Diagnosis of Diabetes

National Diabetes Information Clearinghouse

U.S. Department of Health and Human Services

NATIONAL INSTITUTES OF HEALTH

NIDDK
NATIONAL INSTITUTE OF DIABETES AND DIGESTIVE AND KIDNEY DISEASES

What is diabetes?

Diabetes is a disease in which levels of blood glucose, also called blood sugar, are above normal. People with diabetes have problems converting food to energy. Normally, after a meal, the body breaks food down into glucose, which the blood carries to cells throughout the body. Cells use insulin, a hormone made in the pancreas, to help them convert blood glucose into energy.

People develop diabetes because the pancreas does not make enough insulin or because the cells in the muscles, liver, and fat do not use insulin properly, or both. As a result, the amount of glucose in the blood increases while the cells are starved of energy. Over the years, high blood glucose, also called hyperglycemia, damages nerves and blood vessels, which can lead to complications such as heart disease, stroke, kidney disease, blindness, nerve problems, gum infections, and amputation.

Main Types of Diabetes

The two main types of diabetes are called type 1 and type 2. A third form of diabetes is called gestational diabetes.

- Type 1 diabetes, formerly called juvenile diabetes, is usually first diagnosed in children, teenagers, and young adults. In this form of diabetes, the pancreas no longer makes insulin because the body's immune system has attacked and destroyed the pancreatic cells specialized to make insulin. These insulin-producing cells are called beta cells.
- Type 2 diabetes, formerly called adult-onset diabetes, is the most common form. People can develop type 2 diabetes at any age, even during childhood. This form of diabetes usually begins with insulin resistance, a condition in which muscle, liver, and fat cells do not use insulin properly. As a result, the body needs more insulin to help glucose enter cells to be used for energy. At first, the pancreas keeps up with the added demand by producing more insulin. In time, however, the pancreas loses its ability to secrete enough insulin in response to meals.
- Gestational diabetes is diabetes that first occurs during pregnancy. When women are pregnant, their need for insulin appears to increase, and many can develop gestational diabetes during the late stages of pregnancy. Although this form of diabetes usually goes away after the baby is born, a woman who has had it is more likely to develop type 2 diabetes later in life.

Other Types of Diabetes

A number of other types of diabetes exist. A person may exhibit characteristics of more than one type. For example, in latent autoimmune diabetes in adults (LADA), also called type 1.5 diabetes or double diabetes, people show signs of both type 1 and type 2 diabetes. Diagnosis usually occurs after age 30.

Most people with LADA still produce their own insulin when first diagnosed, like those with type 2 diabetes, but within a few years, they must take insulin to control blood glucose levels. In LADA, as in type 1 diabetes, the beta cells of the pancreas stop making insulin because the body's immune system attacks and destroys them. Some experts believe that LADA is a slowly developing kind of type 1 diabetes.

Other types of diabetes include those caused by

- genetic defects of the beta cell, such as maturity-onset diabetes of the young (MODY) and neonatal diabetes mellitus
- genetic defects in insulin action, resulting in the body's inability to control blood glucose levels, as seen in leprechaunism and the Rabson-Mendenhall syndrome
- diseases of the pancreas or conditions that damage the pancreas, such as pancreatitis and cystic fibrosis
- excess amounts of certain hormones resulting from some medical conditions—such as cortisol in Cushing's syndrome—that work against the action of insulin
- medications that reduce insulin action, such as glucocorticoids, or chemicals that destroy beta cells
- infections, such as congenital rubella and cytomegalovirus
- rare autoimmune disorders, such as stiff-man syndrome, an autoimmune disease of the central nervous system
- genetic syndromes associated with diabetes, such as Down syndrome and Prader-Willi syndrome

More information about MODY and neonatal diabetes mellitus is in the National Diabetes Information Clearinghouse's fact sheet *Monogenic Forms of Diabetes: Neonatal Diabetes Mellitus and Maturity-onset Diabetes of the Young*. The fact sheet is available at *www.diabetes.niddk.nih.gov* or by calling 1–800–860–8747.

Type 1 and Type 2 Diabetes

In 1997, to move away from naming the two main types of diabetes based on treatment or the age at onset, an American Diabetes Association expert committee recommended universal adoption of simplified terminology. The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) agrees.

Former Name	Preferred Name
Type I juvenile diabetes insulin-dependent diabetes mellitus IDDM	type 1 diabetes
Type II adult-onset diabetes noninsulin-dependent diabetes mellitus NIDDM	type 2 diabetes

What is pre-diabetes?

In pre-diabetes, blood glucose levels are higher than normal but not high enough for a diagnosis of diabetes. However, many people with pre-diabetes develop type 2 diabetes within 10 years. Experts disagree about the specific blood glucose level they should use to diagnose diabetes, and through the years, that number has changed. Individuals with pre-diabetes have an increased risk of heart disease and stroke. With modest weight loss and moderate physical activity, people with pre-diabetes can delay or prevent type 2 diabetes.

How are diabetes and pre-diabetes diagnosed?

The following tests are used for diagnosis:

- A **fasting plasma glucose (FPG) test** measures blood glucose in a person who has not eaten anything for at least 8 hours. This test is used to detect diabetes and pre-diabetes.
- An **oral glucose tolerance test (OGTT)** measures blood glucose after a person fasts at least 8 hours and 2 hours after the person drinks a glucose-containing beverage. This test can be used to diagnose diabetes and pre-diabetes.
- A **random plasma glucose test**, also called a casual plasma glucose test, measures blood glucose without regard to when the person being tested last ate. This test, along with an assessment of symptoms, is used to diagnose diabetes but not pre-diabetes.

Test results indicating that a person has diabetes should be confirmed with a second test on a different day.

FPG Test

The FPG test is the preferred test for diagnosing diabetes because of its convenience and low cost. However, it will miss some diabetes or pre-diabetes that can be found with the OGTT. The FPG test is most reliable when done in the morning. Results and their meaning are shown in Table 1. People with a fasting glucose level of 100 to 125 milligrams per deciliter (mg/dL) have a form of pre-diabetes called impaired fasting glucose (IFG). Having IFG means a person has an increased risk of developing type 2 diabetes but does not have it yet. A level of 126 mg/dL or above, confirmed by repeating the test on another day, means a person has diabetes.

Table 1. FPG test

Plasma Glucose Result (mg/dL)	Diagnosis
99 or below	Normal
100 to 125	Pre-diabetes (impaired fasting glucose)
126 or above	Diabetes*

*Confirmed by repeating the test on a different day.

OGTT

Research has shown that the OGTT is more sensitive than the FPG test for diagnosing pre-diabetes, but it is less convenient to administer. The OGTT requires fasting for at least 8 hours before the test. The plasma glucose level is measured immediately before and 2 hours after a person drinks a liquid containing 75 grams of glucose dissolved in water. Results and their meaning are shown in Table 2. If the blood glucose level is between 140 and 199 mg/dL 2 hours after drinking the liquid, the person has a form of pre-diabetes called impaired glucose tolerance (IGT). Having IGT, like having IFG, means a person has an increased risk of developing type 2 diabetes but does not have it yet. A 2-hour glucose level of 200 mg/dL or above, confirmed by repeating the test on another day, means a person has diabetes.

Table 2. OGTT

2-hour Plasma Glucose Result (mg/dL)	Diagnosis
139 or below	Normal
140 to 199	Pre-diabetes (impaired glucose tolerance)
200 or above	Diabetes*

*Confirmed by repeating the test on a different day.

Gestational diabetes is also diagnosed based on plasma glucose values measured during the OGTT, preferably by using 100 grams of glucose in liquid for the test. Blood glucose levels are checked four times during the test. If blood glucose levels are above normal at least twice during the test, the woman has gestational diabetes. Table 3 shows the above-normal results for the OGTT for gestational diabetes.

Table 3. Gestational diabetes: Above-normal results for the OGTT*

When	Plasma Glucose Result (mg/dL)
Fasting	95 or higher
At 1 hour	180 or higher
At 2 hours	155 or higher
At 3 hours	140 or higher

Note: Some laboratories use other numbers for this test.

*These numbers are for a test using a drink with 100 grams of glucose.

Additional information about the diagnosis and treatment of gestational diabetes is in the publication *What I need to know about Gestational Diabetes*. This publication is available at *www.diabetes.niddk.nih.gov* or by calling 1–800–860–8747.

Random Plasma Glucose Test

A random, or casual, blood glucose level of 200 mg/dL or higher, plus the presence of the following symptoms, can mean a person has diabetes:

- increased urination
- increased thirst
- unexplained weight loss

Other symptoms can include fatigue, blurred vision, increased hunger, and sores that do not heal. The doctor will check the person's blood glucose level on another day using the FPG test or the OGTT to confirm the diagnosis.

Who should be tested for diabetes and pre-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. The chart on page 8 can be used to find out whether someone is normal weight, overweight, obese, or extremely obese.

People aged 45 or older should consider getting tested for pre-diabetes or diabetes. People younger than 45 should consider testing if they are overweight, obese, or extremely obese and have one or more of the following risk factors:

- being physically inactive
- having a parent, brother, or sister 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
- having high blood pressure—140/90 mmHg 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 IFG or IGT on previous testing
- having a condition called acanthosis nigricans, characterized by a dark, velvety rash around the neck or armpits
- having a history of cardiovascular disease—disease affecting the heart and blood vessels

If results of testing are normal, testing should be repeated at least every 3 years. Doctors may recommend more frequent testing depending on initial results and risk status. People whose test results indicate they have pre-diabetes should have their blood glucose checked again in 1 to 2 years and take steps to prevent type 2 diabetes.

When a woman is pregnant, the doctor will assess her risk for developing gestational diabetes at her first prenatal visit and order testing as needed during the pregnancy. Women who develop gestational diabetes should also have follow-up testing 6 to 12 weeks after the baby is born.

Type 2 diabetes has become more common in children and teens than in the past, and those at high risk for developing diabetes should be tested every 2 years. Testing should begin at age 10 or at puberty, whichever occurs first. Children and teens who are overweight or obese and have other risk factors, such as a family history of diabetes, are at high risk for developing diabetes.

Body Mass Index (BMI)

BMI is a measurement of body weight relative to height. Adults aged 20 or older can use the BMI Table on page 8 to find out whether they are normal weight, overweight, obese, or extremely obese. To use the table,

- find the adult's height in the left-hand column
- move across the row to the number closest to that person's weight
- find 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 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, height, weight, and sex. The Centers for Disease Control and Prevention (CDC) has information about BMI in children and teens, including a BMI calculator, at *www.cdc.gov/nccdphp/dnpa/bmi*. The CDC website also has a BMI calculator for adults.

Body Mass Index Table

	Normal						Overweight					Obese										Extreme Obesity																			
BMI	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Height (inches)	**Body Weight (pounds)**																																			
58	91	96	100	105	110	115	119	124	129	134	138	143	148	153	158	162	167	172	177	181	186	191	196	201	205	210	215	220	224	229	234	239	244	248	253	258
59	94	99	104	109	114	119	124	128	133	138	143	148	153	158	163	168	173	178	183	188	193	198	203	208	212	217	222	227	232	237	242	247	252	257	262	267
60	97	102	107	112	118	123	128	133	138	143	148	153	158	163	168	174	179	184	189	194	199	204	209	215	220	225	230	235	240	245	250	255	261	266	271	276
61	100	106	111	116	122	127	132	137	143	148	153	158	164	169	174	180	185	190	195	201	206	211	217	222	227	232	238	243	248	254	259	264	269	275	280	285
62	104	109	115	120	126	131	136	142	147	153	158	164	169	175	180	186	191	196	202	207	213	218	224	229	235	240	246	251	256	262	267	273	278	284	289	295
63	107	113	118	124	130	135	141	146	152	158	163	169	175	180	186	191	197	203	208	214	220	225	231	237	242	248	254	259	265	270	278	282	287	293	299	304
64	110	116	122	128	134	140	145	151	157	163	169	174	180	186	192	197	204	209	215	221	227	232	238	244	250	256	262	267	273	279	285	291	296	302	308	314
65	114	120	126	132	138	144	150	156	162	168	174	180	186	192	198	204	210	216	222	228	234	240	246	252	258	264	270	276	282	288	294	300	306	312	318	324
66	118	124	130	136	142	148	155	161	167	173	179	186	192	198	204	210	216	223	229	235	241	247	253	260	266	272	278	284	291	297	303	309	315	322	328	334
67	121	127	134	140	146	153	159	166	172	178	185	191	198	204	211	217	223	230	236	242	249	255	261	268	274	280	287	293	299	306	312	319	325	331	338	344
68	125	131	138	144	151	158	164	171	177	184	190	197	203	210	216	223	230	236	243	249	256	262	269	276	282	289	295	302	308	315	322	328	335	341	348	354
69	128	135	142	149	155	162	169	176	182	189	196	203	209	216	223	230	236	243	250	257	263	270	277	284	291	297	304	311	318	324	331	338	345	351	358	365
70	132	139	146	153	160	167	174	181	188	195	202	209	216	222	229	236	243	250	257	264	271	278	285	292	299	306	313	320	327	334	341	348	355	362	369	376
71	136	143	150	157	165	172	179	186	193	200	208	215	222	229	236	243	250	257	265	272	279	286	293	301	308	315	322	329	338	343	351	358	365	372	379	386
72	140	147	154	162	169	177	184	191	199	206	213	221	228	235	242	250	258	265	272	279	287	294	302	309	316	324	331	338	346	353	361	368	375	383	390	397
73	144	151	159	166	174	182	189	197	204	212	219	227	235	242	250	257	265	272	280	288	295	302	310	318	325	333	340	348	355	363	371	378	386	393	401	408
74	148	155	163	171	179	186	194	202	210	218	225	233	241	249	256	264	272	280	287	295	303	311	319	326	334	342	350	358	365	373	381	389	396	404	412	420
75	152	160	168	176	184	192	200	208	216	224	232	240	248	256	264	272	279	287	295	303	311	319	327	335	343	351	359	367	375	383	391	399	407	415	423	431
76	156	164	172	180	189	197	205	213	221	230	238	246	254	263	271	279	287	295	304	312	320	328	336	344	353	361	369	377	385	394	402	410	418	426	435	443

Source: Adapted from *Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults: The Evidence Report*, National Institutes of Health, 1998.

In addition to weight, the location of excess fat on the body can be important. A waist measurement of 40 inches or more for men or 35 inches or more for women is linked to insulin resistance and increases a person's risk for type 2 diabetes.

What steps can delay or prevent type 2 diabetes?

A major research study, the Diabetes Prevention Program (DPP), confirmed that people with IGT—pre-diabetes—were able to sharply reduce their risk of developing diabetes during the study by losing 5 to 7 percent of their body weight through dietary changes and increased physical activity. Study participants followed a low-fat, low-calorie diet and engaged in regular physical activity, such as walking briskly for 30 minutes, five times a week. These strategies worked well for both men and women and were especially effective for participants aged 60 and older.

More information about insulin resistance, the DPP, or how to lower risk for type 2 diabetes is available in the following publications:

- *Insulin Resistance and Pre-diabetes*
- *Diabetes Prevention Program (DPP)*
- *Am I at Risk for Type 2 Diabetes?*

These publications are available at *www.diabetes.niddk.nih.gov* or by calling 1–800–860–8747.

The National Diabetes Education Program (NDEP) offers several booklets as part of its Small Steps, Big Rewards campaign on preventing type 2 diabetes, including information about setting goals, tracking progress, implementing a walking program, and finding additional resources. These materials are available at *www.ndep.nih.gov* or by calling the NDEP at 1–888–693–NDEP (6337).

How is diabetes managed?

People with diabetes can manage it with meal planning, physical activity, and, if needed, medications. Additional information about taking care of type 1 or type 2 diabetes is available in the publication *Your Guide to Diabetes: Type 1 and Type 2*. This publication is available at *www.diabetes.niddk.nih.gov* or by calling 1–800–860–8747.

Points to Remember

- Diabetes, pre-diabetes, and gestational diabetes are diagnosed by checking blood glucose levels.
- Tests used for diagnosing diabetes and pre-diabetes include the fasting plasma glucose (FPG) test and the oral glucose tolerance test (OGTT).
- People aged 45 or older should consider getting tested for pre-diabetes or diabetes. People younger than 45 who are overweight, obese, or extremely obese and have one or more additional risk factors for diabetes should consider testing.
- Many people with pre-diabetes develop type 2 diabetes within 10 years.
- People with pre-diabetes can delay or prevent type 2 diabetes by losing a modest amount of weight through regular physical activity and a diet low in fat and calories.

Hope through Research

The NIDDK conducts and supports research related to the causes, treatment, and prevention of diabetes.

Participants in clinical trials can play a more active role in their own health care, gain access to new research treatments before they are widely available, and help others by contributing to medical research. For information about current studies, visit *www.ClinicalTrials.gov*.

For More Information

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Phone: 1–800–338–3633 or 312–424–2426
Diabetes Educator Access Line:
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Alexandria, VA 22311
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Juvenile Diabetes Research Foundation International
120 Wall Street
New York, NY 10005–4001
Phone: 1–800–533–CURE (2873)
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Email: info@jdrf.org
Internet: www.jdrf.org

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1 Diabetes Way
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Internet: www.ndep.nih.gov

You may also find additional information about this topic by

- searching the NIDDK Reference Collection at *www.catalog.niddk.nih.gov/resources*
- visiting MedlinePlus at *www.medlineplus.gov*

This publication may contain information about medications. When prepared, this publication included the most current information available. For updates or for questions about any medications, contact the U.S. Food and Drug Administration toll-free at 1–888–INFO–FDA (463–6332) or visit *www.fda.gov*. Consult your doctor for more information.

National Diabetes Information Clearinghouse

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The National Diabetes Information Clearinghouse (NDIC) is a service of the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). The NIDDK is part of the National Institutes of Health of the U.S. Department of Health and Human Services. Established in 1978, the Clearinghouse provides information about diabetes to people with diabetes and to their families, health care professionals, and the public. The NDIC answers inquiries, develops and distributes publications, and works closely with professional and patient organizations and Government agencies to coordinate resources about diabetes.

Publications produced by the Clearinghouse are carefully reviewed by both NIDDK scientists and outside experts. This publication was reviewed by David Harlan, M.D., NIDDK.

This fact sheet is also available at *www.diabetes.niddk.nih.gov.*

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