

Insulin Resistance and Pre-diabetes

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What is insulin resistance?

Insulin resistance is a condition in which the body produces insulin but does not use it properly. Insulin, a hormone made by the pancreas, helps the body use glucose for energy. Glucose is a form of sugar that is the body's main source of energy.

The body's digestive system breaks food down into glucose, which then travels in the bloodstream to cells throughout the body. Glucose in the blood is called blood glucose, also known as blood sugar. As the blood glucose level rises after a meal, the pancreas releases insulin to help cells take in and use the glucose.

When people are insulin resistant, their muscle, fat, and liver cells do not respond properly to insulin. As a result, their bodies need more insulin to help glucose enter cells. The pancreas tries to keep up with this increased demand for insulin by producing more. Eventually, the pancreas fails to keep up with the body's need for insulin. Excess glucose builds up in the bloodstream, setting the stage for diabetes. Many people with insulin resistance have high levels of both glucose and insulin circulating in their blood at the same time.

Insulin resistance increases the chance of developing type 2 diabetes and heart disease. Learning about insulin resistance is the first step toward making lifestyle changes that can help prevent diabetes and other health problems.

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What causes insulin resistance?

Scientists have identified specific genes that make people more likely to develop insulin resistance and diabetes. Excess weight and lack of physical activity also contribute to insulin resistance.

Many people with insulin resistance and high blood glucose have other conditions that increase the risk of developing type 2 diabetes and damage to the heart and blood vessels, also called cardiovascular disease. These conditions include having excess weight around the waist, high blood pressure, and abnormal levels of cholesterol and triglycerides in the blood. Having several of these problems is called metabolic syndrome or insulin resistance syndrome, formerly called syndrome X.

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Metabolic Syndrome

Metabolic syndrome is defined as the presence of any three of the following conditions:

- waist measurement of 40 inches or more for men and 35 inches or more for women

- triglyceride levels of 150 milligrams per deciliter (mg/dL) or above, or taking medication for elevated triglyceride levels
- HDL, or “good,” cholesterol level below 40 mg/dL for men and below 50 mg/dL for women, or taking medication for low HDL levels
- blood pressure levels of 130/85 or above, or taking medication for elevated blood pressure levels
- fasting blood glucose levels of 100 mg/dL or above, or taking medication for elevated blood glucose levels

Source: Grundy SM, et al. Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute scientific statement. *Circulation*. 2005;112:2735–2752.

Similar definitions have been developed by the World Health Organization and the American Association of Clinical Endocrinologists.

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What is pre-diabetes?

Pre-diabetes is a condition in which blood glucose levels are higher than normal but not high enough for a diagnosis of diabetes. This condition is sometimes called impaired fasting glucose (IFG) or impaired glucose tolerance (IGT), depending on the test used to diagnose it. The U.S. Department of Health and Human Services estimates that about one in four U.S. adults aged 20 years or older—or 57 million people—had pre-diabetes in 2007.

People with pre-diabetes are at increased risk of developing type 2 diabetes, formerly called adult-onset diabetes or noninsulin-dependent diabetes. Type 2 diabetes is sometimes defined as the form of diabetes that develops when the body does not respond properly to insulin, as opposed to type 1 diabetes, in which the pancreas makes little or no insulin.

Studies have shown that most people with pre-diabetes develop type 2 diabetes within 10 years, unless they lose 5 to 7 percent of their body weight—about 10 to 15 pounds for someone who weighs 200 pounds—by making changes in their diet and level of physical activity. People with pre-diabetes also are at increased risk of developing cardiovascular disease.

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What are the symptoms of insulin resistance and pre-diabetes?

Insulin resistance and pre-diabetes usually have no symptoms. People may have one or both conditions for several years without noticing anything. People with a severe form of insulin resistance may have dark patches of skin, usually on the back of the neck. Sometimes people have a dark ring around their neck. Other possible sites for dark patches include elbows, knees, knuckles, and armpits. This condition is called acanthosis nigricans.

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How are insulin resistance and pre-diabetes diagnosed?

Health care providers use blood tests to determine whether a person has pre-diabetes but do not usually test for insulin resistance. Insulin resistance can be assessed by measuring the level of insulin in the blood. However, the test that most accurately measures insulin resistance, called the euglycemic clamp, is too costly and complicated to be used in most doctors' offices. The clamp is a research tool used by scientists to learn more about glucose metabolism. If tests indicate pre-diabetes or metabolic syndrome, insulin resistance most likely is present.

Diabetes and pre-diabetes can be detected with one of the following tests:

- **Fasting glucose test.** This test measures blood glucose in people who have not eaten anything for at least 8 hours. This test is most reliable when done in the morning. Fasting glucose levels of 100 to 125 mg/dL are above normal but not high enough to be called diabetes. This condition is called pre-diabetes or IFG. People with IFG often have had

insulin resistance for some time. They are much more likely to develop diabetes than people with normal blood glucose levels.

- **Glucose tolerance test.** This test measures blood glucose after people fast for at least 8 hours and 2 hours after they drink a sweet liquid provided by a doctor or laboratory. A blood glucose level between 140 and 199 mg/dL means glucose tolerance is not normal but is not high enough for a diagnosis of diabetes. This form of pre-diabetes is called IGT and, like IFG, it points toward a history of insulin resistance and a risk for developing diabetes.

People whose test results indicate they have pre-diabetes should have their blood glucose levels checked again in 1 to 2 years.

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Risk Factors for Pre-diabetes and Type 2 Diabetes

The American Diabetes Association recommends that testing to detect pre-diabetes and type 2 diabetes be considered in adults without symptoms who are overweight or obese and have one or more additional risk factors for diabetes. In those without these risk factors, testing should begin at age 45.

Risk factors for pre-diabetes and diabetes—in addition to being overweight or obese or being age 45 or older—include the following:

- being physically inactive
- having a parent or sibling with diabetes
- having a family background that is African American, Alaska Native, American Indian, Asian American, Hispanic/Latino, or Pacific Islander
- giving birth to a baby weighing more than 9 pounds or being diagnosed with gestational diabetes—diabetes first found during pregnancy
- having high blood pressure—140/90 or above—or being treated for high blood pressure
- having an HDL, or “good,” cholesterol level below 35 mg/dL or a triglyceride level above 250 mg/dL
- having polycystic ovary syndrome, also called PCOS
- having impaired fasting glucose (IFG) or impaired glucose tolerance (IGT) on previous testing
- having other conditions associated with insulin resistance, such as severe obesity or acanthosis nigricans
- having a history of cardiovascular disease

If test results are normal, testing should be repeated at least every 3 years. Health care providers may recommend more frequent testing depending on initial results and risk status.

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Can insulin resistance and pre-diabetes be reversed?

Yes. Physical activity and weight loss help the body respond better to insulin. By losing weight and being more physically active, people with insulin resistance or pre-diabetes may avoid developing type 2 diabetes.

The Diabetes Prevention Program (DPP) and other large studies have shown that people with pre-diabetes can often prevent or delay diabetes if they lose a modest amount of weight by cutting fat and calorie intake and increasing physical activity—for example, walking 30 minutes a day 5 days a week. Losing just 5 to 7 percent of body weight prevents or delays diabetes by nearly 60 percent. In the DPP, people aged 60 or older who made lifestyle changes lowered their chances of developing diabetes by 70 percent. Many participants in the lifestyle intervention group returned to normal blood glucose levels and lowered their risk for developing heart disease and other problems associated with diabetes. The DPP also showed that the diabetes drug metformin reduced the risk of developing diabetes by 31 percent.

People with insulin resistance or pre-diabetes can help their body use insulin normally by being physically active, making wise food choices, and reaching and maintaining a healthy weight. Physical activity helps muscle cells use blood glucose for energy by making the cells more sensitive to insulin.

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Body Mass Index (BMI)

BMI is a measurement of body weight relative to height. Adults aged 20 or older can use the BMI table below to find out whether they are normal weight, overweight, obese, or extremely obese. To use the table, follow these steps:

- Find the person's height in the left-hand column.
- Move across the row to the number closest to that person's weight.
- Check the number at the top of that column.

The number at the top of the column is the person's BMI. The words above the BMI number indicate whether the person is normal weight, overweight, obese, or extremely obese. People who are overweight, obese, or extremely obese should consider talking with a doctor about ways to lose weight to reduce the risk of diabetes.

The BMI table has certain limitations. It may overestimate body fat in athletes and others who have a muscular build and underestimate body fat in older adults and others who have lost muscle. BMI for children and teens must be determined based on age and sex in addition to height and weight. Information about BMI in children and teens, including a BMI calculator, is available from the Centers for Disease Control and Prevention (CDC) at www.cdc.gov/nccdphp/dnpa/bmi. The CDC website also has a BMI calculator for adults.

Body Mass Index Table

[Printer-friendly version](#) *

Body Mass Index Table 1 of 2

| | Normal | | | | | | Overweight | | | | | Obese | | | | | |
|-----------------|----------------------|-----|-----|-----|-----|-----|------------|-----|-----|-----|-----|-------|-----|-----|-----|-----|-----|
| BMI | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 |
| Height (inches) | Body Weight (pounds) | | | | | | | | | | | | | | | | |
| 58 | 91 | 96 | 100 | 105 | 110 | 115 | 119 | 124 | 129 | 134 | 138 | 143 | 148 | 153 | 158 | 162 | 167 |
| 59 | 94 | 99 | 104 | 109 | 114 | 119 | 124 | 128 | 133 | 138 | 143 | 148 | 153 | 158 | 163 | 168 | 173 |
| 60 | 97 | 102 | 107 | 112 | 118 | 123 | 128 | 133 | 138 | 143 | 148 | 153 | 158 | 163 | 168 | 174 | 179 |
| 61 | 100 | 106 | 111 | 116 | 122 | 127 | 132 | 137 | 143 | 148 | 153 | 158 | 164 | 169 | 174 | 180 | 185 |
| 62 | 104 | 109 | 115 | 120 | 126 | 131 | 136 | 142 | 147 | 153 | 158 | 164 | 169 | 175 | 180 | 186 | 191 |
| 63 | 107 | 113 | 118 | 124 | 130 | 135 | 141 | 146 | 152 | 158 | 163 | 169 | 175 | 180 | 186 | 191 | 197 |
| 64 | 110 | 116 | 122 | 128 | 134 | 140 | 145 | 151 | 157 | 163 | 169 | 174 | 180 | 186 | 192 | 197 | 204 |
| 65 | 114 | 120 | 126 | 132 | 138 | 144 | 150 | 156 | 162 | 168 | 174 | 180 | 186 | 192 | 198 | 204 | 210 |
| 66 | 118 | 124 | 130 | 136 | 142 | 148 | 155 | 161 | 167 | 173 | 179 | 186 | 192 | 198 | 204 | 210 | 216 |
| 67 | 121 | 127 | 134 | 140 | 146 | 153 | 159 | 166 | 172 | 178 | 185 | 191 | 198 | 204 | 211 | 217 | 223 |
| 68 | 125 | 131 | 138 | 144 | 151 | 158 | 164 | 171 | 177 | 184 | 190 | 197 | 203 | 210 | 216 | 223 | 230 |
| 69 | 128 | 135 | 142 | 149 | 155 | 162 | 169 | 176 | 182 | 189 | 196 | 203 | 209 | 216 | 223 | 230 | 236 |
| 70 | 132 | 139 | 146 | 153 | 160 | 167 | 174 | 181 | 188 | 195 | 202 | 209 | 216 | 222 | 229 | 236 | 243 |
| 71 | 136 | 143 | 150 | 157 | 165 | 172 | 179 | 186 | 193 | 200 | 208 | 215 | 222 | 229 | 236 | 243 | 250 |
| 72 | 140 | 147 | 154 | 162 | 169 | 177 | 184 | 191 | 199 | 206 | 213 | 221 | 228 | 235 | 242 | 250 | 258 |
| 73 | 144 | 151 | 159 | 166 | 174 | 182 | 189 | 197 | 204 | 212 | 219 | 227 | 235 | 242 | 250 | 257 | 265 |
| 74 | 148 | 155 | 163 | 171 | 179 | 186 | 194 | 202 | 210 | 218 | 225 | 233 | 241 | 249 | 256 | 264 | 272 |
| 75 | 152 | 160 | 168 | 176 | 184 | 192 | 200 | 208 | 216 | 224 | 232 | 240 | 248 | 256 | 264 | 272 | 279 |
| 76 | 156 | 164 | 172 | 180 | 189 | 197 | 205 | 213 | 221 | 230 | 238 | 246 | 254 | 263 | 271 | 279 | 287 |

