

## **Diabetes Mellitus**

Diabetes is a chronic disease that occurs either when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces. Insulin is a hormone that regulates blood glucose. Hyperglycaemia, also called raised blood glucose or raised blood sugar, is a common effect of uncontrolled diabetes and over time leads to serious damage to many of the body's systems, especially the nerves and blood vessels. In 2014, 8.5% of adults aged 18 years and older had diabetes. In 2019, diabetes was the direct cause of 1.5 million deaths and 48% of all deaths due to diabetes occurred before the age of 70 years. Another 4,60,000 kidney disease deaths were caused by diabetes, and raised blood glucose causes around 20% of cardiovascular deaths. Between 2000 and 2019, there was a 3% increase in age-standardized mortality rates from diabetes. In lower-middle-income countries, the mortality rate due to diabetes increased 13%. By contrast, the probability of dying from any one of the four main non-communicable diseases (cardiovascular diseases, cancer, chronic respiratory diseases or diabetes) between the ages of 30 and 70 decreased by 22% globally between 2000 and 2019.

### **Types:**

Diabetes is a chronic (long-lasting) disease that affects how your body turns food into energy. There are three main types of diabetes: Type 1 diabetes Type 2 diabetes Gestational diabetes (diabetes while pregnant)

1. **Type-1 Diabetes:** Type 1 diabetes (previously known as insulin-dependent, juvenile or childhood-onset) is characterized by deficient insulin production and requires daily administration of insulin. In 2017 there were 9 million people with type 1 diabetes; the majority of them live in high-income countries. Neither its cause nor the means to prevent it are known. Causes: Without insulin, your body will break down its own fat and muscle, resulting in weight loss. This can lead to a serious short-term condition called diabetic ketoacidosis. This is when the bloodstream becomes acidic, you develop dangerous levels of ketones in your blood stream and become severely dehydrated. The exact cause of type 1 diabetes is unknown. Usually, the body's own immune system — which normally fights harmful bacteria and viruses — destroys the insulin-producing (islet) cells in the pancreas. Other possible causes include: Genetics Exposure to viruses and other environmental factors
2. **Age:** Type 1 diabetes can appear at any age, but it appears at two noticeable peaks. The first peak occurs in children between 4 and 7 years old. The second is in children between 10 and 14 years old.

### **Symptoms:**

Type 1 diabetes symptoms can appear suddenly and may include:

- Feeling more thirsty than usual
- Urinating a lot
- Bed-wetting in children who have never wet the bed during the night
- Feeling very hungry
- Losing weight without trying
- Feeling irritable or having other mood changes

- Feeling tired and weak
- Having blurry vision The symptoms of type 1 diabetes usually develop very quickly in young people (over a few hours or days). In adults, the symptoms often take longer to develop (a few days or weeks).

**Pathogenesis:** Type 1 diabetes is a result of the destruction of pancreatic beta cells, although what triggers that destruction remains unclear. People with type 1 diabetes tend to have more CD8+ T-cells and B-cells that specifically target islet antigens than those without type 1 diabetes, suggesting a role for the adaptive immune system in beta cell destruction. Type 1 diabetics also tend to have reduced regulatory T cell function, which may exacerbate autoimmunity. Destruction of beta cells results in inflammation of the islet of Langerhans, called insulinitis. These inflamed islets tend to contain CD8+ T-cells and – to a lesser extent – CD4+ T cells. Abnormalities in the pancreas or the beta cells themselves may also contribute to beta-cell destruction. The pancreases of people with type 1 diabetes tend to be smaller, lighter, and have abnormal blood vessels, nerve innervations, and extracellular matrix organization. In addition, beta cells from people with type 1 diabetes sometimes overexpress HLA class I molecules (responsible for signaling to the immune system) and have increased endoplasmic reticulum stress and issues with synthesizing and folding new proteins, any of which could contribute to their demise.

**Complications:** Conditions associated with diabetes mellitus type 1 include:

- Autoimmune thyroid disease (ATD)
- Celiac disease (CD)
- Autoimmune gastritis (AIG)
- Pernicious anemia (PA)
- Vitiligo
- Addison's disease

**Gross pathology:** On gross pathology, pancreas may demonstrated the following changes:

- Decreased overall weight and size
- Dorsal region atrophy
- Possible hypertrophy (related to hydrophic changes)

**Microscopic pathology:** On microscopic histopathological analysis, the following changes can be detected in islet cells:

- Insulinitis
- Beta cell loss due to necrosis or apoptosis
- Major histocompatibility complex class one hyperexpression
- Reduction in insulin in remnant beta cells
- Interferon alpha expression in beta cells
- CD3-positive cells in Islet cell

## 2. Type 2 diabetes:

Type 2 diabetes affects how your body uses sugar (glucose) for energy. It stops the body from using insulin properly, which can lead to high levels of blood sugar if not treated. Over time, type 2 diabetes can cause serious damage to the body, especially nerves and blood vessels. Type 2 diabetes is often preventable. More than 95% of people with diabetes have type 2 diabetes. Type 2 diabetes was formerly called non-insulin dependent, or adult onset. Until recently, this type of diabetes was seen only in adults but it is now also occurring increasingly frequently in children. Causes:

**Genetic Predisposition:** Individuals with a family history of type 2 diabetes have a higher risk.

**Obesity:** Excess body weight, particularly abdominal fat, contributes to insulin resistance.

**Age:** Risk increases with age, especially after 45 years.

**Physical Inactivity:** Lack of exercise contributes to obesity and insulin resistance.

**Poor Diet:** High consumption of processed foods, sugary drinks, and low fiber intake.

**Ethnicity:** Some ethnic groups, such as African Americans, Hispanics, and Native Americans, are more susceptible.

### **Symptoms:**

- Increased Thirst (Polydipsia): Excessive thirst and frequent drinking.
- Frequent Urination (Polyuria): Higher glucose levels lead to increased urine production.
- Unexplained Weight Loss: Despite increased appetite.
- Fatigue: Lack of energy due to inefficient glucose utilization.
- Blurred Vision: High blood sugar levels affect the eyes.
- Slow Healing: Wounds and infections take longer to heal.
- Numbness or Tingling: Especially in the hands and feet.

### **Pathophysiology:**

In type 2 diabetes, the body encounters challenges in managing blood sugar. The trouble begins with insulin resistance, where cells resist the signal from insulin to let glucose in. Additionally,

the pancreas might not produce enough insulin or the insulin it produces doesn't work effectively. The liver further complicates matters by producing too much glucose, contributing to elevated blood sugar levels. Low-level inflammation can worsen insulin resistance, and hormonal imbalances also play a role in disrupting blood sugar control. These factors collectively create a scenario where the body struggles to regulate blood sugar levels, leading to the development and progression of type 2 diabetes.

### **Complications:**

- Conditions associated with diabetes mellitus type 2 include:
- Cardiovascular complications (Heart disease and stroke, high blood pressure)
- Nerve damage (Neuropathy)
- Eye complications (Retinopathy)
- Kidney damage (Nephropathy)
- Foot problems

- Hearing impairment
- Alzheimer's disease
- Complications during pregnancy

### **Difference between type-1 and type-2 diabetes:**

**3. Gestational diabetes:** Gestational diabetes mellitus (GDM) is a form of diabetes that occurs during pregnancy. It is characterized by elevated blood glucose levels in pregnant women who did not have diabetes before pregnancy. The pathogenesis of gestational diabetes involves a combination of hormonal, metabolic, and genetic factors. Gestational diabetes is hyperglycaemia with blood glucose values above normal but below those diagnostic of diabetes. Gestational diabetes occurs during pregnancy. Women with gestational diabetes are at an increased risk of complications during pregnancy and at delivery. These women and possibly their children are also at increased risk of type 2 diabetes in the future.

### **Causes:**

The exact cause of gestational diabetes is not known, but it is believed to involve a combination of genetic and hormonal factors. During pregnancy, the body produces hormones that can interfere with the normal action of insulin, leading to insulin resistance.

### **Risk factors:**

Women are at a higher risk of developing gestational diabetes if they:

- Are over the age of 25.
- Have a family history of diabetes.
- Are overweight or obese.
- Belong to certain ethnic groups (e.g., African American, Hispanic, Native American, South or East Asian).

### **Complications:**

If left untreated, gestational diabetes can lead to complications for both the mother and the baby. Complications may include an increased risk of preeclampsia (a potentially dangerous condition characterized by high blood pressure), cesarean delivery, and the baby being born with high birth weight, low blood sugar (hypoglycemia) after birth, and an increased risk of developing type 2 diabetes later in life.

### **Screening and diagnosis:**

Pregnant women are typically screened for gestational diabetes between 24 and 28 weeks of pregnancy. This involves a glucose challenge test, where the woman drinks a sugary solution and then has her blood sugar levels tested. If the results are elevated, a glucose tolerance test may be conducted to confirm the diagnosis.

### **Diagnosis of Diabetes:**

**Clinical Assessment:** The diagnostic process begins with a thorough clinical assessment. Healthcare providers gather the patient's medical history, assess symptoms, and conduct physical examinations.

Common symptoms of diabetes include excessive thirst, frequent urination, unexplained weight loss, and fatigue.

**Blood Tests:** Blood tests, such as fasting blood sugar and hemoglobin A1c tests, play a crucial role in diagnosing diabetes. These tests measure blood sugar levels over time and help determine the type and severity of diabetes.

**Monitoring and Self-Testing:** Regular monitoring and self-testing of blood sugar levels, especially for individuals at risk or already diagnosed, provide valuable information for managing diabetes effectively.

### **Treatment Modalities for Diabetes:**

- **Lifestyle Modifications:** For many individuals with diabetes, lifestyle changes are fundamental. These include adopting a healthy diet, regular physical activity, and maintaining a healthy weight.
- **Oral Medications:** Oral medications, such as metformin and sulfonylureas, are commonly prescribed to help regulate blood sugar levels. The choice of medication depends on the type and severity of diabetes.
- **Insulin Therapy:** In some cases, individuals with diabetes may require insulin therapy to manage blood sugar effectively. This involves regular insulin injections or the use of insulin pumps.

### **Monitoring and Management:**

**Continuous Glucose Monitoring (CGM):** Advancements in technology have led to the development of continuous glucose monitoring systems, allowing individuals to track their blood sugar levels in real-time and make informed decisions about diet and medication.

**Education and Support:** Education about diabetes management, including meal planning, medication adherence, and lifestyle choices, is crucial. Support from healthcare professionals and peer groups enhances the overall well-being of individuals with diabetes.

**Regular Check-ups:** Regular medical check-ups help monitor diabetes-related complications, such as eye, kidney, and nerve problems. Early detection and intervention contribute to better long-term outcomes.

**Lifestyle Adherence:** Adhering to a healthy lifestyle, including a balanced diet, regular exercise, and stress management, is essential for preventing complications and ensuring overall well-being.

### **Latest Research on Diabetes:**

#### **New Player in Diabetes Type 1:**

Hybrid insulin peptides (HIPs) in human islets and reactive T cells in residual islets of type 1 diabetes (T1D) organ donors prompt investigation into ongoing autoimmunity in T1D patients. Using interferon- $\gamma$  enzyme-linked immune absorbent spot analyses on peripheral blood mononuclear cells (PBMCs), we assessed T-cell reactivity to 16 HIPs in new-onset T1D patients and controls. Nearly half of the T1D patients exhibited responses to one or more HIPs, with four HIPs showing significantly elevated responses. Isolating antigen-specific T-cell clones revealed persistence in the peripheral blood. This underscores the potential importance of HIPs as critical target antigens in T1D.

## **Legacy Effect of Diabetes:**

Dr. Laiteerapong found that indeed in a real-world setting, people with lower hemoglobin A1C levels after diagnosis had significantly lower vascular complications later on, a phenomenon known as the ‘legacy effect’ of glucose control. Her research noted the importance of early intervention for the best outcomes, as those with the low A1C levels just one-year after diagnosis had significantly lower vascular disease risk compared to people with higher A1C levels.

With these findings in hand, physicians and policymakers will have more material to debate and determine the best course of action for improving outcomes in people newly diagnosed with diabetes.

## **Pathophysiology of Diabetes Mellitus**

Diabetes Mellitus

### **Definition and Epidemiology**

As per the WHO,

“Diabetes mellitus (DM) is defined as a heterogeneous metabolic disorder characterized by common feature of chronic hyperglycemia with disturbance of carbohydrate, fat and protein metabolism.”

DM is a leading cause of morbidity and mortality world over. It is estimated that approximately 1% of population suffers from DM. The incidence is rising in the developed countries of the world at the rate of about 10% per year, especially of type 2 DM, due to rising incidence of obesity and reduced activity levels. DM is expected to continue as a major health problem owing to its serious complications, especially end-stage renal disease, IHD, gangrene of the lower extremities, and blindness in the adults. It is anticipated that the number of diabetics will exceed 250 million by the year 2010

### **Classification and Etiology**

The older classification systems dividing DM into primary (idiopathic) and secondary types, juvenile-onset and maturity onset types, and insulin-dependent (IDDM) and non-insulin dependent (NIDDM) types, have become obsolete and undergone major revision due to extensive understanding of etiology and pathogenesis of DM in recent times

classification of DM based on etiology divides it into two broad categories—type 1 and type 2; besides there are a few uncommon specific etiologic types, and gestational DM. American Diabetes Association (2007) has identified risk factors for type 2 DM listed in Table 27.5. Brief comments on etiologic terminologies as contrasted with former nomenclatures of DM are as under:

#### **1. Type 1 DM:**

It constitutes about 10% cases of DM. It was previously termed as juvenile-onset diabetes (JOD) due to its occurrence in younger age, and was called insulin dependent DM (IDDM) because it was known that these patients have absolute requirement for insulin replacement as treatment. However, in the new classification, neither age nor insulin-dependence are considered as absolute criteria.

Instead, based on underlying etiology, type 1 DM is further divided into 2 subtypes:

Subtype 1A (immune-mediated) DM characterized by autoimmune destruction of  $\beta$ -cells which usually leads to insulin deficiency

Subtype 1B (idiopathic) DM characterized by insulin deficiency with tendency to develop ketosis but these patients are negative for autoimmune markers.

Though type 1 DM occurs commonly in patients under 30 years of age, autoimmune destruction of  $\beta$ -cells can occur at any age. In fact, 5-10% patients who develop DM above 30 years of age are of type 1A DM and hence the term JOD has become obsolete.

## **2. Type 2 DM:**

This type comprises about 80% cases of DM. It was previously called maturity-onset diabetes, or non-insulin dependent diabetes mellitus (NIDDM) of obese and non-obese type. Although type 2 DM predominantly affects older individuals, it is now known that it also occurs in obese adolescent children; hence the term MOD for it is inappropriate. Moreover, many type 2 DM patients also require insulin therapy to control hyperglycemia or to prevent ketosis and thus are not truly non-insulin dependent contrary to its former nomenclature.

### **Other specific Etiological Types Of DM**

Besides the two main types, about 10% cases of DM have a known specific etiologic defect listed in Table 27.4. One important subtype in this group is

Maturity-onset diabetes of the young (MODY) which has autosomal dominant inheritance, early onset of hyperglycemia and impaired insulin secretion.

Gestational DM: About 4% pregnant women develop DM due to metabolic changes during pregnancy. Although they revert back to normal glycaemia after delivery, these women are

prone to develop DM later in their life. Pathogenesis Depending upon etiology of DM, hyperglycemia may result from the following: Reduced insulin secretion, Decreased glucose use by the body, Increased glucose production. Pathogenesis of two main types of DM and its complications is distinct. In order to understand it properly, it is essential to first recall physiology of normal insulin synthesis and secretion.

### **Normal Insulin Metabolism**

The major stimulus for both synthesis and release of insulin is glucose. The steps involved in biosynthesis, release and actions of insulin are as follows

#### **Synthesis:**

Insulin is synthesized in the  $\beta$ -cells of pancreatic islets of Langerhans:

- i) It is initially formed as pre-proinsulin which is single-chain 86-amino acid precursor polypeptide.
- ii) Subsequent proteolysis removes the amino terminal signal peptide, forming proinsulin.
- iii) Further cleavage of proinsulin gives rise to A (21 amino acids) and B (30 amino acids) chains of insulin, linked together by connecting segment called C-peptide, all of which are stored in the secretory granules in the  $\beta$ -cells. As compared to A and B chains of insulin, C-peptide is less susceptible to

degradation in the liver and is therefore used as a marker to distinguish endogenously synthesized and exogenously administered insulin. For therapeutic purposes, human insulin is now produced by recombinant DNA technology.

### **Release:**

Glucose is the key regulator of insulin secretion from  $\beta$ -cells by a series of steps: i) Hypoglycemia (glucose level below 70 mg/dl or below 3.9 mmol/L) stimulate transport into  $\beta$ -cells of a glucose transporter, GLUT2. Other stimuli influencing insulin release include nutrients in the meal, ketones, amino acids etc. ii) An islet transcription factor, glucokinase, causes glucose phosphorylation, and thus acts as a step for controlled release of glucose-regulated insulin secretion.

iii) Metabolism of glucose to glucose-6-phosphate by glycolysis generates ATP.

iv) Generation of ATP alters the ion channel activity on the membrane. It causes inhibition of ATP-sensitive  $K^+$  channel on the cell membrane and opening up of calcium channel with resultant influx of calcium, which stimulates insulin release.

### **Action:**

Half of insulin secreted from  $\beta$ -cells into portal vein is degraded in the liver while the remaining half enters the systemic circulation for action on the target cells:

Insulin from circulation bind to its receptor on the target cells. Insulin receptor has intrinsic tyrosine kinase activity.

ii) This, in turn, activates post-receptor intracellular signaling pathway molecules, insulin receptor substrates (IRS) 1 and 2 proteins, which initiate sequence of phosphorylation and dephosphorylation reactions.

iii) These reactions on the target cells are responsible for the main mitogenic and anabolic actions of insulin—glycogen synthesis, glucose transport, protein synthesis, lipogenesis.

iv) Besides the role of glucose in maintaining equilibrium of insulin release, low insulin level in the fasting state promotes hepatic gluconeogenesis and glycogenolysis, reduced glucose uptake by insulin-sensitive tissues and promotes mobilisation of stored precursors, so as to prevent hypoglycemia.

### **Pathogenesis Of Type 1 DM**

The basic phenomenon in type 1 DM is destruction of  $\beta$ -cell mass, usually leading to absolute insulin deficiency. While type 1B DM remains idiopathic, pathogenesis of type 1A DM is immune-mediated and has been extensively studied. Currently, pathogenesis of type 1A DM

is explained on the basis of 3 mutually-interlinked mechanisms: genetic susceptibility, autoimmune factors, and certain environmental factors .

#### **1. Genetic susceptibility:**

Type 1A DM involves inheritance of multiple genes to confer susceptibility to the disorder:



- i) It has been observed in identical twins that if one twin has type 1A DM, there is about 50% chance of the second twin developing it, but not all. This means that some additional modifying factors are involved in development of DM in these cases.
- ii) About half the cases with genetic predisposition to type 1A DM have the susceptibility gene located in the HLA region of chromosome 6 (MHC class II region), particularly HLA DR3, HLA DR4 and HLA DQ locus.

## **2. Autoimmune factors:**

Studies on humans and animal models on type 1A DM have shown several immunologic abnormalities

- i) Presence of islet cell antibodies against GAD (glutamic acid decarboxylase), insulin etc, though their assay largely remains a research tool due to tedious method.
- ii) Occurrence of lymphocytic infiltrate in and around the pancreatic islets termed insulinitis. It chiefly consists of CD8+ T lymphocytes with variable number of CD4+ T lymphocytes and macrophages.
- iii) Selective destruction of  $\beta$ -cells while other islet cell types (glucagon-producing alpha cells, somatostatin-producing delta cells, or polypeptide-forming PP cells) remain unaffected. This is mediated by T-cell mediated cytotoxicity or by apoptosis.
- iv) Role of T cell-mediated autoimmunity is further supported by transfer of type 1A DM from diseased animal by infusing T lymphocytes to a healthy animal.
- v) Association of type 1A DM with other autoimmune diseases in about 10-20% cases such as Graves' disease, Addison's disease, Hashimoto's thyroiditis, pernicious anaemia.
- vi) Remission of type 1A DM in response to immunosuppressive therapy such as administration of cyclosporin A

## **3. Environmental factors:**

Epidemiologic studies in type 1A DM suggest the involvement of certain environmental factors in its pathogenesis, though role of none of them has been conclusively proved. In fact, the trigger may precede the occurrence of the disease by several years. It appears that certain viral and dietary proteins share antigenic properties with human cell surface proteins and trigger the immune attack on  $\beta$ -cells by a process of molecular mimicry. These factors include the following:

- i) certain viral infections preceding the onset of disease e.g. mumps, measles, coxsackie B virus, cytomegalovirus and infectious mononucleosis.
- ii) Experimental induction of type 1A DM with certain chemicals has been possible e.g. alloxan, streptozotocin and pentamidine
- iii) Geographic and seasonal variations in its incidence suggest some common environmental factors.
- iv) Possible relationship of early exposure to bovine milk proteins and occurrence of autoimmune process in type 1A DM is being studied

## **Pathogenesis of type 2 DM.**

The basic metabolic defect in type 2 DM is either a delayed insulin secretion relative to glucose load (impaired insulin secretion), or the peripheral tissues are unable to respond to insulin (insulin resistance). Type 2 DM is a heterogeneous disorder with a more complex etiology and is far more common than type 1, but much less is known about its pathogenesis. A number

of factors have been implicated though, but HLA association and autoimmune phenomena are not implicated.

### **1. Genetic factors:**

Genetic component has a stronger basis for type 2 DM than type 1A DM. Although no definite and consistent genes have been identified, multifactorial inheritance is the most important factor in development of type 2 DM:

- i) There is approximately 80% chance of developing diabetes in the other identical twin if one twin has the disease.
- ii) A person with one parent having type 2 DM is at an increased risk of getting diabetes, but if both parents have type 2 DM the risk in the offspring rises to 40%.

### **2. Constitutional factors:**

Certain environmental factors such as obesity, hypertension, and level of physical activity play contributory role and modulate the phenotyping of the disease.

### **3. Insulin resistance:**

One of the most prominent metabolic features of type 2 DM is the lack of responsiveness of peripheral tissues to insulin, especially of the skeletal muscle and liver. Obesity, in particular, is strongly associated with insulin resistance and hence type 2 DM. Mechanism of hyperglycemia in these cases is explained as under:

- i) Resistance to action of insulin impair glucose utilization and hence hyperglycemia.
- ii) There is increased hepatic synthesis of glucose.
- iii) Hyperglycemia in obesity is related to high levels of free fatty acids and cytokines (e.g. TNF- $\alpha$  and adiponectin) affect peripheral tissue sensitivity to respond to insulin. The precise underlying molecular defect responsible for insulin resistance in type 2 DM has yet not been fully identified. Currently, it is proposed that insulin resistance may be possibly due to one of the following defects:

Polymorphism in various post-receptor intracellular signal pathway molecules. Elevated free fatty acids seen in obesity may contribute e.g. by impaired glucose utilization in the skeletal muscle, by increased hepatic synthesis of glucose, and by impaired  $\beta$ -cell function. Insulin

resistance syndrome is a complex of clinical features occurring from insulin resistance and its resultant metabolic derangements that includes hyperglycaemia and compensatory hyperinsulinaemia. The clinical features are in the form of accelerated cardiovascular disease and may occur in both obese as well as non-obese type 2 DM patients.

**The features include:**

Mild hypertension (related to endothelial dysfunction) and dyslipidemia (characterised by reduced HDL level, increased triglycerides and LDL level).

**4. Impaired insulin secretion:**

In type 2 DM, insulin resistance and insulin secretion are interlinked:

- i) Early in the course of disease, in response to insulin resistance there is compensatory increased secretion of insulin (hyperinsulinaemia) in an attempt to maintain normal blood glucose level.
- ii) Eventually, however, there is failure of  $\beta$ -cell function to secrete adequate insulin, although there is some secretion of insulin i.e. cases of type 2 DM have mild to moderate deficiency of insulin (which is much less severe than that in type 1 DM) but not its total absence. The exact genetic mechanism why there is a fall in insulin secretion in these cases is unclear. However, following possibilities are proposed: Islet amyloid polypeptide (amylin) which forms fibrillar protein deposits in pancreatic islets in longstanding cases of type 2 DM may be responsible for impaired function of  $\beta$ -cells of islet cells. Metabolic environment of chronic hyperglycemia surrounding the islets (glucose toxicity) may paradoxically impair islet cell function. Elevated free fatty acid levels (lipotoxicity) in these cases may worsen islet cell function.

**5. Increased hepatic glucose synthesis:**

One of the normal roles played by insulin is to promote hepatic storage of glucose as glycogen and suppress gluconeogenesis. In type 2 DM, as a part of insulin resistance by peripheral tissues, the liver also shows insulin resistance i.e. in spite of hyperinsulinaemia in the early stage of disease, gluconeogenesis in the liver is not suppressed. This results in increased hepatic synthesis of glucose which contributes to hyperglycaemia in these cases.

**Morphologic Features in Pancreatic Islets**

Morphologic changes in islets have been demonstrated in both types of diabetes, though the changes are more distinctive in type 1 DM:

**1. Insulitis:**

In type 1 DM, characteristically, in early stage there is lymphocytic infiltrate, mainly by T cells, in the islets which may be accompanied by a few macrophages and polymorphs. Diabetic infants born to diabetic mothers, however, have eosinophilia infiltrate in the islets. In type 2 DM, there is no significant leucocytic infiltrate in the islets but there is variable degree of fibrous tissue in the islets.

**2. Islet cell mass:**

In type 1 DM, as the disease becomes chronic there is progressive depletion of  $\beta$ -cell mass, eventually resulting in total loss of pancreatic  $\beta$ -cells and its hyalinisation.

In type 2 DM,  $\beta$ -cell mass is either normal or mildly reduced. Infants of diabetic mothers, however, have hyperplasia and hypertrophy of islets as a compensatory response to maternal hyperglycaemia.

### **3. Amyloidosis:**

In type 1 DM, deposits of amyloid around islets are absent.

In type 2 DM, characteristically chronic long-standing cases show deposition of amyloid material, amylin, around the capillaries of the islets causing compression atrophy of islet tissue

### **4. $\beta$ -cell degranulation:**

In type 1 DM, EM shows The Endocrine System degranulation of remaining  $\beta$ -cells of islets.

In type 2 DM, no such change is observed

### **Clinical Features**

It can be appreciated that hyperglycaemia in DM does not cause a single disease but is associated with numerous diseases and symptoms, especially due to complications. Two main types of DM can be distinguished clinically. However, overlapping of clinical features occurs as regards the age of onset, duration of symptoms and family history. Pathophysiology in evolution of clinical features is schematically

#### **Type 1 DM:**

Patients of type 1 DM usually manifest at early age, generally below the age of 35.

- i) The onset of symptoms is often abrupt.
- ii) At presentation, these patients have polyuria, polydipsia and polyphagia.
- iii) The patients are not obese but have generally progressive loss of weight.
- iv) These patients are prone to develop metabolic complications such as ketoacidosis and hypoglycemic episodes.

#### **Type 2 DM:**

- i) This form of diabetes generally manifests in middle life or beyond, usually above the age of 40.
- ii) The onset of symptoms in type 2 DM is slow and insidious.
- iii) Generally, the patient is asymptomatic when the diagnosis is made on the basis of glycosuria or hyperglycemia during physical examination, or may present with polyuria and polydipsia.
- iv) The patients are frequently obese and have unexplained weakness and loss of weight.
- v) Metabolic complications such as ketoacidosis are infrequent

### **Complications of Diabetes**

As a consequence of hyperglycemia of diabetes, every tissue and organ of the body undergoes biochemical and structural alterations which account for the major complications in diabetics which may be acute metabolic or chronic systemic. Both types of diabetes mellitus may develop complications which are broadly divided into 2 major groups:

Acute metabolic complications: These include diabetic ketoacidosis, hyperosmolar nonketotic coma, and hypoglycemia.

Late systemic complications: These are atherosclerosis, diabetic microangiopathy, diabetic nephropathy, diabetic neuropathy, diabetic retinopathy and infection

Acute metabolic complications:

Metabolic complications develop acutely. While ketoacidosis and hypoglycemic episodes are primarily complications of type 1 DM, hyperosmolar nonketotic coma is chiefly a complication of type 2 DM

### **1. Diabetic ketoacidosis:**

Ketoacidosis is almost exclusively a complication of type 1 DM. It can develop in patients with severe insulin deficiency combined with glucagon excess. Failure to take insulin and exposure

to stress are the usual precipitating causes. Severe lack of insulin causes lipolysis in the adipose tissues, resulting in release of free fatty acids into the plasma. These free fatty acids are taken up by the liver where they are oxidized through acetyl coenzyme-A to ketone bodies, principally acetoacetic acid and  $\beta$ -hydroxybutyric acid. Such free fatty acid oxidation to ketone bodies is accelerated in the presence of elevated level of glucagon. Once the rate of ketogenesis exceeds the rate at which the ketone bodies can be utilized by the muscles and other tissues, ketonaemia and ketonuria occur. If urinary excretion of ketone bodies is prevented due to dehydration, systemic metabolic ketoacidosis occurs. Clinically, the condition is characterised by anorexia, nausea, vomiting, deep and fast breathing, mental confusion and coma. Most patients of ketoacidosis recover.

### **2. Hyperosmolar hyperglycemic nonketotic coma (HHC)**

Hyperosmolar hyperglycemic nonketotic coma is usually a complication of type 2 DM. It is caused by severe dehydration resulting from sustained hyperglycemic diuresis. The loss of glucose in urine is so intense that the patient is unable to drink sufficient water to maintain urinary fluid loss. The usual clinical features of ketoacidosis are absent but prominent central nervous signs are present. Blood sugar is extremely high and plasma osmolality is high. Thrombotic and bleeding complications are frequent due to high viscosity of blood. The mortality rate in hyperosmolar nonketotic coma is high.

### **3. Hypoglycemia:**

Hypoglycaemic episode may develop in patients of type 1 DM. It may result from excessive administration of insulin, missing a meal, or due to stress. Hypoglycemic episodes are harmful as they produce permanent brain damage, or may result in worsening of diabetic control and rebound hyperglycemia, so called Somogyi's effect.

### **Late systemic complications:**

A number of systemic complications may develop after a period of 15-20 years in either type of diabetes. Late complications are largely responsible for morbidity and premature mortality in diabetes mellitus.

#### **1. Atherosclerosis:**

Diabetes mellitus of both type 1 and type 2 accelerates the development of atherosclerosis. Consequently, atherosclerotic lesions appear earlier than in the general population, are more

extensive, and are more often associated with complicated plaques such as ulceration, calcification and thrombosis. The cause for this accelerated atherosclerotic process is not known but possible contributory factors are hyperlipidemia, reduced HDL levels, nonenzymatic glycosylation, increased platelet adhesiveness, obesity and associated hypertension in diabetes. The possible ill-effects of accelerated atherosclerosis in diabetes are early onset of coronary artery disease, silent myocardial infarction, cerebral stroke and gangrene of the toes and feet. Gangrene of the lower extremities is 100 times more common in diabetics than in non-diabetics.

## **2. Diabetic Microangiopathy:**

Microangiopathy of diabetes is characterized by basement membrane thickening of small blood vessels and capillaries of different organs and tissues such as the skin, skeletal muscle, eye and kidney. Similar type of basement membrane-like material is also deposited in nonvascular tissues such as peripheral nerves, renal tubules and Bowman's capsule. The pathogenesis of diabetic microangiopathy as well as of peripheral neuropathy in diabetics is believed to be due to recurrent hyperglycemia that causes increased glycosylation of hemoglobin and other proteins (e.g. collagen and basement membrane material) resulting in thickening of basement membrane.

## **3. Diabetic neuropathy:**

Renal involvement is a common complication and a leading cause of death in diabetes. Four types of lesions are described in diabetic nephropathy:

- i) Diabetic glomerulosclerosis which includes diffuse and nodular lesions of glomerulosclerosis.
- ii) Vascular lesions that include hyaline arteriolosclerosis of afferent and efferent arterioles and atheromas of renal arteries.
- iii) Diabetic pyelonephritis and necrotising renal papillitis.
- iv) Tubular lesions or Armanni-Ebstein lesion.

## **4. Diabetic retinopathy:**

Diabetic retinopathy is a leading cause of blindness. There are 2 types of lesions involving retinal vessels: background and proliferative. Besides retinopathy, diabetes also predisposes the patients to early development of cataract and glaucoma.

## **5. Infections diabetics:**

It have enhanced susceptibility to various infections such as tuberculosis, pneumonias, pyelonephritis, otitis, carbuncles and diabetic ulcers. This could be due to various factors such as impaired leucocyte functions, reduced cellular immunity, poor blood supply due to vascular involvement and hyperglycemia per se.

## **Diagnosis of Diabetes**

## **1. Urine testing:**

Urine tests are cheap and convenient but the diagnosis of diabetes cannot be based on urine testing alone since there may be false-positives and false-negatives. They can be used in population screening surveys. Urine is tested for the presence of glucose and ketones.

1. Glucosuria.
2. Renal glucosuria
3. Alimentary (lag storage) glucosuria

## **2. Ketonuria:**

Tests for ketone bodies in the urine are required for assessing the severity of diabetes and not for diagnosis of diabetes.

3. Screening by enhancing glucose level test
4. Oral glucose tolerance test
5. Other test:

1. Glycosylated hemoglobin (HbA1C)
2. Glycated albumin.
3. Extended GTT
4. Intravenous GTT
5. Cortisone-primed GTT.
6. Insulin assay
7. Proinsulin assay.
8. C-peptide assay
9. Islet autoantibodies.
10. Screening for diabetes-associated complications.

## **Islet cell tumors:**

Islet cell tumors are rare as compared with tumors of the exocrine pancreas. Islet cell tumors are generally small and may be hormonally inactive or may produce hyper function. They may be benign or malignant, single or multiple. They are named according to their histogenesis such as:  $\beta$ -cell tumor (insulinoma), G-cell tumor (gastrinoma), A-cell tumors (glucagonoma) D-cell tumor (somatostatinoma), vipoma (diarrhoeagenic tumour from D1 cells which elaborate VIP), pancreatic polypeptide (PP)-secreting tumour, and carcinoid tumour. However, except insulinoma and gastrinoma, all others are extremely rare and require no further comments. Insulinoma ( $\beta$ -Cell Tumour) Insulinomas or beta ( $\beta$ )-cell tumours are the most common islet cell tumours. The neoplastic  $\beta$ -cells secrete insulin into the blood

stream which remains unaffected by normal regulatory mechanisms. This results in characteristic attacks of hypoglycaemia with blood glucose level falling to 50 mg/ dl or below, high plasma insulin level (hyperinsulinism) and high insulin-glucose ratio. The central nervous manifestations are conspicuous which are promptly relieved by intake of glucose. Besides insulinoma, however, there are other causes of hypoglycaemia such as: in starvation, partial gastrectomy, diffuse liver disease, hypopituitarism and hypofunction of adrenal cortex

### **Morphological features:**

Grossly, insulinoma is usually solitary and well-encapsulated tumors which may vary in size from 0.5 to 10 cm. Rarely, they are multiple. Microscopically, the tumor is composed of cords and sheets of well-differentiated  $\beta$ -cells which do not differ from normal cells. Electron microscopy reveals typical crystalline rectangular granules in the neoplastic cells. It is extremely difficult to assess the degree of anaplasia to distinguish benign from malignant  $\beta$ -cell tumour.

Gastrinoma (G-Cell Tumour, Zollinger-Ellison Syndrome)

Zollinger and Ellison described diagnostic triad consisting of the following: Fulminant peptic ulcer disease Gastric acid hypersecretion Presence of non- $\beta$  pancreatic islet cell tumour. Such

non- $\beta$  pancreatic islet cell tumors is the source of gastrin, producing hypergastrinaemia and hence named gastrinoma. Definite G cells similar to intestinal and gastric G cells which are normally the source of gastrin in the body, have not been identified in the normal human pancreas but neoplastic cells of certain islet cell tumors have ultrastructural similarities.

### **Morphological features:**

Majority of gastrinomas occur in the wall of the duodenum. They may be benign or malignant. Gastrinomas are associated with peptic ulcers at usual sites such as the stomach, first and second part of the duodenum, or sometimes at unusual sites such as in the oesophagus and jejunum. About one-third of patients have multiple endocrine neoplasia—multiple adenomas of the islet cells, pituitary, adrenal and parathyroid gland

### **Multiple endocrine neoplasia (MEN)**

Multiple adenomas and hyperplasias of different endocrine organs are a group of genetic disorders which produce heterogeneous clinical features called multiple endocrine neoplasia (MEN) syndromes. Presently, 4 distinct types of MEN syndromes are distinguished.

**These are briefly outlined below along with major disease associations:**

1. MEN type 1 syndrome (Wermer's syndrome) includes adenomas of the parathyroid glands, pancreatic islets and pituitary. The syndrome is inherited as an autosomal dominant trait. There is 50% chance of transmitting the predisposing gene, MEN 1 (or menin) gene, to the child of an affected person. MEN 1 is characterised by the following features:

1. **Parathyroid:** Hyperplasia or adenoma; hyperparathyroidism is the most common (90%) clinical manifestation.



**2. Pancreatic islet cells:** Hyperplasia or adenoma seen in 80% cases; frequently with Zollinger-Ellison syndrome.

**3. Pituitary:** Hyperplasia or adenoma in 65% cases; manifest as acromegaly or hypopituitarism. 4. Adrenal cortex: Uncommonly involved by adenoma or pheochromocytoma.

**5. Thyroid:** Less commonly involved by adenoma or hyperplasia.

### **MEN type 2 syndrome (Sipple's syndrome)**

It is characterised by medullary carcinoma thyroid and pheochromocytoma. Genetic abnormality in these cases is mutation in RET gene in almost all cases. MEN 2 has two major syndromes:

MEN type 2A is the combination of medullary carcinoma thyroid, pheochromocytoma and hyperparathyroidism. MEN type 2A has further three sub variants:

1. MEN 2A with familial medullary carcinoma thyroid
2. MEN 2A with cutaneous lichen amyloidosis
3. MEN 2A with Hirschsprung's disease. MEN type 2B the combination of medullary carcinoma thyroid, pheochromocytoma, mucosal neuromas, intestinal ganglioneuromatosis, and marfanoid features.

Mixed syndromes include a variety of endocrine neoplastic combinations which are distinct from those in MEN type 1 and type 2. A few examples are as under: von Hippel-Lindau syndrome from mutation in VHL gene is association of CNS tumours, renal cell carcinoma, and pheochromocytoma and islet cell tumours. Type 1 neurofibromatosis from inactivation of neurofibromin protein and activation of RAS gene, is associated with MEN type 1 or type 2 features

### **Polyglandular autoimmune (PGA) syndromes**

Immunologic syndromes affecting two or more endocrine glands and some non-endocrine immune disturbances produce syndromic presentation termed polyglandular autoimmune (PGA) syndromes. PGA syndromes are of two types:

PGA type I occurring in children is characterised by mucocutaneous candidiasis, hypoparathyroidism, and adrenal insufficiency.

PGA type II (Schmidt syndrome) presents in adults and commonly comprises of adrenal insufficiency, autoimmune thyroiditis, and type 1 diabetes mellitus.

### **Introduction:**

Diabetes mellitus, a complex metabolic disorder, is characterized by chronic hyperglycemia due to defects in insulin secretion or action. Insulin, produced by pancreatic beta cells, is central to glucose metabolism. It regulates glucose uptake by cells, facilitating energy production.

▪ And storage in diabetes, disruptions occur in insulin dynamics. Defects in insulin secretion or action led to persistent hyperglycemia. In type 1 diabetes, an autoimmune attack on beta cells results in insulin.

- Deficiency, while type 2 diabetes. Involves insulin resistance and relative deficiency. The consequences of disrupted glucose metabolism extend beyond elevated blood glucose levels.
- Lipid metabolism and protein synthesis are affected, contributing to complications such as atherosclerosis and impaired wound healing. The chronic nature of diabetes underscores the need for personalized management strategies, including lifestyle modifications and pharmacological interventions.
- Comprehensive approaches aim to mitigate hyperglycemia's impact and prevent associated complications, emphasizing the intricate balance required for optimal glucose regulation within the body.

## **Etiology:**

### **1.Genetic Factors:**

Genetic susceptibility contributes to the risk of diabetes. Specific gene variants influence susceptibility to both type 1 and type 2 diabetes.

### **2.Autoimmune Factors (Type 1 Diabetes):**

In type 1 diabetes, an autoimmune process leads to the destruction of beta cells in the pancreas, resulting in an absolute insulin deficiency.

### **3.Environmental Factors (Type 2 Diabetes):**

Lifestyle factors such as sedentary behavior, unhealthy diet, and obesity play a significant role in the development of insulin resistance and type 2 diabetes.

## **Types/Classification:**

### **1.Type 1 Diabetes (T1DM):**

- Usually diagnosed in children and young adults.
- Autoimmune destruction of beta cells leads to a lack of insulin production.
- Type 1 diabetes is less common than type 2 about 5-10% of people with diabetes have type 1. Currently, no one knows how to prevent type 1 diabetes, but it can be treated successfully by: Following your doctor's recommendations for living a healthy lifestyle. Managing your blood sugar.

### **2.Type 2 Diabetes (T2DM):**

- More common in adults, but increasingly diagnosed in children and adolescents.
- Insulin resistance, where cells fail to respond adequately to insulin, and relative insulin deficiency are characteristic.

### **3.Gestational Diabetes:**

- Develops during pregnancy and increases the risk of type 2 diabetes later in life.

## **Morphology:**

In terms of morphology, diabetes primarily manifests through complications. Microvascular changes, such as thickening of basement membranes in small blood vessels, contribute to diabetic complications in organs like the eyes, kidneys, and nerves.

### **Pathogenesis:**

#### **1.Type 1 Diabetes:**

- Autoimmune destruction of beta cells mediated by T lymphocytes and antibodies.

#### **2.Type 2 Diabetes:**

- Insulin resistance is associated with obesity and inflammation.
- Beta cell dysfunction and apoptosis contribute to relative insulin deficiency.

### **Clinical Manifestations:**

#### **1.Polyuria, Polydipsia, Polyphagia:**

- Polyuria results from osmotic diuresis due to elevated blood glucose.
- Polydipsia and polyphagia are compensatory responses to fluid loss and energy deficit.

#### **2.Weight Loss (Type 1 Diabetes):**

- Due to the breakdown of fats and proteins for energy in the absence of insulin.

### **Management:**

#### **1.Type 1 Diabetes:**

##### **Insulin Replacement Therapy:**

- Multiple daily injections or insulin pump.

##### **Continuous Glucose Monitoring:**

- Allows for real-time adjustments to insulin doses.

#### **2.Type 2 Diabetes:**

##### **Lifestyle Modification:**

- Dietary changes and regular physical activity.

##### **Oral Medications/Injectable Therapies:**

- Metformin, sulfonylureas, GLP-1 receptor agonists, insulin in advanced cases.

#### **3.Gestational Diabetes:**

- Diet control, monitoring blood glucose levels, and insulin therapy if necessary.

### **Difference:**

## **Type 1 vs. Type 2 Diabetes:**

### **Onset:**

Type 1 often abrupt in childhood; Type 2 gradual, more common in adults. Autoimmune Component: Present in Type 1, absent in Type 2.

### **Treatment:**

Insulin is essential in Type 1; Type 2 may involve oral medications or insulin. Diabetes management is a dynamic process, requiring regular monitoring, adjustments in treatment plans, and a multidisciplinary approach involving healthcare professionals, nutritionists, and educators. Patient education is pivotal for promoting self-management and preventing complications associated with diabetes.

## **Gestational Diabetes Mellitus (GDM):**

Gestational Diabetes Mellitus develops during pregnancy, usually in the second or third trimester, and is characterized by high blood sugar levels. GDM increases the risk of complications for both the mother and the baby, including preeclampsia, macrosomia (large birth weight), and neonatal hypoglycemia. Treatment involves blood sugar monitoring, dietary changes, and, in some cases, insulin therapy to ensure a healthy pregnancy and delivery.

## **LADA (Latent Autoimmune Diabetes in Adults):**

LADA is a form of autoimmune diabetes that shares characteristics of both Type 1 and Type 2 Diabetes. It is typically diagnosed in adults and is characterized by a gradual loss of insulin-producing beta cells, leading to a need for insulin therapy over time. LADA may initially appear as T2D but progresses more rapidly, requiring insulin treatment sooner than typical T2D.

## **MODY (Maturity-Onset Diabetes of the Young):**

MODY is a rare form of diabetes caused by genetic mutations that affect insulin production and secretion. It is typically diagnosed in young adults and is often mistaken for Type 1 or Type 2 Diabetes. MODY is usually inherited in an autosomal dominant pattern and can be managed through lifestyle changes and/or oral medications, depending on the specific genetic mutation.

## **Secondary Diabetes:**

Secondary Diabetes refers to diabetes that develops as a result of certain medical conditions, medications, or surgeries. Conditions such as pancreatitis, Cushing's syndrome, or hemochromatosis can damage the pancreas and impair insulin production, leading to diabetes. Certain medications, such as corticosteroids or antipsychotic medications, can also cause secondary diabetes. Management involves addressing the underlying cause and may include lifestyle modifications and medications to control blood sugar levels.

Several factors contribute to the development of diabetes, including both genetic predisposition and lifestyle-related factors:

**Genetics:** Having a family history of diabetes increases the risk of developing the condition. Genetic factors play a significant role in determining an individual's susceptibility to diabetes, including both Type 1 Diabetes (T1D) and Type 2 Diabetes (T2D).

**Obesity:** Excess body fat, particularly around the abdominal area, contributes to insulin resistance, a key feature of Type 2 Diabetes (T2D). Obesity-related insulin resistance impairs the body's ability to properly utilize insulin, leading to elevated blood sugar levels and an increased risk of developing diabetes.

**Physical Inactivity:** A sedentary lifestyle can lead to insulin resistance and increased blood sugar levels. Regular physical activity helps improve insulin sensitivity, promote weight management, and reduce the risk of developing Type 2 Diabetes (T2D).

**Age:** The risk of developing diabetes increases with age, especially after 45. Aging is associated with changes in hormone levels, decreased physical activity, and changes in body composition, all of which can contribute to an increased risk of diabetes.

**Ethnicity:** Certain ethnic groups have a higher risk of developing diabetes due to genetic and environmental factors. African Americans, Hispanic/Latino Americans, Native Americans, Asian Americans, and Pacific Islanders are at an increased risk compared to non-Hispanic whites.

**Previous History of Gestational Diabetes Mellitus (GDM):** Women who have had gestational diabetes mellitus (GDM) during pregnancy are at an increased risk of developing Type 2 Diabetes (T2D) later in life. GDM occurs when the body is unable to produce enough insulin to meet the increased demands of pregnancy, leading to elevated blood sugar levels.

**Poor Diet:** Consuming a diet high in refined carbohydrates, sugars, and unhealthy fats can contribute to weight gain, insulin resistance, and elevated blood sugar levels. A diet low in fiber and nutrient-dense foods such as fruits, vegetables, and whole grains may also increase the risk of developing diabetes.

**Polycystic Ovary Syndrome (PCOS):** PCOS is a hormonal disorder characterized by irregular menstrual cycles, high levels of androgens (male hormones), and ovarian cysts. Women with PCOS are at an increased risk of insulin resistance and T2D due to hormonal imbalances and metabolic abnormalities associated with the condition.

**Hypertension (High Blood Pressure):** Hypertension is a common comorbidity of diabetes and can contribute to cardiovascular complications. High blood pressure can damage blood vessels and increase the risk of heart disease, stroke, and kidney disease, particularly in individuals with poorly controlled diabetes.

**Chronic Stress:** Chronic stress and elevated levels of cortisol (the stress hormone) can contribute to insulin resistance, weight gain, and dysregulation of blood sugar levels. Stress management techniques such as mindfulness, relaxation exercises, and adequate sleep can help mitigate the impact of stress on diabetes risk and management.

**Environmental Factors:** Environmental factors such as exposure to toxins, pollutants, and certain chemicals may increase the risk of developing diabetes. Environmental pollutants, including air pollution and endocrine-disrupting chemicals, have been linked to insulin resistance and metabolic dysfunction, potentially contributing to the development of diabetes.

**Sleep Disorders:** Sleep disorders such as obstructive sleep apnea (OSA) and insufficient sleep duration have been associated with an increased risk of developing diabetes. Poor sleep quality and duration can disrupt hormonal regulation, including insulin sensitivity, glucose metabolism, and appetite regulation, contributing to the development of insulin resistance and T2D.

Understanding these causes and risk factors is essential for identifying individuals at higher risk of developing diabetes and implementing preventive strategies, including lifestyle modifications, regular screening, and targeted interventions, to reduce the risk and burden of diabetes-related complications.

### **1. Increased Thirst and Hunger:**

High blood sugar levels can cause the kidneys to work harder to filter excess glucose out of the blood, leading to increased urination. This excessive urination can result in dehydration, triggering feelings of thirst. Additionally, when cells are unable to properly absorb glucose due to insulin resistance or deficiency, the body may signal hunger in an attempt to obtain more energy.

## **2. Frequent Urination:**

Elevated blood sugar levels can lead to increased urine production as the kidneys attempt to remove excess glucose from the bloodstream. This excess glucose in the urine draws more water from the body, resulting in frequent urination, particularly during the night (nocturia).

## **3. Fatigue:**

When cells are unable to efficiently utilize glucose for energy due to insulin resistance or deficiency, the body may resort to breaking down fat and muscle for fuel, leading to feelings of fatigue and weakness. Additionally, fluctuating blood sugar levels can disrupt energy levels and contribute to fatigue.

## **4. Blurred Vision:**

High blood sugar levels can cause fluid to be pulled from the lenses of the eyes, resulting in changes in shape and focusing ability. This can lead to blurred vision and difficulty seeing clearly. Prolonged periods of elevated blood sugar levels can also damage the blood vessels in the retina, leading to diabetic retinopathy and further vision problems.

## **5. Slow Healing of Cuts and Wounds:**

High blood sugar levels can impair the function of white blood cells, which are responsible for fighting infections and promoting wound healing. Additionally, elevated glucose levels can interfere with the production of collagen, a protein essential for wound repair, leading to delayed healing of cuts, wounds, and infections.

## **6. Tingling or Numbness in Hands and Feet:**

Prolonged exposure to high blood sugar levels can damage the nerves, a condition known as diabetic neuropathy. This nerve damage often manifests as tingling, numbness, or burning sensations, typically starting in the extremities such as the hands and feet. Over time, diabetic neuropathy can lead to loss of sensation, increased risk of injuries, and difficulty with balance and coordination.

## **Unexplained Weight Loss:**

Despite increased hunger and food intake, individuals with uncontrolled diabetes may experience unexplained weight loss. This occurs when the body is unable to effectively utilize glucose for energy, leading to the breakdown of fat and muscle tissue as alternative fuel sources. Additionally, increased urination and dehydration can contribute to weight loss.

**Increased Infections:**

High blood sugar levels can weaken the immune system, making individuals with diabetes more susceptible to infections. Common infections include urinary tract infections, skin infections (such as boils and fungal infections), and recurrent yeast infections. Poorly controlled diabetes can impair the body's ability to fight off infections, leading to more frequent and severe bouts of illness.

**Dry Mouth and Skin:**

Dehydration resulting from frequent urination can cause dry mouth and skin. Inadequate fluid intake, coupled with elevated blood sugar levels, can lead to reduced saliva production, resulting in a dry, sticky feeling in the mouth. Dry skin may also occur due to impaired hydration and poor circulation, increasing the risk of skin irritation and infections.

**Increased Irritability and Mood Swings:**

Fluctuating blood sugar levels can affect mood and emotional well-being. When blood sugar levels are too high or too low, individuals may experience irritability, mood swings, difficulty concentrating, and decreased tolerance to stress. These mood disturbances can impact daily functioning and quality of life if blood sugar levels are not adequately managed.

**Digestive Issues:**

Diabetes can affect digestion and gastrointestinal function, leading to symptoms such as nausea, vomiting, bloating, and diarrhea. High blood sugar levels can slow down stomach emptying (gastroparesis), causing food to linger in the stomach and leading to discomfort and digestive disturbances. Additionally, nerve damage from diabetes (diabetic neuropathy) can affect the nerves that control digestion, exacerbating gastrointestinal symptoms.

**Increased Thirst and Hunger Despite Eating:**

In some cases, individuals with diabetes may experience persistent feelings of thirst and hunger even after eating. This occurs when blood sugar levels remain elevated due to insulin resistance or deficiency, causing cells to continue signaling for more energy and fluid intake despite adequate food consumption. Uncontrolled diabetes can exacerbate these symptoms, leading to ongoing thirst and hunger sensations.

In addition to insulin therapy, which involves injecting insulin to regulate blood sugar levels and is commonly used in individuals with Type 1 Diabetes (T1D) and some cases of Type 2 Diabetes (T2D), there are several oral medications available for the treatment of T2D. These oral medications come in the form of pills or tablets and work through various mechanisms to help control blood sugar levels. Some of the most commonly prescribed classes of oral medications include:

**1. Biguanides**



Such as metformin, which works by reducing glucose production in the liver and improving insulin sensitivity in muscle cells, thereby lowering blood sugar levels. Metformin is often recommended as a first-line therapy for T2D due to its effectiveness and relatively low risk of hypoglycemia.

## **2. Sulfonylureas**

Including medications like glipizide, glyburide, and glimepiride, which stimulate the pancreas to produce more insulin. Sulfonylureas can be effective in lowering blood sugar levels but may carry a higher risk of hypoglycemia compared to other oral medications.

## **3. DPP-4 Inhibitors (Dipeptidyl Peptidase-4 Inhibitors):**

Such as sitagliptin, saxagliptin, and linagliptin, which work by increasing the levels of incretin hormones that stimulate insulin release and decrease glucagon secretion, leading to lower blood sugar levels.

## **4. SGLT2 Inhibitors (Sodium-Glucose Cotransporter-2 Inhibitors):**

Including medications like canagliflozin, dapagliflozin, and empagliflozin, which work by inhibiting the reabsorption of glucose by the kidneys, thereby increasing glucose excretion in the urine and lowering blood sugar levels.

## **5. GLP-1 Receptor Agonists (Glucagon-Like Peptide-1 Receptor Agonists):**

Such as exenatide, liraglutide, and dulaglutide, which mimic the action of incretin hormones to stimulate insulin release, inhibit glucagon secretion, slow gastric emptying, and promote satiety, leading to improved blood sugar control and potential weight loss.

In addition to oral medications, there are also injectable medications available for the treatment of T2D. These non-insulin injectable medications are typically used in combination with oral medications when blood sugar levels are not adequately controlled. Examples include:

### **1. GLP-1 Receptor Agonists:**

These medications, which were previously mentioned as oral medications, are also available in injectable form for individuals who prefer or require injectable therapy.

### **2. Amylin Analogues:**

Such as pramlintide, which mimics the action of amylin, a hormone that is released along with insulin to regulate blood sugar levels. Pramlintide slows gastric emptying, suppresses glucagon secretion, and promotes satiety, helping to lower blood sugar levels after meals.

These medications, whether taken orally or via injection, play a crucial role in the management of diabetes by helping to regulate blood sugar levels, improve insulin sensitivity, and reduce the risk of complications associated with uncontrolled diabetes. It's important for individuals with diabetes to work closely with their healthcare providers to determine the most appropriate medication regimen based on their individual needs, preferences, and overall health status.

The **\*\*Fasting Plasma Glucose (FPG) Test\*\*** is a commonly used method for diagnosing diabetes. It involves measuring blood glucose levels after an overnight fast, typically for at least 8 hours. A fasting plasma glucose level of 126 milligrams per deciliter (mg/dL) or higher on two separate occasions indicates diabetes. This test is valuable for screening and diagnosing both diabetes and prediabetes.

### **Another diagnostic test**

#### **Oral Glucose Tolerance Test (OGTT)**

During this test, individuals consume a sugary solution containing 75 grams of glucose, followed by blood glucose measurements at intervals, usually 1, 2, and sometimes 3 hours after ingestion. A blood glucose level of 200 mg/dL or higher 2 hours after drinking the solution indicates diabetes. OGTT is particularly useful for diagnosing gestational diabetes during pregnancy and detecting impaired glucose tolerance.

#### **Hemoglobin A1c (HbA1c) Test**

provides an indication of average blood glucose levels over the past 2-3 months. It measures the percentage of hemoglobin that is glycated (bound to glucose). An HbA1c level of 6.5% or higher indicates diabetes. Unlike other tests, HbA1c does not require fasting and is commonly used for diagnosing and monitoring long-term blood glucose control in individuals with diabetes.

For diagnosing diabetes in emergency situations or when fasting is not possible,

#### **Random Plasma Glucose Test**

is used. It measures blood glucose levels at any time of day, regardless of when the person last ate. A random plasma glucose level of 200 mg/dL or higher, along with classic symptoms of diabetes such as increased thirst and urination, indicates diabetes.

In addition to these standard tests, there are other methods for assessing blood glucose control.

### **Glycated Albumin (GA) Test**

measures the percentage of glycated albumin in the blood, offering an indication of average blood glucose levels over the past 2-3 weeks. This test may be used as an alternative to HbA1c in certain situations, such as when conditions affecting red blood cells may interfere with HbA1c results.

### **Continuous Glucose Monitoring (CGM)**

provides real-time glucose readings by wearing a small sensor under the skin to measure interstitial glucose levels continuously throughout the day and night. CGM is particularly useful for detecting patterns of blood glucose fluctuations, assessing the impact of meals, physical activity, and medication adjustments on blood glucose levels.

These tests play a crucial role in diagnosing diabetes, monitoring blood glucose levels, and guiding treatment decisions. Depending on individual circumstances, healthcare providers may recommend specific tests or combinations of tests to accurately assess blood glucose control and overall diabetes management.

#### **1. Heart Disease:**

- High blood sugar levels can lead to the buildup of fatty deposits in blood vessels, causing them to become narrow and stiff, a condition known as atherosclerosis.
- This narrowing of blood vessels restricts blood flow to the heart, increasing the risk of heart attacks and other cardiovascular diseases.
- Diabetes doubles the risk of heart disease and stroke.
- People with diabetes are more likely to have high blood pressure and high cholesterol levels, further increasing the risk of heart disease.
- Lifestyle factors such as smoking, unhealthy diet, and lack of physical activity can exacerbate the risk of heart disease in individuals with diabetes.

#### **2. Kidney Disease:**

- High blood sugar levels can damage the tiny blood vessels in the kidneys, impairing their ability to filter waste products from the blood.
- Over time, this damage can progress to kidney disease or kidney failure, requiring dialysis or a kidney transplant.
- Diabetes is the leading cause of kidney failure, accounting for approximately 44% of new cases.

- Controlling blood sugar levels, along with blood pressure and cholesterol levels, is crucial for preventing or delaying kidney disease progression.
- Regular monitoring of kidney function through blood and urine tests is essential for early detection of kidney disease in individuals with diabetes.

### **3. Nerve Damage (Neuropathy):**

- High blood sugar levels can damage the nerves throughout the body, particularly those in the hands and feet.
- Symptoms of diabetic neuropathy may include numbness, tingling, burning sensation, or pain in the affected areas.
- Neuropathy can also lead to digestive issues, urinary problems, and sexual dysfunction.
- Poorly managed blood sugar levels over time increase the risk and severity of neuropathy.
- Foot care practices, including daily inspection, proper footwear, and avoiding walking barefoot, are essential for preventing foot complications associated with neuropathy.

### **4. Eye Damage (Retinopathy):**

- High blood sugar levels can damage the small blood vessels in the retina, the light-sensitive tissue at the back of the eye.
- Diabetic retinopathy is the leading cause of blindness among working-age adults.
- Early stages of retinopathy may have no noticeable symptoms, but as the condition progresses, it can cause blurred vision, floaters, or even complete vision loss.
- Regular eye exams, including dilated eye exams, are essential for early detection and treatment of diabetic retinopathy.
- Tight control of blood sugar levels and blood pressure can help reduce the risk of developing retinopathy and slow its progression.

### **5. Foot Damage (Foot Ulcers and Amputations):**

- Nerve damage and poor circulation resulting from diabetes can lead to foot complications, including foot ulcers and infections.
- Reduced sensation in the feet increases the risk of injuries going unnoticed, leading to infections and ulcers.
- Poor circulation impairs the healing process, increasing the risk of complications and the need for amputation.

- Approximately 15% of people with diabetes will develop a foot ulcer in their lifetime.
- Daily foot care, regular foot exams, wearing proper footwear, and avoiding smoking are crucial for preventing foot complications in individuals with diabetes.

These complications underscore the importance of effective diabetes management, which includes maintaining healthy blood sugar levels, regular medical check-ups, adopting a healthy lifestyle, and adhering to prescribed medications and treatments. It's essential for individuals with diabetes to work closely with their healthcare team to minimize the risk of complications and maintain overall health and well-being.

### **Warm-Up:**

Start with 5-10 minutes of light cardio such as brisk walking or cycling to warm up your muscles and get your heart rate up gradually. This helps to prepare your body for the main workout.

### **Main Workout:**

#### **1. Strength Training:**

##### **- Exercise: Bodyweight Squats**

- Explanation: Stand with your feet shoulder-width apart, lower your body as if you're sitting back into a chair, keeping your knees aligned with your toes. Push through your heels to return to the starting position. This exercise strengthens your leg muscles, which is beneficial for managing blood sugar levels.

#### **2. Cardiovascular Exercise:**

##### **- Exercise: Walking or Jogging**

- Explanation: Aim for 20-30 minutes of moderate-intensity walking or jogging. Cardio exercises help improve insulin sensitivity and lower blood sugar levels. Start at a pace that is comfortable for you, and gradually increase the intensity as your fitness improves.

#### **3. Flexibility Training:**

##### **- Exercise: Seated Forward Bend**

- Explanation: Sit on the floor with your legs extended in front of you. Lean forward from your hips and reach towards your toes, keeping your back straight. Hold the stretch for 15-30 seconds. This

exercise helps improve flexibility in your lower back and hamstrings, reducing the risk of injury and improving overall mobility.

#### **4. Balance Exercises:**

- Exercise: Single Leg Stance
- Explanation: Stand on one leg while keeping the other leg slightly bent or lifted off the ground. Hold this position for 15-30 seconds, then switch legs. Balance exercises help improve stability and reduce the risk of falls, which can be particularly important for individuals with diabetes who may experience nerve damage or neuropathy.

#### **Cool Down:**

Finish with 5-10 minutes of gentle stretching, focusing on the major muscle groups used during your workout. This helps to reduce muscle soreness and improve flexibility.

#### **Important Tips:**

- Stay hydrated before, during, and after exercise.
- Monitor your blood sugar levels before and after exercise, especially if you're taking insulin or other medications that can affect blood sugar.
- Wear comfortable, supportive footwear to reduce the risk of foot problems.
- Listen to your body and modify exercises as needed to suit your fitness level and any existing health conditions.

#### **Quit Smoking**

It is no secret that smoking is bad for your health. Smoking hurts your lungs and your heart. It lowers the amount of oxygen that gets to your organs, raises your bad cholesterol and raises your blood pressure. All of these can raise your risk of heart attack or stroke.

If you don't smoke, that's great. Make a plan to never start.

If you do smoke, there is something you can do: challenge yourself to quit smoking. Here are some steps to help you do it.

### **Step one: Realize the benefits of quitting**

Quitting helps your heart and lungs—and it lowers the risk of hurting your blood vessels, eyes, nerves and other organs. And quitting smoking can leave you with fewer wrinkles on your face; better-smelling hair, breath, and clothes; and less exposure for your family to secondhand smoke.

### **Step two: Prepare to quit**

Quitting is hard work, so approach it like any major project. Before you quit:

Set a quit date, and tell your friends and family. Make this a time when your life is fairly calm and stress levels are low.

Think of your reasons for quitting, and write them down. Put the list where you'll see it every day.

Throw away your cigarettes, matches, lighters and ashtrays.

Ask others for their help and understanding. Ask a friend who smokes to consider quitting with you.

Step three: Choose a quitting strategy

Go cold turkey. Quitting all at once works for some people.

Taper off. Quit smoking gradually by cutting back over several weeks.

Use a nicotine patch, gum, inhaler or spray. Or ask your doctor for a prescription medicine.

Ask your doctor about counseling, acupuncture or hypnosis.

You can use one of these steps or a combination of them. When you do, you'll feel healthier right away, and you'll be healthier for the rest of your life.

### **Diabetes and High Blood Pressure**

Two of three people with diabetes report having high blood pressure or take prescription medications to lower their blood pressure.

When your blood pressure is high, your heart has to work harder and your risk for heart disease, stroke, and other problems go up.

The thing you may not know is that high blood pressure won't go away without treatment. That could include lifestyle and dietary changes and, if your doctor prescribes it, medication.

### **Know the Diabetes-Cancer Link**

Researchers are still trying to learn more about the link between type 2 diabetes and certain cancers, including:

liver

pancreas

uterus

colon

breast

bladder

### **Understand the Joint Risk Factors**

Type 2 diabetes and certain cancers share some risk factors. The good news is that some of these risk factors are within your control to manage:

**Age**—As you get older, your risk for both type 2 diabetes and cancer goes up.

**Gender**—Overall, cancer occurs more often in men. Men also have a slightly higher risk of diabetes than women.

**Race/ethnicity**—African Americans and non-Hispanic whites are more likely to develop cancer. African Americans, Native Americans, Hispanics/Latinos, and Asian Americans/Pacific Islanders are at higher risk for developing type 2 diabetes.

**Overweight**—Being overweight can increase your risk of type 2 diabetes and certain types of cancer.

**Inactivity**—Higher physical activity levels lower the risk of type 2 diabetes and certain types of cancer.

**Smoking**—Smoking is linked to several types of cancer. Studies suggest that smoking is a risk factor for the development of type 2 diabetes.

**Alcohol**—Drinking more than one drink a day for women or two drinks a day for men raises the risk for both diabetes and cancer.

### **Next, Lower Your Risks**

**Lose weight**—If you are overweight, even losing just 7% of your weight (15 pounds if you weigh 200 pounds) can make a big difference. Use the Body Mass Index (BMI) Calculator to find out how much weight you need to lose.

### **Eat healthy – Choose a diet with plenty of:**

**Fresh vegetables**—The best choices are fresh, frozen, and canned vegetables and vegetable juices without added sodium, fat, or sugar. Try to eat at least 3–5 daily servings of vegetables, including asparagus, broccoli, cabbage, carrots, cauliflower, celery, eggplant, greens, peppers, snap peas and tomatoes. A serving of vegetables is ½ cup of cooked vegetables or vegetable juice; or 1 cup of raw vegetables.



**Whole grains**—A whole grain is the entire grain, which includes the bran, germ, and endosperm (starchy part). Shop for cereals and grains that have the first ingredient with a whole grain such as bulgur (cracked wheat), whole wheat flour, whole oats/oatmeal, whole grain corn/corn meal, brown rice, or whole rye. Try to include dried beans, legumes, peas, and lentils into several meals per week. They are a great source of protein and are loaded with fiber, vitamins and minerals.

**Fruits**—Eat fruits that are fresh, frozen, or canned without added sugars. Common fruits include apples, blackberries, blueberries, cantaloupe, dates, figs, grapes, oranges, pears, and strawberries.

### **Choose healthier options for dairy and meat:**

**Low-fat or non-fat dairy products** – Choose fat-free or low-fat (1%) milk, non-fat yogurt (without added sugar), and unflavored soy milk.

**Lean meats**—The best choices are cuts of meats and meat alternatives that are lower in saturated fat and calories. Include fish and seafood, poultry without the skin, eggs, and choice grades of meats trimmed of fat.

Most importantly, be sure to watch portion sizes.

**Stay active**—Set a goal to exercise five days a week. Thirty minutes of brisk walking or a similar activity will work. You can even break it up into 3 10-minute blocks if it is easier to fit in your day. The important thing is to keep moving.

**Quit smoking**—If you smoke, Prepare by setting a date to quit, throwing away your cigarettes, or asking others for help. Then choose a strategy, such as going cold turkey, tapering off, or working with your healthcare professional.

### **Get Recommended Cancer Screenings**

Preventative screenings are the next step in staying healthy. Work with your healthcare provider to see what types of cancer screenings you should have. Your age and gender will help determine the recommended screenings.

## **PREDIABETES**

### **With prediabetes, action is the best medicine.**

If you've been diagnosed with prediabetes, we know that can feel like a lot—like your life has changed and you'll never be “normal” again. But know that that isn't the case.

### **You have the power to change things.**

For some people with prediabetes, early treatment as well as moderate lifestyle changes can actually return blood glucose (blood sugar) levels to a normal range, effectively preventing or delaying type 2

diabetes. Ask your doctor plenty of questions and listen to their answers. Increase your daily physical activity. Start eating healthy. And your life can be yours again.

## **What it Means and What You Can Do**

There are no clear symptoms of prediabetes so you may have it and not know it. But before people develop type 2 diabetes, they almost always have prediabetes—where blood glucose levels are higher than normal but not yet high enough to be diagnosed as diabetes. It is possible that you may have some of the symptoms of diabetes or even some of the complications. If you think you may have diabetes or prediabetes, check with your doctor and get tested.

If you discover that you do have prediabetes, remember that it doesn't mean you'll develop type 2, particularly if you follow a treatment plan and make changes to your lifestyle through food choices and physical activity. Even small changes can have a huge impact on delaying or preventing diabetes all together. Work with a health care professional to make a plan that works for your lifestyle, or look for a Centers for Disease Control and Prevention (CDC)-recognized lifestyle change program, guided by a lifestyle coach trained to use a CDC-approved curriculum, where you will meet other people who are working to prevent diabetes.

## **Newly Diagnosed with Diabetes**

1.4 million people will be diagnosed with diabetes this year. We make sure that's not the end of the story.

### **Newly Diagnosed**

Look—we know it can be hard to hear that you have diabetes.

You probably feel overwhelmed and confused. You're asking yourself, “What now?”

Well, the good news is you have a community to fall back on. You don't have to maneuver this by yourself. You have the support of countless others who have felt the same shock. Your diagnosis is simply the first step. There are ways you can manage your diabetes—through diet, exercise, medical support and emotional help. Dig in. Take action. And know that we have everything you need to help you live a long, healthy life surrounded by people who know exactly what you're going through.

## **Getting started with type 2**

To use blood glucose (blood sugar) as energy, your body uses insulin. But with type 2 diabetes, your body doesn't make enough insulin, use it well, or both—and your body's cells can't use blood glucose for the energy it needs. When blood glucose isn't used and your blood glucose levels rise, it can cause serious problems.

## **Taking medication**

Medication is an important part of managing type 2 diabetes. Work with your doctor to see what medications fit into your diabetes management plan to help reach your target range. Here are a few questions about your medications you can ask your doctor, pharmacist, or diabetes care and education specialist:

## **Living with type 1**

If you have type 1 diabetes, it means that your pancreas does not produce insulin. It requires monitoring your blood glucose and administering multiple daily insulin injections with a pen, syringe, or a pump.

If you've just learned you have type 1 diabetes, know that you have an array of tools at your disposal to help you manage it. Finding ways to manage your blood glucose levels, your insulin intake, diet and exercise, and working with your diabetes care team, can help you feel healthier and help you stay on top of your condition.

Remember, millions of people live healthy lives with type 1. Find others with type 1 and ask them what they do to stay healthy. You may be curious about an insulin pump, and find someone who uses one. You can get tips and tricks that will make life just a little bit easier.

The important thing is to share your feelings with those around you and don't hold back from asking for help. Reaching out is key to living a vital life with type 1 diabetes.

## **Diabetes technology has come a long way.**

From blood glucose meters and continuous glucose monitoring (CGM) to cutting-edge insulin pumps and more, devices are easier to use and less invasive. There are lots of options so that you can find what works best for you.

## **What I Wish I Had Known When I Was Diagnosed with Diabetes**

Being diagnosed with diabetes is hard, especially if you don't know anyone else who is living with it. It may feel like your life has changed in an instant, and you probably don't know the questions you should ask or the options available to you. Many people hide their diabetes from others instead of reaching out for support and treatment.

## **What Is a Smart Insulin Pen?**

The new generation of connected insulin delivery devices may help simplify your routine.

A smart insulin pen is a reusable injector pen with an intuitive smartphone app that can help people with diabetes better manage insulin delivery. This smart system calculates and tracks doses and provides helpful reminders, alerts, and reports. They can come in the form of an add-on to your current insulin pen or a reusable form which uses prefilled cartridges instead of vials or disposable pens.

Smart insulin pens are a rapidly growing market. Why? Because they are typically more affordable, easy to use, and offer many benefits and improvements for people who depend upon insulin to manage their diabetes.

## **Insulin Pens**

If you're always on the go and have diabetes, then you know traditional diabetes management methods don't always make sense for your active lifestyle. If you find that syringes and insulin pumps don't work for you, consider insulin pens for convenient and quick doses of insulin.

## **Pros and cons of insulin pens**

Here are some of the pros and cons of insulin pens compared to administering insulin through other methods:

### **Pros**

Insulin pens can make taking insulin more convenient because they combine the medication and syringe in one handy unit. Unlike syringes, pens come preloaded with insulin—including premixed insulins. They are fairly simple to use: simply twist or snap on a new needle, dial a dose, inject the insulin, and throw away the used needle into a needle-safe, sharps container. Certain insulin pens are disposable, so you can trash the pen once the insulin is gone or expired, while other pens can be reused once a new cartridge of insulin is inserted.

Many brands offer pens that are color-coded and use different designs to help you know which type of insulin you're using at a glance. This makes the administration time faster than syringes and vials—and they're more portable, too. Plus, some new models come with a digital application, to help you remember when you last injected insulin and how much was administered.

### **Cons**

**Pens vs. Syringes:** The convenience factor of insulin pens means they cost more than syringes. Talk to your insurance provider to see if and how much they'll cover for insulin pens. Compare the costs of other diabetes management tools to see which one makes the most sense.

**Pens vs. Pumps:** Despite the benefits, a draw-back to using insulin pens (and syringes) is the need to administer insulin more often than if you were to use a pump. If you are particularly active and eat several times a day, you should consider the number of times a day you'll have to administer insulin versus that of a pump, which doesn't require shots.

## **Picking the right pen**

Pens come in two basic types: disposable and reusable.

Disposable pens are preloaded with insulin and are thrown away after the insulin cartridge is empty or the pen has been in use for 28 or 32 days (depending on insulin type).

Reusable pens work with insulin cartridges that can be loaded into the pen and then tossed away once the insulin is used, leaving the pen ready for the next cartridge. Each pen only works with certain types of insulin, so keep that in mind as you browse pens.

Even though reusable pens are more expensive at first, replacement cartridges for reusable pens are cheaper than those for disposable, making them about the same price over the long term.

Another pen trait you may want to note when picking a pen is how it doses insulin. Some pens can dose in half-unit increments (for example, 1.5 units), while others dose in whole units. The maximum dosage of insulin that can be delivered at one time also varies among pens.

## **Don't forget the needles**

Once you've picked your pen, you'll need a needle for the tip. Pen needles screw onto the top of an insulin pen. It's good practice to change your needle after each injection or at least once daily. Fresh, sharp needles mean shots that are less painful.

Most brands of pen needles will fit any of the insulin pens. Pen needles come in different lengths—between 4 and 12 mm—and gauges (thickness of the needle).

## **Length**

A shorter needle is effective for all body types. You want to aim to deliver the insulin just below the skin without hitting the muscle beneath. When using a shorter needle, administer at a 90-degree angle and do not pinch up the skin. Very thin people and children may want to pinch up the skin and inject at an angle even with a shorter needle to avoid hitting muscle. Hold the needle in the skin for 5 to 10 seconds after you give the insulin so the medication doesn't leak from the site.

## **Gauge**

A higher gauge means a thinner needle and less pain, while a thicker needle may be more painful—length shouldn't really affect pain levels. If you inject a large dose of insulin at one time, a lower gauge (thicker) needle may make for quicker insulin delivery and help you to avoid medication leaking out of your skin.

### **Storing your pens**

For unused pens, be sure to keep them refrigerated. For pens you're currently using, keep those at room temperature. Extreme temperatures should be avoided altogether, so they should stay out of the freezer. Also avoid leaving them in places where the temperature can get too hot or cold, such as on a windowsill or in a car, too.

### **High-Tech Help to Better Manage Your Diabetes**

The biggest challenges for many insulin pen (multiple daily injection) users are:

**Dose amount:** How much to inject

**Dose timing:** Shelf-life, temperature, and storage conditions

**Insulin quality:** Shelf-life, temperature, and storage conditions

### **Choosing How to Check Your Blood Glucose**

For most people, checking blood glucose (blood sugar) meter is just a part of life. That's why getting it right matters.

The two main types are blood glucose meters that use a drop of blood to check what your levels are at that moment and continuous glucose monitors (CGMs) that check your blood glucose regularly day or night—pick the one that works best for you and your lifestyle.

Of these two options, there are more choices than ever, from basic designs to more advanced models that have all the bells and whistles. And fancier isn't necessarily better. Here are some things to consider:

**Ease of use**—Some meters are made for simpler operation, whether it's larger buttons, illuminated screens or audio capabilities.

**Cost and insurance coverage**—Meters vary in price, and some insurers limit coverage to specific models. Start by checking with your provider to find out what they'll cover.

**Information retrieval**—Consider how the meter retrieves your information and whether you can download the data to a computer or mobile device to make it easier to share with your diabetes care team.

**Flexibility**—If you're using a blood glucose meter and are tired of finger pricks, there's an alternative site monitor that lets you draw blood samples from your arm, thigh, or the palm of your hand.

### **Fewer Finger Pricks with CGM**

If you have type 1 or type 2 and just want to manage your blood glucose better, continuous glucose monitoring may be right for you. CGMs report your blood glucose levels in real time (for example every five minutes throughout the day), alert you when your glucose hits a high or a low limit, and provide insight into glucose trends. Learn more about continuous glucose monitoring and time in range.

CGMs work through a sensor placed on your skin. It transmits readings to a small recording device. Whether you manage your diabetes with a pump, daily injections, or oral medications, a CGM can help you manage your blood glucose.

### **Is a CGM right for you?**

Many people with type 1 and type 2 can benefit from using a CGM. Those that would benefit the most are people that have trouble reaching and maintaining target blood glucose. CGMs are particularly useful if you often have lows and are unaware of when they happen (hypoglycemia unawareness).

Even if you have a good handle on your diabetes management, you still may want to consider using a CGM for the convenience and the elimination of finger pricks. However, you'll want to keep in mind that if you are managing your diabetes well without the use of a CGM, your insurance may not cover it—they might consider it a non-necessity.

**When it comes to choosing the right CGM for you, we are here to help.**

### **With Insulin Pumps, It's Your Choice**

The important thing to know is that a pump gives you options. You can get a pump, wear it for a time, decide to stop wearing it, and restart it if you think it will fit better with your treatment—work with your insurance to match whatever works for you.

Pumps are an extra piece of hardware attached to your body. They're programmed to deliver insulin continuously (basal), or as a surge (bolus) dose close to mealtime to control the rise in blood glucose after a meal. They work by closely mimicking your body's normal release of insulin.

### **Is a Pump Right for You?**

If your doctor determines that a pump is a good option for you, it's important to check with your insurance provider before you buy anything. Most insurance providers cover pumps, but sometimes they may not be covered and pumps can be expensive. In addition to cost, some considerations to consider when it comes to getting a pump are lifestyle, commitment, and safety. Learn more about the pros and cons of insulin pumps, and if they may be a good fit for you.

Remember, using a pump doesn't mean you no longer have to check your blood glucose. And it can take some getting used to, from setting it up and putting it in to managing it day-to-day. Make sure you've spoken with your diabetes care team about how to use your insulin pump correctly and how to check if it's working properly.

### **Who Should Use a Pump?**

Insulin pumps have been used successfully across the age spectrum. Whether or not to use a pump is a personal decision. You can manage your diabetes equally well with pumps or multiple injections, so it comes down to your preference.

Choosing one method over the other is not a lifelong commitment. Some people go on and off their pumps (but this should always be done with instructions from a person's diabetes care team). Remember that a pump is just a tool—you can reach blood glucose goals with a pump or injections. But here are some things to consider...

### **Pump safety is a commitment**

The one absolute requirement for using a pump is that you and/or your caregivers are ready and willing to do what it takes to use the pump safely. Most diabetes providers and insurance companies require that you check your blood glucose at least four times per day before you go on an insulin pump. Checking blood glucose is important because it will warn you if your pump stops working right, or your infusion set stops working. This can cause high blood glucose levels and cause you can go into diabetes ketoacidosis, which is very serious and dangerous. Checking blood glucose levels frequently will alert you to this possibility and will prevent the development of ketones.

### **A pump might be considered for:**

People who like the idea of a pump. If this is what you want, or you want for your child, and it can be used it safely, then it should be used.

Active people, who benefit from changes in basal rates or suspending the pump when exercising.

People who have frequent low blood glucose reactions.



Anyone who has delays in absorption of food from the stomach (gastroparesis).

Women planning pregnancy.

People who want to use the pump's bolus calculator functions to determine insulin doses.

**Other factors to consider:**

The insulin pump doesn't take away the need to check blood glucose and give insulin before meal.

There are technical aspects to using a pump—setting it up, putting it in, interacting with it—that are more complicated in some ways than using injections. It only gives shorter-acting insulin. If it breaks or falls off, the person wearing it needs to be ready to give insulin by injection any time it is needed. It is expensive, so find out which pumps are covered by your insurance and if those pumps meet your needs. All pumps are an extra piece of hardware attached to your body, either with tubing or attached to your skin. There are many clever ways to wear pumps, and hide them from view, but they do take a bit of getting used to at first. It's a choice most people use their pump continuously, but it is not a permanent part of the body. Some kids use it during the school year but not during the summer. Others revert to injections when they go on vacation. Some have issues with their infusion sites, so they go off the pump for a while to let their sites recover. Whatever works to make diabetes treatment easier and better.

There are a number of pumps on the market; research what is best for you/your child. Look at the individual pump company sites and read bloggers who have experience using the pumps. Speak with your diabetes team. Most insurance companies will not pay for a new pump more often than every four years, so this is a device you will have for a while. Finally, remember this is not a permanent decision. You can get a pump, wear it, stop wearing it, restart it—whatever works for you. It is an option for treating your diabetes and the choice is yours.

**Connected CGM-Insulin Pumps and “Closed Loop” Systems**

A newer option to consider is using a combination CGM-insulin pump. Your insulin pump will be able to integrate your glucose data from the CGM sensor and either suggest changes to insulin dosing or adjust the appropriate amount of background or basal insulin on its own. This is triggered when you run high (more insulin needed)—or when your blood sugar runs low (insulin needs to be suspended)—so you don't have to think about it as much. Keep in mind, though, that you will still need to administer insulin for meals.

**CGM & Time in Range**

Continuous glucose monitors (CGM), as the name suggests, continually monitor the glucose (sugar) in your blood through an external device that's attached to your body, and gives real-time updates. They've become popular and more accurate over the years, and with that improvement has come a new way to manage your blood glucose—enter time in range (TIR).

## **What is time in range?**

Time in range is the amount of time you spend in the target blood glucose (blood sugar) range—between 70 and 180 mg/dL for most people.

The time in range method works with your CGM's data by looking at the amount of time your blood glucose has been in target range and the times you've been high (hyperglycemia) or low (hypoglycemia). Time in range is often depicted as a bar graph showing the percentage of time over a specific amount of time when your blood glucose was low, in range, and high. This data is helpful in finding out which types of foods and what activity level causes your blood glucose to rise and fall.

Most people with type 1 and type 2 diabetes should aim for a time in range of at least 70 percent of readings—meaning 70 percent of readings, you should aim for roughly 17 out of 24 hours each day to be in range (not high or low). Some may have different targets. Talk with your doctor to figure out the right blood glucose levels and time in range targets are right for you.

## **What does the research say?**

Because CGMs are relatively new, we're still learning about the long-term results of time in range. Here's what we do know: the more time you spend in range, the less likely you are to develop certain diabetes complications. However, a lot more research needs to be done. What we understand about the link between time in range and diabetes complications comes from data before CGMs were in use. The good news is, as more people start using CGMs, we anticipate more data for research will be collected and more information will be available for the long-term effect of spending more time in your target range.

## **Time in range versus A1C**

A1C is a measure of your average blood glucose for the previous three months—but it doesn't document the daily highs and lows that people may have. The introduction of time in range is a result of the improvements in diabetes management (specifically CGMs) and what we find out from your A1C, the current gold standard for determining diabetes management.

Without knowing the details of your highs and lows, your doctor might prescribe medication in a dose that lowers your blood glucose into hypoglycemia territory, creating a situation where you need to correct medications over time. Being able to know your average blood glucose levels as well as the highs and lows time in range provides a bigger picture of what's needed to manage your diabetes.

Does that mean A1C is on the way out? No. It has been and likely will remain the standard measure of diabetes management because it's well established that A1C can be used to predict and help prevent diabetes complications.

## **Who should use time in range?**

People with type 1 diabetes and those with type 2 who use insulin and have tight blood glucose goals will benefit the most from reviewing their time in range data. That's because they're most likely to have blood glucose levels outside their target range. Research has yet to establish how often people should

check their time in range status. However, many people with diabetes find daily and weekly summaries to be helpful. The more times you check your blood glucose levels each day, the more you'll know about how long you are in range. If you have type 2 diabetes, but do not use insulin, your health care provider may still advise you to use a CGM periodically to measure how much time your glucose is in range.

Still interested in understanding your time in range? Talk to your doctor about using a professional CGM for about two weeks to figure out your time in range patterns. Your doctor may recommend that you do this to confirm that your time in range since it gives more information than standard blood glucose meters. One barrier to the widespread use of time in range for diabetes management is the limited number of people who use a CGM. Though the numbers have dramatically increased in recent years, we still believe a minority of people with diabetes are using one.

With insurance coverage of CGMs improving and with Medicare covering CGMs for anyone who uses an insulin pump, injects insulin multiple times a day, or checks their blood glucose at least four times a day—there will likely be more and more people who begin to use them.

At the end of the day though, time in range data is meaningless unless both patients and their diabetes care team take the time to check it.

As for what time in range target you should aim for, remember: there's no universal time in range goal. Yours will depend on your diabetes management needs and lifestyle, and your doctor can help you determine the right range for you.

## **Tips for Eating Well**

### **Eat Good to Feel Good**

Simplify healthy eating with the Diabetes Plate Method—an easy, tool-free way to portion your plate that supports your diabetes management. woman eating a healthy meal of fruits and yogurt in blue bowl

Knowing what to eat can be confusing—especially when life gets hectic and you're trying to eat healthy on the go or make healthy choices when ordering fast food. Regardless of what cuisine you prefer, here's what all healthy eating plans have in common. They include:

### **Fruits and vegetables**

- Lean meats and plant-based sources of protein
- Less added sugar
- Less processed foods

### **Try the Diabetes Plate Method**

Eating healthy is important, it can be hard to know what and how much to eat—especially when you're managing diabetes. If you're looking for an easy place to start, then try following the Diabetes Plate Method. This simple guide offers a stress-free way to plan your portions without any counting, calculating, or measuring.

Plate method infographic showing plate broken out into vegetable carbohydrate protein

First, grab a nine-inch plate. You want to fill half your plate with non-starchy vegetables, one quarter of the plate of protein foods, and the last quarter of the plate with carbohydrate foods. Top it off with a glass of water or another zero-calorie drink and you've got yourself a well-balanced plate! This helps take the guess work out of meal planning so you can spend more time doing the things you love.

### **Non-Starchy Vegetables**

Using the Diabetes Plate Method as your guide, fill half your plate with non-starchy vegetables for a healthy meal. These vegetables keep you feeling full for longer and provide you with the great-tasting nutrients your body needs without as many calories and carbs. Non-starchy vegetables include broccoli, carrots, cauliflower, and more! Learn more about non-starchy vegetables.

### **Protein**

Protein is an important part of a diabetes meal plan. Are you plant-based? That's okay! There are plenty of protein-rich plant-based options, such as beans, hummus, lentils, and others.

### **Fruits**

Wondering if you can eat fruit? Yes! While fruit does count as a carbohydrate food, they are loaded with vitamins, minerals, and fiber just like vegetables. Fruit can also help you satisfy your sweet tooth without the added sugar.

### **Fats**

Fats are not the enemy. Focus on adding healthy fats (like monounsaturated and polyunsaturated fats) to lower your cholesterol and protect your heart. Healthy fats can be found in foods like olive oil, nuts, avocados, some types of fish, and a host of other tasty options. Make healthy choices to decrease your risk of heart disease

No doubt about it, carbohydrate—commonly known as carbs—gets all the attention in diabetes management. However, another important nutrient to consider as part of a balanced diet is fat. Even though it sounds counter intuitive to what you might expect, eating the right amount of the right type of fat plays an important role in our bodies.

### **What is fat?**

Fat cushions organs, stores energy, insulates the body against elements, supports cell growth and more. Since fats are higher in calories per gram, when it comes to fat, the key is being mindful of portions. Eating the right types of fat is also important for reducing your risk of type 2 diabetes, cardiovascular disease, some cancers and other health problems.

**There are four main types of fat:** saturated, trans, monounsaturated and polyunsaturated fat. The American Diabetes Association (ADA) recommends including more monounsaturated and polyunsaturated fats than saturated or trans fats in your diet. Some types of fat are listed in the Nutrition Facts label on food products. Learn how to decode the label.

## **What is cholesterol and what you should know about it**

When we talk about fat, it's important to understand what we mean when we mention cholesterol. There are two types: the type found in our blood, known as blood cholesterol, and the cholesterol we eat, known as dietary cholesterol.

Blood cholesterol plays an important role in the body and is the starting point in making hormones, cell structures, vitamin D and more. Your body makes more than enough cholesterol for these uses, but it can also absorb small amounts from the foods you eat.

When the total cholesterol in your blood is too high, you are at greater risk of heart disease. However, contrary to popular belief, dietary cholesterol has less of an impact on this number than previously believed. For most people, saturated fat and trans fat play a much more significant role in increasing blood cholesterol, resulting in an increased risk of heart disease. Since foods that are typically high in dietary cholesterol are also high in saturated fat, it's easiest to focus on limiting saturated fat.

To figure out what targets are right for you, talk to a registered dietitian nutritionist (RD/RDN) or your health care provider.

## **The Four Types of Fat**

### **Monounsaturated fat**

Monounsaturated fats are considered part of a healthy, balanced diet because of the protective effect they have on our hearts. These fats have been shown to lower our low-density lipoprotein (LDL) cholesterol, an important marker for heart health. Monounsaturated fats are not required to be listed on the Nutrition Facts label, but for foods where they are a good source, they often are.

### **Sources of monounsaturated fat include:**

- Avocado
- Canola oil
- Nuts like almonds, cashews, pecans and peanuts
- Olive oil and olives (look for low/reduced sodium)
- Peanut butter and peanut oil
- Safflower Oil

To include more monounsaturated fats in your diet, try to substitute olive or canola oil instead of butter, margarine or shortening when cooking. Sprinkling a few nuts on a salad, yogurt or cereal is an easy way to eat more monounsaturated fats. But be sure to be mindful of the portions you are eating—like all fats, these products are high in calories.

### **Polyunsaturated fat**

Polyunsaturated fats are another important fat to include as part of a healthy balanced diet. Much like monounsaturated fat, this fat lowers LDL cholesterol and your risk for heart disease and stroke.

Omega-3 and Omega-6 fatty acids are two types of polyunsaturated fat that are also linked with improved heart health. Considered essential fatty acids because our body is unable to produce them, these fats need to be included as part of a healthy diet.

#### **Sources of Omega 3s include:**

- Oily fish (salmon, sardines, herring, mackerel, tuna)
- Walnuts
- Flaxseeds and flaxseed oil
- Canola Oil
- Chia seeds

#### **Sources of Omega 6s include:**

- Tofu
- Walnuts
- Flaxseed and flaxseed oil
- Canola oil
- Eggs
- Sunflower seeds
- Peanut butter

### **Saturated fat**

This type of fat can increase your cholesterol, and as a result, your risk of heart disease. This is one of the fats that should be limited in our diet. Typically, this fat is found in animal products and tropical oils that are solid at room temperature.

**Animal products containing saturated fat include:**

- Lard
- Fatback and salt pork
- High-fat meats like regular ground beef, bologna, hot dogs, sausage, bacon and spareribs
- High-fat dairy products such as full-fat cheese, cream, ice cream, whole milk, 2% milk and sour cream.
- Butter
- Cream sauces
- Gravy made with meat drippings
- Poultry skin (example: chicken, turkey etc.)

**Oils containing saturated fat include:**

- Palm oil and palm kernel oil
- Coconut and coconut oil

Saturated fat grams are listed on the Nutrition Facts label under “total fat”. The goal is to get less than 10% of one’s calories from saturated fat. For example, someone eating a 2,000 calorie diet should aim for 20 grams or less of saturated fat. To figure out the right target for you, talk to your dietitian.

**Trans fat**

Trans fats are produced when liquid oil is made into a solid fat—a process called hydrogenation. Like saturated fat, trans fat can be damaging to blood cholesterol levels. It is more harmful than saturated fat, and for a heart-healthy diet, you want to eat as little trans fat as possible by avoiding foods that contain it.

Trans fats are listed on the Nutrition Facts label, making it easier to identify these foods. However, keep in mind that if there isn’t at least 0.5 grams or more of trans fat in a food, the label can claim 0 grams. To avoid as much trans fat as possible, you should read the ingredients list on food labels. Look for words like hydrogenated oil or partially hydrogenated oil. Avoid foods that where a liquid oil is listed first on the ingredients list.

**Sources of trans fat include:**

Processed foods like snacks (crackers and chips) and baked goods (muffins, cookies and cakes) with hydrogenated oil or partially hydrogenated oil

- Margarine
- Shortening
- Some fast food items, such as french fries

For help figuring out what targets are right for you when it comes to fats, talk to a registered dietitian nutritionist (RD/RDN) or your health care provider.

## **Diabetes Superfoods**

You may have heard of diabetes superfoods. Get the facts, and supercharge your meal plan with these 10 foods full of vitamins, minerals, and fiber. Learn more about diabetes superfoods.

## **Planning for Sick Days**

When you get sick with things like colds or the flu, the illness and stress from it causes your body to release hormones that raise blood glucose (blood sugar) levels, making it harder to keep your blood glucose in your target range.

And while having diabetes does not make you more likely to get a cold or flu, it does raise your chances of getting seriously sick. Having a plan for sick days ahead of time will help you manage your diabetes and will make additional complications less likely.

One thing to keep in mind is to be sure you're getting enough water—so drink plenty of it. If you're having trouble keeping water down, have small sips every 15 minutes or so throughout the day.

You'll also want to be sure to get your annual flu shot to make getting the flu less likely.

## **Manage your blood glucose**

Being sick can make it hard to eat. Having simple carbs handy like regular soda, Jell-O, or popsicles will help keep your blood glucose up if you are at risk for lows. Use the 15-15 rule to treat the lows you may have. Making sure your blood glucose remains in target is one of the best ways to help your body deal with sickness.

## **Watch for signs of DKA**

If your body does not have the proper amount of insulin, you run the risk of your body producing too many ketones, which puts you at risk of developing a serious condition called diabetic ketoacidosis (DKA). We recommend testing for ketones every four to six hours when you're feeling sick.

The following are warning signs of DKA. If you experience any of these, contact your doctor immediately.



- High blood glucose
- High ketones
- Thirst or dry mouth
- Frequent urination
- Drowsiness
- Dry or flushed skin
- Nausea, vomiting, or abdominal pain
- Difficulty breathing
- Fruity odor on breath
- Confusion

NOTE: Severe DKA that goes untreated can cause coma or death.

### **Have a plan**

Before you get sick, decide on an action plan with your health care team. This plan should include the following:

- When to call your doctor (in most cases if you are vomiting or have diarrhea more than three times over 24 hours or have had a fever over 101° for 24 hours).
- How often to check your blood glucose.
- What foods and fluids to take during your illness.
- How to adjust your insulin or oral medication, if you need to.
- If and when you need to check for ketones.

Discuss what over the counter medications you should use for colds, flu, etc. Some can raise your blood glucose or affect your usual medications.

After you've discussed these topics with your diabetes care team, be sure to write your plan down to reference when you're feeling sick. You will also want to keep a list of emergency information such as your doctor's phone number, a list of medications you're taking, and your insurance information.

### **Create a Sick-Day Kit**

If you do get sick, it'll make things easier if you already have a sick-day kit ready to go with the things you'll need. You might want to include:

- A glucose meter
- Extra batteries
- Supplies for your insulin pump or continuous glucose monitor
- Ketone test strips
- A week's worth of glucose-lowering medication (don't store these longer than 30 days before use)

- Glucose tabs or gels
- Flu or cold medications that won't disrupt your diabetes management

### **Regular exercise can help put you in control of your life.**

If you're not into regular exercise, putting together an exercise plan can be a bummer. But remember, along with your diet and medications, regular physical activity is an important part of managing diabetes or dealing with prediabetes. Because when you're active, your cells become more sensitive to insulin so it works more effectively to lower your blood glucose, also known as blood sugar. (You might notice that exercising sometimes raises your blood glucose, find out why.) Exercise just makes you feel better. So, however you want to do it—taking regular walks around the block, going for a run, or signing up for a marathon—getting started is the most important part.

### **How to get started exercising safely**

It doesn't matter where you are physically. If you've never set foot in a gym, that's okay—as long as you start doing something now. If you haven't been very active or are worried about your health, it's important to consult your doctor and start slowly.

Light walking is a great place to start—and a great habit to incorporate into your life. Walk with a loved one, with your dog, or just by yourself while listening to an audio book. Set goals every day and meet them and you'll start feeling like you're back in control of your life. Learn more about how to get started safely.

### **Even little changes make a big difference**

If you're still struggling with getting started or feeling overwhelmed by the idea of starting a more active life, take heart: every change, no matter how small, makes a difference in your ability to manage diabetes. Even losing 10–15 pounds can have a significant impact on your health. The power to change is firmly in your hands—so get moving today.

### **Eating Tips Before and After Exercise**

Woman using fitness tracker to count calories eat after workout

Learning what and when to eat before and after exercise can be a little overwhelming. The questions to consider are endless: Should you eat before you exercise? Low-carb? Simple carbs? High-fat or low-fat? What about after your workout? What if you're trying to lose weight? What if you take insulin?

Here, we'll discuss a few basic tips on what and when to eat before and after exercise—and what to consider if you take diabetes medications like insulin.

If you're trying to lose weight. Woman with overweight running in a park. If you're trying to lose weight, it's important to make sure you aren't consuming additional calories your body doesn't need. That means trying to time your meals or snacks around your workouts so you aren't eating extra snacks for the sake of the workout.

Here are some things to consider:

### **Exercising on an empty stomach can help you burn more body fat for fuel.**

When you eat right before exercising, your body is going to first use the calories you just consumed for fuel. By exercising when it's been about three to four hours since you last ate, your body is more able to burn fat for fuel because other easier methods of fuel aren't available. Remember, before exercising, check your glucose levels to make sure you're within a safe range to do so—about 100 to 180 mg/dL.

This can be a very helpful weight-loss tool because regardless of how many calories you burn during your workout, you're ensuring that you're burning more body fat for fuel.

If you want to eat before exercising, choose a small snack or light meal.

If exercising on an empty stomach isn't a great fit for you, you can avoid consuming extra calories by simply timing your workout right after a small snack or a light meal.

**What should you eat?** Stick with real food. It doesn't need to be complicated. Often, combining a carbohydrate source with a protein source is recommended. Some examples include:

- Fruit + protein (examples: apple with a tablespoon of peanut butter, berries, and a few slices of turkey or nuts)
- Starch + protein (examples: whole grain crackers and cheese or 1/2 sandwich)  
Light yogurt
- Or a lighter snack of veggies and hummus, dip, or string cheese may be desired. Real food. Keep it simple.

### **Don't force yourself to eat a "post workout meal" for low-intensity exercise.**

If you're trying to lose weight and your workouts are lower in intensity (like power walking, jogging, or cycling less than an hour at a time) then you likely do not need an intentional "post-workout meal". Instead, strive to eat mostly whole foods every four to five hours throughout the day to support your calorie needs while also getting daily exercise.

In losing weight, there's a constant balancing act of eating enough to fuel your metabolism and manage hunger vs. reducing calories carefully to encourage your body to burn more body fat. By planning your meals and exercise routine carefully, you can avoid taking in more calories than your goal and still keep yourself well-fueled!

## **When you really should eat after your workout**

For some types of exercise, it's important to eat a meal (or a protein shake) within the hour after your workout.

Types of exercise that might call for an immediate post-workout protein shake or meal include:

- Weight-lifting
- High intensity interval training
- Endurance training (long-distance running, cycling, etc.)
- Any intense exercise over 60 minutes
- High-intensity competitive sports (soccer, tennis, racquet ball, etc.)
- If you don't eat a substantial meal or post-workout protein shake after high intensity exercise, a few issues are of concern:

You're depriving your muscles of the amino acids they need to rebuild and recover.

You're not replenishing the stored glucose (glycogen) in your muscles which can lead to further muscle breakdown. You'll get hungry a few hours later and likely overeat at that later meal. Intense training requires proper fuel. Eating every three to four hours throughout the day and eating post-workout is an important part of supporting your body.

## **If you take insulin**

If you take mealtime insulin or other medications that can cause low blood glucose levels, you'll need to plan the timing of your meals and your exercise more carefully. If you've just eaten a meal and taken your full dose of insulin, exercising in the three hours afterwards can lead to low blood glucose (hypoglycemia). This is because exercise causes your muscles to use the glucose in your bloodstream faster. This means you'd need less insulin to manage your goal blood glucose levels after a meal.

## **Timing Your Meals, Insulin Needs, and Exercise**

Reduce the amount of insulin you take for that meal. If you know you're going to exercise immediately after eating, you can talk to your doctor about reducing your mealtime insulin dose. The type of exercise you choose (walking or jogging vs. lifting weights), the duration (15 minutes vs. 45 minutes), and the intensity can impact just how much less insulin you need with that meal. Depending on the intensity of your workout (like a rigorous weightlifting session), you may find that you need to reduce your insulin dose for the meal you eat in the few hours after exercising. Still, your insulin needs for exercise can depend on other various factors. Consult your health care provider to determine how and if you should adjust insulin doses before and after exercise.

Exercise before eating and taking mealtime insulin. By exercising before you eat and taking your mealtime insulin, you reduce your risk of low blood glucose. This can hugely simplify your ability to exercise without low blood glucose. This can also help prevent the need to eat extra carbs during exercise to prevent/manage low blood glucose. Keep in mind that if you experience a low blood glucose even without rapid-acting mealtime insulin in your system, this is a sign that your other insulin/medication dosages may be too high.

Most importantly: Be sure to check your blood glucose before you exercise and carry fast-acting carbohydrates with you (like glucose tablets, gummy candy, or juice) whenever exercising in case you experience low blood glucose. Talk to your doctor about making adjustments in your insulin doses or other medications to prevent lows during and after exercising.

### **Make a Difference with Positive Self-Talk**

A younger woman looks in the mirror and smiles at herself.

Self-talk is the internal conversation that you have with yourself. Believe it or not, the way you talk to yourself can have a big influence on how you feel and act. Your words matter. That's why it is so important to be aware of the conversations you have with yourself about physical activity and your fitness abilities. It can have an impact on your performance and whether or not you stick to your plan. For example, you can set yourself up for failure by thinking things like, "I've never been very athletic, so there's no way I'm going to be able to keep up this exercise routine."

The good news is you can turn negative self-talk into realistic, positive thoughts that can help you succeed. Next time you find yourself having negative thoughts about exercise, make an effort to drop the negativity and turn it into positive self-talk. Here are some examples:

#### **All or nothing**

Example

I didn't walk every day last week. I'm an exercise failure.

Positive alternative I walked four out of seven days last week; some exercise is always better than none.

#### **Disqualifying the positive**

Example

The only reason I parked far away from the entrance to the store was because I couldn't find a closer spot.

Positive alternative

I like to walk; it is a good, healthy activity for me to do.

#### **Over-generalizing**

Example

I can't run, so I can't get enough exercise to do me any good.

Positive alternative

I'm glad I decided to get out on a walk. Some exercise is better than nothing!

### **Negative interpretation**

Example

My doctor wants me to have a foot evaluation before I start doing more activity. That must mean exercise is bad for my feet.

Positive alternative

Because I have diabetes, I always have to take good care of my feet. I'm glad that my doctor is making sure that the activity I do is right for me.

### **Personalization**

Example

The weatherman has something against me. I was planning to walk, but it has been raining cats and dogs all day long. I just can't win.

Positive alternative

You can never really predict the weather, so I'm glad I have a plan for doing exercise indoors on rainy days like today.

### **A Quick Guide to Insulin**

If you're just starting out with insulin, it can take a little getting used to. With a little practice, you'll be a pro in no time. Insulin is a naturally occurring hormone secreted by your pancreas. If you are prescribed insulin, it may be because your body doesn't produce it (type 1 diabetes) or your body doesn't use it properly (type 2 diabetes).

There are many different types of insulin sold in the United States, which differ in how they're made, how they work in the body, and how much they cost. It's also available in different strengths—most commonly, U-100. Your doctor will help you find the right type of insulin for your health needs.

When it comes to syringes, your doctor will advise on which capacity you need based on your insulin dose. In general, smaller capacity syringes can be easier to read and draw an accurate dose. Here are some tips:

- If your largest dose is close to the syringe's maximum capacity, consider buying the next size up in case your dosage changes
- If you need to measure doses in half units, be sure to choose a syringe that has these markings
- If you're traveling outside of the United States, be certain to match your insulin strength with the correct size syringe

## How It Works

When it comes to insulin, you'll get to know three terms: onset, peak time, and duration. The onset is how long it takes for the insulin to start lowering your blood glucose. The peak time is when it's at its maximum strength, and duration is how long it continues to work.

Here's a quick look at the different types of insulin. If you need a mix of two types, you can talk to your doctor about getting a premixed supply.

**Rapid-acting** insulin begins to work about 15 minutes after injection, peaks in about 1 hour, and continues to work for 2 to 4 hours

**Regular or short-acting insulin** usually reaches the bloodstream within 30 minutes after injection, peaks anywhere from 2 to 3 hours after injection, and is effective for approximately 3 to 6 hours

**Intermediate-acting insulin** generally reaches the bloodstream about 2 to 4 hours after injection, peaks 4 to 12 hours later, and is effective for about 12 to 18 hours

**Long-acting insulin** reaches the bloodstream several hours after injection and tends to lower glucose levels fairly evenly over a 24-hour period

## What Is the A1C Test?

The A1C test can be used to diagnose diabetes or help you know how your treatment plan is working by giving you a picture of your average blood glucose (blood sugar) over the past two to three months.

**It's called the A1C test, and it's a powerhouse.**

It can identify prediabetes, which raises your risk for diabetes. It can be used to diagnose diabetes. And it's used to monitor how well your diabetes treatment is working overtime. It's also a critical step in forming your game plan to manage diabetes with your diabetes care team.

### The big picture: monitoring treatment

This relatively simple blood test can tell you a lot. The test results give you a picture of your average blood glucose (blood sugar) level over the past two to three months. The higher the levels, the greater your risk of developing diabetes complications. Your doctor will tell you how often you need the A1C test, but usually you'll have the test at least twice a year if you're meeting your treatment goals. If you're not meeting your goals or you change treatments, you may need to get an A1C test more often.

### So, what do the numbers mean?

When it comes to the numbers, there's no one-size-fits-all target. A1C target levels can vary by each person's age and other factors, and your target may be different from someone else's. The goal for most adults with diabetes is an A1C that is less than 7%.

A1C test results are reported as a percentage. The higher the percentage, the higher your blood glucose levels over the past two to three months.

### **A1C\_Scale**

- If your A1C level is between 5.7 and less than 6.5%, your levels have been in the prediabetes range.
- If you have an A1C level of 6.5% or higher, your levels were in the diabetes range.

### **Finally: A1C is also reported as ‘estimated average glucose,’ or eAG**

Another term you may come across when finding out your A1C is eAG. Your doctor might report your A1C results as eAG. eAG is similar to what you see when monitoring your blood glucose at home on your meter. However, because you are more likely to check your blood glucose in the morning and before meals, your meter readings will likely be lower than your eAG.

## **CBD & Diabetes**

CBD—short for cannabidiol, a part of cannabis (marijuana)—has gotten a lot of attention lately. With changes in the legal status of cannabis, CBD has gone from a criminalized substance to being called a miracle drug. You can find CBD oil supplements, as well as foods, drinks, and lotions in stores and pharmacies across the U.S. and worldwide. However, research on the effects of CBD on the body is still limited and so far no CBD products have been approved by the Food and Drug Administration (FDA).

### **CBD-oil-dropper**

What to know about CBD and diabetes

Along with tetrahydrocannabinol (THC), CBD is the major element of cannabis. But CBD does not cause the “high” that many feel from using cannabis. For decades, CBD was considered inactive, but last year, the FDA approved it under the brand name Epidiolex for a rare form of childhood epilepsy (at a much higher dose than is available in supplements). Researchers are in the very early stages of exploring other potential uses for CBD, including relieving anxiety, insomnia, chronic pain, and inflammation.

There’s a lot of hype surrounding CBD oil and diabetes. There is no noticeable effect on blood glucose (blood sugar) or insulin levels in people with type 2 diabetes. Researchers continue to study the effects of CBD on diabetes in animal studies.

Although CBD is well tolerated by most people, there are side effects. It can suppress immune responses, raise eye pressure (which may worsen glaucoma), and increase blood levels of certain medications, such as the blood thinner Coumadin, which can lead to serious bleeding. Talk to your doctor if you’re thinking of trying CBD.

More to consider about CBD

CBD sits in a gray area. While used as a medicine, it’s also a natural compound. Many effective medications are derived from compounds found in nature, but a lot of work goes into identifying the



specific, active compound and determining what dose is safe and effective. Researchers aren't close to that yet with CBD oil.

Its status as a supplement makes things tricky, too. Because CBD is not regulated by the FDA, creators of these supplements often make claims about its effectiveness based on little—or no—evidence. It's hard to know what you're getting. The amount of CBD in any product varies widely. The FDA has warned that in some products, lab tests have shown no CBD at all. Under the FDA's Dietary Supplement Health and Education Act, manufacturers of dietary supplements and dietary ingredients are banned from marketing products that are tainted or misbranded.

## **Takeaway**

Although many claims continue to be made about CBD oil, there is little evidence of any benefit. It's certainly not an alternative to traditional diabetes management. The safety of CBD is also unknown—it may have dangerous side effects that we won't know about unless further research is done. But there is a great deal of interest in CBD research, so we should learn a lot more in the coming years about what exactly CBD can and can't do. In the meantime, it's best practice pursue optimal health and diabetes management with treatments that have evidence to show they are safe and effective.

## **Effect of Diabetes on Eye Health**

- There are currently more than 37 million American adults living with diabetes. Almost three times that many adults (96 million) are living with prediabetes<sup>1</sup> and 90% don't know they have it<sup>2</sup>.
- Anyone with diabetes is at risk for diabetes-related eye diseases such as diabetic retinopathy, macular

edema, glaucoma, and cataracts<sup>3</sup>.

- Diabetes is the leading cause of new cases of blindness in adults aged 18–64 years<sup>1</sup>.
- Diabetic retinopathy is the most common diabetic eye disease and a leading cause of blindness in American adults. The number of individuals with diabetic retinopathy is predicted to increase by nearly 50% (it's actually 47.7%) to over 11 million people by 2030<sup>4</sup>.
- Inequity: Those who are at a higher risk of losing their vision or going blind from diabetes includes African Americans, American Indians, Alaska Natives, Hispanics/Latinos, and older adults<sup>5</sup>.
- In early stages, diabetic retinopathy may not have any obvious signs or symptoms, but finding it early can help protect your vision, making an annual dilated eye exam essential for those living with diabetes<sup>6</sup>.
- Some, including racial and ethnic minorities, are disproportionately affected by diabetes<sup>7</sup>.
- While genetic factors likely play a role, so do social, economic, and environmental barriers<sup>5,8,9</sup>.

- Black American adults are 60% more likely to be diagnosed with diabetes<sup>10</sup>.
- More than 800,000 Black Americans have diabetic retinopathy that can lead to blindness<sup>11</sup>.
- Native Americans (American Indians and Alaska Natives) are more likely to have type 2 diabetes

Than any other U.S. racial group<sup>12</sup>.

- 3 million Hispanics/Latinos at risk of losing their sight in 2030 as a result of complications from diabetes<sup>13</sup>.

- Hispanics and Latinos are less likely to<sup>14</sup>:
- Have had an eye exam, making them less likely to be diagnosed and treated for eye

Conditions that can lead to vision loss

- Have access to health and eye care services due to language barriers and/or health

Insurance coverage

- If you have ever found it difficult to prioritize managing your diabetes or to find the care and support you need, the American Diabetes Association (ADA) can help.
- Visit the ADA's Community Connection page to find diabetes resources in your area, including financial assistance, medical care, housing assistance, and more.
- One of the easiest and most cost-effective ways to detect and manage disease and economic burden is through an annual dilated and comprehensive eye exam<sup>15</sup>.
- Take the 60-Second Type 2 Diabetes Risk Test to learn your risk factors and get information to share with your care team.
- Use the free RetinaRisk calculator today to help determine your risk for developing diabetic retinopathy.

## **Diabetes & Your Feet**

The connection between diabetes and your feet is important because diabetes can cause nerve damage and reduced circulation, ultimately leading to limb loss and other complications. The good news is, you can lower your chances of complications by managing your blood glucose levels and taking care of your feet.

### **Diabetes and Foot Care**

Diabetes can cause nerve damage. Lost sensitivity in the feet can make it difficult to know when you're hurt or injured and even the smallest cuts and scrapes can become difficult to heal. To help prevent foot complications that can come with diabetes, it's important to have the right information to make smart choices and connect with expert diabetes advice

### **Poor Circulation**

Poor circulation (blood flow) can make your foot less able to fight infection and heal. Diabetes causes blood vessels of the foot and leg to narrow and harden.

**Quick Tip:** Compression socks gently apply

## **Skin Changes**

Diabetes can cause changes in the skin of your foot. At times your foot may become very dry. The skin may peel and crack. This problem is caused by nerve damage that affects your body's ability to control the oil and moisture in your foot.

**Quick Tip:** Use a daily moisturizer to keep the feet healthy and looking great. Look for speciality products specifically formulated for people with diabetes.

## **Calluses**

Calluses occur more often and build up faster on the feet of people with diabetes. Too many calluses may mean that you will need therapeutic shoes and inserts. Calluses, if not trimmed, get very thick, break down, and turn into ulcers (open sores).

**Quick Tip:** Avoid over-the-counter treatments to remove calluses since they use acids that can be harmful to a diabetic foot.

## **Foot Ulcers**

Ulcers occur most often on the ball of the foot or on the bottom of the big toe. Ulcers on the sides of the foot are usually due to poorly fitting shoes. Even though some ulcers may not hurt, every ulcer should be seen by your doctor right away. Neglecting ulcers can result in infections, which can lead to limb loss.

**Quick Tip:** Consider the use of braces or crutches if you have a foot ulcer to promote healing while reducing pressure and irritation.

## **Nerve Damage**

Nerve damage from diabetes is called neuropathy and can lessen your ability to feel pain, heat, and cold. This means that you may not notice a foot injury until the skin breaks down and becomes infected. Neuropathy can also lead to changes in the shape of your feet and toes. If your foot doesn't fit comfortably in regular shoes, ask your doctor about special therapeutic shoes or inserts.

**Quick Tip:** Avoid going barefoot, even in your home, to reduce the risk of injury. Wearing socks and shoes (or slippers at home) gives feet extra protection.

## **Limb Loss**

People with diabetes are far more likely to deal with foot-related limb loss. Because of complications related to neuropathy, poor circulation, foot ulcers, and infections, it's important to monitor foot health to know how to prevent foot complications or stop them from getting worse. Most issues of limb loss are preventable by checking your feet daily, regular care and visits with your doctor, and proper footwear.

**Quick Tip:** Examine your feet every day and look for blisters, cracks, and other signs of injury. Keep a diary of the changes in your feet and contact your doctor if conditions worsen.

## 12 Steps to Happier Feet

Taking care of your feet is an important part of successfully managing diabetes. Take a look at these simple steps to help you make foot care management easier and keep you on the path of living well with diabetes.

- 1. Take care of your Diabetes:**

Make healthy lifestyle choices (including not smoking) to keep your blood glucose (blood sugar), blood pressure, and cholesterol close to normal. Doing so may help prevent or delay diabetes-related foot problems.

- 2. Check Feet Everyday:**

Check your feet every day for cuts, sores, swelling, and infected toenails. Call your doctor right away if a cut, sore, blister, or bruise on your foot does not begin to heal after one day.

- 3. Wash Feet Daily:**

Wash feet in warm water but do not soak your feet — your skin will get dry. Make sure to dry well and dry between your toes. Use talcum powder or cornstarch to keep the skin between your toes dry.

- 4. Keep your skin smooth and Soft:**

Rub a thin coat of skin lotion or cream on the tops and bottoms of your feet. Do not moisturize between your toes because this might trap moisture and lead to further skin problems.

- 5. Smooth corns and calluses gently:**

If you have corns or calluses, check with your doctor for best care tips. If you have neuropathy (nerve damage), do not care for these yourself. If your doctor allows, use a pumice stone to smooth corns and calluses after bathing.

- 6. Trim toenails weekly:**

Do not cut your own toenails if you have neuropathy, vision impairment, or if toenails are thick or yellowed. If able, trim toenails with clippers after you wash and dry your feet. Trim straight across without cutting the corners. Smooth toenails with an emery board or nail

- 7. Wear comfortable shoes and socks at all times:**

Do not walk barefoot, not even indoors. A good pair of slippers around the house provides extra protection. When wearing shoes, always wear socks or stockings to help avoid blisters and sores. Before putting shoes on, check the insides for any debris and make sure the lining is smooth.

- 8. Protect feet from hot and cold:**

Keep your feet away from radiators and open fires and do not put hot water bottles or heating pads on your feet. Wear socks at night if your feet are cold. Be sure to wear warm shoes or boots in cold weather and check your feet often to avoid frostbite.

- 9. Keep blood flowing to your feet:**

Take time throughout the day to ensure good circulation in your feet. Put your feet up when you're sitting. Be sure to wiggle your toes for five minutes two or three times a day and move

your ankles up and down and in and out to improve blood flow. Don't cross your legs for long periods of time.

**10. Be more active:**

Ask your doctor to help you plan a daily activity program that's right for you. Avoid activities that are hard on the feet, such as running and jumping. Always include a warm-up and cool-down period and wear athletic shoes that fit well and provide good support.

**11. Talk with your Doctor:**

Your doctor is one of your strongest allies when managing diabetes and foot health. Ask your doctor about any questions about foot care such as: Can you check the sense of feeling and pulses in my feet? Am I likely to have serious foot problems? Would special shoes help my feet stay healthy?

**12. Wear the right footwear:**

Proper footwear is very important for preventing serious foot problems. When not wearing diabetic shoes, comfortable athletic or walking shoes are good for daily wear. They support your feet and allow them to breathe.

**Overcome Barriers and Get Moving**

A barrier is something that keeps you from doing something else. If you're not active, it's likely that you have at least one barrier or reason why. Perhaps you've never been very active. Maybe you're afraid that your blood glucose (also called blood sugar) will drop.

Think about what is keeping you from being active and then check out some of our solutions to the most common barriers to physical activity. Is there a solution for you?

**I don't have time to exercise for 30 minutes a day.**

Think about your day—do you have available time slots? Take advantage of any extra time that you may have and get moving. If you find yourself waiting for the kids to finish practice or watching their game from the sidelines, use that time to take a walk or pace while you watch.

Do as much as you can. Every step counts. If you're just starting out, start with 5-10 minutes a day and add more, little by little. Work up to three times a day. You can also try for 15-minute sessions twice a day.

Make physical activity part of your daily routine. For example, walk or bike to work or to the store, exercise while you watch TV, take the stairs instead of the elevator or do something active with your family to spend time together.

**I've never been active.**

Don't discount your everyday activities. You may be more active than you think. Housekeeping or mowing the lawn counts as activity. Being active is more than just planned exercise.

If you have never been active or have not been active for a while, it is important to start slowly. If you feel unsure about your health, check with your health care provider before making big changes in your exercise plan. Starting slowly is important and so is choosing activities that you enjoy. Over time, the activities you do will get easier. You will even find that you can increase the duration and/or intensity.

**I'm too tired after work.**

Find a time when your energy is highest. You could plan to do something active before work or during the day. For example, you could try walking for 30 minutes during your lunch break a few days each week or hitting the gym early in the morning.

Remember that increasing the amount of physical activity you do will actually increase your energy.

**I don't have the right clothes.**

Wear anything that's comfortable as long as you have shoes that fit well and socks that don't irritate your skin.

**I'm too shy to exercise in a group.**

Choose an activity you can do on your own, such as following along with an exercise video or going for a walk. Remember that the everyday activities you do on your own like gardening and household chores get you moving and help burn calories.

**I don't want to have sore muscles.**

- Exercise shouldn't hurt if you go slowly at first. Choose something you can do without getting sore.
  - Make sure you warm up and cool down.
  - I'm afraid my blood glucose level will drop too low.
  - The people who need to be most careful about lows are people with type 1 and those who are on insulin or medications that can cause low blood glucose. If you're taking a medication that could cause low blood glucose, talk to your health care provider about ways to exercise safely.
  - Always be prepared. Make sure you've got some regular soda or sports drink (not diet), glucose tabs, or another fast-acting carbohydrate to treat a low if one should occur.
- Wearing a diabetes ID is another important safety precaution.

**Walking hurts my knees.**

- Try chair exercises, swimming, biking, or an elliptical machine. These and other low-impact exercises may be less painful.
- It's too hot outside.
- If it's too hot, too cold, or too humid, walk inside at a school gym or a shopping center.
- Think of some other activities that are always available regardless of the weather like using a stationary bike, indoor aerobics classes, yoga videos at home, indoor swimming, stair climbing, calisthenics, or dancing.

**It's not safe to walk in my neighborhood.**

- Find an indoor activity, such as an exercise class at a community center.
- Think of activities you can do in the safety of your home.
- I'm afraid I'll make my condition worse.
- Remember that getting enough physical activity is important for everyone's general health—whether you have diabetes or not.
- Remember that exercise helps lower A1C and has many other health benefits.
- If you have certain complications from diabetes and are unsure about your health, talk to your doctor before making any big changes to your fitness routine.
- I can't afford to join a fitness center or buy equipment.

- Do something that doesn't require fancy equipment, such as chair exercises, walking or using water bottles for weights. Jumping rope and resistance band exercises are activities that only require one piece of inexpensive equipment.
- Look for inexpensive resources in your community like community education programs, park and recreation programs, walking trails, school running tracks, or worksite wellness programs. Your employer is another place to check for discounts on gym membership or reimbursement for fitness-related activities.

### **Exercise is boring.**

- Find something you enjoy doing.
- Mix it up. Try different activities on different days, and make sure you pick an activity that you enjoy!
- Exercise with someone else to keep you company.
- If you can, try exercising while listening to music or watching television.
- I don't really know how to exercise.
- Find a personal trainer, exercise physiologist or physical therapist to help you get started.
- Choose activities that require few skills, like climbing stairs, walking, or jogging.
- Take a class and develop new skills.
- I don't have the motivation to exercise.
- Invite a family member or friend to exercise with you on a regular basis. You can also join an exercise group or class in your community.
- Remember all of the benefits that come with being physically active.
- Make a plan so you decide when you will do each type of activity. Be sure to set realistic goals and make a plan so you know what you are working toward.

### **The Benefits of Walking**

If you've never been physically active or have been sedentary for a while, it's important to start getting active slowly. Walking is one of the easiest activities to start with, and most people with diabetes can do it. The risk of injury is low, and even people with diabetes complications can usually walk for exercise. (Check with your health care provider if you have a foot injury, open sore, or ulcer.)

You don't need any special equipment, clothing, or even shoes to begin walking for your health, but it may help you stay motivated if you wear comfortable clothes and shoes. Pick a safe place to walk and invite a friend to join you! Or if you prefer some alone time, listen to music, audiobooks, podcasts (if you can do so safely), or catch up with friends and family by phone while you walk. The key to success is to make it an enjoyable part of your routine that you look forward to every day. This will help it become a healthy habit for life.

### **How Walking Helps Your Health**

Walking at a brisk pace or moderate intensity is an aerobic exercise. When you do aerobic activities regularly over time, you can see many health benefits:

- Blood glucose (blood sugar) levels go down
- Insulin sensitivity goes up
- Heart health improves
- Metabolism increases
- Weight loss or maintenance becomes easier
- Balance improves
- Blood pressure decreases
- HDL (“good”) cholesterol increases
- LDL (“bad”) cholesterol decreases
- Your mood is better
- You feel more focused and alert
- Memory and cognition improve

### **How to Get Started Safely**

It’s important to check your blood glucose (blood sugar) level more often when you begin being active or increase the intensity of exercise. Check it both before and after you walk. This will help you see how your body reacts and help you avoid possible drops in blood glucose (hypoglycemia) that can be dangerous. Learn more about blood glucose and exercise.

It’s never too late to start! But if you’ve been very inactive for a while, start slowly and walk for just a few minutes the first time. The more you walk, the easier it will get, and you’ll be able to add intensity by increasing your time, pace, or distance.

And remember, it all adds up. If you can’t walk for 30 minutes each day, try two 15-minute or three 10-minute walks during the day. And try to build up to five 30-minute walks each week.

- Other Easy Ways to Walk More
- Walk instead of driving to nearby destinations
- If driving, park a bit farther away from your destination
- Get off the bus or train at a farther stop and walk the rest of the way
- If you have a dog, walk it daily, or offer to walk a neighbor or friend’s dog
- When traveling, take walking tours to see the sights
- Start or join a walking group in your neighborhood or at work
- Start walking more today and reap the benefits!

### **Maintain Your Motivation**



It's easy to start an exercise routine once you've decided it's time for a change, but keeping it up is a challenge for many people. Hitting a roadblock or two is normal, but by planning ahead, you can overcome it. There are bound to be days when you have a bad work out or don't get to exercise at all. When this happens, the most important thing is to accept it, turn any negative thoughts into positive thoughts and plan to get back at it tomorrow. Read more about positive self-talk, which can be really helpful for getting over these hurdles.

### **Track Your Activity**

Stay on track with your routine by keeping a record of the activity that you do. It can help keep you more accountable for times that you do not make time for activity and times that you could have done more. A record or log will also help you see patterns so you can adjust your routine to work better for you.

- Is there a certain day of the week that you have trouble finding time to work out?
- Are there some activities that are easier to keep going than others?
- Are there certain activities that you enjoy more than others?

### **Mix up Your Routine**

By mixing up your routine with activities you enjoy, you'll have more fun and you'll stay active longer. It will also help you work different muscles.

Let's say you are getting tired of walking every day. For a change of pace, you could try a group class once a week instead. Another day, you could do a brisk walk or bike ride with a friend to mix it up even more. By varying your activities and how hard you're working out, you can also lower your risk of injury.

### **Find an Exercise Buddy**

Having an exercise buddy or a group to work out with can be a real motivator. If you have regular planned activities with a group or even just one other person, it helps hold you accountable and get you moving. Plus it can make working out more fun.

### **Do What You Enjoy**

Choosing activities that you enjoy, fit into your schedule and are within your budget will also help you stick with it. Select a few things that keep you moving (aerobic exercise like walking or swimming) and a few that help you build muscles (like using weight machines or walking with light weights). Be prepared—choose a few activities you can do outside and a few you can do inside when the weather is bad.

### **Putting the Fun in Fitness**

Do you view exercise with the same enthusiasm usually reserved for preparing your taxes? Perhaps you work out to maintain your weight and reach your blood glucose (also called blood

sugar) targets, but you've never experienced anything near a runner's high and have beaten yourself up for letting more than a few gym memberships go unused.

You're hardly alone. According to the Centers for Disease Control and Prevention's (CDC) National Center for Health Statistics, about 26% of Americans don't participate in leisure time physical activity—at all.

### **A matter of mindset**

One unexpected culprit may be the things we tell ourselves about exercise before we even lace up our sneakers. Being active reduces your risk for heart disease, promotes lower blood pressure, contributes to weight loss and can help keep your blood glucose in check—all important. But seeing exercise as something you need to do solely to meet long-term health goals can make you miss out on its other more immediate benefits, such as having fun (yes, really!) or feeling less stressed and more energetic.

Exercise is often recommended prescription-style, not suggested as a fun part of life. Reframing physical activity helps people view it as a friend, instead of an enemy, and embrace it when they do it, instead of feeling like they are suffering. Reframing exercise also helps shed light on its less-obvious benefits, such as feeling more focused and alert.

### **Define and redefine**

We may also have a rigid idea of what counts as exercise. In a study by BMC Public Health, focus groups were conducted among women to find out how physical activity fit in with their daily goals and priorities. Many who were less active said they associated only certain types of exercise, such as sweaty gym workouts, with achieving fitness goals. Yet simply choosing an activity that you enjoy—whether it's an advanced spin class or a walk at the mall—makes it far more likely that you'll move more.

In terms of sticking with an exercise plan, it helps if you feel like you have some control over how exercise works toward your goals and how it would benefit you mentally, physically, socially or spiritually. The key is to look at exercise in terms of what it can do for you right now, not down the road. That shift in thinking could also reduce stress and increase positive emotions—things that we know promote health.

### **5 ways to make exercise more fun**

Ready to add some fun to your exercise plan? Here are five ways:

#### **Redefine “exercise”**

Exercise doesn't have to be an hour-long run that leaves you sweaty and winded. Even 10 minutes per week of a leisure activity such as gardening or dancing can lower your risk for early death from cardiovascular disease, among other conditions. The point is to find pleasure in the activity you've chosen.

#### **Get social**

Enlisting a fitness buddy doesn't just make you accountable—it ups the fun factor, too! Taking a class or working out in a group also multiplies the benefits of exercise. Many have programs geared to seniors, such as water aerobics, low-impact cardio workouts and light weight training. Another great option is to get your family together and start a team to take part in American Diabetes Association's Step Out Walk to Stop Diabetes® or Tour de Cure®! Find an event near you.

### **Make exercise an adventure**

Learning something new can be an effective motivator for exercise. It can help you discover new activities you enjoy, stimulate your interest and reveal skills you may not even know you have (perhaps you're an ace at fencing!). Predictable, repetitive experiences are also prime causes of boredom, so consider trying a dancing class, or go kayaking, rock climbing or kickboxing.

### **Add the fun factor**

Experts often suggest choosing activities you enjoy. But what if you just don't like working out? Try pairing exercise with something you already like doing. Lift light weights while watching your favorite cooking show or play Frisbee in the park while spending time with your kids or grandkids.

### **Turn up the tunes**

Feeling blah about your workout? Turn on some music. Studies suggest that listening to music while exercising can help distract you from fatigue and discomfort, motivate you to work harder and put you in a better mood.

## **Weekly Exercise Targets**

### **The magic number: 150.**

You've likely heard that getting 150 minutes of moderate intensity exercise each week can help you manage your diabetes. But dedicating that much time to exercise can seem daunting if you're busy, don't enjoy working out or have diabetes-related complications that make physical activity difficult. But don't worry: Tackling 150 minutes of exercise is much easier than you might think!

Be sure to check with your health care provider before starting or changing your exercise plan.

### **Why 150?**

Any physical activity is better than none at all, but most health organizations say you need a minimum of 150 minutes of activity per week to reap significant results. But a slow stroll won't cut it. To benefit, you'll need to work out at a moderate intensity—at this pace, you'll be able to talk, but not sing.

Regular physical activity has lots of benefits for people with diabetes, including improved blood pressure and blood glucose (blood sugar) control. Plus, research has shown that doing 150 minutes per week of moderate-intensity exercise can reduce your chances of heart disease and premature death, compared with being sedentary.

### **Spread it out**

Instead of viewing weekly exercise as one huge goal, think of it as a series of mini goals. Depending on your schedule and preference, you could aim for 50 minutes of exercise three times a week, 30 minutes five times a week or 25 minutes six times a week.

Each breakdown will have a slightly different impact on your blood glucose. To really reap the benefits of exercise on glucose control, keep your muscles in a constant state of increased glucose uptake. To do that, try to go no more than 48 hours between exercise sessions. To maximize the benefits, aim to exercise five to six days a week.

### **Shorten your sessions**

It's easy to brush exercise aside if you don't have a 30 to 60-minute chunk of time, but you don't need a wide-open schedule to meet your fitness goals. Think about three spots in your day where you could fit in 10 minutes of exercise. It could be a 10-minute jump rope session before work, a 10-minute walk at lunchtime and 10 minutes on an exercise bike after dinner.

### **The health benefits remain:**

10 minutes of exercise three times a day gives you the same cardiovascular benefit as 30 minutes at one time. Just don't go too fun-sized with your sessions. When you're working at a moderate intensity, sweat sessions that clock in at 10 minutes or more are the most beneficial for heart health.

### **Setting smart goals**

If a goal is specific, measurable, attainable, realistic and time-bound, there is a higher chance of sustaining the new behavior, seeing results and avoiding any lapses or relapses.

Sure, you might be aiming for 150 minutes of mountain biking each week. But you might also fill those 150 minutes with shorter, less-intense activities. Something as simple as vacuuming for 10 minutes could get your heart rate up. Doing this type of mini activity throughout the day is a more realistic and attainable fitness goal for people who have diabetes-related complications, too.

### **Fine-tuning your fitness level**

Are you a novice exerciser or total pro? It makes a big difference in the type of exercise routine that will work best for you.

If you're new to fitness, create goals that help you gradually build toward 150 minutes of exercise. If you sit at a desk all day and don't have an exercise routine, your first goal might be to get up from your desk

twice every hour and do a walking tour of the office. From there, add 10 minutes of exercise a week until you reach the 150-minute mark. It's not about how long it takes you to get to that goal, what's more important is taking the steps to get there.

### **Make time for fitness**

A successful exercise routine works into the demands of your day. To find a time that works for you, think about when you have availability and when you're at your most energized.

Your medication regimen may also affect your workout timing. Certain diabetes drugs, such as insulin and sulfonylureas, can increase your risk for low blood glucose (hypoglycemia). Add in the blood glucose-lowering effect of exercise, and your evening workout may up your risk of overnight lows. In that case, you might be more likely to stick with a morning or afternoon workout regimen instead of working out in the evening.

Sometimes, increasing your amount of exercise will affect your medications. If you aim to exercise two to three hours after eating, for instance, you may need to reduce your premeal bolus of rapid-acting insulin to prevent lows.

### **How to stay motivated**

Choosing an activity you enjoy, creating a log to monitor your progress and preparing for snags—all of these can help keep you motivated.

### **Have fun.**

Making exercise fun will help you stick with it—nobody wants to do 150 minutes of something they don't enjoy! Find workouts that will check off those boxes for you—whether that's a dance class, a pickleball league or a walking club.

### **Track your progress.**

Logging your workouts can help you track just how many of those 150 minutes of exercise you have left to meet this week. Make sure your exercise goals are right in front of you every day to act as a visual reminder. That could mean a calendar on your wall, a day planner on your desk or an app on your phone or computer.

### **Excuse-proof your plan.**

Come up with an alternative workout option for days the weather isn't great or things don't go as planned. Instead of cycling outside, you could walk laps at the local mall, use the elliptical machine at the gym or do 10 minutes of stair-climbing at home.

Enlisting a friend to exercise with you is another way to ensure you won't bail on plans. It could even motivate you to go the extra mile.

## **Diabetes Can Affect Your Heart**

Diabetes and heart disease often go hand-in-hand. In fact, adults with diabetes are twice more likely to have a heart attack or stroke than those without it.

### **Be Aware, Take Control**

Those affected by all types of diabetes are still at risk of developing heart disease, even if blood glucose (blood sugar) levels are managed.

The most common form of heart disease is coronary artery disease, which develops over time as the arteries that supply blood to the heart fill with plaque. Plaque, which is made up of cholesterol and other substances, causes the arteries to harden. The medical term for this is atherosclerosis. When plaque continues to build, the arteries narrow, therefore reducing the flow of oxygen-rich blood to the heart. This causes the heart muscle to weaken, increasing the risk of heart disease, heart attacks, strokes, and even heart failure

### **Recognize the Symptoms of Heart Disease**

If you have prediabetes or type 1 or type 2 diabetes, you should be aware of the symptoms of heart disease, including:

- Shortness of breath
- Fainting or near fainting
- Fluttering in your chest
- Chest pain, also known as angina, including feelings of chest tightness or pressure
- Slow heartbeat
- Dizziness or lightheadedness
- Pain in one or both arms
- Fast heartbeat, not due to a temporary increase in physical activity
- Numbness or weakness in your legs
- Neck, jaw, throat, back, or upper abdomen pain
- Extreme fatigue
- Nausea and vomiting

### **Keep Your Kidneys Healthy**

The number one cause of kidney disease is diabetes. Understanding this connection is the first step to helping avoid kidney problems. Kidney disease affects one in seven adults in the U.S. The Living with Diabetes, Kidney Care initiative, supported in part by DaVita, can help you improve your lifestyle to manage your health.

### **Fight back against CKD**

Where are you in your journey? Approximately 1 in 3 adults with diabetes has chronic kidney disease (CKD).[1] Because the symptoms of CKD are often mild and go undetected, it's critical to understand the risk factors and take necessary steps to protect your health. We are here to help you!

## **How to Slow the Progression of Chronic Kidney Disease**

There are many ways to help delay kidney failure, especially when chronic kidney disease (CKD) is diagnosed in the earlier stages. Use the tips below and talk with a nephrologist for advice on how to slow the progression of CKD.

### **Causes of CKD**

- Diabetes
- Hypertension

### **Manage your blood pressure.**

Keeping your blood pressure within a healthy range may help slow the progression of kidney disease. This is especially true in people who have diabetes and protein in the urine (proteinuria). Lifestyle changes such as maintaining a healthy weight, exercising, meditating, consuming less salt and alcohol, and quitting smoking may help lower your blood pressure. If you've been diagnosed with hypertension, your doctor may prescribe blood pressure medicine for you to incorporate into your routine in addition to making lifestyle changes.

### **Monitor your blood glucose.**

If you have diabetes, controlling your blood glucose (blood sugar) levels may help slow the progression of kidney disease. Adopt a diabetes- and kidney-friendly diet, and follow the instruction of your doctor when it comes to diet, insulin, or other medications.

### **Eat a kidney-friendly diet and exercise regularly.**

You are what you eat! Following a kidney-friendly diet may help you slow the progression of kidney disease, especially one that is recommended specifically for you by a dietitian. A dietitian can help you plan meals that you like based on your preferences. Regular exercise and maintaining a healthy weight are also effective ways to help manage your disease progression. Talk to your doctor about incorporating exercise into your daily routine.

### **Use caution when taking over-the-counter supplements and medicines.**

If you've been diagnosed with CKD, talk to your doctor about the appropriate medication for you, even when it comes to over-the-counter medications and supplements.

## **Late-Stage Kidney Disease**

Stage 4 or stage 5 of chronic kidney disease means the kidneys are losing more of their function. Get helpful information on how to manage late-stage kidney disease.

Here is some expert advice from nephrologists that can help you manage advanced CKD along with five things to discuss with your doctor.

### **5 Things a Nephrologist Wants You to Know**

Here are five things to keep in mind and discuss with your kidney doctor, known as a nephrologist:

### **1. You are still in control of your own care.**

While having kidney disease and being on dialysis may make you feel like you have lost control, that's not entirely true. You can still take charge of your health and play an active role in your care. If you're not sure about something or you have questions about medications, how you're feeling or anything else related to your health, don't be afraid to ask your care team about it. They are there to support you! Together, you can find solutions to help you lead your best life.

### **2. Taking care of yourself goes beyond your physical health.**

While it's important to care for your body, it's also important to take care of your mental or spiritual health. The way we feel emotionally can impact the way we feel physically. Staying connected to your friends, family, or faith community can go a long way in helping you feel your best.

### **3. Transplantation is a treatment option.**

If you are interested in a kidney transplant, the first thing you should do is talk to your doctor. You can use these [Top 8 Questions to Ask Your Doctor About Kidney Transplants](#) to guide your conversation.

### **4. Home dialysis is also a treatment option.**

If you currently dialyze in-center, dialyzing at home may be an option for you. Up to 25 percent of people with kidney disease in other countries dialyze at home. So, talk to your doctor if you're interested in exploring home dialysis.

### **5. Set goals for your care.**

It's important to set health goals for yourself and share them with your care team. Here are some things to consider:

- What are your goals for your everyday treatment?
- What are some activities or events you'd like to be able to do or attend?

## **End-Stage Kidney Disease (ESKD)**

When kidney function declines too much, different health choices need to be made. Learn what happens during ESKD so you can manage your symptoms and find the right treatment.

End stage kidney disease (ESKD) is the last stage (stage five) of chronic kidney disease (CKD). This means kidneys are only functioning at 10 to 15 percent of their normal capacity. Kidneys are important organs that contribute to your overall wellbeing. When kidney function is this low, they cannot effectively remove waste or excess fluid from your blood. Kidneys are also responsible for other functions that support the body, such as balancing electrolytes and producing certain hormones. When CKD develops into ESKD, dialysis or a kidney transplant is necessary to stay alive.

## **Urine Production**

Fully functioning kidneys clean the blood of wastes and excess fluid. These items are eliminated through urine. Because kidneys with ESKD do a very poor job of removing these items, waste and fluid collect in the body to unhealthy levels. Accumulated waste in the bloodstream can make you feel sick. This is a



condition called uremia. When fluid is not removed from the body, tissues will swell and lead to a condition called edema. Excess fluid in the bloodstream can also increase blood pressure.

## **Electrolytes**

Electrolytes are minerals and salts such as magnesium, sodium, and potassium. They are found in foods you eat and are essential to good health. However, too much or too little of these electrolytes can make you sick. Healthy kidneys make sure these levels are balanced. But kidneys affected with ESKD cannot regulate the levels of electrolytes. When this happens, changes in your body's functions occur. Sodium can cause tissues to retain water. Excess potassium can cause an abnormal heart rhythm, which may lead to cardiac arrest. Too little magnesium can affect your heartbeat and cause changes in your mental state—too much can leave you feeling weak.

## **Hormones**

Healthy kidneys make certain hormones. One is a parathyroid hormone that activates vitamin D into a substance called calcitriol. Calcitriol helps your body absorb calcium. If your body cannot absorb calcium, your bones become weak and may break. Another hormone your kidneys make is erythropoietin. Erythropoietin tells your body to make red blood cells, which carry oxygen to the cells throughout your body. If your red blood cell count is low, you may develop anemia, which will leave you feeling weak and fatigued.

## **Enzymes**

Renin is an enzyme kidneys produce. Renin helps the body regulate sodium and potassium levels in the blood, as well as help regulate blood pressure. When blood pressure drops, renin is released and starts a chemical reaction in the body that will produce a substance called angiotensin. Angiotensin causes your blood vessels to narrow. This helps raise blood pressure. Angiotensin also signals the adrenal glands (found at the top of your kidneys) to release a hormone called aldosterone. Aldosterone tells the kidneys to retain salt (sodium) and excrete potassium. By retaining salt, the body keeps more water in the system. This water raises the blood volume and blood pressure. Kidneys affected by ESKD sometimes make too much renin, which keeps blood pressure levels high. This kind of high blood pressure can be difficult to treat. Regular dialysis treatment, following your renal diet and taking prescribed medications can go a long way in managing ESKD. If you have been diagnosed with end stage kidney disease, it is important to follow your health care team's advice regarding treatment.

## **Mental Health**

### **Understanding diabetes and mental health.**

Diabetes takes a toll on more than your body. It's normal to feel emotional strain—and it's important to ask for help. With diabetes, you have a lot on your mind. Tracking your blood glucose (blood sugar) levels, dosing insulin, planning your meals, staying active—it's a lot to think about. It can leave you feeling run down, emotionally drained and completely overwhelmed. It's called diabetes burnout. And that's why it's important to stay in touch with your emotions as you manage your diabetes. What are you

feeling? Stressed out? Angry? Sad? Scared? Take time to take inventory of your emotions and reach out to those around you to talk honestly and openly about how you feel.

Better yet, find a mental health care provider to guide you through the emotional terrain around your disease and discover ways to lighten your mental load. With diabetes, feeling physically good is half the battle. Feeling mentally good is the other half.

### **It's natural to feel angry**

It can start with your diagnosis. It can go from “why me?” to pure rage at your disease. Anger is an important part of your journey toward accepting your life with diabetes. And while it can feel good and empowering, out-of-control anger can be harmful to you and those around you—and it can lead to depression and stress.

The key to dealing with your anger starts with being able to identify what's making you angry. Is it fear? Is it loss of control? Is it anger at yourself? As you find yourself getting angry, try to identify its root cause—and then work to transcend it.

When you feel anger, there are a number of things you can do to short circuit it:

- Take a breath
- Take an even deeper breath
- Get a drink of water
- Sit down
- Lean back
- Shake your arms loose
- Work to silence yourself
- Take a walk

### **Depression can sneak up on anybody**

Sometimes, there's a sadness or an emotional flatness that just won't go away. Sometimes, you just feel hopeless—and have no idea what comes next. However it shows up, depression can be hard to detect and can wreak havoc with your self care. Spotting depression is important—and it's important to check for these symptoms:

- Loss of interest or pleasure
- Change in sleep patterns
- Waking up earlier than normal
- Change in appetite
- Trouble concentrating
- Loss of energy
- Nervousness
- Guilt
- Morning sadness

- Suicidal thought
- Withdrawal from friends and activities
- Declining school and work performance

If you feel like you might be depressed, talk with your doctor. See if it makes sense to talk to a psychotherapist or counselor and then work to overcome it. It takes time for depression to lift, but once you have the proper emotional tools in place, you can learn to recognize the symptoms and act fast.

## Oral Health

Your mouth doesn't lie. Swollen, bleeding, or receding gums; loose or missing teeth; and persistent bad breath are all signs of gum disease. If you have diabetes, you're at higher risk for both gingivitis (early-stage gum disease) and what's known as periodontitis (advanced gum disease).

Both start with plaque, a soft, sticky substance that accumulates on your teeth as you eat and is made up mostly of bacteria. More than 500 types of bacteria can be found in plaque—some are good for your mouth and some aren't.

Bacteria in a person with diabetes is no different than people without doesn't have diabetes. The difference is in the nature and intensity of the body's inflammatory response to the bacteria. If you have diabetes—especially if you're not meeting your targets—you will have more of an inflammatory response, which could result in a loss of supporting tissue for your teeth. Eventually, the tooth could become so loose it has to be removed.

There are some oral conditions that are more common in people with diabetes, such as dry mouth. It may be a result of aging or medications, but it could also be a complication of diabetes. Whatever the cause, the lack of saliva from dry mouth means food debris, sugar, acid and bacteria don't get washed away as easily.

There is good news, though: None of this happens right away. And there's plenty you can do to prevent gum disease. If you manage your diabetes and your oral health by getting regular checkups with a dentist or periodontist, you will reduce your risk.

## What Can You Do Now?

Here are three essential steps to maintaining a healthy smile:

**Brush twice a day.** The American Dental Association recommends brushing for two minutes, twice a day, with a fluoride toothpaste. Place your toothbrush at a 45-degree angle to the gums and gently move the brush back and forth along the outer, inner and chewing surfaces of your teeth. Be sure to clean each surface thoroughly. Whether you use a manual or electric brush doesn't matter, but the size and shape of your brush should make it easy to reach all areas. And be sure to use soft bristles. Research shows that firm bristles tend to wear away the enamel on your teeth.

**Floss once a day.** If you don't, plaque and food particles build up between teeth and along the gum line, setting you up for tooth decay and gum disease. To floss, wind an 18-inch piece around your middle fingers, leaving an inch or two to work with. Holding the floss between your thumbs and index fingers,

curve it around each tooth in a C shape and gently slide it up and down the tooth and beneath the gum line. Not a fan of flossing? Try an interdental device. The tiny brush is designed to reach places a regular toothbrush can't.

**See your dentist twice a year.** Depending on the health of your gums, he or she may recommend cleanings every three months. Your dentist may also suggest an antibacterial mouth rinse or antibiotics. Be sure to let your dentist know of any changes in your health or medications because both can affect your oral health—such as symptoms of dry mouth.

### **Know Before You Go**

Check out these four ways to get the most out of your next dental appointment:

- Find a dentist who is aware of the needs of people with diabetes.
- Be honest with your dentist. Your dentist needs to know if you've been reaching your diabetes targets since it will affect how you'll respond to dental treatments.
- Be sure to eat normally prior to your appointment and take your usual meds on schedule.
- Be proactive. When you go in for a cleaning, ask: How do my gums look? Was there a lot of bleeding? Is there anything more I should be doing? You're the most important part of your diabetes care team—and that's also true when it comes to keeping your teeth and gums healthy.

### **Did You Know?**

Did you know that it's possible for your dentist to refer you to your doctor to get screened for prediabetes or type 2 diabetes? A study published recently in *BMJ Open Diabetes Research & Care* found that nearly 1 in 5 people with severe gum disease may have had type 2 diabetes and didn't know it.

### **Living with Diabetes**

#### **KEY POINTS**

- It takes time and practice to live well with diabetes.
- Everything you do to take care of yourself helps.
- Over time, you'll learn how to make diabetes fit with the rest of your life.

### **Diabetes basics**

Remember when you first found out you had diabetes and learned the basics of self-care?

- Make and eat healthy food.
- Be active most days.
- Test your blood sugar often.
- Take medicines as prescribed, even if you feel good.
- Learn ways to manage stress.
- Cope with the emotional side of diabetes and learn to manage stress.
- Go to checkups.

You've had to make diabetes care fit with family, work, school, holidays, and everything else in your life. Here's our short list of tips to help.

## **Tips for living well with diabetes**

- Healthy eating
- Take the time to cook. Simple recipes can be healthy and delicious.
- Write down or take photos of meals and snacks to help you stay on track.
- Try an online cooking class to learn how to make veggies taste delicious.
- Skip "diabetic" foods. They tend to be high cost and low flavor.
- Make the same food for you and your family. Healthy eating for everyone!
- Try Meatless Monday. Beans and lentils are cheap, tasty, and good for you.
- Swap veggies for rice or pasta or blend them and add to sauces.

## **Being active**

- Being active is one of the best tools to manage diabetes, and it's free!
- Find ways to be active throughout the day, like climbing stairs.
- Work out with a friend. You'll be more likely to stick with it.
- Try an activity tracker (many are free) and watch your steps add up.
- Try online workout videos. There's something for every level of fitness.

## **Managing stress**

- Try meditation or yoga to relax.
- Get moving! Taking a walk can help you unwind.
- Call or make plans to get together with a friend who understands you.
- Keep Reading: Diabetes and Mental Health
- Getting enough sleep
- Keep your bedroom dark and cool (65 degrees is recommended).
- Keep TVs, computers, and smartphones out of the bedroom.
- Get some physical activity during the day.
- Mentally unwind and relax before bedtime.
- Have a bedtime routine, like taking a shower or reading.

## **Healthy habits**

- For new habits, start small. Small successes make bigger goals easier.
- Make goals specific: "I'm going to walk after dinner on weekdays."
- Make good choices easier, such as leaving the dog's leash by the door.

## **Type 2 Diabetes and Your Liver**

Did you know that type 2 diabetes and overweight can increase your risk for liver disease?

Learn more about this connection and how to care for your liver. Illustration of liver inside the human body. All about your liver. Your liver is the largest internal organ in your body, and it's responsible for many vital functions, including:

- Filtering your blood to remove wastes like chemicals or toxins.
- Breaking down medicines and other substances.
- Producing bile, which helps you digest fat.
- Helping your immune system fight germs that could make you sick.

Your liver also plays a key role in balancing your blood sugar levels. When you eat, a hormone called insulin removes extra sugar from your bloodstream. This sugar is stored in your liver for future use. Between meals and overnight, your liver releases that sugar back into your bloodstream so your body has the energy it needs.

### **Types of liver disease**

Viral hepatitis is a liver infection caused by certain viruses. Liver damage or liver cancer can be caused by heavy alcohol consumption. Other types of liver disease can be caused by chronic conditions like:

- Obesity (especially weight around your belly).
- High cholesterol.
- High blood pressure.

### **Type 2 diabetes.**

Non-alcoholic fatty liver disease (NAFLD) happens when too much fat builds up in your liver. It's normal for your liver to store some fat. But if more than 5% of your liver's weight comes from fat, this can cause problems.

A more severe form of fatty liver disease is called non-alcoholic steatohepatitis (NASH). This is when you have NAFLD and also have swelling, inflammation (an immune response to injury or illness), and liver damage. About 20% to 30% of people with NAFLD also develop NASH.

NAFLD and NASH can lead to more serious complications like liver cirrhosis, which is scarring and permanent damage to your liver. This damage could eventually lead to liver failure and the need for a liver transplant.

### **The type 2 diabetes and liver connection**

There is an often-overlooked connection between type 2 diabetes and your liver. Research on this connection is relatively new, but it's becoming clear that each condition increases the risk for the other.

When your blood sugar is high over a long time, it can damage your internal organs, including your liver. Similarly, NAFLD and NASH increase the risk of developing prediabetes or type 2 diabetes. A buildup of fat and damage in your liver can increase your blood sugar levels.

NAFLD and type 2 diabetes share many of the same risk factors. These include overweight or obesity, high blood pressure, and high cholesterol. Researchers are seeing increasing numbers of people with both type 2 diabetes and liver disease. In fact, up to 70% of people with type 2 diabetes also have NAFLD.

### **Getting screened**

NAFLD and NASH usually don't have any signs or symptoms and can develop over many years unnoticed. Some people may experience symptoms like:

- Loss of appetite.
- Fatigue.
- Yellowing of the skin and/or eyes.
- Right-sided pain in the belly.
- Unexplained weight loss.

Most people don't notice any changes during the early stages of liver disease. Because of this, screening and early diagnosis are crucial, even if you don't think anything is wrong. If you have diabetes, be sure to ask your doctor about your liver health at your next visit.

Your doctor can screen you for NAFLD by testing your liver enzymes (a measure of liver function) with simple blood tests. The test results along with your age are used to calculate your risk for liver damage. Your risk score, known as the Fibrosis-4 (FIB-4) Index, means the following:

- FIB-4 score less than 1.3: low risk.
- FIB-4 score of 1.3 to 2.67: medium risk.
- FIB-4 score higher than 2.67: high risk.

Your FIB-4 result shows your risk of liver disease. Your doctor may also perform a liver biopsy or imaging tests to diagnose liver disease if needed like:

### **Ultrasound.**

- Computed tomography (CT) scan.
- Magnetic resonance imaging (MRI).

Diabetes experts are noticing that chronic liver disease is a growing health concern. Early diagnosis and lifestyle changes for NAFLD can help to prevent more severe forms of liver damage like cirrhosis.

### **Prevent or manage liver disease**

There are no medicines available yet that cure NAFLD or NASH. But there's good news. Many of the same lifestyle changes that help manage prediabetes and type 2 diabetes also help with liver diseases, including NAFLD and NASH. With healthy lifestyle changes, you can prevent, slow down, or even reverse the buildup of extra fat in your liver.

Losing weight if you have overweight or obesity is a great place to start. Losing 5% to 10% of your current body weight (about 10 pounds for someone who weighs 200 pounds) can help reduce extra fat in your liver. This can also improve your blood sugar and take stress off all your internal organs.

Healthy eating, including balancing your carbohydrate intake and limiting sweets, is important for diabetes. It also matters for liver health since extra carbohydrates and sugars are stored in your liver. Limiting the amount of saturated fats in your diet helps protect your liver from fat buildup.

Being physically active helps improve the way your body uses blood sugar. It also helps reduce the amount of fat stored in your liver. Try getting at least 150 minutes of physical activity per week, but every active minute counts.

Limiting alcohol can also reduce the stress on your liver and slow the development of liver damage. Limit alcohol as much as you can if you have liver disease or are at risk for it.

## **Your Brain and Diabetes**

- Your brain is sensitive to the amount of glucose (sugar) it receives.
- Both high and low blood sugar can damage blood vessels in the brain.
- Help prevent problems by keeping your blood sugar close to target levels.
- Group of hands holding a paper heart-shaped brain cut out symbolizing a healthy brain.

## **The diabetes-brain connection**

Your brain is your body's command center. To do all its work, your brain uses sugar in your blood for energy. In fact, the brain is the most energy-demanding organ. It needs half of all the sugar energy in the body to function properly.

If your blood sugar levels fall outside your normal range, it can throw your command center off balance. In the same way diabetes can damage nerves in other parts of your body, it can damage nerves in your brain. Diabetes can damage blood vessels in the brain and cause a stroke or memory loss. Diabetes can damage blood vessels in the brain and cause a stroke or memory loss. This can lead to problems with memory and learning, mood shifts, weight gain, and hormonal changes. Over time, it can also lead to other serious problems like Alzheimer's disease. Both high and low blood sugar levels can cause these harms. That's why it's important for people with diabetes to keep their blood sugar at target levels.

Your doctor will set a personal blood sugar target range for you. You can help protect your brain by keeping your blood sugar levels close to your target. Eat a diet rich in vegetables, fiber, and fruit and make sure to get regular physical activity. These healthy habits can help you manage your diabetes and support your brain health.

## **High blood sugar**

Having frequent episodes of high blood sugar (hyperglycemia) can stress the brain. The effects of high blood sugar happen over time and aren't obvious right away. People often don't know that their brain is being affected.



High blood sugar over time damages blood vessels in the brain that carry oxygen-rich blood. When your brain receives too little blood, brain cells can die. This can cause problems with memory and thinking and eventually can lead to vascular dementia.

### **Low blood sugar**

Low blood sugar (hypoglycemia) happens when your blood sugar levels drop below 70 mg/dL. It can be very dangerous if left untreated.

When your brain doesn't get enough sugar, it also doesn't get enough oxygen. And unlike high blood sugar, the signs of low blood sugar are often immediate. Symptoms of low blood sugar may include feeling dizzy, shaky, or irritable. You may have trouble walking or talking. Severe low blood sugar can cause you to pass out or have seizures. It can even put you in a coma.

Some people with low blood sugar may not have any symptoms, which can make it hard to treat early. This is why it's important to check your blood sugar often. That way you can catch low blood sugar before it causes serious problems.

Some research shows that big dips in blood sugar may be linked to problems with depression, memory, and attention. If you have any of these problems and often have low blood sugar, talk to your doctor, who can:

- Help figure out why you're having low blood sugar.
- Adjust your medicine if needed.
- Refer you to a mental health counselor.
- Keep brain health top of mind

You can take steps to improve or prevent problems with brain health and diabetes, such as:

- Follow a healthy eating plan.
- Maintain a healthy weight.
- Keep your blood sugar within target levels.
- Get regular physical activity.
- Take medicine as prescribed.
- Stop smoking if you smoke.
- Manage stress.

### **Testing for Diabetes**

Health care professional interacting with a patient

#### **Why get tested**

Prediabetes and type 2 diabetes often don't have any symptoms. (Type 1 diabetes is different—symptoms can develop quickly and can be severe.)

That's why people with any risk factors are urged to ask their doctor if they should be screened. Being screened means getting tested when you don't have any symptoms.

Catching prediabetes early can help people prevent or delay type 2 diabetes. Finding out they have type 2 diabetes—and taking action—can help people prevent or delay serious health complications.

Getting tested is simple and quick. Your blood will be drawn at your doctor's office or at a clinic so your blood sugar can be tested. Results are usually available quickly.

### **When to get tested**

#### **Type 2 diabetes or prediabetes**

Ask your doctor about getting tested for prediabetes or type 2 diabetes if you have any of the risk factors. If you had your blood sugar tested at a health fair or pharmacy, follow up with your doctor. Your doctor may want to re-test you to make sure the results are accurate.

#### **Type 1 diabetes**

If your doctor thinks you have type 1 diabetes, your blood may also be tested for autoantibodies. These substances show your body is attacking itself and are often found with type 1 diabetes but not with type 2.

You may have your urine tested for ketones. Ketones are produced when your body burns fat for energy. Having ketones in your urine indicates you have type 1 diabetes instead of type 2.

#### **Gestational diabetes**

Gestational diabetes usually develops around the 24th week of pregnancy. You'll probably be tested between 24 and 28 weeks.

If you're at higher risk for gestational diabetes, your doctor may test you earlier. If your blood sugar is higher than normal early in your pregnancy, you may not have gestational diabetes. You may have type 1 or type 2 diabetes instead.

### **Types of tests**

Tests for type 1 diabetes, type 2 diabetes, prediabetes, and gestational diabetes

#### **A1C test**

The A1C test measures your average blood sugar level over the past 2 or 3 months.

- Normal: below 5.7%
- Prediabetes: 5.7–6.4%
- Diabetes: 6.5% or above

#### **Fasting blood sugar test**

This measures your blood sugar after an overnight fast (not eating).

- Normal: 99 mg/dL or below
- Prediabetes: 100–125 mg/dL
- Diabetes: 126 mg/dL or above

### **Glucose tolerance test**

This measures your blood sugar before and after you drink a liquid that contains glucose. You'll fast (not eat) overnight before the test and have your blood drawn to measure your fasting blood sugar level. Then you'll drink the liquid and have your blood sugar level checked. These checks usually happen at 1 hour, 2 hours, and possibly 3 hours afterward.

At 2 hours:

- Normal: 140 mg/dL or below
- Prediabetes: 140–199 mg/dL
- Diabetes: 200 mg/dL or above

### **Random blood sugar test**

This measures your blood sugar at the time you're tested. You can take this test at any time and don't need to fast (not eat) first.

- Normal: n/a
- Prediabetes: n/a
- Diabetes: 200 mg/dL or above

### **Tests for gestational diabetes**

#### **Glucose screening test**

This measures your blood sugar at the time you're tested. You'll drink a liquid that contains glucose. Then, 1 hour later your blood will be drawn to check your blood sugar level. A normal result is 140 mg/dL or lower. If your level is higher than 140 mg/dL, you'll need to take a glucose tolerance test.

#### **Glucose tolerance test**

This measures your blood sugar before and after you drink a liquid that contains glucose. You'll fast (not eat) overnight before the test and have your blood drawn to measure your fasting blood sugar level. Then you'll drink the liquid and have your blood sugar level checked. These checks usually happen at 1 hour, 2 hours, and possibly 3 hours afterward.

Results can differ depending on the size of the glucose drink and how often your blood sugar is tested. Ask your doctor what your test results mean.

### **After a diagnosis**

If your results show you have type 1, type 2, or gestational diabetes, talk with your doctor about a detailed treatment plan. Your plan should include:

- A referral to diabetes self-management education and support services.

- Specific steps you can take to be your healthiest.

## **Diabetes Risk Factors**

Some diabetes risk factors can be managed through behavior change, such as being more physically active. Other risk factors can't be changed, such as family history and age. Find out your risk for each type of diabetes. Measuring device concept

### **Type 1 diabetes**

Type 1 diabetes is thought to be caused by an autoimmune reaction (the body attacks itself by mistake). No one knows how to prevent type 1 diabetes. Known risk factors include:

- Family history: Having a parent, brother, or sister with type 1 diabetes.
- Age: You can get type 1 diabetes at any age, but it usually develops in children, teens, or young adults.
- In the United States, White people are more likely to develop type 1 diabetes than African American and Hispanic or Latino people.

### **Prediabetes and type 2 diabetes**

Prediabetes and type 2 diabetes share almost all of the same risk factors. If you already have prediabetes, this is an added risk factor that makes you more likely to develop type 2 diabetes. You're at risk for both prediabetes and type 2 diabetes if you:

- Have overweight or obesity.
- Are age 45 or older.
- Have a parent or sibling with type 2 diabetes.
- Are physically active less than 3 times a week.
- Have non-alcoholic fatty liver disease (NAFLD).
- Have ever had gestational diabetes (diabetes during pregnancy) or given birth to a baby who weighed over 9 pounds.
- Are an African American, Hispanic or Latino, American Indian, or Alaska Native person. Some Pacific Islander people and Asian American people also have a higher risk.

### **Gestational diabetes**

You're at risk for gestational diabetes (diabetes while pregnant) if you:

- Had gestational diabetes during a previous pregnancy.
- Have given birth to a baby who weighed over 9 pounds.
- Have overweight or obesity.
- Are more than 25 years old.
- Have a family history of type 2 diabetes.

- Have a hormone disorder called polycystic ovary syndrome (PCOS).
- Are an African American, Hispanic or Latino, American Indian, Alaska Native, Native Hawaiian, or Pacific Islander person.
- Gestational diabetes usually goes away after you give birth. But having a history of gestational diabetes increases your risk for type 2 diabetes. The baby is also more likely to have obesity as a child or teen, and to develop type 2 diabetes later in life.

## Reduce your risk

Some risk factors like age and family medical history can't be helped. But there are some things you can do to reduce your risk of prediabetes, type 2 diabetes, or gestational diabetes. Some behavior changes to lower your risk include:

- Increasing physical activity.
- Eating a healthy diet.
- Losing weight if you have overweight or obesity.

Small, gradual changes can make a big difference in lowering your risk of prediabetes, type 2 diabetes, or gestational diabetes, and improving your overall health and wellness. It's never too late or too early to get started.

If you have prediabetes and need additional support, help is available through the National Diabetes Prevention Program lifestyle change program. Find out here if you're eligible. You can reverse prediabetes to prevent or delay type 2 diabetes

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