Episode 91 – Diabetes – Part 1: Overview

August 25, 2023

Introduction

Diabetes mellitus[1] is a serious, chronic disease characterized by elevated blood glucose concentrations due to impairment of insulin secretion, defective insulin action, or both. It is a leading cause of death and disability globally, and affects individuals regardless of country, age, or sex. Diabetes poses many challenges for those with the disease, their families, and communities, and has various implications for healthcare systems.

In 2021, based on data from 204 countries and territories, there were an estimated 529 million individuals with diabetes worldwide, a number projected to grow to over 1.31 billion by 2050. The age-standardized global diabetes prevalence was 6% in 2021 and is anticipated to increase to ~10% in 2050. This increase is expected to be driven by increases in type 2 diabetes. In 2021, type 2 diabetes accounted for 90% of all diabetes cases. It also accounted for 95% of the diabetes disability-adjusted life-years (DALYs).[2]

Type 2 diabetes is largely preventable and, in some cases, potentially reversible if identified and managed early. The increasing prevalence of type 2 diabetes is primarily from a rise in obesity caused by multiple factors. Current trends suggest obesity rates are likely to continue to climb. [1]

Major behavioural shifts and changes in food systems contributing to high body mass index (BMI) include greater availability of high-calorie products; limited financial and proximal access to healthy food options; increased consumption of fat, sugar, animal products, and ultra-processed foods; and reduced physical activity related to global work and transportation trends. Other attributable risk factors for type 2 diabetes include environmental and occupational risks, and tobacco and alcohol use. Preventing and controlling type 2 diabetes remains an ongoing challenge. [1]

Childhood diabetes is an increasing global health challenge with rising incidence. An analysis by Zhang et al. 2023, which included 1,449,897 children, showed in 2019 there were 227,580 cases of childhood diabetes worldwide, resulting in 5,390 deaths and 519,117 DALYs; and a 39% increase in incident cases of diabetes since 1990. [2]

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[1] The term diabetes mellitus is often used to distinguish this disorder from diabetes insipidus. Diabetes insipidus is a relatively rare disorder that does not affect blood glucose levels but causes increased urination (polyuria) and extreme thirst (polydipsia).

[2] Diabetes disability-adjusted life-years (DALYs) is the sum of years of life lost due to premature death plus the years lived with disability.

Diabetes represents a substantial burden to healthcare systems resulting in health expenditures of $966 billion USD globally in 2021, forecast to reach more than $1,054 billion USD by 2045. Estimates for the global type 2 diabetes drugs market over the next decade vary widely, with some reaching more than $100 billion USD. [1] [3]

Estimated prevalence in Canada [4]

Diabetes prevalence	2022	2032
Type 1 + type 2 diagnosed + type 2 undiagnosed	5,719,000 / 14%	7,277,000 / 17%
Type 1 and type 2 diagnosed	4,003,000 / 10%	5,094,000 / 10%
Type 1	5-10% of diabetes prevalence	
Type 1 + type 2 diagnosed + type 2 undiagnosed and prediabetes combined	11,704,000 / 30%	13,965,000 / 33%
Increase in type 1 and type 2 diagnosed, 2022-2032	27%	

Diabetes prevalence in Canada is increasing at an average rate of 3% per year. This upward trend is expected to continue in the coming decades with Canada's aging population, leading to increasing comorbidities and complications, and greater demand on healthcare systems. It costs the Canadian healthcare system $30 billion per year to treat diabetes. Among Canadians with type 2 diabetes, 33% do not feel comfortable disclosing their disease to others. [4] [5]

According to data from 2017-2018, just over 25,000 children and youth were living with diagnosed diabetes in Canada. Each year, >3,000 individuals aged 1-19 years are newly diagnosed with diabetes. The incidence of type 1 and type 2 diabetes is expected to rise, by 3-fold and by 4-fold, respectively, in youth in the coming decades. [5]

Out-of-pocket cost in Canada[3] [4]

Out-of-pocket cost per year*	
Type 1 diabetes on multiple daily insulin injections	$1,100–$2,600
Type 1 diabetes on insulin pump therapy	$1,400–$4,900
Type 2 diabetes on oral medication	$1,200–$1,900

* Based on estimates from 2015 data

Estimated prevalence in Ontario [6]

Diabetes prevalence	2022	2032
Type 1 + type 2 diagnosed + type 2 undiagnosed	2,346,000 / 15%	2,953,000 / 17%
Type 1 and type 2 diagnosed	1,643,000 / 10%	2,067,000 / 12%
Type 1	5-10% of diabetes prevalence	
Type 1 + type 2 diagnosed + type 2 undiagnosed and prediabetes combined	4,713,000 / 30%	5,642,000 / 33%
Increase in type 1 and type 2 diagnosed, 2022-2032	26%	
Direct cost to the health care system	$1.7 billion	$2.1 billion

[3] For many Canadians with diabetes, cost affects treatment adherence. Most Canadians with diabetes pay >3% of their income or >$1,500/year for prescribed medications and supplies out-of-pocket. [4]

Out-of-pocket cost in Ontario [6]

Out-of-pocket cost per year*	
Type 1 diabetes on multiple daily insulin injections	$1,100–$2,300
Type 1 diabetes on insulin pump therapy	$500–$1,700
Type 2 diabetes on oral medication	$200–$1,900

* Based on estimates from 2015 data

Types of diabetes

The three main types of diabetes include type 1, type 2, and gestational diabetes. Other types are rare and are associated with:

- Genetic mutations (e.g., monogenic diabetes caused by genetic defects in beta cell [β-cell] function).
- Diseases of the exocrine pancreas (e.g., cystic fibrosis[4]) and other diseases.
- Drug exposure (e.g., glucocorticoids, drugs to treat HIV/AIDS, atypical antipsychotics).

Approximately 90% of diabetes cases are type 2, 9% are type 1, and <1% account for gestational and other types of diabetes. In all types of diabetes, the pancreas does not produce enough insulin or the body cannot effectively use the insulin it produces (i.e., insulin resistance). Each type of diabetes may differ in its potential causes, prognosis, and treatment. [5]

Type 1 diabetes

Type 1 diabetes (previously known as insulin-dependent, juvenile, or childhood-onset) is an autoimmune disease characterized by deficient or no insulin production. Daily insulin injections are required. It most often develops in childhood and symptoms frequently begin abruptly and dramatically. Currently, the cause and means to reduce the risk of acquiring type 1 diabetes are not known. [5] [7]

Several viruses (e.g., coxsackievirus, rubella virus, cytomegalovirus, Epstein-Barr virus, retroviruses) have been linked to type 1 diabetes onset. Viruses may directly infect and destroy β-cells, or they may indirectly cause β-cell destruction. [8]

Type 2 diabetes

Type 2 diabetes (formerly called noninsulin-dependent diabetes or adult-onset diabetes) occurs when the pancreas does not produce enough insulin or when the body becomes insulin resistant. It is often preventable. Daily insulin injections may be required. [5]

Although type 2 diabetes has historically been viewed as an adult disease, it has been on the rise globally in children and youth for the last two decades due to the rise in childhood obesity. [5]

[4] Refer to Episode 83 for additional information on cystic fibrosis and diabetes.

Clinical features for type 1 and type 2 diabetes [9]

Clinical features	Type 1	Type 2
Age of onset	Most <25 years but can occur at any age (but not before the age of 6 months)	Usually >25 years but incidence increasing in adolescents, paralleling increasing rate of obesity in youth
Weight	Usually thin, but with obesity epidemic, can have overweight or obesity	>90% at least overweight
Islet autoantibodies	Usually present	Absent
C-peptide[5]	Undetectable/low	Normal/high
Insulin production	Absent	Present
First-line treatment	Insulin	Noninsulin antihyperglycemic agents, gradual dependence on insulin may occur
Family history of diabetes	Infrequent (5-10%)	Frequent (75-90%)
Diabetic ketoacidosis	Common	Rare

Gestational diabetes

Gestational diabetes is blood glucose values above normal but below values diagnostic of diabetes. Gestational diabetes develops during pregnancy and usually disappears after delivery. Three to 20% of pregnant individuals develop gestational diabetes. They are at an increased risk of complications during pregnancy and at delivery. They and possibly their children are also at increased risk of type 2 diabetes in the future. Gestational diabetes is diagnosed through prenatal screening, rather than through reported symptoms because often there are no signs or symptoms. [10] [11] [12]

Prediabetes

Prediabetes refers to blood sugar levels that are higher than normal, but not yet high enough to be diagnosed as type 2 diabetes. Prediabetes occurs when there is impaired fasting glucose, impaired glucose tolerance, or A1C[6] of 6-6.4%, each of which places individuals at increased risk of developing type 2 diabetes and its complications. Approximately, 50% of individuals with prediabetes will transition to type 2 diabetes. Individuals with prediabetes usually do not have any signs or symptoms. [9] [13]

Metabolic syndrome

Prediabetes and type 2 diabetes are often manifestations of an underlying disorder, including metabolic syndrome, a highly prevalent, multifaceted condition characterized by a variety of conditions, including abdominal obesity, hypertension, dyslipidemia, and elevated blood glucose. Individuals with the metabolic syndrome are at significant risk of developing cardiovascular disease (CVD).[7] While metabolic syndrome and type 2 diabetes often coexist, those with metabolic syndrome without diabetes are at substantial risk of developing diabetes. [9]

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[5] C-peptide test measures the level of C-peptide in a blood or urine sample. Measuring C-peptide is an accurate way to determine how much insulin the body is making. [41]

[6] A1C, also called hemoglobin A1C (HbA1c), is an estimate of the average levels of blood glucose over the last three months.

[7] Refer to Episodes 79, 80, and 81 for additional information on cardiovascular disease.

Diabetes symptoms

Diabetes symptoms depend on the elevation of blood glucose. Symptoms of type 2 diabetes can be mild and may take several years to be noticed. As a result, the disease may be diagnosed several years after onset, after complications have already arisen. In type 1 diabetes, symptoms tend to come on quickly and be more severe. [10] [14]

Symptoms of diabetes may include:

- Polydipsia (increased thirst)
- Polyuria (frequent urination)
- Polyphagia (extreme hunger)
- Unintentional weight loss
- Blurred vision
- Fatigue
- Nausea
- Decreased endurance during exercise
- Feeling irritable or having other mood changes
- Slow wound healing
- Frequent infections, foot ulcers, fungal infections
- Numbness or tingling in the feet or hands
- Acanthosis nigricans[8]
- Numerous skin tags (e.g., on neck, armpit, eyelids, groin) [15] [16]

Complications associated with diabetes

Years of poorly controlled hyperglycemia with type 1 or type 2 diabetes can lead to multiple complications, including vascular disease affecting small and large blood vessels, neuropathy, and immune dysfunction. However, because type 2 diabetes may be present for some time before it is diagnosed, complications in type 2 diabetes may be more serious or more advanced when discovered. Controlling blood glucose levels makes these complications less likely to develop or worsen. [17]

[8] Acanthosis nigricans is a dark patch of velvety skin (e.g., on neck, armpits, groin); often a sign of prediabetes

Complications of diabetes [14] [15] [17] [18] [19] [20] [21] [22] [23] [24]

Condition	Description	Complications / symptoms
Vascular disease	Long-term high glucose levels cause narrowing of small and large blood vessels via: • Complex sugar-based substances build up in the walls of small blood vessels, causing them to thicken and leak. • Dyslipidemias that commonly accompany diabetes results in atherosclerosis.	Vascular disease can lead to: • Angina, heart failure, myocardial infarction, stroke • Peripheral artery disease, which can lead to claudication (leg cramps during walking) • Retinopathy (which can lead to blindness) • Nephropathy (kidney disease) • Skin breakdown, which can lead to ulcers and infections in feet and legs, slow wound healing or wounds that do not heal, which can become infected. This can result in gangrene (tissue death) and osteomyelitis (bone infection). Amputation of the foot or part of the leg may be needed.
Neuropathy	Elevated glucose levels can cause neuropathy (nerve damage)	Neuropathy can cause: • Decreased sensation (mainly in the feet and legs) • Orthostatic hypotension • Exercise intolerance • Resting tachycardia • Dysphagia (swallowing difficulties) • Nausea and vomiting due to gastroparesis (a disorder that slows or stops the movement of food from the stomach to the small intestine • Erectile dysfunction
Immune dysfunction	Increased susceptibility to infections due to adverse effects of hyperglycemia on granulocyte and T-cell function.	Immune dysfunction increases risk of: • Bacterial infections • Fungal infections (e.g., oral and vaginal candidiasis) • Surgical site infections • Severe illness, hospitalization, or dying from COVID-19[9]

[9] In July 2023, Public Health Agency of Canada released guidance from the National Advisory Committee on Immunization (NACI) on COVID-19 vaccine use. Beginning in the fall of 2023, NACI recommends a dose of the new formulation of COVID-19 vaccine for individuals in the authorized age groups who have previously received a COVID-19 vaccine, if it has been at least six months since the last COVID-19 vaccine dose, or known SARS-CoV-2 infection (whichever is later). Immunization is important for those at increased risk of COVID-19 infection or severe disease, including: adults ≥65 years; residents of long-term care homes and other congregate living settings; individuals with medical conditions putting them at high risk of severe COVID-19 (e.g., type 1 or type 2

Condition	Description	Complications / symptoms
Fatty liver disease	Abnormal fat deposits collect in the liver.	May progress to more serious liver disease including cirrhosis.
Musculoskeletal disorders	Glucose is not used normally, causing tissues to thicken or contract increasing risk of certain musculoskeletal disorders.	Musculoskeletal disorders more common in diabetes includes: • Muscle infarction • Carpal tunnel syndrome • Dupuytren contracture (progressive tightening of fascia inside the palms, causing the fingers to curl in eventually resulting in a clawlike hand).
Depression	Both type 1 and type 2 increase risk of developing depression. Depression increases risk of developing type 2 diabetes.	Though the relationship between diabetes and depression is not fully understood: • Managing diabetes can be stressful and lead to symptoms of depression. • Diabetes can cause complications and health problems that may make symptoms of depression worse. • Depression can lead to harmful life decisions, such as unhealthy eating, inactivity, smoking, weight gain, all risk factors for diabetes. • Depression can make it difficult to successfully manage diabetes.
Dementia	Risk factors for type 2 diabetes are also risk factors for dementia, including obesity, high cholesterol, hypertension	Type 2 diabetes can be a risk factor for Alzheimer's disease, vascular dementia, and other types of dementia.
Obstructive sleep apnea	Common in individuals with type 2 diabetes.	Obesity may be the main contributing factor to both diabetes and obstructive sleep apnea.
Periodontal disease	Bidirectional relationship between type 2 diabetes and periodontitis exists. Diabetes can promote the progression of periodontitis. Conversely, periodontitis is a risk factor for worsening glycemic control and may increase the risk for diabetes complications.	Type 2 diabetes influences periodontitis initiation and progression by causing a hyperinflammatory response, impairing bone repair processes, and producing advanced glycation end products. Periodontitis can cause interleukin-6 (IL-6), tumour necrosis factor alpha (TNF-α), and C-reactive protein (CRP) levels to increase, resulting in increased systemic inflammation, which contributes to insulin resistance.

diabetes); individuals who are pregnant; individuals in or from First Nations, Métis, and Inuit communities; members of racialized and other equity-deserving communities; and individuals who provide essential community services. Vaccine manufacturers are developing updated formulations of COVID-19 vaccines to provide better protection against currently circulating variants. [42]

Condition	Description	Complications / symptoms
Diabetic ketoacidosis	Acute complication of diabetes that occurs mostly in type 1 diabetes. However, rarely, some individuals with type 2 diabetes develop ketoacidosis. Diabetic ketoacidosis is sometimes the first sign that individuals (usually children) have developed diabetes. Ketoacidosis can occur from: • Individuals stop taking their insulin • An illness stresses the body increasing the body's need for more energy, thus more insulin to move glucose into the cells. If extra insulin is not taken, they can develop diabetic ketoacidosis. • Some medications, especially the sodium-glucose co-transporter-2 (SGLT-2) inhibitors, can cause diabetic ketoacidosis, even in individuals with type 2 diabetes, but this is a rare occurrence.	Initial symptoms of diabetic ketoacidosis include excessive thirst and urination, weight loss, nausea, vomiting, fatigue, and—particularly in children—abdominal pain. Breathing tends to become deep and rapid as the body attempts to correct the blood's acidity. The breath has a fruity (acetone) odour because of the smell of the ketones escaping into the breath. Without treatment, diabetic ketoacidosis can progress to coma and death (especially in children).
Hyperosmolar hyperglycemic state	Occurs most often in type 2 diabetes. Blood glucose levels become extremely high, which causes the individual to pass large amounts of urine eventually causing severe dehydration and makes the blood abnormally concentrated (i.e., hyperosmolar). Precipitating factors include: • Nonadherence to diabetes treatment (e.g., they stop taking their diabetes medication). • Acute infection or illness that stresses the body. • Drugs that impair glucose tolerance (glucocorticoids) or increase fluid loss (diuretics). Diagnosed by blood tests that show very high levels of glucose and very concentrated blood. Treatment is intravenous fluids and insulin.	Symptoms include frequent urination, extreme thirst, mild confusion, disorientation, and drowsiness. Complications include seizures, temporary partial paralysis resembling a stroke, coma, and death. Up to 20% of individuals die.
Hearing impairment	Chronic high glucose levels can damage small blood vessels and nerves in the inner ear and low blood glucose can damage how nerve signals travel from the inner ear to the brain. Both types of nerve damage can cause hearing loss.	Hearing loss can happen slowly, so it can be hard to notice. Problems with the inner ear may also affect balance.

Complications of gestational diabetes
Uncontrolled blood glucose levels during pregnancy can cause complications for the infant and pregnant individual.

Complications in the infant include:
- Excess growth. Extra glucose crosses the placenta, triggering the infant's pancreas to make extra insulin, which can cause the infant to grow too large. It can lead to a difficult birth and sometimes the need for a C-section.
- Hypoglycemia. Infants may develop hypoglycemia shortly after birth because their own insulin production is high.
- Type 2 diabetes later in life. Infants born to someone who had gestational diabetes have a higher risk of developing obesity and type 2 diabetes later in life.
- Death, which can occur either before or shortly after birth. [14]

Complications in the pregnant individual include:
- Developing preeclampsia. Symptoms include hypertension, proteinuria (too much protein in the urine), and edema of the legs and feet. Left untreated, preeclampsia can lead to serious, even fatal, complications for the pregnant individual and infant.
- Developing gestational diabetes in subsequent pregnancies. [14] [25]

Risk factors for type 1 diabetes
Risk factors for type 1 diabetes include:
- Having a parent or sibling with type 1 diabetes slightly increases risk.
- Both genetic and environmental factors are thought to contribute to the development of type 1 diabetes. [12]

Risk factors for type 2 diabetes
Having any of the following conditions increases risk of developing type 2 diabetes:
- Prediabetes
- High BMI or overweight, especially weight carried around the abdomen
- High blood pressure
- High cholesterol
- Tobacco use
- Over the age of 40
- Parent or sibling with type 2 diabetes
- Physically inactivity
- Unhealthy eating
- History of gestational diabetes
- Gave birth to an infant who weighed >4 kg (9 lbs)
- Fatty liver disease
- Obstructive sleep apnea
- Polycystic ovary syndrome
- Acanthosis nigricans
- Use of corticosteroid medication
- Being of African, Arab, Asian, Hispanic, Indigenous, or South Asian descent
- Psychiatric disorders (e.g., schizophrenia, depression, bipolar disorder) [5] [12] [26]

Risks factors for gestational diabetes
Having any of the following conditions increases risk of developing gestational diabetes:

- Prediabetes
- 35 years of age or older
- History of gestational diabetes
- Gave birth to an infant who weighed >4 kg
- High BMI or overweight before pregnancy
- Parent or sibling with type 2 diabetes
- Polycystic ovary syndrome
- Being of African, Arab, Asian, Hispanic, Indigenous, or South Asian descent
- Use of corticosteroid medication
- Acanthosis nigricans [12] [26]

Risk factors for prediabetes
Having any of the following conditions increases risk of developing prediabetes:

- High BMI or overweight
- 45 years or older
- Parent or sibling with type 2 diabetes
- Physically inactive
- History of gestational diabetes
- Gave birth to an infant who weighed >4 kg [26]

A cohort study by Cao et al. (2023) of 45,782 participants with prediabetes found adults whose status shifted from prediabetes to normoglycemia had similar all-cause mortality risk as those whose prediabetes persisted. However, the addition of healthy lifestyle changes, such as staying physically active and not smoking, was associated with improved life expectancy.

Adults who reverted to normoglycemia and were physically active had a lower risk for all-cause mortality than those with persistent prediabetes who were inactive. Adults who reverted to normoglycemia and were current smokers had a higher risk of death than those with persistent prediabetes who never smoked. Among adults who reverted to normoglycemia, those who were physically active had a lower risk of death than those who were moderately active.

Adults who reverted to normoglycemia who remained physically active had a life expectancy of 2.5 years longer than those with persistent prediabetes who were not physically active. However, adults who reverted to normoglycemia and were current smokers had a 3.6-year lower life expectancy than those with persistent prediabetes who never smoked. These findings highlight the importance of lifestyle modification among those with prediabetes. [27]

Reducing risk for developing diabetes
Decreasing risk of developing or delaying the onset of type 2 diabetes and its complications includes:

- Maintaining a healthy body weight.

- Staying physically active. Regular physical activity helps lower insulin resistance. A brisk 30-minute walk at least five days a week has been shown to significantly reduce the risk of diabetes and CVD.[10]
- Eating a healthy diet and avoiding sugar and saturated fat. Drink water instead of sugar sweetened beverages, and choose whole foods instead of highly processed foods with added sugars (free sugars[11]). Consuming too many foods and drinks high in free sugars[12] can lead to weight gain and increase the risk of developing prediabetes, type 2 diabetes, or gestational diabetes.[13]
- Smoking cessation.
- Maintaining healthy blood pressure.
- Managing stress.
- Getting 7-9 hours of good-quality sleep on a regular basis, with consistent bed and wake-up times. Research has found insufficient sleep is linked to an increased risk for the development of type 2 diabetes. Both sleep duration and quality have emerged as predictors of A1c levels.
- Reduce alcohol consumption. Heavy alcohol use can cause inflammation in the pancreas and limit its ability to produce sufficient insulin.[14] [10] [28] [29]

Non-sugar sweeteners

In May 2023, the World Health Organization (WHO) released a new guideline on non-sugar sweeteners (NSS), recommending against their use to control body weight or reduce the risk of noncommunicable diseases. The recommendation is based on the findings of a systematic review, which suggests NSS use does not confer any long-term benefit in reducing body fat in adults or children. Replacing free sugars with NSS does not help with weight control in the long term.

[10] Refer to the Canadian 24-Hour Movement Guidelines for Adults in the Client Resources below for more information. Following the movement guidelines is associated with a lower risk of type 2 diabetes, CVD, hypertension, several cancers, anxiety, depression, dementia, weight gain, adverse blood lipid profile, and mortality as well as improved bone health, cognition, quality of life and physical function.

[11] Free sugars include monosaccharides (glucose, fructose, galactose) and disaccharides (sucrose, lactose, maltose) added to foods and beverages by the manufacturer, cook or consumer and sugars naturally present in honey, syrups, fruit juices, and fruit juice concentrate. [45]
Refer to Episode 86 for discussion on sources of free sugars hidden in foods.

[12] Reducing free sugars intake also benefits gingival health. A systematic review and meta-analysis by Woelber et al. (2023) showed restricting free sugar consumption was associated with statistically significantly improved gingival health scores (i.e., reduced gingival inflammation) and a trend toward lower dental plaque scores. [46]

[13] The WHO guideline on sugar intake recommends adults and children reduce their daily intake of free sugars to less than 10% of their total daily calories. A further reduction to below 5% or roughly 25 grams (6 teaspoons) per day provides additional health benefits. WHO's sugar intake guideline provides recommendations on the intake of free sugars to reduce the risk of noncommunicable diseases in adults and children, with a particular focus on the prevention and control of unhealthy weight gain and dental caries. Measures aimed at reducing overweight and obesity are likely to also reduce the risk of developing type 2 diabetes and CVD, and the complications associated with those diseases. [13] [43] [44]

[14] Follow 'Canada's Guidance on Alcohol and Health' as research shows no amount or kind of alcohol is good for health, regardless if it is wine, beer, cider, or spirits. Refer to Client Resources and Additional Resources below for hyperlinks to the guidance. [47]

Long-term use of NSS may cause undesirable effects, such as increased risk of type 2 diabetes, CVDs, and mortality in adults. NSS are not essential dietary factors and have no nutritional value. Individuals should reduce the sweetness of the diet altogether, starting early in life, to improve their health.

The NSS recommendation includes all synthetic and naturally occurring or modified non-nutritive sweeteners found in manufactured foods and beverages, or sold on their own to be added to foods and beverages, such as aspartame, saccharin, sucralose, stevia, and stevia derivatives.

The NSS recommendation does not apply to individuals with pre-existing diabetes. NSS are frequently recommended as a means of controlling blood glucose levels in individuals with diabetes and providing guidance on the management of diabetes in individuals with pre-existing diabetes was beyond the scope of NSS guideline.

The guideline does not apply to personal care and oral hygiene products containing NSS, such as toothpaste and medications, or to low-calorie sugars and sugar alcohols (polyols), such as xylitol, which are sugars or sugar derivatives containing calories and are not considered NSS. [30] [31]

Aspartame
On July 14, 2023, WHO's International Agency for Research on Cancer (IARC) classified aspartame as "possibly carcinogenic to humans". The decision was based on limited evidence for liver cancer in human and animal studies.

WHO's Joint Expert Committee on Food Additives (JECFA) determined there was no reason to change their previous conclusion that a daily intake of aspartame at levels up to 40 milligrams per kilogram body weight would not cause adverse health effects, including cancer. For example, an adult weighing 70 kg (154 lb) would need to consume more than 9-14 cans of diet soft drink containing 200-300 mg of aspartame, per day to exceed the acceptable daily intake, assuming no other intake from other food sources. For children, specifically a child who weighs approximately 20 kg (44 lb), the limit is 800 mg of aspartame, or two to three cans of diet soft drink per day.

The conclusions conflict because IARC classifies substances' hazard, whether the substance can cause cancer and does not reflect the risk based on exposure level. JECFA evaluates risk, the likelihood that cancer will occur because of exposure to a substance. These two approaches contribute to the differing conclusions of the two organizations.

Aspartame is one of the most studied food additives and is approved in many countries. Regulatory and scientific authorities, such as Health Canada, the US Food and Drug Administration (FDA), and the European Food Safety Authority have evaluated aspartame and consider it safe at the current permitted use levels. [32] [33] [34]

Steffen et al. (2023) showed long-term artificial sweetener intake was related to greater adipose tissue volume. Over 20 years, the research team examined participants' regular

dietary intake. They found long-term consumption of aspartame, saccharin, and diet beverages were linked to increased fat stores in the abdomen and fat within muscle. This was found even after accounting for other factors, including diet quality and caloric intake. These outcomes underscore the importance of finding alternatives to artificial sweeteners in foods and beverages, especially since these added sweeteners may have negative health consequences. [35]

Diabetes and food choices

A comparative risk-assessment model of dietary intake in 184 countries by O'Hearn et al. (2023) estimated poor diet contributed to >14.1 million cases of type 2 diabetes in 2018, representing >70% of new diagnoses globally. The analysis, which looked at data from 1990 and 2018, provides insight into which dietary factors are driving type 2 diabetes burden by world region.

Of the 11 dietary factors considered, three had the greatest contribution to the rising global incidence of type 2 diabetes:

- Insufficient intake of whole grains,
- Excesses of refined rice and wheat, and
- Overconsumption of processed meat.

Central and Eastern Europe and Central Asia (particularly in Poland and Russia, where diets tend to be rich in red meat, processed meat, and potatoes) had the greatest number of type 2 diabetes cases linked to diet. Incidence was also high in the Caribbean and Latin America, especially in Colombia and Mexico, which was credited to high consumption of sugary drinks, processed meat, and low intake of whole grains. The study suggests poor carbohydrate quality is a leading driver of diet-attributable type 2 diabetes globally. [36]

Dietary interventions play a fundamental role in the glycemic management of adults with type 2 diabetes. However, little is known about consumption of specific types of beverages in relation to disease outcomes and mortality among adults with diabetes. Ma et al. (2023) investigated the intake of specific beverages in relation to mortality and CVD outcomes among adults with type 2 diabetes. The researchers analyzed health data for 15,486 adults diagnosed with type 2 diabetes over an average follow-up period of 18.5 years. Every two to four years, the participants reported on how often they consumed sugar sweetened beverages (SSBs) including soft drinks, fruit punch, and lemonade; artificially sweetened beverages (ASBs); fruit juice; coffee, tea, low-fat milk, full-fat milk, and plain water.

After accounting for other lifestyle factors and medical history, the researchers found participants with the highest intake of SSBs (>one serving a day) had a 20% increased risk of death from any cause compared with participants with the lowest intake (<one serving a month). In contrast, high intakes of certain beverages (up to six servings a day) were associated with lower mortality: 26% lower for coffee, 21% for tea, 23% for plain water, and 12% for low fat milk.

Replacing SSBs with ASBs was also associated with lower all cause mortality and CVD mortality, but less so. Replacing sugar SSBs, ASBs, fruit juice, or full fat milk with coffee, tea, or plain water was consistently associated with lower all cause mortality. The results emphasize the importance of beverage choices in maintaining overall health among adults with diabetes. [37]

A meta-analysis by Malik et al. (2010) of 310,819 participants showed individuals who consumed SSBs (e.g., soft drinks, fruit drinks, iced tea, energy drinks, vitamin water) regularly (~1-2 servings/day) had a 26% greater risk of developing type 2 diabetes than individuals who rarely had such drinks. Higher consumption of SSBs was also associated with weight gain and the development of metabolic syndrome. The study provides further support to limit consumption of these beverages in place of healthy alternatives such as water to reduce obesity-related chronic disease risk. [38]

Drouin-Chartier et al. (2019) evaluated 22-26 years of data from 192,352 participants and found increasing total sugary beverage intake (including both SSBs and 100% fruit juice) by ≥125mL per day over a four-year period was associated with a 16% higher risk of type 2 diabetes in the subsequent four years. [39]

In a review by Huang et al. (2023) of 73 meta-analyses, high consumption of added sugar was associated with significantly higher risks of 45 negative health outcomes, including diabetes, gout, obesity, hypertension, myocardial infarction, stroke, cancer, asthma, dental caries, depression, and early death. The authors concluded high dietary sugar consumption is more harmful than beneficial for health. Reducing the consumption of free sugars to below 25 g/day (six teaspoons/day) and limiting the consumption of SSBs to less than one serving/week (200-355 ml/week) are recommended to reduce the adverse effect of sugars on health. [40]

Take home messages

- Considering diabetes is a common condition, oral health clinicians are likely to encounter clients with diabetes frequently.
- Oral health clinicians can support clients with and without diabetes through education on healthy lifestyle choices, including reducing free sugar intake to benefit systemic and oral health.

References

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Client Resources

Assess your risk for diabetes. Take the CANRISK test to know your risk of having prediabetes or type 2 diabetes
https://www.healthycanadians.gc.ca/en/canrisk

Body Mass Index (BMI) Calculator
https://www.diabetes.ca/managing-my-diabetes/tools---resources/body-mass-index-(bmi)-calculator

Canada's Food Guide
https://food-guide.canada.ca/en/

Your Guide to Diabetes
https://www.canada.ca/en/public-health/services/chronic-diseases/reports-publications/diabetes/your-guide-diabetes.html

Smokers' helpline
https://www.smokershelpline.ca/

Cost calculator: How much do you spend on cigarettes?
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