

## Diagnosis of Diabetes and Prediabetes

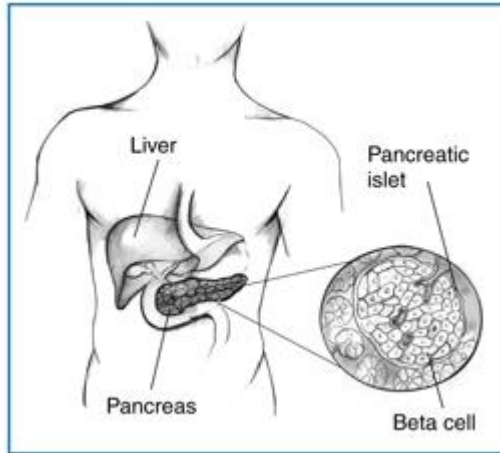
### What is diabetes?

Diabetes is a complex group of diseases with a variety of causes. People with diabetes have high blood glucose, also called high blood sugar or hyperglycemia.

Diabetes is a disorder of metabolism—the way the body uses digested food for energy. The digestive tract breaks down carbohydrates—sugars and starches found in many foods—into glucose, a form of sugar that enters the bloodstream. With the help of the hormone insulin, cells throughout the body absorb glucose and use it for energy. Insulin is made in the pancreas, an organ located behind the stomach. As the blood glucose level rises after a meal, the pancreas is triggered to release insulin. Within the pancreas, clusters of cells called islets contain beta cells, which make the insulin and release it into the blood.

Diabetes develops when the body doesn't make enough insulin or is not able to use insulin effectively, or both. As a result, glucose builds up in the blood instead of being absorbed by cells in the body. The body's cells are then starved of energy despite high blood glucose levels.

Over time, high blood glucose damages nerves and blood vessels, leading to complications such as heart disease, stroke, kidney disease, blindness, dental disease, and amputations. Other complications of diabetes may include increased susceptibility to other diseases, loss of mobility with aging, depression, and pregnancy problems.



Islets within the pancreas contain beta cells, which make insulin and release it into the blood.

## Main Types of Diabetes

The three main types of diabetes are type 1, type 2, and gestational diabetes:

- **Type 1 diabetes**, formerly called juvenile diabetes, is usually first diagnosed in children, teenagers, and young adults. In this type of diabetes, the beta cells of the pancreas no longer make insulin because the body's immune system has attacked and destroyed them.
- **Type 2 diabetes**, formerly called adult-onset diabetes, is the most common type of diabetes. About 90 to 95 percent of people with diabetes have type 2.<sup>1</sup> People can develop type 2 diabetes at any age, even during childhood, but this type of diabetes is most often associated with older age. Type 2 diabetes is also associated with excess weight, physical inactivity, family history of diabetes, previous history of gestational diabetes, and certain ethnicities.

Type 2 diabetes usually begins with insulin resistance, a condition linked to excess weight 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. But in time, the pancreas loses its ability to produce enough insulin in response to meals, and blood glucose levels rise.

- **Gestational diabetes** is a type of diabetes that develops only during pregnancy.

The hormones produced during pregnancy increase the amount of insulin needed to control blood glucose levels. If the body can't meet this increased need for insulin, women can develop gestational diabetes during the late stages of pregnancy.

Gestational diabetes usually goes away after the baby is born. Shortly after pregnancy, 5 to 10 percent of women with gestational diabetes continue to have high blood glucose levels and are diagnosed as having diabetes, usually type 2.<sup>1</sup> Research has shown that lifestyle changes and the diabetes medication, metformin, can reduce or delay the risk of type 2 diabetes in these women. Babies born to mothers who had gestational diabetes are also more likely to develop obesity and type 2 diabetes as they grow up.

More information about gestational diabetes is available in the booklet *What I need to know about Gestational Diabetes*, available online from the National Diabetes Information Clearinghouse (NDIC) at [www.diabetes.niddk.nih.gov](http://www.diabetes.niddk.nih.gov) or by calling 1-800-860-8747.

<sup>1</sup> National diabetes statistics report, 2014. Centers for Disease Control and Prevention website. [www.cdc.gov/diabetes/pubs/statsreport14.htm](http://www.cdc.gov/diabetes/pubs/statsreport14.htm). Updated June 13,

2014. Accessed June 16, 2014.

## Other Types of Diabetes

Many other types of diabetes exist, and a person can exhibit characteristics of more than one type. For example, in latent autoimmune diabetes in adults, people show signs of both type 1 and type 2 diabetes. Other types of diabetes include those caused by genetic defects, diseases of the pancreas, excess amounts of certain hormones resulting from some medical conditions, medications that reduce insulin action, chemicals that destroy beta cells, infections, rare autoimmune disorders, and genetic syndromes associated with diabetes.

For more information about other types of diabetes, see the NDIC fact sheet *Causes of Diabetes*, available at [www.diabetes.niddk.nih.gov](http://www.diabetes.niddk.nih.gov) or by calling 1–800–860–8747.

## What is prediabetes?

Prediabetes is when blood glucose levels are higher than normal but not high enough for a diagnosis of diabetes. Prediabetes means a person is at increased risk for developing type 2 diabetes, as well as for heart disease and stroke. Many people with prediabetes develop type 2 diabetes within 10 years.

However, modest weight loss and moderate physical activity can help people with prediabetes delay or prevent type 2 diabetes.



## How are diabetes and prediabetes diagnosed?

Blood tests are used to diagnosis diabetes and prediabetes because early in the disease type 2 diabetes may have no symptoms. All diabetes blood tests involve drawing blood at a health care provider's office or commercial facility and sending the sample to a lab for analysis. Lab analysis of blood is needed to ensure test results are accurate. Glucose measuring devices used in a health care provider's office, such as finger-stick devices, are not accurate enough for diagnosis but may be used as a quick indicator of high blood glucose.

Testing enables health care providers to find and treat diabetes before complications occur and to find and treat prediabetes, which can delay or prevent type 2 diabetes from developing.

Any one of the following tests can be used for diagnosis:\*

- an **A1C** test, also called the hemoglobin A1c, HbA1c, or glycohemoglobin test
- a **fasting plasma glucose (FPG)** test
- an **oral glucose tolerance test (OGTT)**

\*Not all tests are recommended for diagnosing all types of diabetes. See the individual test descriptions for details.

Another blood test, the random plasma glucose (RPG) test, is sometimes used to diagnose diabetes during a regular health checkup. If the RPG measures 200 micrograms per deciliter or above, and the individual also shows symptoms of diabetes, then a health care provider may diagnose diabetes.

Symptoms of diabetes include

- increased urination
- increased thirst
- unexplained weight loss

Other symptoms can include fatigue, blurred vision, increased hunger, and sores that do not heal.

Any test used to diagnose diabetes requires confirmation with a second measurement unless clear symptoms of diabetes exist.

The following table provides the blood test levels for diagnosis of diabetes for nonpregnant adults and diagnosis of prediabetes.

**Blood Test Levels for Diagnosis of Diabetes and Prediabetes**

	A1C (percent)	Fasting Plasma Glucose (mg/dL)	Oral Glucose Tolerance Test (mg/dL)
<b>Diabetes</b>	6.5 or above	126 or above	200 or above
<b>Prediabetes</b>	5.7 to 6.4	100 to 125	140 to 199
<b>Normal</b>	About 5	99 or below	139 or below

Definitions: mg = milligram, dL = deciliter  
 For all three tests, within the prediabetes range, the higher the test result, the greater the risk of diabetes.

Source: Adapted from American Diabetes Association. Standards of medical care in diabetes—2012. *Diabetes Care*. 2012;35(Supp 1):S12, table 2.

## A1C Test

The A1C test is used to detect type 2 diabetes and prediabetes but is not recommended for diagnosis of type 1 diabetes or gestational diabetes. The A1C test is a blood test that reflects the average of a person’s blood glucose levels over the past 3 months and does not show daily fluctuations. The A1C test is more convenient for patients than the traditional glucose tests because it does not require fasting and can be performed at any time of the day.

The A1C test result is reported as a percentage. The higher the percentage, the higher a person’s blood glucose levels have been. A normal A1C level is below 5.7 percent.

An A1C of 5.7 to 6.4 percent indicates prediabetes. People diagnosed with prediabetes may be retested in 1 year. People with an A1C below 5.7 percent may still be at risk for diabetes, depending on the presence of other characteristics that put them at risk, also known as risk factors. People with an A1C above 6.0 percent should be considered at very high risk of developing diabetes. A level of 6.5 percent or above means a person has diabetes.

**Laboratory analysis.** When the A1C test is used for diagnosis, the blood sample must be sent to a laboratory using a method that is certified by the NGSP to ensure the results are standardized. Blood samples analyzed in a health care provider's office, known as point-of-care tests, are not standardized for diagnosing diabetes.

**Abnormal results.** The A1C test can be unreliable for diagnosing or monitoring diabetes in people with certain conditions known to interfere with the results. Interference should be suspected when A1C results seem very different from the results of a blood glucose test. People of African, Mediterranean, or Southeast Asian descent or people with family members with sickle cell anemia or a thalassemia are particularly at risk of interference.

However, not all of the A1C tests are unreliable for people with these diseases. The NGSP provides information about which A1C tests are appropriate to use for specific types of interference and details on any problems with the A1C test at [www.ngsp.org](http://www.ngsp.org).

False A1C test results may also occur in people with other problems that affect their blood or hemoglobin such as chronic kidney disease, liver disease, or anemia.

More information about limitations of the A1C test and different forms of sickle cell anemia is available in the NDIC booklet *For People of African, Mediterranean, or Southeast Asian Heritage: Important Information about Diabetes Blood Tests*, available at [www.diabetes.niddk.nih.gov](http://www.diabetes.niddk.nih.gov) or by calling 1–800–860–8747.

## Changes in Diagnostic Testing

In the past, the A1C test was used to monitor blood glucose levels but not for diagnosis. The A1C test has now been standardized, and in 2009, an international expert committee recommended it be used for diagnosis of type 2 diabetes and prediabetes.<sup>2</sup>

More information about the A1C test is available in the NDIC fact sheet *The A1C Test and Diabetes*, available at [www.diabetes.niddk.nih.gov](http://www.diabetes.niddk.nih.gov) or by calling 1–800–860–8747.

<sup>2</sup>

The International Expert Committee. International Expert Committee report on the role of the A1C assay in the diagnosis of diabetes. *Diabetes Care*.

2009;32(7):1327–1334.

## Fasting Plasma Glucose Test

The FPG test is used to detect diabetes and prediabetes. The FPG test has been the most common test used for diagnosing diabetes because it is more convenient than the OGTT and less expensive. The FPG test measures blood glucose in a person who has fasted for at least 8 hours and is most reliable when given in the morning.

People with a fasting glucose level of 100 to 125 mg/dL have impaired fasting glucose (IFG), or prediabetes. A level of 126 mg/dL or above, confirmed by repeating the test on another day, means a person has diabetes.

### **Oral Glucose Tolerance Test**

The OGTT can be used to diagnose diabetes, prediabetes, and gestational diabetes. Research has shown that the OGTT is more sensitive than the FPG test, but it is less convenient to administer. When used to test for diabetes or prediabetes, the OGTT measures blood glucose after a person fasts for at least 8 hours and 2 hours after the person drinks a liquid containing 75 grams of glucose dissolved in water.

If the 2-hour blood glucose level is between 140 and 199 mg/dL, the person has a type of prediabetes called impaired glucose tolerance (IGT). If confirmed by a second test, a 2-hour glucose level of 200 mg/dL or above means a person has diabetes.

### **Are diabetes blood test results always accurate?**

All laboratory test results can vary from day to day and from test to test. Results can vary

- **within the person being tested.** A person's blood glucose levels normally move up and down depending on meals, exercise, sickness, and stress.
- **between different tests.** Each test measures blood glucose levels in a different way.
- **within the same test.** Even when the same blood sample is repeatedly measured in the same laboratory, the results may vary due to small changes in temperature, equipment, or sample handling.



Although all these tests can be used to indicate diabetes, in some people one test will indicate a diagnosis of diabetes when another test does not. People with differing test results may be in an early stage of the disease, where blood glucose levels have not risen high enough to show on every test.

Health care providers take all these variations into account when considering test results and repeat laboratory tests for confirmation. Diabetes develops over time, so even with variations in test results, health care providers can tell when overall blood glucose levels are becoming too high.

More information about variation among diabetes blood test results is available in the NDIC publication *The A1C Test and Diabetes*, available at [www.diabetes.niddk.nih.gov](http://www.diabetes.niddk.nih.gov) or by calling 1-800-860-8747.

## **Diagnosis of Gestational Diabetes**

Health care providers test for gestational diabetes using the OGTT. Women may be tested during their first visit to the health care provider after becoming pregnant or between 24 to 28 weeks of pregnancy depending on their risk factors and symptoms. Women found to have diabetes at the first visit to the health care provider after becoming pregnant may be diagnosed with type 2 diabetes.

## **Defining Safe Blood Glucose Levels for Pregnancy**

Many studies have shown that gestational diabetes can cause complications for the mother and baby. An international, multicenter study, the Hyperglycemia and Adverse Pregnancy Outcome (HAPO) study, showed that the higher a pregnant woman's blood glucose is, the higher her risk of pregnancy complications. The HAPO researchers found that pregnancy complications can occur at blood glucose levels that were once considered to be normal.

Based on the results of the HAPO study, new guidelines for diagnosis of gestational diabetes were recommended by the International Association of the Diabetes and Pregnancy Study Groups in 2011. So far, the new guidelines have been adopted by the American Diabetes Association (ADA)<sup>3</sup> but not by the American College of Obstetricians

and Gynecologists (ACOG)<sup>4</sup> or other medical organizations. Researchers estimate these new guidelines, if widely adopted, will increase the proportion of pregnant women diagnosed with gestational diabetes to nearly 18 percent.<sup>5</sup>

Both ADA and ACOG guidelines for using the OGTT in diagnosing gestational diabetes are shown in the following tables.

<sup>3</sup> American Diabetes Association. Standards of medical care in diabetes—2012. *Diabetes Care*. 2012;35(Supp 1):S11–S63.

<sup>4</sup> Committee on Obstetric Practice, Committee Opinion No. 504, American College of Obstetricians and Gynecologists. Screening and diagnosis of gestational diabetes mellitus. *Obstetrics and Gynecology*. 2011;118:751–753.

<sup>5</sup> International Association of Diabetes and Pregnancy Study Groups Consensus Panel. International association of diabetes and pregnancy study groups recommendations on the diagnosis and classification of hyperglycemia in pregnancy. *Diabetes Care*. 2010;33:676–682.

### Recommendations for Testing Pregnant Women for Diabetes

Time of testing	ACOG	ADA
At first visit during pregnancy	No recommendation	<p>Test women with risk factors for diabetes using standard testing for diagnosis of type 2 diabetes.</p> <p>Women found to have diabetes at this time should be diagnosed with type 2 diabetes, not gestational diabetes.</p>
At 24 to 28 weeks of pregnancy	<p>Test women for diabetes based on their history, risk factors, or a 50-gram, 1-hour, nonfasting, glucose challenge test—a modified OGTT.</p> <p>If score is 130–140 mg/dL, test again with fasting, 100-gram, 3-hour OGTT.*</p>	Test all women for diabetes who are not already diagnosed, using a fasting, 75-gram, 2-hour OGTT.*

\*See “OGTT Levels for Diagnosis of Gestational Diabetes” for blood glucose levels.

## OGTT Levels for Diagnosis of Gestational Diabetes

Time of Sample Collection	ACOG Levels <sup>**</sup> ,4 (mg/dL)	ADA Levels <sup>3</sup> (mg/dL)
	100-gram Glucose Drink	75-gram Glucose Drink
Fasting, before drinking glucose	95 or above	92 or above
1 hour after drinking glucose	180 or above	180 or above
2 hours after drinking glucose	155 or above	153 or above
3 hours after drinking glucose	140 or above	Not used
Requirements for Diagnosis	TWO or more of the above levels must be met	ONE or more of the above levels must be met

<sup>\*\*</sup>Carpenter and Coustan Conversion, some labs use different numbers.

More information about treating gestational diabetes is available in the NDIC publication *What I need to know about Gestational Diabetes*, available at [www.diabetes.niddk.nih.gov](http://www.diabetes.niddk.nih.gov) or by calling 1–800–860–8747.

### Who should be tested for diabetes and prediabetes?

Adults, pregnant women, children, and teens should be tested for diabetes and prediabetes according to their risk factors.

#### Adults

Anyone age 45 or older should consider getting tested for diabetes or prediabetes. Testing is strongly recommended for people older than age 45 who are overweight or obese. People younger than 45 should consider testing if they are overweight or obese<sup>\*\*\*</sup> and have one or more of the following risk factors:

- physical inactivity
- parent, brother, or sister with diabetes
- family background that is African American, Alaska Native, American Indian, Asian American, Hispanic/Latino, or Pacific Islander American
- history of giving birth to at least one baby weighing more than 9 pounds
- history of gestational diabetes
- high blood pressure—140/90 mmHg or higher—or being diagnosed with high blood pressure
- high-density lipoprotein, or HDL, cholesterol—“good” cholesterol—level below 35 mg/dL or a triglyceride level above 250 mg/dL
- polycystic ovary syndrome, also called PCOS
- prediabetes—an A1C level of 5.7 to 6.4 percent; an FPG test result of 100–125 mg/dL, indicating IFG; or a 2-hour OGTT result of 140–199 mg/dL, indicating IGT
- acanthosis nigricans, a condition associated with insulin resistance and characterized by a dark, velvety rash around the neck or armpits
- history of cardiovascular disease—disease affecting the heart and blood vessels

\*\*\*[The “Body Mass Index” chart](#) (PDF, 70 KB) \* can be used to find out whether someone is normal weight, overweight, or obese.

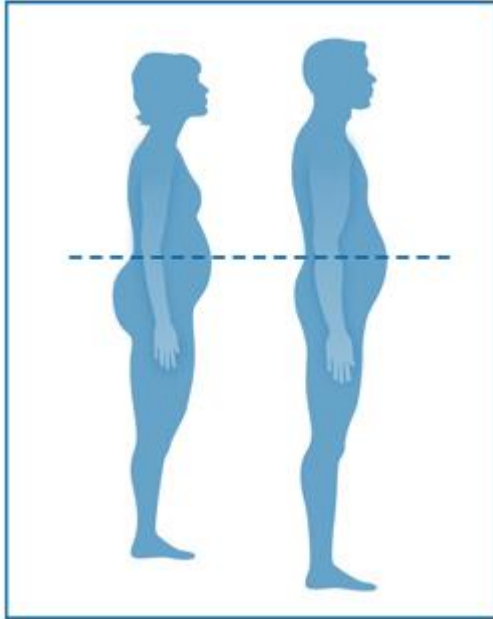
In addition to weight, the location of excess fat on the body can be important. A waist measurement of 40 inches or more for men and 35 inches or more for women is linked to insulin resistance and increases a person’s risk for type 2 diabetes. This is true even if a person’s body mass index (BMI) falls within the normal range.

### **How to Measure the Waist**

To measure the waist, a person should

- place a tape measure around the bare abdomen just above the hip bone

- make sure the tape is snug but isn't digging into the skin and is parallel to the floor
- relax, exhale, and measure



Source: [www.cdc.gov](http://www.cdc.gov)

If results of testing 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. People whose test results indicate they have prediabetes may be tested again in 1 year and should take steps to prevent or delay type 2 diabetes.

### **Pregnant Women**

All pregnant women with risk factors for type 2 diabetes should be tested using standard diabetes blood tests during their first visit to the health care provider during pregnancy to see if they had undiagnosed diabetes before becoming pregnant. After that, pregnant women should be tested for gestational diabetes between 24 and 28 weeks of their pregnancy using the OGTT.

Women who develop gestational diabetes should also have follow-up testing 6 to 12 weeks after the baby is born to find out if they have type 2 diabetes or prediabetes. If results of testing are normal, testing should be repeated at least every 3 years. Blood

glucose tests, rather than the A1C test, should be used for testing within 12 weeks of delivery.

## **Children and Teens**

Type 2 diabetes has become increasingly common in children and teens. Children are at high risk for developing type 2 diabetes and should be tested if they are

- overweight or obese and have other risk factors, such as a family history of diabetes
- older than age 10 or have already gone through puberty

## **Body Mass Index (BMI)**

Body mass index is a measurement of body weight relative to height for adults age 20 or older. To use the chart

- find the person's height in the left-hand column
- move across the row to find the number closest to the 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, or obese. People who are overweight or obese should consider talking with a health care provider about ways to lose weight and reduce the risk of diabetes.

The BMI has certain limitations. The BMI 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.

The 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](http://www.cdc.gov/nccdphp/dnpa/bmi). The CDC website also has a BMI calculator for adults.

A BMI calculator from the National Institutes of Health (NIH) is available at [www.nhlbi.nih.gov/guidelines/obesity/BMI/bmicalc.htm](http://www.nhlbi.nih.gov/guidelines/obesity/BMI/bmicalc.htm). The NIH also has a free smartphone app for calculating BMI. People can search “My BMI Calculator” on their phone to find the app. The app also provides links to information about steps people can take to bring their BMI into a healthy range.

### Body Mass Index Table

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

Table 2 of 2

	Obese				Extreme Obesity															
BMI	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	172	177	181	186	191	196	201	205	210	215	220	224	229	234	239	244	248	253	258	
59	178	183	188	193	198	203	208	212	217	222	227	232	237	242	247	252	257	262	267	
60	184	189	194	199	204	209	214	219	224	229	234	239	244	249	254	259	264	269	274	
61	190	195	200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	
62	196	201	206	211	216	221	226	231	236	241	246	251	256	261	266	271	276	281	286	
63	202	207	212	217	222	227	232	237	242	247	252	257	262	267	272	277	282	287	292	
64	208	213	218	223	228	233	238	243	248	253	258	263	268	273	278	283	288	293	298	
65	214	219	224	229	234	239	244	249	254	259	264	269	274	279	284	289	294	299	304	
66	220	225	230	235	240	245	250	255	260	265	270	275	280	285	290	295	300	305	310	
67	226	231	236	241	246	251	256	261	266	271	276	281	286	291	296	301	306	311	316	
68	232	237	242	247	252	257	262	267	272	277	282	287	292	297	302	307	312	317	322	
69	238	243	248	253	258	263	268	273	278	283	288	293	298	303	308	313	318	323	328	
70	244	249	254	259	264	269	274	279	284	289	294	299	304	309	314	319	324	329	334	
71	250	255	260	265	270	275	280	285	290	295	300	305	310	315	320	325	330	335	340	
72	256	261	266	271	276	281	286	291	296	301	306	311	316	321	326	331	336	341	346	
73	262	267	272	277	282	287	292	297	302	307	312	317	322	327	332	337	342	347	352	
74	268	273	278	283	288	293	298	303	308	313	318	323	328	333	338	343	348	353	358	



Table 2 of 2																			
	Obese				Extreme Obesity														
BMI	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Height (inches)	Body Weight (pounds)																		
75	28 7	29 5	30 3	31 1	31 9	32 7	33 5	34 3	35 1	35 9	36 7	37 5	38 3	39 1	39 9	40 7	41 5	42 3	43 1
76	29 5	30 4	31 2	32 0	32 8	33 6	34 4	35 3	36 1	36 9	37 7	38 5	39 4	40 2	41 0	41 8	42 6	43 5	44 3

For a printer-friendly version of this table, use the [pdf](#). (PDF, 70 KB)\*

## What steps can delay or prevent type 2 diabetes?


A major research study, the Diabetes Prevention Program (DPP), proved that people with prediabetes 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 five times a week for 30 minutes. These strategies worked well for both men and women in all racial and ethnic groups, but were especially effective for participants age 60 and older. A follow-up study, the Diabetes Prevention Program Outcomes Study (DPPOS), showed losing weight and being physically active provide lasting results. Ten years after the DPP, modest weight loss delayed onset of type 2 diabetes by an average of 4 years.

The diabetes medication metformin also lowers the risk of type 2 diabetes in people with prediabetes, especially those who are younger and heavier and women who have had gestational diabetes. The DPPOS showed that metformin delayed type 2 diabetes by 2 years. People at high risk should ask their health care provider if they should take metformin to prevent type 2 diabetes. Metformin is a medication that makes insulin work better and can reduce the risk of type 2 diabetes.

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

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

These publications are available at [www.diabetes.niddk.nih.gov](http://www.diabetes.niddk.nih.gov) or by calling 1–800–860–8747. Additional information about the DPP, funded under NIH clinical trial number NCT00004992, and the DPPOS, funded under NIH clinical trial number NCT00038727, can be found at [www.bsc.gwu.edu/dpp](http://www.bsc.gwu.edu/dpp) .

As part of its Small Steps, Big Rewards campaign, the National Diabetes Education Program (NDEP) offers several booklets about 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](http://www.ndep.nih.gov) or by calling the NDEP at 1–888–693–NDEP (1–888–693–6337).

## How is diabetes managed?

People can manage their diabetes 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 publications

- *What I need to know about Diabetes Medicines*
- *What I need to know about Eating and Diabetes*
- *Your Guide to Diabetes: Type 1 and Type 2*

These NDIC publications are available at [www.diabetes.niddk.nih.gov](http://www.diabetes.niddk.nih.gov) or by calling 1–800–860–8747.

## Points to Remember

- Tests used for diagnosing diabetes and prediabetes include the A1C test—for type 2 diabetes and prediabetes—the fasting plasma glucose (FPG) test, and the oral glucose tolerance test (OGTT). Another blood test, the random plasma glucose (RPG) test, is sometimes used to diagnose diabetes when symptoms are present during a regular health checkup.
- Anyone age 45 or older should consider getting tested for diabetes or prediabetes. People younger than 45 should consider testing if they are overweight or obese and have one or more additional risk factors for diabetes.
- If results of testing 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.
- People whose test results indicate they have prediabetes may be tested again in 1 year and should take steps to prevent or delay type 2 diabetes.
- Many people with prediabetes develop type 2 diabetes within 10 years.
- Modest weight loss and moderate physical activity can help people with prediabetes delay or prevent type 2 diabetes.

## Hope through Research

The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) conducts and supports research related to the causes, treatment, and prevention of diabetes. The NIDDK conducts research in its own laboratories and supports a great deal of basic and clinical research in medical centers and hospitals throughout the United States. The NIDDK also gathers and analyzes statistics about diabetes. Other Institutes at the NIH conduct and support research on diabetes-related eye diseases, heart and vascular complications, autoimmunity, pregnancy, and dental problems.

The NIDDK also works collaboratively on diagnostic issues with other Government agencies that sponsor diabetes programs such as the CDC, the Indian Health Service, the Health Resources and Services Administration, the U.S. Department of Veterans Affairs, and the U.S. Department of Defense.

Clinical trials related to diabetes include

- Molecular and Clinical Profile of Diabetes Mellitus and Its Complications, funded by the NIDDK under NIH clinical trial number NCT01105858
- Diabetes and Heart Disease Risk in Blacks, funded by the NIDDK under NIH clinical trial number NCT00001853

Clinical trials are research studies involving people. Clinical trials look at safe and effective new ways to prevent, detect, or treat disease. Researchers also use clinical trials to look at other aspects of care, such as improving the quality of life for people with chronic illnesses. To learn more about clinical trials, why they matter, and how to participate, visit the NIH Clinical Research Trials and You website at [www.nih.gov/health/clinicaltrials](http://www.nih.gov/health/clinicaltrials). For information about current studies, visit [www.ClinicalTrials.gov](http://www.ClinicalTrials.gov).

## For More Information

### **American Association of Diabetes Educators**

200 West Madison Street, Suite 800

Chicago, IL 60606

Phone: 1-800-338-3633

Internet: [www.diabeteseducator.org](http://www.diabeteseducator.org) 

### **American Diabetes Association**

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Phone: 1-800-DIABETES (1-800-342-2383)

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Internet: [www.diabetes.org](http://www.diabetes.org) 

## **JDRF**

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## **Acknowledgments**

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

## **National Diabetes Education Program**

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[www.yourdiabetesinfo.org](http://www.yourdiabetesinfo.org)

The National Diabetes Education Program is a federally funded program sponsored by the U.S. Department of Health and Human Services' National Institutes of Health and the Centers for Disease Control and Prevention and includes over 200 partners at the federal, state, and local levels, working together to reduce the morbidity and mortality associated with diabetes.

You may also find additional information about this topic by visiting MedlinePlus at [www.medlineplus.gov](http://www.medlineplus.gov).

This publication may contain information about medications and, when taken as prescribed, the conditions they treat. 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 (1–888–463–6332) or visit [www.fda.gov](http://www.fda.gov). Consult your health care provider for more information.

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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.

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NIH Publication No. 14–4642

June 2014

Page last updated July 9, 2014