IN THIS CHAPTER

- Picking up the basics about diabetes risk, blood glucose, and insulin
- Defining the types of diabetes (including prediabetes)
- Identifying diabetes symptoms and getting a proper diagnosis
- Working with a blood glucose meter or a continuous monitor
- Recognizing the important links between fitness and diabetes management

# Chapter 1
# Getting an Overview of Diabetes



One in three Americans currently has diabetes or prediabetes; that's over 100 million people in the United States alone. This isn't a small health issue, and it's not likely to go away anytime soon. But what do you really know about diabetes, other than it involves having extra "sugar" in your blood? How do you know whether you have type 1, type 2, or prediabetes? What's the difference?

In this chapter, you find out what makes someone develop diabetes and the types, along with how each is diagnosed. I also explain why a blood glucose meter can become your new best friend and how to get the most information you can out of it.

# Knowing Your Risks for Diabetes

What's your risk for getting diabetes? It has gone up substantially in the past few decades. In fact, anyone born in the United States from the year 2000 forward has a one-in-three chance of developing diabetes during his or her lifetime, and the incidence is closer to 50 percent if you're part of a minority group (like African Americans, Hispanics, or Native Americans).

More than 29 million Americans — close to 10 percent of the population — are estimated to already have diabetes, and this number is growing rapidly. Over a quarter of them don't even know they have it. Add in prediabetes, and the number goes up to over 100 million Americans, or one person out of every three.

WARNING

Everyone knows someone who has diabetes, so why worry about it? Because high blood glucose levels can be deadly. Having poorly managed diabetes can rob years from your life, and the shorter time you do have may be lived in much poorer health. Ignorance isn't bliss; ignoring diabetes and not attempting to prevent or manage its possible health consequences isn't the way to go if you want to live long and well.

Worldwide, this disease causes more than 3.2 million deaths per year, or 6 deaths every minute. Many more deaths are likely related to health problems caused by diabetes that are attributed to some other direct cause, such as a heart attack or a stroke, even though diabetes lead to those events. Unfortunately, poorly managed blood glucose can cause problems with almost every part of your body, including your heart, blood vessels, brain, kidneys, nerves, muscles, and bones. It can even lead to impotence and hearing loss.

Okay, so far this section has been depressing. Here's some good news: Most diabetes-related health problems are preventable. You simply need to get more physically active and follow a more healthful diet. If your health care provider prescribes medications, taking those may also help prevent future health issues. The combination of these improved lifestyle choices helps lower your blood glucose and prevent systemic inflammation that leads to heart disease, nerve damage, and other health complications when not thwarted.

REMEMBER

Well-managed diabetes can be the cause of nothing — that is, no health problems.

# Understanding the Culprits: Glucose and Insulin

The human body has to manage its own blood glucose, which it does quite effectively in most people most of the time. You have to have enough glucose in your

blood; it's required for your brain and your nerves to function properly. The amount in blood is regulated by a hormone called insulin. The following sections explain how these two components work.


TIP

Think of glucose and insulin as the actor and the director in a performance. The insulin (director) tells the glucose (actor) where to go and what to do to get the best showing out of it. It takes the two coordinating their roles to get the show done.

## Glucose is the actor

When people talk about "blood sugar," they mean *blood glucose,* the primary sugar in your bloodstream that fuels the brain, nerves, muscles, and other cells around the body. Having too little in your blood can kill you. Unfortunately, so can having too much, especially over the long haul.

Normally, your body digests the food you eat and breaks it down into more easily absorbed molecules, of which glucose is one. It's a simple sugar that comes mostly from the carbohydrates you eat.

Blood glucose can come from different sources, but you get it mostly from your food and drinks (although your liver makes some, too). Foods rich in carbohydrates (such as grains, milk, fruit and fruit juice, starchy vegetables, most desserts, and sugary drinks) are released as glucose in your bloodstream after your body digests them. Blood glucose levels normally increase slightly after eating, even if you don't have diabetes. Your brain, nervous system, and active muscles use some of that glucose right away, although all cells in the body use glucose at some point. When everything is working right, the body stores away the rest for later.


TECHNICAL STUFF

When your blood glucose levels are higher (such as after a meal), extra glucose usually gets packed away and stored in the liver and muscles as *glycogen.* When your blood glucose is low, *glucagon* (a hormone made by the pancreas) is released and signals the liver to let out some of its stored glycogen as blood glucose. When you're active, your muscles also use some of the glycogen stored in them as fuel, but the glucose coming from muscle glycogen stores stays in the muscle and doesn't raise your blood glucose. Using up the glycogen in your muscles by exercising gives your body a place to easily store more carbohydrates after you eat the next time, reducing the amount of excess glucose flowing around in your blood, potentially causing inflammation and damage.

## Insulin is the director

When your body is working normally, your blood glucose goes up after you eat a meal, and your pancreas senses this increase and releases a hormone called *insulin*

to help lower it. Insulin works by binding to its receptors on cells in muscle and fat, the primary places where the body can store glucose for later use.

Two separate, but related, aspects of diabetes are associated with your body's insulin. One is how effectively insulin works. If you have type 2 diabetes or prediabetes, insulin may be abundant, but it doesn't work well to lower blood glucose — that is, you have *insulin resistance.* People with other types of diabetes can become insulin resistant as well. The second is the amount of insulin that is available. Persons with type 1 diabetes make little or no insulin; people with prediabetes and type 2 diabetes have an inadequate amount of insulin produced to meet their needs.

Insulin is a hormone made by the pancreas that, when released into the bloodstream, works to allow blood glucose to enter your cells that are insulin sensitive, primarily muscle, fat, and liver cells. Some of it gets used as a fuel by those cells, but the rest is stored in these tissues for later use. During rest, insulin works to make sure that glucose leaves the blood and goes into the cells, which keeps your blood glucose from going too high or staying that way after eating. Unfortunately, excess blood glucose that can't enter cells for any reason can cause damage to your body over time.

The other aspect is how much insulin the pancreas produces. You can be deficient in insulin, meaning that you simply don't make much. People with various types of diabetes can also have this issue. In that case, they may need to take medications to stimulate the pancreas to produce more, take insulin to supplement their supply, or use other medications that lower blood glucose other ways. In either case, your blood glucose may rise too high at various times, such as after you eat, when you're stressed out, if you're ill, and when you exercise vigorously.

Regardless of whether you have insulin that doesn't work well or too little of it overall, exercise can help your body use insulin more effectively. Weight loss can also help. Being more sensitive to the insulin you do have means that less insulin can lower blood glucose more. In people who have insulin resistance, improving the action of insulin may even reverse the course of their disease.

REMEMBER

When overweight people with type 2 diabetes lose just 7 percent of their body weight, their insulin action increases by 57 percent.

Even if you don't have diabetes, you may still be insulin resistant. Being overweight, staying sedentary, and eating a poor diet can all lead to insulin resistance, in which case your body will need more insulin to get the job done. If you're insulin resistant, you can take steps to improve your insulin action that will benefit your overall health.

### UNDERSTANDING INSULIN RESISTANCE

Regardless of which type of diabetes you have, you can become resistant to the effects of the hormone insulin, even if you have to pump or inject it instead of making your own. That fact makes insulin resistance relevant to everyone with diabetes of any type or prediabetes.

Think of insulin resistance with a lock and key analogy. In your body, glucose in the blood is trying to get through the door to your muscle and fat cells. To get inside the cells, the glucose must have a key to open the door. Insulin is the key that goes into the lock (or insulin receptors, in this case) to make it open. If you have the key (insulin), but the keyhole on the lock is blocked or the key won't turn when it goes in, then glucose can't enter, and you have insulin resistance — lots of insulin available but not working well. When the keys and the keyholes are functioning well together, the doors open, and glucose enters the cells and lowers the levels in the blood.

# Navigating the Types of Diabetes

Diabetes comes in many forms — type 1, type 2, and gestational are the most common forms — as well as being tied to the related condition prediabetes. The following sections give you a glimpse into these conditions.

## Taking a look at type 1 diabetes

About 5 to 10 percent of people have type 1 diabetes, which equates to around 1.25 million American children and adults. Prior to having this name, *type 1 diabetes* used to be called *insulin-dependent diabetes*, which is accurate because you have to take insulin if you have this type. But that name got confusing and was dropped because many people with type 2 diabetes use insulin as well.

Early on, type 1 was called *juvenile onset diabetes* because three-quarters of all cases are diagnosed in youth under 18. You can develop type 1 diabetes at any age, though, and most people living with type 1 are adults who inject or pump insulin daily to survive. Because adults also get type 1 diabetes, this term was inaccurate and misunderstood and was, therefore, abandoned decades ago.

Type 1 diabetes results from a relative insulin deficiency, which occurs after the body's own immune system destroys the *beta cells* of the pancreas that make insulin. Although the trigger for this autoimmune response is unclear, it's likely due to a combination of a genetic predisposition and environmental factors. Some causes under investigation include exposure to certain viruses, early introduction of cow's milk or other proteins in the diet of infants, and lack of vitamin D.

How rapidly type 1 diabetes develops is quite variable; it's rapid in some individuals (mainly infants and children) and slow in others (mainly adults). In either case, the symptoms of elevated blood glucose first appear when only about 10 percent of the insulin-making capacity of the pancreas remains.

## Talking about type 2 diabetes

About 90 to 95 percent of cases of diabetes are *type 2 diabetes,* which used to be called *non-insulin-dependent diabetes* and *adult onset diabetes.* Most people diagnosed with type 2 are adults, but it has become more common among teenagers with the current obesity epidemic and prevalence of sedentary lifestyles. It's largely related to lifestyle habits that promote insulin resistance and other bodily changes that lead to high blood glucose levels.

Type 2 diabetes primarily results from an inability of insulin to work well enough to lower blood glucose to normal levels, a state of insulin resistance. However, most people with type 2 diabetes suffer from some degree of beta cell burnout, which leads to a diminishing release of insulin over time and rising blood glucose levels. The beta cells in the pancreas that make insulin lose some or all of their ability to produce insulin when exposed to high levels of blood glucose over time.

REMEMBER

If you develop type 2 diabetes, you likely have insulin resistance, paired with insulin secretion that is maximal but insufficient. In other words, your body can't make enough insulin to fully overcome your body's resistance to it.

Many consider type 2 diabetes a less severe condition than type 1, but type 2 is more complex in its origin. With this type, you likely have an underlying genetic susceptibility that, when exposed to a variety of social, behavioral, and/or environmental factors, unleashes a latent tendency for diabetes. In other words, diabetes genes are triggered by combined environmental and lifestyle factors, such as inactivity, poor eating habits, weight gain, exposure to pollutants, vitamin and mineral deficiencies, and more.

Although having a family history of type 2 increases your risk, the recent, unprecedented increase in type 2 diabetes cases suggests that a bigger cause is a combination of factors that increase insulin resistance, such as a sedentary lifestyle and a poor diet. Many people who get this type of diabetes don't have any relatives with it. Having a parent, sibling, or other close relative who has it increases your risk of developing it, though.

TIP

Particularly when you're first diagnosed with type 2 diabetes, you may be able to manage your blood glucose levels effectively or even reverse your diabetes by making lifestyle changes, such as exercising regularly and eating a better diet.

## Getting a handle on gestational diabetes

Women can develop *gestational diabetes* during pregnancy if their blood glucose levels rise too high, which is most likely to happen during the second or third trimester. Pregnancy hormones make the mother more insulin resistant — to spare glucose for the developing fetus — but her blood glucose can rise as a result.

Managing blood glucose during pregnancy is important because elevated levels aren't good for the mother or the baby. Unborn babies make their own insulin during the third trimester and can get too large (over 9 pounds) from gaining extra fat when exposed to high levels of glucose, making the birth process difficult for the mother and the child. Babies can also have other health problems if the mother's glucose levels aren't managed well enough.

If you have ever given birth to a baby weighing 9 pounds or more, then you likely had gestational diabetes during your pregnancy (whether diagnosed or not).

You often can manage blood glucose levels during pregnancy with physical activity and dietary changes (particularly limiting carbohydrate intake). Regular exercise is recommended for all women during pregnancy, but it's even more important if you have or are at high risk for developing gestational diabetes. Some women must take diabetes medications that are acceptable during pregnancy to manage their blood glucose levels.

WARNING

Although gestational diabetes usually disappears after the baby is born, it increases the mother's risk for developing type 2 diabetes later in life.

## Previewing prediabetes

*Prediabetes* is basically a relative state of insulin resistance. About 40 percent of adults between 40 and 74 years old who were screened in 2000 were diagnosed with prediabetes. In 2014, 86 million Americans age 20 and older had prediabetes, up from only 79 million in 2011. That is a huge number of people affected by this condition.

Even though blood glucose levels aren't in a diabetic range yet with prediabetes, having prediabetes puts you at high risk for progressing to type 2 diabetes at some point in your lifetime. What's more, you can develop some of the complications usually associated with diabetes, like nerve damage in your feet, heart disease, and stroke, while only having prediabetes.


TIP

You can reverse prediabetes with improvements to your lifestyle. The same changes that help manage type 2 diabetes — regular exercise, a more healthful diet, and fat weight loss — can help eliminate prediabetes and prevent its progression into full-blown diabetes.

# Diagnosing Diabetes or Prediabetes

Some people have symptoms of diabetes before they're diagnosed, but many more never have any or realize that any symptoms they're having are related to diabetes. That makes it even more important to get annual checkups — particularly when you're getting older — that measure your fasting blood glucose. Of course, that's only one way to diagnose it, and testing only fasting levels misses some people who experience spikes in their blood glucose after eating although their morning levels are just fine.

## Recognizing the symptoms

The more classic symptoms of *hyperglycemia,* or elevated blood glucose levels, include increased thirst, excessive urination, unusual fatigue, blurred vision, unexplained hunger, rapid weight loss, and slow-healing cuts and infections. These symptoms are common in youth who develop type 1 diabetes rapidly. However, diabetes can have subtle symptoms and may go undetected for some time, particularly in adults who develop it slowly.

TIP

If you or a loved one has complained recently about excessive thirst, frequent urination, or excessive hunger, schedule an appointment with your doctor or health care provider to check for diabetes.

REMEMBER

These symptoms aren't always indicative of diabetes. Sometimes elevated glucose levels can occur temporarily due to illness or medication use.

# Testing for diabetes and prediabetes

Three main clinical methods are currently approved for diagnosing diabetes or prediabetes: fasting plasma glucose, oral glucose tolerance, and the A1C test (glycated hemoglobin). Any test that appears to indicate that you have either of these conditions should be repeated a second time (on another day) before your diagnosis is officially confirmed.

REMEMBER

Though this test isn't a usual official method, diabetes can sometimes be diagnosed when someone experiences the classic symptoms of hyperglycemia *and* has a random plasma glucose value of 200 mg/dL or higher.

## Fasting plasma glucose

This simple blood test measures your blood glucose levels after an overnight fast of at least eight hours. It determines the amount of glucose in plasma, which is the clear part of the blood with all the red blood cells removed.

The fasting value is reported (in the United States) in mg/dL, which is simply a measure of the amount of glucose (in milligrams, or mg) in a set amount of plasma (100 milliliters, which equals 1 deciliter, or dL). Outside of the United States or in research papers, it's reported as mmol/L (millimoles per liter, or sometimes mM). ***Note:*** To convert from mg/dL to mmol/L, divide the value in mg/dL by 18.

The fasting plasma levels used for diagnosis are

- **Normal:** 70 to 99 mg/dL (3.9 to 5.5 mmol/L)
- **Prediabetes:** 100 to 125 mg/dL (5.6 to 6.9 mmol/L)
- **Diabetes:** 126 mg/dL (7.0 mmol/L) or above

Prediabetes is diagnosed when your fasting glucose levels are elevated above normal (also known as *impaired fasting glucose*, or IFG). Diabetes is diagnosed when your fasting plasma glucose exceeds the prediabetes range.

TIP

Being on the lower end of the normal range in the morning is always better, and you should take steps to lower it if it rises over time toward the high end of normal.

## Oral glucose tolerance

An alternate testing method is the oral glucose tolerance test (OGTT), which involves drinking 75 grams of glucose and having your blood glucose monitored for two to three hours afterward. This approach tests your body's ability to respond to a large influx of sugar. If your blood glucose goes up or stays up too high for long from this oral sugar load, you're said to have *impaired glucose tolerance* (IGT). This test is used to diagnose diabetes, prediabetes, and gestational diabetes.

TIP

Make sure to have your fasting blood glucose levels tested annually, and an A1C test (discussed in the following section) as well if you can swing it.

## A1C test (glycated hemoglobin)

A third approved method to diagnose diabetes is to test your A1C (previously called glycated hemoglobin or hemoglobin A1C). The A1C indicates your average blood glucose over the past two or three months. Basically, the higher your blood glucose has been, the more glucose will be "stuck" to the hemoglobin part of red blood cells, and those blood cells live about 120 days.

This simple blood test can also be used to diagnose prediabetes because it averages in post-meal spikes in your blood glucose that a fasting value may not detect. Finding out your risk for developing diabetes is important because complications can occur when your A1C test is still in the normal range (at the high end).

## Interpreting your test results

Table 1-1 illustrates how the results of these tests are used to diagnose diabetes and prediabetes.

Your test results can be confusing because you may not get diagnosed with diabetes with one test, but meet the criteria for another. To be considered as having diabetes, you only have to meet the criteria for one test. But then how your diabetes is managed may vary based on which category you met. For instance, if you just have elevated fasting levels but your A1C is okay, your doctor may put you on a medication that will lower your morning blood glucose. If your blood glucose shoots up after meals (as indicated by an oral glucose test), you may need a medication that makes your pancreas release more insulin when you eat but not at other times of day.

REMEMBER

Talk to your doctor or health care provider about your diagnosis and the best course of action to follow based on your test results.

**TABLE 1-1** Diagnosis of Diabetes and Prediabetes

| Diabetes Diagnosis | Fasting Plasma Glucose | Oral Glucose Tolerance Test (OGTT) | A1C | Symptoms |
|---|---|---|---|---|
| Type 1 | ≥ 126 mg/dL (7.0 mM) | 2-hour value: ≥ 200 mg/dL (11.1 mM) | 6.5% or higher | Classic symptoms of hyperglycemia or a random plasma glucose ≥ 200 mg/dL (11.1 mM) |
| Type 2 | ≥ 126 mg/dL (7.0 mM) | 2-hour value: ≥ 200 mg/dL (11.1 mM) | 6.5% or higher | Classic symptoms of hyperglycemia or a random plasma glucose ≥ 200 mg/dL (11.1 mM) |
| Gestational | ≥ 92 mg/dL (5.1 mM) | 1-hour value: ≥ 180 mg/dL (10.0 mM) or 2-hour value: ≥ 153 mg/dL (8.5 mM) | | |
| Prediabetes | 100–125 mg/dL (5.6–6.9 mM) | 2-hour value: 140–199 mg/dL (7.8–11.0 mM) | 5.7–6.4% | |

## Getting tested for gestational diabetes

Gestational diabetes is typically tested for and diagnosed between 24 and 28 weeks of pregnancy with an oral glucose tolerance test. Managing it may involve using insulin or other medications, along with diet changes and regular exercise. All pregnant women should be screened for this condition no later than 28 weeks and possibly even earlier if it was diagnosed during previous pregnancies.

## FIND OUT YOUR PREDIABETES RISK ONLINE

A quick and easy way to assess your risk for prediabetes is to take an online risk test created by the American Diabetes Association. It asks you a few simple questions about your diet, activity levels, body shape and size, and more and only takes a couple of minutes to do.

Access the Association's prediabetes risk test online at `www.doIhaveprediabetes.org`.

The good news is that prediabetes is possible to reverse with some simple and easy lifestyle changes like some small changes in your diet and a little more exercise. Find out if you're at risk and start making those lifestyle improvements now, and you may avoid ever getting prediabetes or type 2 diabetes.

## Being misdiagnosed with type 2 diabetes

Given the current diagnosis methods for diabetes, determining which kind of diabetes a person has can sometimes be difficult. In addition, diabetes can sometimes have other causes, such as pancreatic cancer or other rare conditions. Having excess body fat used to lead to an almost guaranteed diagnosis of type 2 diabetes, but that is no longer the case because people who develop type 1 are often overweight and can develop an insulin-resistant state related to weight gain, dietary choices, and physical inactivity.

As many as 20 percent of adults who develop type 1 later in life may initially be misdiagnosed with type 2 due to their older age and slower onset. Being misdiagnosed because of your adult age is common, and you may initially respond well to oral diabetes medications (which further confuses the diagnosis). But you're not likely to be as insulin resistant as someone who has type 2 diabetes.

TIP

If you're an extremely athletic adult (age 25 or older) and you were diagnosed with type 2 over the age of 18 while regularly active and at normal or near-normal body weight, you likely have a slow-onset form of type 1 diabetes instead.

REMEMBER

You can get antibody tests done to help make the diagnosis between type 1 and type 2. Knowing which you have can help because starting insulin therapy (rather than diabetes pills) early may help preserve your remaining beta cells for a little longer.

# Self-Monitoring Your Blood Glucose

People living successfully with any type of diabetes use their blood glucose meters regularly. Frequent testing allows you to detect patterns and learn your body's unique response to different things — foods, activities, medications, emotional and physical stress, and more. Then you can adjust your medications, insulin, or lifestyle to better manage your blood glucose and prevent future health problems.

You may wake up every day and test, and your blood glucose is somewhat consistent then. But do you know what it's doing the rest of the day? What effect does eating one food have on it compared with another or doing one type of exercise rather than a different one?

TIP

If you don't know the answers to these questions, consider occasionally monitoring at alternate times — such as before and after exercise — even if you don't increase the number of times a day you check overall. Testing your blood glucose at different times rather than just first thing in the morning or before meals can often reveal trends with your blood glucose that you may not notice otherwise.

Here's another reason monitoring is important. Minimizing post-meal glucose spikes may be the key to preventing microvascular (small blood vessel) complications like diabetic eye disease (retinopathy). Testing not only before meals but also one hour and two hours afterward can let you know how meals and different foods are affecting your blood glucose and how much variability you're experiencing.

Regardless of which type of diabetes you have, your blood glucose typically starts to rise in 20 minutes and peaks in one to two hours after eating. It's recommended that you check blood glucose one to two hours after your first bite of a meal. However, blood glucose changes after meals vary widely from person to person and can even differ within one person depending on the food, time of day, and recent exercise.

REMEMBER

How much your blood glucose goes up in the two hours after a meal may be just as important in causing diabetes complications as overall glucose control — maybe even more so.

# Using a Blood Glucose Meter

Depending on your medications, you may have to make some changes to keep your levels optimal. Regardless of what type of diabetes you have, using injected or pumped insulin requires you to be vigilant to manage diabetes with activity. Even if you don't typically get low blood glucose during exercise, monitoring frequently is still advisable.

Most insulin users agree that glucose monitoring is essential for detecting patterns and making changes, although it still involves a lot of trial and error for each individual by activity. Blood glucose levels can be monitored in various ways at present, including blood glucose meters and continuous glucose monitors.

TIP

Using a meter, you can manage the many factors affecting your unique responses by checking your blood glucose levels before, during, and after exercise.

If you use certain oral medications, you may have higher risk for developing *hypoglycemia,* or low blood glucose. Luckily, type 2 exercisers aren't prone to developing diabetic ketoacidosis (DKA) — which can be life-threatening — even when their blood glucose runs high, but knowing your starting level is still important when you have that type of diabetes. Flip to Chapter 4 to find out more about this condition.

REMEMBER

Monitoring can be motivational, especially when your blood glucose goes down from an activity and you're hoping to lower it that way.

## Tackling types of meters

Many different blood glucose meters are available for self-monitoring. Most give readings in only five seconds and are small enough to carry around in your pocket or small bag. They vary somewhat in accuracy, but using whichever one you have access to is still better than checking infrequently or not at all. Talking to a certified diabetes educator may help you find the meter that is right for you.

You may want to consider these factors when choosing a meter:

- **Insurance coverage:** Your provider may limit your coverage to certain models or only reimburse for a limited number of test strips per month. Choose a meter that gives you the greatest flexibility when it comes to testing as much as possible.
- **Cost:** Although costs for the meters themselves have come down tremendously over time, they still vary in price, as do the test strips. Be sure to factor that in when making your selection.
- **Ease of use and features:** Check out a variety of meters to see which ones are easier for you to use. Do you need one with big numbers on the screen that are easier to read? Do you need one with auditory cues? Is it easy to hold in your hand? Some meters are equipped with large, easy-to-handle buttons and test strips; illuminated screens; and audio, which may be useful for people with impaired vision. Consider these factors when making your choice.
- **Data storage:** Many meters now track everything so you don't have to write anything down (including time, date, trends, and so on), and others let you input data like whether the reading is before or after a meal or exercise. Most allow you to download all your results to a computer or upload them to a mobile device or app. Consider which of these features would make your life and diabetes management easier.

## Examining what affects meter readings

Many things can cause you to get erroneous readings using your blood glucose meter, which can then lead you to make incorrect or inappropriate adjustments to your diabetes regimen. Be careful to avoid these situations if you can. Some meters are rather inaccurate, but you can throw your measured values off further with the following:

- **Dirty fingers:** Wash your hands before testing.
- **Cold fingers:** Warm them up before attempting to get a finger stick sample.
- **Calluses on fingertips:** Choose a less callused spot to prick.

- **Excessive squeezing of fingers:** You can dilute your blood this way.
- **Dehydration:** Being dehydrated makes blood glucose seem higher than it is.

## Looking ahead to other ways to measure blood glucose

For many years, the race has been on to develop an effective noninvasive monitor that doesn't require actual blood samples, or at least not pricking your fingers or other body part with a lancet, but such devices are still in development (like the Google contact lenses that are supposed to monitor glucose levels in the eye). Such devices will likely be available in the near future and make exercise and daily monitoring even easier. Make sure you only rely on ones that have been approved by the FDA, though, as some fitness vendors have started hawking unapproved ones that may not be accurate enough for making safe and effective diabetes management decisions.

## Exploring the pros and cons of continuous glucose monitors

Other glucose monitoring devices called *continuous glucose monitors* (CGMs) have been approved by the FDA for use in the past decade or so. They're still invasive, requiring that you place a small and thin wire filament under your skin. Most of these monitors aren't a complete closed-loop system (yet), meaning that currently you still have to check the blood glucose readings and make regimen adjustments yourself based on those results. One combined insulin pump and CGM sensor system that adjusts basal rates overnight and throughout the day without your input is now approved and on the market, and more with this feature are coming soon. Even with just the readings, however, obtaining a glucose reading every 5 minutes 24 hours a day can be quite useful to people who are trying to learn their patterns and keep blood glucose in tighter, more normal ranges.

REMEMBER

Though it's worn more frequently by people with type 1 diabetes, CGM technology can be used to determine which exercise programs are most beneficial for lowering blood glucose in people with type 2 diabetes.

CGM can provide useful information on glucose fluctuations. Although this technology is advancing, it still is imperfect. These systems currently measure glucose levels in the skin (in interstitial fluids between cells) rather than the blood, a lag between actual and measured blood glucose levels of anywhere from 6 to 12 or more minutes, and the values it displays are also time-delayed from 2.5 to 7.5 minutes.

Thus, its trend arrows (for example, one or two arrows down or up, with more arrows indicating a faster rate of change) aren't perfectly in sync with rapidly changing blood glucose levels that can occur during exercise or after eating a meal. When blood glucose levels are rising, the CGM is likely to display values that are lower than actual blood glucose, and when they're falling, it may display values that are higher than blood glucose actually is. CGM values can also be inaccurate due to other factors, such as improper insertion of the sensors under the skin, irritation of the skin in that area, or improper monitor calibration.

On the helpful side, at least one CGM system now allows cloud sharing of values in real-time, which is especially appealing to parents of children with type 1 diabetes or significant others of adults wearing CGM devices. Wouldn't life be simpler if you always knew in real time that your loved one had a blood glucose level in a safe range?

TECHNICAL STUFF

Some of the newer-generation CGM systems can communicate with insulin pumps and suspend insulin delivery when low blood glucose levels are detected and adjust basal rates based on sensor values. These developments are some of the first steps in creating a viable closed-loop insulin delivery and glucose monitoring system that combines CGM and insulin pumps. Many research groups are using the two technologies together with a central control unit with algorithms to create a system that can balance blood glucose levels in people with type 1 diabetes without much, if any, user input. These so-called artificial pancreas systems are still subject to the many limitations that these technologies currently have, including measurement of interstitial fluid glucose (rather than blood glucose), time lags, and insulin delivery under the skin (rather than directly into the vein that flows from the pancreas to the liver, the *portal vein*). In the near future, other devices like heart rate monitors or accelerometers (movement and activity monitors) may eventually be paired with such systems to make them more effective during exercise.

# Discovering Why Being Fit with Diabetes Matters

Without a doubt, being physically active is good for your body, heart, and mind. If you're already an avid exerciser, then you're likely aware of most of the benefits of exercise for your physical health and your diabetes management. If you're just getting serious about engaging in more fitness activities or sports, you have many positive changes to look forward to.

TIP

Exercising regularly is likely the single most important thing you can do to keep your blood glucose in check, prevent or reduce your risk of developing diabetes-related or other health complications, and slow down aging.

Exercise can help you build muscle and lose body fat, suppress your appetite, eat more without gaining fat weight, enhance your mood, reduce stress and anxiety, increase your energy, bolster your immune system, keep your joints and muscles more flexible, and improve the quality of your life — all this and more, especially when you have diabetes.

Getting and staying fit when you have diabetes (or prediabetes) is even more important. For many people, being physically active has made all the difference between managing and living well with diabetes or letting it control them. People who are physically fit live longer, healthier lives. It's not just about living longer, but living well and feeling your best as you age. Having diabetes increases your risk of getting health problems that can reduce your quality of life. You can fight back by keeping fit.


TIP

Confused about which activities you should you be doing or how much is necessary to be as healthy as you can be? You get different (but all good) results from doing a variety of types of daily activity, and that gives you a lot of options.