



## Overview of Diabetes in Children and Teens

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### ABSTRACT

Type 1 and type 2 diabetes affect about 186,000 youth under age 20. Previously considered an adult disease, type 2 diabetes is becoming increasingly common in overweight minority youth over 10 years of age. Criteria help to identify young people at risk for type 2 diabetes as well as those with the disease. Prevention or delay of type 2 requires weight loss through healthy eating, portion control and increased physical activity, along with family counseling and support. Type 1 diabetes usually has an acute onset and needs prompt diagnosis and treatment. It is important not to confuse its diagnosis with gastroenteritis. For both types of diabetes, management is determined by the family and diabetes care team depending on the child's type of diabetes and individual needs. Healthy eating and daily physical activity are key components. For those using glucose lowering medications, especially insulin (which is essential for type 1 diabetes), avoiding low blood glucose is important. Careful ongoing management of diabetes contributes to well-being and the avoidance or delay of onset of the long term diabetes complications. These complications affect normal function of the eyes, nerves, kidneys and cardiovascular system. Psychological support helps youth cope with the ongoing demands of diabetes management. Educators can help ensure the child's full participation in school activities.

Kaufman FR, Gallivan JM, Warren-Boulton E. Overview of diabetes in children and teens. *Am J Health Educ.* 2009;40(5):259-263. This paper is part of a sponsored set of papers contributed through the National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health.

### STATISTICS – SCOPE OF THE DIABETES PROBLEM

Diabetes is one of the most common diseases in school-aged children. According to the National Diabetes Fact Sheet, approximately 186,300 youth in the U.S. under age 20 years had diabetes in 2007.<sup>1</sup> This figure represents 0.2% of all people in this age group. Based on data from 2002-2003, the SEARCH for Diabetes in Youth study reported that approximately 15,000 U.S. youth under 20 years of age are diagnosed annually with type 1 diabetes, and 3,700 are newly diagnosed with type 2 diabetes.<sup>2</sup> Type 2 diabetes is rare in children younger than 10 years of age, regardless of race or ethnicity.

After 10 years of age, however, type 2 diabetes becomes increasingly common, especially in minority populations, representing 14.9% of newly diagnosed cases of diabetes in non-Hispanic whites, 46.1% in Hispanic youth, 57.8% in African Americans, 69.7% in Asian/Pacific Islanders, and 86.2% in American Indian youth.<sup>2</sup>

Results from the 2005-2006 National Health and Nutrition Examination Survey (NHANES), using measured heights and weights, indicate that an estimated 16% to 17% of children and adolescents ages 2-19 years had a body mass index (BMI) greater than or equal to the 95th percentile of the age- and sex-specific BMI—about double

the number two decades ago.<sup>3</sup> Overweight and obesity in youth contribute to increas-

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ing numbers of young people who have type 2 diabetes.

## TYPES OF DIABETES

Diabetes mellitus is a group of diseases characterized by high levels of glucose in the blood resulting from defects in insulin production, insulin action, or both. Poorly managed diabetes is associated with serious complications (damage to the cardiovascular system, kidneys, eyes, nerves, blood vessels, skin, gums and teeth) and premature death. People with diabetes and their health care team can take steps to manage the disease effectively and lower the risk of complications.

### *Type 1 Diabetes*

Type 1 diabetes is an autoimmune disease in which the immune system destroys the insulin-producing beta cells of the pancreas that help regulate blood glucose levels. The immunologic process that leads to type 1 diabetes can begin years before the symptoms of type 1 diabetes develop. Type 1 diabetes mostly has an acute onset, with children and adolescents usually able to pinpoint when symptoms began. Symptoms become apparent when most of the beta-cell population is destroyed. The peak age of the diagnosis of type 1 diabetes is 12 years. Early symptoms, mainly due to high blood glucose, include increased thirst and urination, constant hunger, weight loss and blurred vision. Children also may experience fatigue. As insulin deficiency worsens, ketoacids (formed from the breakdown of fat) build up in the blood and are excreted in the urine and breath. They cause shortness of breath and abdominal pain, vomiting and worsening dehydration. Elevation of blood glucose, acidosis and dehydration comprise the condition known as diabetic ketoacidosis, or DKA. If diabetes is not diagnosed and treated with insulin at this point, the individual can lapse into a life-threatening diabetic coma. It is not uncommon for children with vomiting to be mistakenly diagnosed as having gastroenteritis. New-onset cases of diabetes can be differentiated from gastrointestinal infections by the frequent urination that accompanies continued vomiting with diabetes.

### *Type 2 Diabetes*

Often the first stage in the development of type 2 diabetes is insulin resistance, a condition requiring increasing amounts of insulin to be produced by the pancreas to control blood glucose levels. Initially, the pancreas responds by producing more insulin, but after some time, insulin production may decrease and diabetes develops. Type 2 diabetes used to occur mainly in adults who were overweight and older than 40 years. Now, as more children and adolescents in the U.S. become overweight, obese and inactive, type 2 diabetes rates are increasing, especially in children who have a family member with diabetes. Type 2 diabetes is more common in certain racial and ethnic groups such as African Americans, American Indians, Hispanic/Latino Americans and some Asian and Pacific Islander Americans. The increased incidence of type 2 diabetes in youth is a consequence of the obesity epidemic among young people, and is a significant and growing public health problem.<sup>4</sup>

Type 2 diabetes usually develops slowly and insidiously. Some youth with type 2 diabetes may show no symptoms at all when they are diagnosed, but in others, symptoms may be similar to those of type 1 diabetes:

- Feeling fatigued, thirsty, or nauseated
- Urinating often
- Experiencing weight loss, blurred vision, frequent infections, and slow healing of wounds or sores, vaginal yeast infection or burning on urination
- Experiencing severe dehydration and coma in those with extreme elevation of the blood glucose level

Conditions associated with insulin resistance include:

- Acanthosis nigricans, where the skin around the neck or in the armpits appears dark and thick, and has a velvety texture
- High blood pressure and lipid abnormalities
- Polycystic ovary syndrome in girls who have infrequent or absent periods, and excess hair and acne

Because children with type 2 diabetes are at risk for the long-term complications

of diabetes and the co-morbidities associated with insulin resistance (lipid problems and high blood pressure), it is important that the health care team identify and test children or teens who are at high risk for type 2 diabetes.

### *Gestational Diabetes*

Gestational diabetes mellitus (GDM) is a form of diabetes that is diagnosed in about 7% of all pregnancies; with an occurrence of about 200,000 per year.<sup>5</sup> It is more common among obese women, women with a family history of diabetes, and among African American, Hispanic/Latino American and American Indian women. During pregnancy, GDM must be treated to normalize maternal blood glucose levels and to avoid complications in the infant. GDM imparts a lifetime risk for type 2 diabetes to the mother, but the child also is at increased risk for obesity and diabetes compared to other children. The mother's GDM should be noted in the child's permanent medical record.

### *Pre-diabetes*

Pre-diabetes occurs when a person's blood glucose level is higher than normal but not high enough for a diagnosis of diabetes. It is important to assess high-risk youth for pre-diabetes or type 2 diabetes because timely diagnosis and treatment of type 2 diabetes can prevent or delay the onset of diabetes complications.

## DIABETES SCREENING AND DIAGNOSIS

A pre-diabetes diagnosis occurs when a fasting plasma glucose level is 100 to 125 mg per dl (5.6 to 6.9 mmol per L). A diabetes diagnosis occurs when a fasting plasma glucose levels is 126 mg per dl (7.0 mmol per L) or greater. A second confirmatory test should be repeated on a subsequent day. Note that hemoglobin A1C, an estimate of the average blood glucose over the past 2-3 months, may be used to diagnose diabetes in the near future.

### *Screening Criteria<sup>6</sup>*

Screening for the presence of type 2 diabetes should occur in children and youth who are overweight (BMI 85th to 94th per-



centile) or obese (BMI >95th percentile) for age and gender, whose weight for height is >85th percentile, or whose weight is >120% of ideal for height and who have any two of the following risk factors:

- Family history of type 2 diabetes in a first-degree or second-degree relative
- American Indian, African American, Hispanic/Latino, Asian American, or Pacific Islander heritage
- Signs of insulin resistance or conditions associated with insulin resistance (acanthosis nigricans, hypertension, dyslipidemia, polycystic ovarian syndrome)

Testing should begin at 10 years of age or at onset of puberty, if puberty occurs earlier than age 10. Testing frequency should be every two years. The screening test of choice is the fasting plasma glucose test. Clinical judgment should be used to perform testing in children and adolescents who do not meet the above criteria. The Centers for Disease Control and Prevention (CDC) BMI and growth curves can be used to calculate body fatness in children (<http://www.cdc.gov/nc-cdphp/dnppa/bmi/index.htm>).

## TREATMENT STRATEGIES

There is no single diabetes management recipe that fits all youth. Blood glucose targets; frequency of blood glucose testing, type, dose and frequency of insulin; use of insulin injections with a syringe or a pen or pump; use of other injectable or oral glucose-lowering medication; and details of nutrition management vary among individuals. The family and diabetes care team determine the regimen that best suits each child's individual characteristics and circumstances.

The management of type 1 diabetes involves insulin therapy, nutrition management, physical activity, blood glucose testing and the avoidance of hypoglycemia. Insulin therapy is required for type 1 diabetes and algorithms are used for insulin dosing based on blood glucose level and food intake. Children receiving fixed insulin doses of intermediate-acting and rapid-acting insulins must have food given at the time of

peak action of the insulin. Children receiving a long-acting basal insulin analogue or using an insulin pump receive a rapid-acting insulin analogue just before meals, with the amount of pre-meal insulin based on carbohydrate content of the meal using an insulin-to-carbohydrate ratio and a correction scale for hyperglycemia. Further adjustment of insulin or food intake may be made based on anticipation of special circumstances such as increased exercise and intercurrent illness. Children on these regimens are expected to check their blood glucose levels routinely before meals, after meals at bedtime, and occasionally, in the middle of the night. Blood glucose levels should be reassessed after an abnormally high or low glucose value to be sure that the corrective action taken normalized the glucose level.

The management of type 2 diabetes involves nutrition management with portion control, increased physical activity and blood glucose testing. If these actions are not sufficient to normalize blood glucose levels, glucose-lowering medications and/or insulin therapy are used as well. There are a variety of different diabetes medications, some that are taken orally and some taken by injection or pump, such as insulin. Youth with type 2 diabetes may take one or more different glucose-lowering medications. Glucose lowering medications differ by their mechanism of actions. The most frequently used oral glucose-lowering medication in children and adolescents is metformin. Glimperide is also approved for children who are ≥8 years of age.

It is important to counsel the child or teen with type 2 diabetes about healthy eating habits and the need for daily physical activity so that he or she can reach a healthy weight. Weight loss and physical activity independently increase the body's sensitivity to insulin.

For both types of diabetes, appropriate A1C, estimated average blood glucose (eAG), and daily glucose targets need to be determined by the child or teen and family with their health care team so that these can be met without excessive hypoglycemia.

Note that most children younger than 6 or 7 years of age are unable to recognize or respond to symptoms of hypoglycemia.<sup>2,6</sup> Optimal A1C goal values for youth with type 1 diabetes are:

- Toddlers and preschoolers under age 6 – between 7 and 8.5
- Ages 6 to 12 -- < 8
- Adolescents and young adults ages 13 to 19 - < 7.5 (A goal of < 7.0 percent is reasonable if it can be achieved without excessive hypoglycemia)

Before meal and bedtime blood glucose goals can be found by consulting the American Diabetes Association 2009 Standards of Care.<sup>6</sup> These goals may be generally applicable to youth with type 2 diabetes.

## Prevention or Delay of Type 2 Diabetes

Prevention or delay of type 2 diabetes in children and at-risk teens requires health care professionals to educate, encourage and support the entire family to make lifestyle changes. Such lifestyle changes include incorporation of healthy eating habits and appropriate physical activity levels of 60 minutes per day.

## MANAGEMENT OF HYPOGLYCEMIA

Diabetes treatment can sometimes cause blood glucose levels to drop too low, resulting in hypoglycemia (low blood glucose). Causes of hypoglycemia include taking too much insulin, missing a meal or snack, or engaging in strenuous exercise. Hypoglycemia also can occur when there is no apparent cause.

A child with hypoglycemia may become irritable, unstable, or confused. When blood glucose levels decline to very low levels, loss of consciousness or seizures may occur.

When hypoglycemia is recognized, the child should drink or eat a quick-acting sugar product equivalent to 15 grams of carbohydrate to quickly raise the blood glucose to greater than 70 mg/dl. Examples of 15 grams of carbohydrate are 3 or 4 glucose tablets or hard candies, 3 teaspoons (or three-fourths of a tube) of glucose gel, 4 ounces of juice, or 6 ounces (half a can) of non-diet soda. Once the blood glucose is over 70 mg/dl,



the child can eat food containing protein to maintain blood glucose levels in the target range. If the child is unable to eat or drink, a glucose gel may be administered to the buccal mucosa of the cheek; however, in the face of an altered level of consciousness or if the child cannot cooperate, glucagon or IV glucose should be administered. Hypoglycemia can be prevented by monitoring glucose levels regularly and before and after exercise, adjusting insulin dose and/or snacking before, during, or after vigorous activity, and at bedtime if blood glucose levels are below the bedtime target range.

### MANAGEMENT OF HYPERGLYCEMIA

Causes of hyperglycemia (high blood glucose) include forgetting to take glucose lowering medications on time, eating too much, getting less physical activity than usual, or having an illness. Some episodes of hyperglycemia may occur without an apparent reason. A variety of medications used for other reasons can elevate the blood glucose, such as prednisone and other glucocorticoid compounds and psychotropic medications.

Sick day management rules, including assessment for ketosis with every illness, must be established for children with type 1 diabetes. Families need to be taught what to do for vomiting and for ketosis to prevent severe hyperglycemia and ketoacidosis.<sup>7</sup> Hyperglycemia can be prevented by monitoring glucose levels regularly, adjusting the insulin dose, adjusting the amount of food and/or amount of carbohydrate eaten and following sick day management rules.

### MONITORING COMPLICATIONS AND REDUCING CVD RISK

Regular monitoring for the presence of diabetes complications allows for their early identification and the initiation of effective treatment. Early treatment can halt or delay the onset of disabilities associated with these complications. Detailed guidance on the prevention, screening and treatment of these complications in young people is available and is specific to type 1<sup>6</sup> and type 2 diabetes.<sup>8</sup>

*Retinopathy* (diabetes eye disease) most commonly occurs after the onset of puberty

and after five to 10 years of diabetes duration, but it has been reported in prepubertal children and those with diabetes after only one to two years. Referrals for a dilated eye exam should be made to eye care professionals who have expertise in diabetic retinopathy, an understanding of the risk for retinopathy in the pediatric population, as well as experience in counseling the pediatric patient and family on the importance of early prevention/intervention.

To reduce the risk and/or slow the progression of *nephropathy* (diabetes kidney disease), regular screening is necessary for microalbuminuria, with a random spot urine sample analyzed for microalbumin-to-creatinine ratio. Optimal glucose and blood pressure management is essential.

Diabetes affects nerve functioning and may cause several conditions, including loss of sensation in the feet. Although it is unclear whether foot examinations are important in children and adolescents, annual foot examinations are painless, inexpensive, and provide an opportunity for education about foot care. The risk for foot complications is increased in people who have had diabetes over 10 years.

Because lipid abnormalities are associated with diabetes, regular assessment of a fasting lipid profile is necessary. Weight loss, increased physical activity and improvement in glycemic control often result in improvements in lipid levels. In people with diabetes, the goal for LDL-cholesterol is less than 100 mg/dl.

Careful control of hypertension in children is critical. Hypertension in childhood is defined as an average systolic or diastolic blood pressure >95th percentile for age, sex and height measured on at least three separate days. Normal blood pressure levels for age, sex and height, appropriate methods for measurement and treatment recommendations are available online at [http://www.nhlbi.nih.gov/health/heart/hbp/hbp\\_ped.pdf](http://www.nhlbi.nih.gov/health/heart/hbp/hbp_ped.pdf).

### HELPING CHILDREN AND ADOLESCENTS MANAGE DIABETES

Diabetes management needs to address the physical and emotional growth

needs of children, adolescents and their families, as well teens' emerging autonomy and independence. A health care team can address these issues and usually involves a physician, diabetes educator, dietitian and a social worker or psychologist. The team in partnership with the young person with diabetes and parents or other caregivers needs to develop a personal diabetes management plan and daily schedule. The plan helps the child or teen to follow a healthy meal plan, get regular physical activity, check blood glucose levels, take insulin or glucose lowering medication as prescribed and manage hyperglycemia and hypoglycemia.

A meal plan can help keep blood glucose levels in the target range, ensure proper nutrition for growth and energy, but reduce or prevent obesity. Families can learn how different types of food affect blood glucose levels, to measure portion sizes, select the right amount of calories and make healthy food choices. Family support for following the meal plan and setting up regular meal times is a key to success.

Children with diabetes need at least 60 minutes of physical activity each day, as do all children. Physical activity helps increase insulin sensitivity, lower blood glucose levels and maintains a healthy weight. The most common problem caused by physical activity is hypoglycemia in children taking insulin. It is important that blood glucose levels be checked before and after a game or sport and low values treated as necessary.

Young people with diabetes need to know the acceptable range for their blood glucose. Those using insulin need to check blood glucose values regularly with a meter and keep a record of the results to discuss with their health care team. The results help the team determine changes to the management plan. All diabetes medications need to be taken as prescribed.

Diabetes presents unique issues for young people with the disease. Self-care tasks need planning and carrying them out can make children feel "different" from their classmates. This type of "uniqueness" can be particularly bothersome or stigmatizing for teens. Learning to cope with diabetes



is a big task and may cause emotional and behavioral challenges, sometimes leading to depression. Talking to a social worker or psychologist may help young people and their families learn to adjust to the lifestyle changes needed to stay healthy and to find supportive help.

Whereas, all parents should talk to their children about avoiding tobacco, alcohol and other drugs, this dialogue is particularly important for children with diabetes. Smoking and diabetes independently increase the risk of cardiovascular disease, and people with diabetes who smoke have a greatly increased risk of heart disease and circulatory problems. Binge drinking can cause hyperglycemia acutely, followed by an increased risk of hypoglycemia. The symptoms of intoxication are similar to the symptoms of hypoglycemia, and thus, may result in delay of treatment of hypoglycemia, with potentially disastrous consequences.

Children with diabetes, depending on their age and level of maturity, will learn to take over much of their care. Most school-age children can recognize symptoms of hypoglycemia and monitor blood glucose levels. They also participate in nutrition decisions. They often can give their own insulin injections but may not be able to draw up the dose accurately in a syringe until ages 11 or 12 years. Adolescents often have the motor and cognitive skills to perform all diabetes-related self care, but because peer acceptance is important, risk-taking behaviors are common and rebellion against authority is part of a teens' search for independence. Thus, adolescents may need supervision in their diabetes tasks and be allowed gradual independence only if they maintain reasonable metabolic control.

In school, several federal and some state

laws provide protections to children with disabilities, including diabetes. These laws help ensure that all students with diabetes are educated in a medically safe environment and have the same access to educational opportunities as their peers—in public and some private schools. A written plan that outlines the student's diabetes management helps the student, families, school staff and health care team to know what is expected of them. The school nurse is the most appropriate person to coordinate care for students with diabetes and to train, monitor and supervise school personnel.

Research is underway to find ways to prevent type 1 diabetes, to preserve beta cell function in people who have type 1 diabetes and to identify factors that trigger type 1 diabetes in susceptible individuals. New management strategies are helping children with type 1 diabetes live long and healthy lives. New research findings will help determine effective ways to lower risk factors for type 2 diabetes in high-risk children. Ongoing efforts to prevent and treat diabetes in children will require collaborative involvement of health care professionals, educators, schools, community institutions, and government agencies.

## RESOURCES

National Diabetes Education Program (NDEP) Toll-free: 1-888-693-NDEP (6337). <http://www.yourdiabetesinfo.org>.

American Association of Diabetes Educators Toll-free: 800-TEAM-UP4 (1-800-832-6874). <http://www.diabeteseducator.org>.

American Diabetes Association Toll-free: 1-800-DIABETES (1-800-342-2383). <http://www.diabetes.org>.

Centers for Disease Control and Preven-

tion Toll-free: 1-800-311-3435. <http://www.cdc.gov>.

Juvenile Diabetes Research Foundation International Toll-free: 1-800-223-1138. <http://www.jdf.org>.

Children with Diabetes Website. <http://www.childrenwithdiabetes.com>.

National Diabetes Information Clearinghouse Toll-free: 1-800-860-8747. <http://www.niddk.nih.gov/health/diabetes/diabetes.htm>.

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