This finding highlights the importance of continued behavioural therapies. It is important to note there are limited long-term safety data for adolescent populations. There is also no established optimal duration of therapy, and weight regain occurs following treatment discontinuation.

Practical prescribing considerations

Incretin-based therapies, such as GLP-1 analogues, should be prescribed within a comprehensive care plan rather than as standalone treatment. In general practice, this means shared decision-making through clarifying goals, reviewing comorbidities and ensuring that behavioural, nutritional and family-based supports remain in place throughout treatment (Box 2). Consultation with a paediatrician or with multidisciplinary paediatric weight management services may be appropriate when initiating therapy. When considering incretin-based therapy, some key factors include:

- confirming that pharmacotherapy is being used as an adjunct to structured behavioural care, rather than as a substitute
- discussing likely adverse effects, particularly nausea, vomiting, abdominal discomfort and constipation, and the use of gradual dose escalation to improve tolerability
- monitoring nutritional intake, hydration and overall adequacy to support ongoing growth, including sufficient lean protein intake to help preserve muscle mass during marked appetite suppression or rapid weight loss
- screening for psychological vulnerability, including body image concerns, anxiety, depression and disordered eating behaviours, with ongoing monitoring for emerging psychological concerns
- reviewing adherence, injection tolerance and burden, and family capacity to support regular administration and follow up, including consideration of exposure therapy for injection anxiety
- setting realistic expectations, including that weight loss is gradual, response varies and regain may occur if treatment is discontinued
- confirming that there is no personal or family history of thyroid cancer or pancreatitis.

Regular review is important to assess tolerability, the trajectory of weight change, metabolic markers and broader wellbeing. Ongoing treatment decisions should consider the clinical benefit, adverse effects, adherence, cost and adolescent's developmental context. Oral semaglutide, approved by the US Food and Drug Administration for adults with obesity and type 2 diabetes, may be a future option for the management of adolescent obesity.

Australian access and PBS context

GPs are increasingly managing requests for incretin therapies and need clear, realistic discussions with adolescents and families about indications, expected benefits, access barriers and the need for long-term follow up.

However, many adolescents will not receive incretin therapy (e.g. GLP-1 receptor agonists) because of:

- the lack of PBS access for adolescent obesity treatment
- cost barriers in private prescribing for some families
- younger age or developmental concerns
- patient or family preference.

Recent Australian data suggest a marked increase in GLP-1 receptor agonist use, including substantial private prescribing for obesity.[12] Although semaglutide has TGA approval for use in adolescents with obesity, PBS access is currently restricted to adolescents and adults with type 2 diabetes or other indications, although the policy is evolving.[13,14] Tirzepatide, a combined glucose-dependent insulinotropic polypeptide/GLP-1 receptor agonist, is not approved for children and adolescents younger than 18 years of age.

In adolescents who are not eligible for or do not wish to use pharmacotherapy, intensive behavioural and dietitian-led interventions remain the cornerstone of care and should be optimised before further escalation.

Follow up

Adolescent obesity requires ongoing care. Regular follow up enables monitoring, support and adjustment of management strategies. Short, frequent consultations are often more effective than infrequent longer visits. Addressing stigma remains crucial. Using neutral language and focusing on health, rather than weight alone, improves engagement and therapeutic relationships.

Conclusion

Adolescent obesity is a chronic, biologically driven condition shaped by hormonal, metabolic and behavioural factors.

By integrating an understanding of neuroendocrine mechanisms with practical, patient-centred strategies, including behavioural intervention and emerging pharmacotherapy, GPs play a central role in improving long-term outcomes for adolescents. MT

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A list of references is included in the online version of this article (https://medicinetoday.com.au/mt/2026/july/supplements/type-2-diabetes-in-youth).

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