



# Why do my glucose levels vary from day to day?

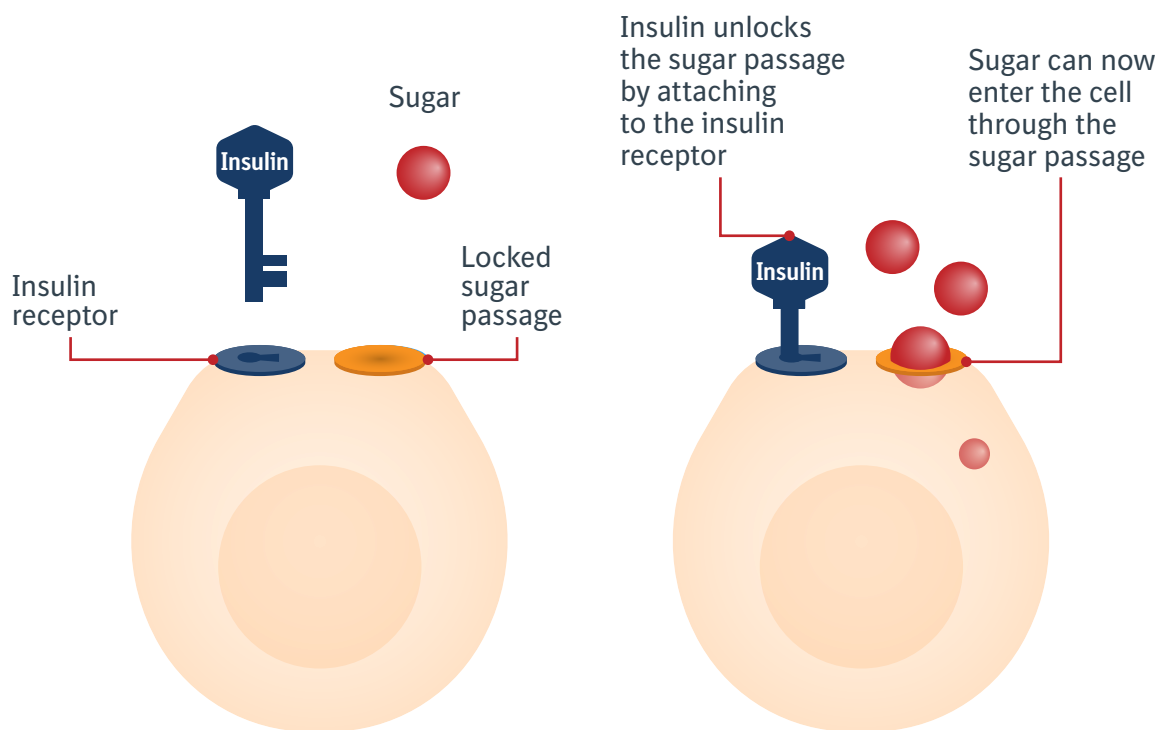
**A guide to the role of insulin resistance in people living with diabetes**

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# What is insulin and what does it do?

Sugar, or glucose, is the main source of energy used by our bodies. **Insulin** is a hormone (or chemical messenger), that is produced by the pancreas in response to blood sugar levels. Insulin attaches to special insulin receptors on the surface of our cells and allows sugar to move from the blood into all the cells of our bodies.

Think of insulin as a key and the insulin receptor as a keyhole in a lock. When the key (insulin) enters the keyhole (insulin receptor), sugar can move from the blood into the cell.



When the pancreas does not produce enough insulin, or when our cells do not respond correctly to insulin at the insulin receptor on the cell surface, blood sugar levels rise higher than normal, resulting in hyperglycemia (high blood sugar)

# What is insulin resistance (IR)?

A simplified way to help understand IR is to think of a rusty key: when a person has IR, some of the insulin molecules behave like “rusty keys”; they cannot fit perfectly into the keyhole (insulin receptor) and open the lock (sugar passage). This leads to sugar building up in the blood because there are not enough “non-rusty keys” working normally to allow sugar to move from the blood into the cells.

That said, people can experience different levels of IR – or have different amounts of “rusty keys”. A person with a high level of IR will need more insulin molecules in order to have enough “non-rusty keys” to adequately move sugar out of the blood. Over time, IR can cause progression to type 2 diabetes.

## IR can be long term and/or temporary



### Long term (chronic)

- Is the main driver of the development and progression of type 2 diabetes
- Caused by many factors including genetics (family history of type 2 diabetes)
- Occurs in people with increased fat in the abdomen; this fat may make chemicals that contribute to insulin behaving like “rusty keys”



### Temporary (reversible/acute)

- Happens in response to acute or temporary factors or circumstances that impact insulin production and how insulin attaches to cell receptors (keyholes)
- Can occur in anyone, including people without diabetes. In people without diabetes, the body is able to make more insulin to keep blood sugar levels normal
- In people with type 2 diabetes who already have long term IR, temporary IR can be thought of as making the cells “more” insulin resistant; this results in higher glucose levels in the blood

# Temporary IR may be caused by many different factors



**Physical stress**  
including illness, infection, inflammation, injury, and pain



**Emotional/mental stress**  
including anxiety and depression



**Stress hormones**  
such as those produced by the body after hypoglycemia



**Lack of sleep or poor-quality sleep** (less than 6 hours per night) and/or shift work



**Obstructive sleep apnea**



**Steroid medicines**  
such as prednisone and dexamethasone



**Decreased physical activity**  
and prolonged/increased sedentary (sitting) time



**High carbohydrate intake**  
(even one high-carbohydrate meal may result in insulin not working well for several hours)



**Hormones produced by the body during pregnancy**

As you can see, many factors influence reversible IR – this is why blood sugar levels change from day to day, even when you eat the same foods, do the same activities, and take the same medications.

If we modify some of these factors that cause increased reversible IR, we can reduce the amount of insulin that behaves like “rusty keys”. Having fewer “rusty keys” means that the insulin our bodies make or the insulin we take as medicine will work more efficiently to move sugar from the blood into the cells and blood sugar levels will improve.

# How does IR affect people living with type 2 and type 1 diabetes?



**Long-term IR**, with decreased insulin action, can lead to pre-diabetes over time – and ultimately a diagnosis of **type 2 diabetes**. Long-term IR is caused by many factors including genetics, increased body weight, sedentary lifestyle, and higher carbohydrate diet. **Reversible IR** will cause further problems with insulin not working well at the cell receptor, resulting in higher blood sugar levels.



**In type 1 diabetes**, the pancreas is not able to produce enough insulin. Therefore, insulin injections are required to keep blood sugar at normal levels. People with type 1 diabetes tend to be more sensitive to insulin with fewer “rusty keys” than those with type 2 diabetes. This means that most of the insulin that is injected works well at the cell receptor. This is why most people with type 1 diabetes require less insulin than people with type 2 diabetes.

However, **temporary or reversible IR** occurs in everyone, even in people with type 1 diabetes. This results in day-to-day variations in how well insulin works. Reversible IR causes some of the injected insulin to behave like “rusty keys”, and more insulin is required to keep blood sugar levels normal. Therefore, higher insulin doses are required to maintain normal blood sugar levels in situations such as:

- an acute illness
- when under more stress
- after a hypoglycemic episode
- when less physically active
- hours after eating high carbohydrate foods

# Tips on how to reduce IR and improve blood sugar levels

Scan each of the QR codes with your smartphone camera for more helpful tips and information from Diabetes Canada



**Eat less carbohydrates**, particularly refined carbohydrates with high glycemic index. A single high-carbohydrate meal or snack may cause increased IR for many hours.



Diabetes Canada:  
Glycemic Index  
Food Guide



**Eat more non-starchy vegetables, nuts and legumes**; these foods do not cause the same spikes in blood glucose levels that are seen with starchy foods like rice, pasta, bread, and potatoes.



**Try to not eat late in the evening or overnight** so that your body has at least 10-12 hours\* of fasting overnight. Studies have shown that eating within a few hours of going to sleep or during the night interferes with the action of both insulin and melatonin and increases IR, resulting in poor quality sleep, higher glucose levels and weight gain.

Therefore, avoid snacks at bedtime unless you are taking certain types of insulin and are directed by your healthcare provider. If you are a night-shift worker, apply these tips to the time of day you get the most sleep.

\* Information is based on the authors' clinical experience.



**Get restful sleep of at least 6 hours per night.**



**Treatment of obstructive sleep apnea (OSA);** untreated OSA causes the brain to release stress hormones which directly increase IR and glucose levels.



**Recognize and manage the causes of physical stress,** such as pain, with the help of your healthcare provider.



**Decrease emotional/mental stress;** this is difficult, but even identifying what is contributing to your stress and talking about it may reduce IR.

Speak with your healthcare provider and consider counseling, meditation, mindfulness, physical activity, relaxation techniques, and medications.



Diabetes Canada:  
Steps to stress  
management

**Increased physical activity** (starting with decreasing the amount of time spent sitting) can also improve IR – see the next page for more details

# Tips on using physical activity to reduce IR

Structured exercise – like working out at a gym or cycling/walking for 30 minutes every day – is not the only type of physical activity that will lower blood sugar levels. Many studies show that reducing our sedentary time (the time we spend sitting or lying down while awake) is the simplest thing we can do to improve the action of insulin. Physical activity in multiple short bouts is beneficial for decreasing IR and improving glucose levels. Some people like to think of these short episodes of physical activity as exercise “snacks”. The more “exercise snacks” we can do every day, the better our insulin will function.



Diabetes Canada:  
Benefits on  
physical activity

## Consider including these examples of exercise “snacking” in your daily routine



**Frequent** bouts of activity of 3-5 minutes every hour throughout the day, such as:

- walking around the house, office, or apartment building
- climbing up and down stairs
- dancing or jogging on the spot
- doing simple resistance exercises such as partial squats or using light weights or stretch bands



Diabetes Canada:  
Introductory  
resistance  
program





**Three episodes of physical activity of 10-15 minutes duration per day, such as:**

- walking outdoors, indoors or on a treadmill
- riding a bicycle



Diabetes Canada:  
Planning for regular  
physical activity



**Get up and move for 1-2 minutes every 30-40 minutes while sitting at the computer, watching TV, or reading**

**Physical activity performed within 1 hour after a meal** will reduce the rise in blood sugar caused by the consumption of food and drink. This activity may be as simple as walking for 10–20 minutes or going up and down the stairs for 5–10 minutes.\* For many people with type 2 diabetes, physical activity after eating can be one of the easiest ways to lower blood sugar levels. For people taking insulin, exercising after a meal is beneficial but will usually require adjustment to the mealtime insulin dose and guidance from a healthcare provider.

\* Information is based on the authors' clinical experience.

Studies have shown that decreasing sedentary time and exercise “snacking” can lead to improvements in insulin sensitivity, cholesterol, and reduced blood pressure



Diabetes Canada:  
Top 10 Tips to Sit Less  
and Move More



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