Type 2 Diabetes in Youth: A Growing Concern

HOW TO RECEIVE CREDIT

- Read the enclosed course.
- Complete the questions at the end of the course.
- Return your completed Evaluation to NetCE by mail or fax, or complete online at www.NetCE.com. (If you are a behavioral health professional or Florida nurse, please return the included Answer Sheet/Evaluation.) Your postmark or facsimile date will be used as your completion date.
- Receive your Certificate(s) of Completion by mail, fax, or email.

Faculty

Susan Semb, MSN, CDCES, is a retired RN who received her Master's degree in nursing from the University of San Diego. Her nursing experience includes direct patient care, case management, staff development, program development, and health education. She spent the majority of her nursing career working as a diabetes educator in the health education department of a major health maintenance organization. Ms. Semb has also authored other continuing education courses for nurses published by NetCE and contributed to nursing books and other publications. In her retirement, Ms. Semb enjoys travel, line dancing, and pursuing an interest in antiques and vintage items.

Faculty Disclosure

Contributing faculty, Susan Semb, MSN, CDCES, has disclosed no relevant financial relationship with any product manufacturer or service provider mentioned.

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The division planners and director have disclosed no relevant financial relationship with any product manufacturer or service provider mentioned.

Audience

This course is designed for all pediatric and medical/surgical staff as well as counselors, therapists, and social workers who work with youth with type 2 diabetes.

Accreditations & Approvals

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About the Sponsor

The purpose of NetCE is to provide challenging curricula to assist healthcare professionals to raise their levels of expertise while fulfilling their continuing education requirements, thereby improving the quality of healthcare.

Our contributing faculty members have taken care to ensure that the information and recommendations are accurate and compatible with the standards generally accepted at the time of publication. The publisher disclaims any liability, loss or damage incurred as a consequence, directly or indirectly, of the use and application of any of the contents. Participants are cautioned about the potential risk of using limited knowledge when integrating new techniques into practice.

Disclosure Statement

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Course Objective

The purpose of this course is to introduce the reader to nursing and health care issues related to type 2 diabetes in children and adolescents. As the prevalence of this problem continues to grow, the need to understand how we can prevent and treat this condition becomes more imperative.

Learning Objectives

Upon completion of this course, you should be able to:

1. Describe the relationship between obesity, the modern lifestyle, and type 2 diabetes in youth.
2. Differentiate important characteristics of prediabetes, type 1 diabetes, and type 2 diabetes.
3. Identify microvascular and macrovascular complications of diabetes.
4. Discuss major risk factors associated with type 2 diabetes in youth.
5. Identify clinical presentation and diagnostic criteria of type 2 diabetes in youth.
6. Discuss the importance of diet and exercise as a primary treatment modality for type 2 diabetes in youth.
7. Identify pharmacologic approaches to type 2 diabetes in youth.
8. Describe standards of care for the monitoring and prevention of long-term complications of type 2 diabetes.
9. Describe appropriate counseling interventions for parents of children with diabetes.

Sections marked with this symbol include evidence-based practice recommendations. The level of evidence and/or strength of recommendation, as provided by the evidence-based source, are also included so you may determine the validity or relevance of the information. These sections may be used in conjunction with the course material for better application to your daily practice.

INTRODUCTION

PREVALENCE

Diabetes is a chronic illness that affects 38.4 million people in the United States [1]. The vast majority have type 2 diabetes, a condition that usually affects people older than 45 years of age. While type 1 diabetes accounts for about 5% of all diagnosed diabetes, an estimated 352,000 individuals younger than 20 years of age in the United States are diagnosed with type 2 diabetes every year [2]. Although the numbers do not suggest an epidemic, they do represent an unprecedented worldwide rise in type 2 diabetes among children and adolescents over the past 30 years. Prevalence increases with age, tripling between 10 to 14 years of age and 15 to 18 years of age. For reasons that remain unclear, adolescent girls have a 60% higher prevalence rate than adolescent boys [3]. The Centers for Disease Control and Prevention (CDC) has projected that type 2 diabetes in persons younger than 20 years of age in the United States will increase 673% by 2060 [4]. Unfortunately, the rise in incidence of type 2 diabetes among youth is accompanied by a severe shortage of pediatric endocrinologists [5].

In the United States, the incidence of type 2 diabetes is greater in children of certain ethnic groups [3]. Among youth 10 to 19 years of age, type 2 diabetes represents 4.5% of the cases of diabetes in Non-Hispanic White individuals, 37.8% in Non-Hispanic Black individuals, 20.9% in Hispanics, 11.9% in Asian/Pacific Islanders, and 32.8% among Native Americans [6]. The problem is not limited to the United States. In fact, indigenous children around the world bear the greatest burden of youth-onset type 2 diabetes [3; 7]. There is considerable variation in the prevalence of type 2 diabetes depending upon ethnicity and geographical region. Rates are lowest in Europe but increasing in China and India, which is concerning, given their large populations [8; 9].

IMPACT

The potential burden of type 2 diabetes in youth is enormous. This disease is associated with serious, long-term complications, such as blindness, end stage renal disease, lower extremity amputation, and the development of cardiovascular disease. Experts believe that the progression of the disease in children may be more rapid and more severe than in adults [3]. In addition to the more well-known consequences of uncontrolled diabetes, research indicates that obese adolescents with type 2 diabetes may have diminished cognitive performance and brain abnormalities as indicated by magnetic resonance imaging studies. These brain abnormalities include reduced white matter and an increased amount of cerebrospinal fluid space [10; 11; 12].

Diabetes accounts for an overall economic burden of more than $413 billion annually, including a disproportionate use of hospital inpatient care, outpatient and physician office care, emergency visits, skilled nursing days, and home health visits [1]. In addition to these economic costs, diabetes takes an incalculable toll on the individual in terms of lost productivity, disability, decreased quality of life, and early mortality. People with diabetes have healthcare costs that are more than two times greater than those without diabetes [13].

The majority of spending for diabetes goes toward the treatment of long-term complications, such as blindness, renal failure, heart disease, hypertension, and amputation [1]. When the disease begins earlier in life, it is more likely to require more protracted treatment with increased economic, social, and personal burden. Furthermore, many children with type 2 diabetes are undiagnosed due to the asymptomatic nature of the disease, increasing the risk for undetected and untreated long-term complications.

ETIOLOGY

Why has there been an escalation in the prevalence of type 2 diabetes in this previously unaffected population? The answer to this question appears to be closely related to features of our modern way of life. Increased body weight is strongly associated with type 2 diabetes in youth, pointing to lifestyle as a causative factor. Childhood obesity has more than tripled since the 1970s [14]. It is anticipated that obesity will affect the health of 91 million children worldwide by 2025 [15].

Modern eating habits are characterized by the consumption of calorie-laden convenience foods that are high in fat and sugar and low in fiber. Studies have shown that children and adolescents with type 2 diabetes eat more saturated fat than recommended and have inadequate intake of fiber, grains, fruits, and vegetables [16]. Not surprisingly, the combination of these factors has resulted in high rates of overweight and obesity in all age groups, including children. Excessive consumption of foods high in fat and sugar and low in fiber is associated with substantial increases in the risk for diabetes. Obesity alone can have serious consequences for children, including an increased risk for early adult cardiovascular disease.

Adequate physical activity in young people is essential in preventing type 2 diabetes. It is well known that exercise not only helps offset adiposity but enhances insulin sensitivity in young people [17]. In addition to poor eating habits, children have fewer opportunities to burn calories on a daily basis. Television, computers, telephones, and electronic devices provide the primary source of leisure activity for most young people today, while the typical family does not engage in physical activity sufficient to offset the consumption of high-calorie diets. According to government statistics, only 25% of students in grades 9 through 12 are engaged in an adequate amount of moderate-intensity physical activity [18]. Further, coronavirus disease 2019–2020 (COVID-19) increases risk factors for obesity in youth due to increased stress related to academic and social changes as well as decreased physical activity. Online education does not provide physical education classes, recess time, and normal levels of active movement for school-aged children and adolescents [19].

The correlation between obesity, sedentary lifestyle, and type 2 diabetes is clear. Obesity and inactivity are known to significantly impair the body's ability to utilize insulin. This results in a condition known as insulin resistance, which plays an important role in the development of type 2 diabetes and its associated complications.

PATHOPHYSIOLOGY

Diabetes is a metabolic disorder, affecting the way that the body uses food for energy. The primary pathology of diabetes is the body's inability to properly metabolize carbohydrates. In normal physiology, carbohydrates are broken down into glucose molecules that are absorbed in the small intestine, making them available for use by the tissues. In order to be converted to energy for use by the body, the glucose must enter the cell through specific sites called insulin receptors. These receptors can only channel glucose into the cell when insulin is present and properly utilized. This process is often conceptualized as a key (insulin) that opens the door (receptor), allowing glucose to enter the cell and be utilized.

Diabetes occurs when one or more of the following situations exist:

- There is a lack or deficiency of insulin present, causing the receptors on the cells to remain unused.
- There are too few insulin receptors available for the needs of the body, or the existing receptors do not function properly.
- The liver does not properly regulate and store the amount of glucose in the blood; it allows stored glucose to be released when blood levels are already above normal.

PREDIABETES

In the United States, an estimated 97.6 million people older than 18 years of age have prediabetes [1]. Although more study is needed, it is estimated that about one in six adolescents have prediabetes [1]. Prediabetes is defined by a blood glucose level that is higher than normal but not high enough to meet the diagnostic criteria for diabetes. Having prediabetes greatly increases the risk for later development of type 2 diabetes, and most people with type 2 diabetes have had prediabetes prior to the onset of diabetes.

Prediabetes is an asymptomatic condition and can only be detected by laboratory testing. Prediabetes includes any one of the following findings of increased risk for diabetes [20]:

- Impaired fasting glucose (IFG), defined as fasting plasma glucose (FPG) 100–125 mg/dL
- Impaired glucose tolerance (IGT), defined as a postprandial blood glucose 140–199 mg/dL
- Hemoglobin A_{1c} between 5.7% and 6.4%

EVIDENCE-BASED PRACTICE RECOMMENDATION

The American Diabetes Association defines persons at increased risk for diabetes (prediabetes) as those with impaired fasting glucose and/or impaired glucose tolerance and/or A1c 5.7% to 6.4%. Prediabetes should not be viewed as a clinical entity in its own right but rather as an increased risk for diabetes and cardiovascular disease.

(https://diabetesjournals.org/care/issue/47/Supplement_1. Last accessed February 19, 2024.)

Level of Evidence: Expert Opinion

The harmful effects of high blood glucose begin at much lower levels than those established to define diabetes. In other words, complications of diabetes begin early in the course of glucose intolerance—often before diabetes is diagnosed. Studies suggest that when blood glucose is higher than normal and remains untreated, patients have a greater risk for developing the microvascular and macrovascular complications associated with diabetes [21; 22; 23]. Research confirms that long-term damage to the body, especially to the heart and circulatory system, can occur during prediabetes [24]. Although many patients with prediabetes may inevitably develop type 2 diabetes, the Diabetes Prevention Program (DPP) has shown that it is possible to delay or even avoid progression completely by implementing lifestyle modification that leads to healthy weight loss [25]. Healthcare professionals must provide preventive care to individuals who have prediabetes in order to minimize the impact of this condition.

MAIN CLASSES OF DIABETES

The CDC defines diabetes as, "a chronic (long-lasting) health condition that affects how your body turns food into energy" [26]. The CDC divides the various existing types of diabetes into three main classes [26]:

- Type 1 diabetes
- Type 2 diabetes
- Gestational diabetes

The majority of cases are either type 1 or type 2 diabetes. Other types of diabetes include diabetes that are chemically induced or that occur from genetic defects, other diseases, or infections.

Previously, type 1 was known as "juvenile-onset" diabetes, while type 2 was referred to as "adult onset" diabetes. However, these terms are no longer appropriate due to the fact that children and adolescents are now developing what was formerly known as adult onset diabetes in increasing numbers.

Type 1 Diabetes

The presence or absence of endogenous, or internally produced, insulin in the body is the defining factor that differentiates type 1 and type 2 diabetes (***Table 1***). Type 1 diabetes is an autoimmune disease that leads to the destruction of the insulin-producing beta cells of the pancreas, resulting in a complete absence of endogenous insulin [26]. It has traditionally been associated with onset in people younger than 30 years of age. Until recently, it was the only type considered prevalent in children. In this type of

TYPE 1 VS. TYPE 2 DIABETES: WHAT ARE THE DIFFERENCES?		
Characteristics	**Type 1**	**Type 2**
Formerly known as	"Juvenile onset" diabetes	"Adult onset" diabetes
Etiology	Autoimmune disorder	Usually insulin resistance
Pathophysiologic basis	Insulin deficiency: pancreas stops producing insulin, resulting in a complete absence of endogenous insulin	Insulin resistance: body cells cannot utilize insulin that is made by the body Insulin deficiency: pancreas eventually produces less insulin due to "pancreatic fatigue"
Risk factors	Family history Environmental factors	Sedentary lifestyle Family history Overweight or obesity Adiposity Female sex Low socioeconomic status Unhealthy sleep patterns Stress Hispanic, African American, Pacific Islander, Native American race
Treatment	Insulin therapy (always) Diet (primarily carbohydrate management) Increased physical activity	Nutrition therapy (calorie control for weight management and carbohydrate management) Increased physical activity Oral medications (in some cases) Insulin therapy (in some cases)
Associated conditions	High risk for ketoacidosis with hyperglycemia	Metabolic syndrome, characterized by insulinemia, dyslipidemia, and hypertension

Source: Compiled by Author *Table 1*

diabetes, insulin therapy is required and is the only appropriate pharmacologic option. Without insulin therapy, the person with type 1 diabetes will develop ketoacidosis, a life-threatening condition characterized by high blood glucose levels and a buildup of acids in the blood that will result in death if not treated.

Typically, children diagnosed with type 1 diabetes are not overweight and report recent weight loss at presentation. However, it is important to note that as the general population has become increasingly overweight, increasing numbers of children with type 1 diabetes are overweight at the time of diagnosis. Polydipsia and polyuria, along with extreme fatigue, are often present when a child is first diagnosed with type 1 diabetes. The duration of these symptoms prior to diagnosis is usually short and often accompanied by the onset of ketoacidosis.

Type 2 Diabetes

Because it is a relatively new phenomenon, there is still much to learn about the epidemiology and pathophysiology of type 2 diabetes in children. While it closely resembles that of adults, youth-onset type 2 diabetes displays unique aspects, such as rapidly progressive beta-cell decline and accelerated development of diabetes complications [20; 27; 28]. According to the CDC, type 2 diabetes in children is usually diagnosed between 10 and 19 years of age. Risk factors include obesity, having a family member with type 2 diabetes, and being born to a mother with gestational diabetes. After 10 years of age, being a member of minority populations, such as Hispanic, African American, Asian/Pacific Islander, and American Indian, greatly increases the risk for development of type 2 diabetes in youth [29].

Whether it occurs in adults or children, most cases of type 2 diabetes begin with insulin resistance. In this condition, the pancreas initially continues to produce insulin, but the tissues are unable to use it. This may be due to a scarcity of receptors on the cells or because the receptors do not function well. Reasons for poorly functioning receptors include adiposity, muscular inactivity, and genetic factors. The beta cells of the pancreas respond to insulin resistance by producing even more insulin in an attempt to compensate. However, much of the insulin remains unused and blood levels of insulin are temporarily high (hyperinsulinemia). After a period of manufacturing large amounts of insulin, the beta cells of the pancreas eventually become exhausted, the amount of endogenous insulin greatly declines, and clinical diabetes ensues. In some cases, type 2 diabetes can be managed with a combination of diet, exercise, and oral medications. Many times, insulin therapy is required to control blood glucose levels and to prevent long-term complications of the disease. Individuals with type 2 diabetes usually produce enough insulin to prevent ketoacidosis. Therefore, they are not truly "insulin dependent," even if they do use insulin therapy to control blood glucose.

The distinction between type 1 and type 2 diabetes in children can sometimes be difficult and complicated. Since the 1980s, the rates of both type 1 and type 2 diabetes in children have increased concurrently with obesity rates in children. Autoantigens and ketosis are often present in young patients with type 2 diabetes, pointing to the possibility that obesity may be driving the autoimmune beta-cell failure that underlies type 1 diabetes [20; 30]. Furthermore, type 2 diabetes in children is often not detected until glucose levels are extremely high, with resulting ketoacidosis, a condition most commonly found in type 1 diabetes [31]. While challenging, proper diagnosis at onset is critical for the education and treatment of the patient.

When diagnosing diabetes in a child or young person, the National Guideline Alliance recommends assuming type 1 diabetes unless there are strong indications of type 2 diabetes. The possibility of type 2 diabetes should be considered in children and young people with suspected diabetes who:

- Have a strong family history of type 2 diabetes
- Are obese at presentation
- Are of black or Asian family origin
- Have no insulin requirement or have an insulin requirement of less than 0.5 units/kg body weight/day after the partial remission phase
- Show evidence of insulin resistance (e.g., acanthosis nigricans)

(https://www.nice.org.uk/guidance/ng18. Last accessed February 19, 2024.)

Level of Evidence: Expert Opinion

LONG-TERM COMPLICATIONS

Generally, the long-term complications of diabetes are grouped according to whether they are the result of large-vessel or small-vessel damage by the disease process. The problems related to small vessel damage are termed "microvascular complications," while "macrovascular complications" refers to large vessel disease. Both types of complications are of significant concern with regard to type 2 diabetes in children because they have an increased risk of these complications early in the course of their disease [32]. Risk factors for the development of long-term complications in youth are incompletely understood and long-term outcome data are scarce [32]. However, evidence of microvascular complications and risk markers for macrovascular complications are often present at the time of diagnosis of type 2 diabetes in youth [20; 33]. According to the Treatment Options for type 2 Diabetes in Adolescents and Youth (TODAY) study, at the time of enrollment, 14% of participants had a blood pressure at the 95th percentile or greater; 13% had microalbuminuria; 80% had a low HDL cholesterol level; and 10% had high triglycerides [34]. Similar

DYSLIPIDEMIA	
Definition	One or more abnormalities in the circulating blood fats (LDL-C, HDL-C, and triglycerides).
Significance	Lipid abnormalities are a leading factor in the development of arteriosclerosis, a major risk factor for cardiovascular disease.
LDL-C	A lipoprotein that deposits (plaque) in artery walls, leading to inflammation and atherosclerosis. The development of plaque can cause blockage, or rupture of plaque can cause blood clots. The desired blood level is <100 mg/dL.
HDL-C	The so-called "good cholesterol" may help remove excessive amounts of LDL-C, resulting in reduced plaque formation. The desired level is >50–59 mg/dL for women and >40–59 mg/dL for men. Low HDL-C levels are associated with the development of cardiovascular disease.
Triglycerides	Another undesirable fat whose exact role in the development of coronary artery disease is not well understood. Elevated levels are often found in people with type 2 diabetes. The desired blood level is <150 mg/dL. Levels >1,000 mg/dL are sometimes found in people with type 2 diabetes, placing them at high risk for pancreatitis.

Source: Compiled by Author *Table 2*

findings appeared in a population of Canadian First Nation youth with type 2 diabetes. Thirty-seven percent had elevated triglycerides, and 12% and 14% of male and female youth, respectively, had systolic blood pressure greater than the 95th percentile [35]. This population also exhibited renal and neurologic complications within 5 years of diabetes diagnosis, and major complications (e.g., dialysis, blindness, amputation) started to manifest 10 years following diagnosis [32; 36].

MICROVASCULAR COMPLICATIONS

Uncontrolled hyperglycemia over a number of years is known to cause damage to the small vessels that supply the retina of the eye (retinopathy), the nephrons of the kidney, and the motor, sensory, and autonomic nerves. There is evidence that these complications are especially aggressive in young people with type 2 diabetes; they are also highly prevalent [32; 33; 37]. The United Kingdom Prospective Diabetes Study demonstrated that intensive treatment of type 2 diabetes in adults can significantly lower the risk for developing diabetes-related eye, kidney, and nerve disease. The findings from this study included a 25% reduction of microvascular disease in subjects who maintained long-term glycemic control [38].

MACROVASCULAR COMPLICATIONS

The development of serious large vessel disease is also a possible effect of diabetes. Macrovascular complications of diabetes involve the cardiovascular, cerebral vascular, and peripheral vascular systems, leading to high incidences of myocardial infarction, stroke, and lower extremity disease.

While the injurious effects of hyperglycemia on large blood vessels are believed to play a significant role in the development of large vessel disease, hyperinsulinemia is also responsible for other damaging effects to the cardiovascular system. Resulting from insulin resistance, high levels of insulin in the blood are associated with a series of adverse metabolic changes that greatly increase the risk for cardiovascular disease; these changes characterize the metabolic syndrome. This cluster of disorders includes two major independent risk factors for myocardial infarction: hypertension and dyslipidemia.

A person has metabolic syndrome if he or she has any three of the following risk factors [39; 40]:

- In adults, waist circumference more than 40 inches for men or more than 35 inches for women, indicating excess visceral fat. This is known as the round or "apple" body shape.
- Dyslipidemia (***Table 2***)

- Triglycerides greater than 150 mg/dL
- High-density lipoprotein (HDL) cholesterol less than 40 mg/dL in men or less than 50 mg/dL in women
- Blood pressure greater than 130/85 mm Hg
- FPG greater than 100 mg/dL

The presence of metabolic syndrome is a signal of the need for lifestyle modification. Weight loss, exercise, and a low-fat diet can often improve metabolic abnormalities without medication. Even a reduction in sitting time and sedentary pastime can have a positive effect metabolic risk factors [40].

RISK FACTORS FOR TYPE 2 DIABETES IN YOUTH

Risk factors for the development of type 2 diabetes in young people have been identified. These include [7; 30; 41; 42]:

- Overweight or obesity: A clear correlation exists between the incidence of obesity and the development of type 2 diabetes in all age groups, including children and adolescents. Central adiposity, characterized by a concentration of fat in the torso and abdominal region, is also specifically associated with insulin resistance. Excess fat cells are believed to interfere with insulin utilization and cause insulin resistance.
- Ancestry: Insulin sensitivity appears to vary among ethnic groups. Preliminary population studies on the incidence of type 2 diabetes in youth indicate that this disorder appears in significantly higher rates in Native Americans, African Americans, Hispanics, and Pacific Islanders.
- Family history: Type 2 diabetes is more likely to occur in those who have a first- or second-degree relative with the disease. An estimated 45% to 80% of children with type 2 diabetes have at least one parent who also has the disease. Furthermore, obesity has a familial tendency.
- Developmental stage: Most new cases of type 2 diabetes in young people are diagnosed after the onset of puberty, with a mean age of diagnosis of approximately 13.5 years. During normal adolescence, there is an approximate 50% decrease in insulin sensitivity. It is believed that this is related to the increased production of growth hormone during the pubescent years.
- Gender: The occurrence of type 2 diabetes is more frequent in girls and young women than in boys and young men. Girls are typically more insulin-resistant than boys when controlled for body mass index.
- In utero exposure to diabetes: Having a birth mother with pre-existing or gestational diabetes also increases the risk for diabetes.

Risk factors that negatively impact the health outcomes of youth with type 2 diabetes include [33]:

- Socioeconomic status (i.e., parental income, education, employment)
- Sleep abnormalities
- Chronic exposure to environmental and social stressors

CLINICAL PRESENTATION

Many children are asymptomatic at the time they are diagnosed with type 2 diabetes. However, about 20% present with the signs and symptoms of ketoacidosis and glucose levels greater than 600 mg/dL. Many children complain of increased thirst and urination at the time of diagnosis, and some will report an unintentional weight loss over the previous weeks or months [31]. Comorbidities that may be present with diagnosis are early signs of renal insufficiency and retinopathy, hypertension, dyslipidemia, depression, and eating disorders. Other important clinical features frequently found in children newly diagnosed with type 2 diabetes include features or causes of insulin resistance syndrome, such as acanthosis nigricans, polycystic ovary syndrome (PCOS), and fatty liver disease.

ACANTHOSIS NIGRICANS

Acanthosis nigricans is a skin condition characterized by brownish-black patches, usually found on the back of the neck, in the axillae, and on areas exposed to repeated friction. They are slightly raised lesions that feel velvety to touch. Presence of the condition is considered a marker of hyperinsulinemia, and it develops in some cases of type 2 diabetes in children. This sign is most frequently recognized in obese, dark-skinned individuals and occurs more frequently in Native Americans, African Americans, and Hispanics when compared to White or Asian-origin individuals [43]. Parents of children with this condition often mistake acanthosis nigricans for poor hygiene and attempt to treat it with vigorous scrubbing and topical medications or cleansers. Some schools have initiated screening procedures for acanthosis nigricans, as many obese children who go on to develop type 2 diabetes present with only this sign [31].

POLYCYSTIC OVARY SYNDROME

PCOS is a disorder of the female reproductive system and is closely associated with insulin resistance. It is characterized by chronic anovulation, resulting in scanty or infrequent menstruation. In patients with PCOS, estrogen levels are usually normal while androgen levels are high. The elevated androgen levels can result in acne and hirsutism [44].

NONALCOHOLIC FATTY LIVER DISEASE

Nonalcoholic fatty liver disease is a chronic inflammatory process of the liver often associated with insulin resistance. Chronic hepatic inflammation can lead to liver dysfunction and ultimately failure. Evaluation for nonalcoholic fatty liver disease should be done at the time that type 2 diabetes is diagnosed in a child and annually thereafter [7].

DIAGNOSIS AND SCREENING

CRITERIA FOR SCREENING

The American Diabetes Association (ADA) recommends the screening of asymptomatic high-risk youth for type 2 diabetes every three years, beginning at 10 years of age or the onset of puberty, whichever occurs first. For the purposes of screening criteria, the ADA considers children at high risk if they are overweight (BMI ≥85th percentile) or obese (BMI ≥95th percentile) and have one or more of the following additional risk factors [20]:

- Family history of type 2 diabetes in a first- or second-degree relative
- Native American, African American, Hispanic, Asian American, and/or Pacific Islander race or ethnicity
- Signs of insulin resistance, including acanthosis nigricans, hypertension, dyslipidemia, small-for-gestational-age birth weight, or PCOS (as evidenced by menstrual irregularities and/or hirsutism)
- Maternal history of diabetes or gestational diabetes during the child's gestation

DIAGNOSTIC CRITERIA

The diagnostic criteria for diabetes in youth are the same as those established for adults and can be assessed using any of the tests listed in ***Table 3***.

Hemoglobin A_{1c}

This test reports the average amount of glucose that has adhered to the red blood cells over the previous two to three months (***Table 4***). In 2010, the ADA recognized an A_{1c} value that is greater than or equal to 6.5% as diagnostic for diabetes [20; 45]. This value continues to be diagnostic for diabetes [20].

DIAGNOSTIC TESTING FOR DIABETES		
Diagnostic Test	**Criteria for Prediabetes**	**Criteria for Diabetes**
A_{1c}	5.7% to 6.4 %	≥6.5%
Oral glucose tolerance test	140–199 mg/dL two hours after ingestion of glucose liquid	≥200 mg/dL two hours after ingestion of glucose liquid
Fasting plasma glucose	100–125 mg/dL	≥126 mg/dL
Random blood glucose	N/A	≥200 mg/dL and the presence of one or more symptoms of hyperglycemia

Source: [20; 45] *Table 3*

THE HEMOGLOBIN A_{1c} TEST
What is hemoglobin A_{1c}? The measurement of hemoglobin A_{1c} concentration provides a valid and reliable indication of a person's overall blood glucose control in the two- to three-month period prior to the test. Large studies have demonstrated that people with diabetes who are able to maintain an average value of 7% or less over 10 or more years have a greatly reduced risk for the microvascular complications of diabetes. It has been shown that for every percentage point decrease in A_{1c} (e.g., 9% to 8%), there is a 35% reduction in the risk of complications.
If a patient is performing self-monitoring of blood glucose, why is the A_{1c} test necessary? Self-monitoring of blood glucose using a meter gives information about the blood glucose level at a specific moment in time. While this is very useful for the day-to-day management of diabetes, it does not give collective information that can predict the risk for development of long-term complications. By taking into account all times for all days during the two- to three-month period, the A_{1c} gives a better indication of overall glycemic control.
How does the test work? The test works by measuring the amount of glucose that is chemically attached to red blood cells (RBCs). RBCs that have been exposed to high amounts of glucose over their lifespan will have more glucose attached to them. Because the average life of an RBC is approximately 90 days, the A_{1c} indicates glycemic control over this time period. Results of the A_{1c} are expressed as a percentage and reflect the relative amount of glucose that has been in the blood over the past two to three months.

Source: Compiled by Author *Table 4*

Oral Glucose Tolerance Test

The oral glucose tolerance test (OGTT) requires patients to fast for eight hours, then to drink a liquid containing 75 grams of glucose dissolved in water. The test is performed by measuring the plasma glucose levels two hours after drinking the liquid. A diagnosis of diabetes is made when the result is greater than or equal to 200 mg/dL [20; 45].

Fasting Plasma Glucose

To measure FPG, patients are required to fast for at least eight hours, after which a simple blood test is performed. This test is most accurate when administered in the morning. Although it is not as sensitive as the OGTT, it is the preferred method of testing because of its cost-effectiveness and convenience. Diabetes is diagnosed when FPG is greater than or equal to 126 mg/dL [20; 45].

Random Blood Glucose

A random blood glucose (RBG) test, also known as a simple blood test, is taken regardless of when food was last consumed. It is generally administered when an individual presents with the following symptoms of hyperglycemia:

- Increased urination
- Unexplained weight loss
- Fatigue
- Blurred vision
- Increased hunger
- Sores that do not heal

An RBG result that is greater than or equal to 200 mg/dL is diagnostic for diabetes [20; 45].

TREATMENT

The primary means for treating type 2 diabetes in youth is lifestyle management, which includes youth-oriented, culturally appropriate self-management education and support, and weight loss through a healthy eating plan coupled with increased daily physical activity [20]. Blood glucose monitoring is important in providing feedback to the individual on how these changes affect glycemia. Clinical practice guidelines from the American Academy of Pediatrics (AAP) recommend starting metformin in newly diagnosed patients with an A_{1c} of 6.5% or greater [46]. This recommendation also is supported by the ADA [20].

The ultimate goal in managing type 2 diabetes in people of all ages is to prevent or reduce the long-term complications that are associated with this disease. As stated, two major factors warrant vigorous efforts to minimize the risk of both small- and large-vessel complications in young patients with type 2 diabetes [33]:

- The complications have been found to be especially aggressive in this population.
- The earlier the age of onset, the sooner patients will suffer from the devastating complications of diabetes, substantially increasing the burden of the disease on the individual and on society.

Successful management of type 2 diabetes in youth includes [7]:

- Weight loss
- Increasing physical activity
- Normalizing glycemia
- Control of comorbidities, such as hypertension, dyslipidemia, nephropathy, and fatty liver disease

The ADA recommends that a reasonable A_{1c} target for most children and adolescents with type 2 diabetes treated with oral agents alone is <7%. More stringent A_{1c} targets (e.g., <6.5%) may be appropriate for select individual patients if the targets can be achieved without significant hypoglycemia or other adverse effects. Less stringent A_{1c} goals (e.g., <7.5%) may be appropriate if there is increased risk for hypoglycemia. A1c targets should be individualized, taking into account the relatively low rates of hypoglycemia in youth-onset type 2 diabetes [20]. The International Society for Pediatric and Adolescent Diabetes (ISPAD) recommends an overall A1c goal of less than 7.0% for all age-groups [7].

BEHAVIOR/LIFESTYLE MODIFICATION

A family-centered approach is recommended for treating type 2 diabetes in youth [20; 46]. Many families are greatly challenged by the lifestyle changes that are necessary to manage type 2 diabetes in children. Changes in daily habits, such as those involving food and activity, are difficult for people in general because they reflect embedded psychologic, social, and cultural influences. Therefore, psychologists, social workers, registered dieticians, and exercise physiologists play valuable roles in the interdisciplinary diabetes care team. Readiness to change refers to the theory that people move through a series

STAGES OF BEHAVIOR CHANGE		
Stage	**Patient Characteristics**	**Interventions**
Precontemplation	Denies there is a problem Defensive Noncompliant	Explore the problem Offer information Provide support and empathy
Contemplation	Aware of problem Actively considers change Some ambivalence/anxiety	Employ questioning that will increase awareness of the problem Help build confidence in ability to make changes Acknowledge efforts to seek information
Preparation	Ready to take action Makes at least one recent attempt to change	Provide encouragement
Action	Strong commitment to change Restructures lifestyle/environment to accommodate change Confidence in ability to be successful	Help provide strategies to remove or reduce negative behavioral triggers
Maintenance	Maintains healthy behaviors for six months or more	Help maintain focus Help review and renew commitment Address relapse events

Source: [47] *Table 5*

of stages as they give up unhealthy behaviors and adopt those that are health-enhancing. James Prochaska's behavioral change model has been widely used in many areas of health education, including in diabetes self-management. There are five identified stages that people go through when they are trying to change behaviors (***Table 5***). For each stage of change, certain interventions on the part of the healthcare provider are recommended. By employing these interventions, healthcare professionals can help "meet" the families within their own particular stage of change at any given time [47].

According to the AAP, parenting skills are the key to success in treating childhood obesity. They recommend the following parental interventions in helping to change behavior in children [48]:

- Using praise to cultivate and maintain desirable behavior
- Using physical activity time with parents as a reward for good behavior
- Establishing daily meal and snack times
- Offering only healthy options
- Asking children to offer rewards to parents for positive changes in the parents' behavior

Diabetes care professionals should routinely ask the patient/family whether they are feeling overwhelmed or stressed by the diabetes diagnosis as distress can lead to resistance to and/or interruption of treatment [20]. Indications for referral to a qualified behavioral and/or mental health professional include positive screening for overall stress related to work-life balance, diabetes, distress, management difficulties, depression, anxiety, disordered eating, and cognitive dysfunction [20].

EDUCATION

A family approach to health education is essential, as the lifestyle changes required to manage the child's diabetes will have an impact on the entire family. Parental education should include an assessment of existing knowledge about eating, weight, and health. Research has indicated that most parents of obese or overweight children do not consider their children overweight and do not believe that this is a health problem [49]. Therefore, many will need help in understanding that the child is overweight and that the problem must be addressed. Furthermore, there may be a misconception, especially in some cultures, that being overweight is a sign of good health. If this is the case, there will be a need to educate parents regarding the dangers of diabetes and heart disease related to being overweight in a culturally sensitive way.

In addition to lifestyle modification, comprehensive education for young people with type 2 diabetes and their families should include the following components:

- Blood glucose monitoring
- Blood glucose target ranges
- Signs, symptoms, causes, and treatment of hyperglycemia and hypoglycemia
- Prevention of long-term complications
- Management of associated health problems, such as hypertension and dyslipidemia

BLOOD GLUCOSE MONITORING

Self-monitoring of blood glucose (SMBG) provides immediate feedback on the impact of various daily influences, such as food, activity, and medications, on blood glucose levels. For many individuals, this is an empowering activity that provides a sense of control in the management of the disease. By keeping blood glucose levels near normal as much as possible, patients with diabetes can reduce their risk for acute and chronic complications.

Children and adolescents with type 2 diabetes should monitor their blood glucose levels frequently to assess the quality of their control. The AAP recommends that patients with newly diagnosed type 2 diabetes perform fingerstick blood glucose monitoring before meals and at bedtime until glycemic control is achieved [46].

Target ranges for children with type 2 diabetes who monitor blood glucose are not specified in the practice guidelines published by the ADA and the ISPAD, except to say that they should be individualized [20]. As stated, a reasonable A_{1c} target for most children and adolescents with type 2 diabetes is <7% [20]. As with adults, the overall goal is to maintain blood glucose as close to normal as much as possible, without excessive hypoglycemia, and to prevent long-term complications.

MEDICAL NUTRITION THERAPY

Achieving and maintaining a reasonable body weight is the major therapeutic goal in the management of type 2 diabetes in youth. Other goals of medical nutrition therapy include normalizing blood glucose (without excessive hypoglycemia) and maintaining healthy lipid and blood pressure values while allowing for normal growth and development [16; 20].

Even minor reductions in weight can significantly improve blood glucose control. A weight-loss plan for a child should be developed and supervised by a registered dietician to ensure a nutritionally adequate meal plan that allows for growth and development while moderately restricting calories [31]. The ADA recommends that overweight/obese youth with type 2 diabetes and their families be provided with a developmentally and culturally appropriate comprehensive lifestyle program that is integrated with diabetes management and that aims to achieve a 7% to 10% decrease in excess weight [20].

Clinic-based weight management programs appear to be effective in improving the metabolic profile of obese children, if they remain in a supervised program for several years. Results of a pilot program in Philadelphia suggest that an informal, nonintensive program of regular clinician contacts over two years can be more effective than intensive time-limited programs. In this study, the greatest improvements in children's metabolic profile correlated with frequency of visits to the healthcare provider [50].

The safest and most efficacious method for losing weight is to decrease caloric intake from fat and sugar while increasing fiber intake and physical activity [7]. Although weight loss is the goal, the primary focus of treatment should be on healthy eating and physical activity. Nutrition for youth with type 2 diabetes (and for all youth) should focus on healthy eating patterns that emphasize the consumption of nutrient-dense, high-quality foods and decreased consumption of calorie-dense, nutrient-poor foods, particularly sugar-added beverages [20]. Providing the family with restrictive lists of forbidden and allowable foods is not recommended. Instead, overall changes in lifestyle should be promoted [20]. Encouraging positive changes in food consumption patterns improves the chances of successful, long-term weight management by working on the modification of unhealthy behaviors. Family involvement in the nutritional management plan is vital for the successful implementation of behavior changes in the child. This supports the patient with diabetes and treats or prevents obesity and obesity-related health conditions in the entire family.

An appropriate meal plan is based upon an assessment that includes family preferences, timing and location of meals and snacks, cultural preferences and restrictions, food preparation practices, and readiness to change. Dietary recommendations should always be culturally appropriate and sensitive to the financial situation of the family. In order to be successful, a weight-loss program requires frequent interaction with the patient, continuous monitoring, and positive reinforcement. Counseling interventions should include encouraging family-style meals that are low in fat and smaller in portion size [20]. It is also important to help the family increase its awareness of their snacking behaviors and to offer strategies for making healthy changes. Because many people engage in eating that has nothing to do with hunger, families should be offered tactics for changing these habits as well.

Guidelines for facilitating healthy eating-related behaviors in youth include:

- Help set realistic goals. Goals should be oriented to behavior rather than outcomes. An example of a behavior goal might be, "I will eat a piece of fruit every day as my after-school snack." Avoid outcome-oriented goals such as, "I will lose 5 pounds this month," which tend to be less supportive of behavioral change and less empowering for the individual.
- Start slowly, focusing on two or three behavior changes at a time. A plan to make a comprehensive change in a person's eating habits tends to overwhelm and is more likely to result in failure.
- If developmentally appropriate, ask the patient to keep a food diary and review this with the patient. This is often considered the first step in the behavior change. Parents can help younger patients with this.
- Avoid the term "diet." Promote obesity management as a lifelong process. Focus on lifestyle changes that will improve glycemic control and long-term, overall health.
- Focus on a general understanding of the principles of good nutrition instead of handing out food lists and diet sheets. General instructions might include recommendations to reduce portion sizes, reduce the intake of fatty and processed foods, and increase the intake of fiber and fresh produce.

- Develop reward systems for appropriate behavior. Rewards could include earning a trip to an amusement park or getting a special toy. Reward charts can help track progress, providing feedback and a source of motivation.

Guidelines for Facilitating Nutritional Management

Nutritional recommendations should come primarily from a registered dietician who has expertise in the area of growth and child development. Dieticians should be a part of an interdisciplinary diabetes care team [20]. However, access to a dietician is not economically feasible for some patients whose healthcare plans do not cover this service or those who live in remote areas. In many instances, and in various settings, a nurse or counselor may assume responsibility for teaching dietary management to patients with diabetes. Because not all patients have access to the expertise of a dietician, the following information is provided as a guide to start or supplement education for nutritional management. General guidelines that encourage healthier eating habits to promote weight loss and prevent cardiovascular disease include [7; 16; 20; 31; 51]:

- Reduce, then eliminate, caloric beverages (except skim or low-fat milk) from the diet. Appropriate replacements include water, sparkling water, and herbal tea.
- Limit fast foods and fried food.
- Provide food in appropriate portion sizes. Serve portion-controlled snacks on a plate or bowl, not directly from the package.
- Eat a healthy breakfast every day.
- Provide meals on schedule and as a family unit, with no other activities, such as television, taking place at the same time.
- Increase intake of vegetables, unsweetened breakfast cereals, and hot food items that are high in fiber and low in saturated fat. Diets high in these types of foods have been associated with improved glucose tolerance.
- Keep unhealthful foods, such as snack items that are high in saturated fat and sugar, out of the house.
- Do not force children to finish meals if they are not hungry.
- Do not reward children with candy or sweets, especially for finishing meals.
- Provide more foods in their natural state. Have healthful snacks such as fruits, vegetables, and whole grain foods prepared and available as after-school snacks.
- Provide healthful, home-packed lunches to avoid consumption of foods that are high in fat and sugar and are available in many school cafeterias, food courts, and vending machines.
- Plan ahead for parties and other special occasions where high-calorie foods will be available:
  - Have a light snack before attending the party, so food can still be enjoyed at the event, but in smaller quantities.
  - Eat smaller meals for the remainder of the day to "save" some calories for the special event.
  - Learn how to exchange party foods for other foods on the daily meal plan. Sweets can occasionally be exchanged for other carbohydrate foods on the meal plan.

PHYSICAL ACTIVITY

Physical activity counteracts both insulin resistance and obesity, making it an essential component for both the prevention and treatment of type 2 diabetes. Physical activity and exercise also help improve obesity-related risk factors in youth (e.g., proinflammatory state, metabolic health) [52; 53; 54]. A study presented at the 2010 ADA annual meeting revealed that obese boys who engaged in aerobic and resistance exercise decreased their total body fat, visceral fat, and insulin resistance, even without any changes in diet. The study also indicated that resistance exercise training is appealing to boys and that it expends similar energy to aerobic training in this population [55].

The CDC and the ADA recommend that children and adolescents get at least 60 minutes of physical activity every day [20; 56]. Children should be encouraged to participate in sustained activities that use large muscle groups on a daily basis. Aerobic exercise should make up most of the 60 minutes of daily exercise. This should include vigorous intensity exercise at least three days per week. Children should have muscle-strengthening exercise at least three days per week as part of their 60 minutes per day [20]. This could include push-ups and climbing on playground equipment. Bone-strengthening exercise is recommended three days per week, included in the 60 minutes per day requirement [20]. Bone-strengthening exercises include weight-bearing exercise, such as jumping rope and running.

Extended periods of inactivity should be avoided. A 2010 study showed that adolescent boys with two or more hours a day of television or computer screen time are at greater risk for insulin resistance and other markers of metabolic syndrome [57]. A 2017 study found several factors that contribute to prolonged screen time and physical inactivity, including the youth's socioeconomic status, unhealthy food habits, and urban residence (with less exposure to other children) [58]. Overall physical activity can be increased by helping young people find ways to be more active in everyday activities, such as using stairs instead of the elevator, walking instead of riding, and playing outside as much as possible.

Because they are typically not motivated by long-term benefits, young people will not usually be interested in exercising for health reasons. Instead, activities must offer the immediate reward of being fun as well as developmentally appropriate. Physical activities that an adolescent or child may enjoy include dancing, jumping rope, swimming, skating, skateboarding, and team sports. Children and adolescents who have been sedentary should increase activity levels in increments to reach the overall recommendation of 60 minutes per day [18].

Family involvement in the activity plan is recommended to provide support to the child with diabetes and to promote the overall health of the family [16]. Exercising with others, such as parents and friends, promotes the pleasurable aspects of the program and validates its importance [58]. Because finding time to exercise can be challenging for many families, quality school programs that encourage physical activity are also very important. Children should be encouraged to participate in as many different sports as possible. Most importantly, the child must enjoy whatever activities are being encouraged to ensure that he or she will want to continue with them on a regular and consistent basis.

Reduced exercise tolerance is a problem in most overweight children with type 2 diabetes. Walking is considered one of the best forms of activity for those who are exercise intolerant. Walking regimens must be started slowly and engaged in for short periods of time to build tolerance.

Obese children are likely to be uncomfortable participating in organized sports activities. Therefore, other ways of being active should be encouraged. Obese children should begin with a limitation on access to television and increasing non-weight-bearing activities such as swimming, cycling, and paced walking [18].

MEDICATIONS

Evidence suggests that type 2 diabetes in youth is different not only from type 1 diabetes but also from type 2 diabetes in adults. Additionally, given the current obesity epidemic, distinguishing between type 1 and type 2 diabetes in children can be difficult [20]. Accurate diagnosis is critical. Although general treatment goals for patients with the two diagnoses are the same, specific treatment regimens differ markedly between patients with type 1 and type 2 diabetes.

The ADA recommends the initiation of pharmacologic therapy, in addition to lifestyle therapy, at diagnosis of type 2 diabetes [20]. Insulin therapy should be initiated for children and adolescents who are ketotic, in diabetic ketoacidosis, or whose disease cannot be clearly identified as either type 1 or type 2 diabetes [3; 7; 20]. After acidosis is resolved, metformin should be initiated while subcutaneous insulin therapy is continued [20]. Patients treated with insulin therapy who do not meet glycemic targets should be moved to multiple daily injections with basal and premeal bolus insulins [20]. Patients initially treated with insulin and metformin who meet glucose targets (based on SMBG) can be tapered over two to six weeks by decreasing the insulin dose 10% to 30% every few days [20].

In 2023, the U.S. Food and Drug Administration (FDA) approved empagliflozin (Jardiance) and empagliflozin plus metformin (Synjardy) for use in the treatment of type 2 diabetes in children 10 years of age and older [59]. The safety and efficacy of empagliflozin in children were studied in a double-blind, randomized, placebo-controlled trial in 157 patients 10 to 17 years of age with inadequately controlled type 2 diabetes. Participants were randomly assigned to one of three treatment arms for 26 weeks: empagliflozin, a DPP-4 inhibitor (linagliptin), or placebo. At the beginning of the trial, 51% of patients were taking metformin alone, 40% of patients were taking a combination of metformin and insulin, 3% of patients were taking insulin alone, and 6% of patients were not taking other medicines for diabetes. The trial found that, at week 26, treatment with empagliflozin was superior in reducing hemoglobin A_{1c} compared with placebo. Patients treated with empagliflozin also had reductions in fasting plasma glucose, compared to patients taking placebo [59]. Jardiance and Synjardy received FDA approval in 2014 and 2015, respectively, as an adjunct to diet and exercise for treatment of type 2 diabetes in adults [59; 60].

Table 6 lists various medications used in the treatment of type 2 diabetes, although many are not labeled for use in children. Metformin and insulin are approved for children with type 2 diabetes [20; 31]. In addition, the GLP-1 agonists dulaglutide, extended-release exenatide, and liraglutide are approved for use in children 10 years of age and older if glycemic targets are not met with metformin (with or without insulin) and if the child's medical and family history allow [20; 60]. In metabolically stable patients, metformin, if not contraindicated and if tolerated, is the preferred initial pharmacologic agent for the treatment of type 2 diabetes [20].

Metformin acts by decreasing the amount of glucose produced by the liver and improving insulin sensitivity. For adolescents using metformin, it is important to screen for alcohol abuse, including binge drinking, as this medication is contraindicated in those with moderate-to-heavy alcohol use. Besides being effective in lowering blood glucose levels, metformin has other advantages:

- Metformin does not put the child at risk for hypoglycemia when used as the sole pharmacologic agent to treat diabetes. This is especially important in pediatric patients who typically do not appreciate the seriousness of hypoglycemia or respond appropriately to its symptoms.
- Metformin has a beneficial effect on the lipid profile, potentially lowering both low-density lipoprotein cholesterol (LDL-C) and triglyceride levels.

PHARMACOLOGIC TREATMENT OF TYPE 2 DIABETES			
Agent	**Mechanism of Action**	**Route**	**Possible Side Effects and Patient Education Needs**
Insulin	Allows glucose to enter cell for conversion to energy	Subcutaneous	Injection techniques Risk for hypoglycemia; instruct on signs, symptoms, treatment, and prevention
Biguanides (metformin)	Regulates release of stored glucose from liver Increases insulin sensitivity	Oral	Caution against the use of alcohol, especially binge drinking. Most common side effects are headache, nausea, vomiting, and diarrhea, but they subside within weeks of starting therapy. Diminished appetite with resulting weight loss may occur. Medication should be withheld when undergoing procedures that utilize radio contrast material. Lactic acidosis is a very rare but life-threatening risk; instruct patient on treatment and on signs and symptoms, which include myalgia, fatigue, dizziness, difficulty breathing, and gastrointestinal discomfort.
Sulfonylureas[a] (glipizide, glyburide)	Increases insulin secretion from pancreas Regulates glucose output from liver Increases insulin sensitivity	Oral	Risk for hypoglycemia increases with inadequate caloric intake, strenuous exercise, or concurrent use of other hypoglycemic agents; instruct on signs, symptoms, treatment, and prevention.
Thiazolidinediones[a] (pioglitazone)	Increases insulin sensitivity Regulates glucose output from liver	Oral	Risk for hypoglycemia with concurrent use of insulin or sulfonylureas; instruct on signs, symptoms, treatment, and prevention. May cause fluid retention. May cause rare, but serious, effect on the liver; regular monitoring of liver function is necessary.
Incretin mimetics or GLP-1 analogues[a] (exenatide, dulaglutide, liraglutide)	Increases insulin secretion from pancreas	Subcutaneous	Injection techniques Inject with meals Risk for hypoglycemia with concurrent use of sulfonylureas; instruct on signs, symptoms, treatment, and prevention. Modest weight loss may occur. Use with metformin and/or sulfonylureas. Most common side effect is nausea, which tends to improve over time as optimal dosage is reached.
Sodium-glucose cotransporter 2 (SGLT2) inhibitor (empagliflozin)	Increases excretion of glucose in urine Reduces sodium reabsorption	Oral	Dyslipidemia, increased thirst, nausea urinary tract infection
Dipeptidyl peptidase-4 (DPP-4) inhibitors[b] (sitagliptin)	Increases insulin secretion from pancreas Decreases glucagon secretion from pancreas	Oral	May cause mild headache, stuffy or runny nose, sore throat, or diarrhea. Take with or without food.
[a]Only liraglutide is labeled for pediatric use. [b]Off-label for pediatric use.			
Source: [20; 31; 59; 60; 61]			*Table 6*

MANAGEMENT OF HYPOGLYCEMIA	
Definition	Blood glucose less than 70 mg/dL
Signs and symptoms	Shakiness, sweating, confusion, irritability, weakness, hunger, blurred vision
Treatment (for children older than 6 years of age and adults)	15 grams of fast-acting carbohydrate Sources include: • 3 to 4 glucose tablets or glucose gel equivalent to 10 to 15 grams • 4 to 6 ounces fruit juice • 6 to 8 ounces skim milk • 4 to 5 ounces regular soft drink • 5 to 6 hard candies
Follow-up	Recheck blood glucose 15 minutes after initial treatment. If the level is still less than 70 mg/dL, treat again with 10 to 15 grams of fast-acting carbohydrate. When blood glucose is greater than 70 mg/dL, eat the regularly scheduled meal or snack.
Prevention	Do not skip meals. If a meal will be delayed, eat a snack. Check blood glucose before exercise. If it is less than 100 mg/dL, have a snack. Use abdomen for insulin therapy for more consistency of absorption. Rotate sites within the abdominal area. Carry a source of fast-acting carbohydrate and wear medical identification at all times when exercising. Make sure that coaches, teachers, and other supervising adults are aware of the signs, symptoms, prevention, and management of hypoglycemia.

Source: Compiled by Author *Table 7*

- Metformin may aid in weight loss.
- Metformin may normalize ovulatory function in girls with PCOS.

When monotherapy with metformin does not result in appropriate glucose control after three months, other oral medications such as thiazolidinediones, sulfonylureas, incretin mimetics, or sodium-glucose co-transporter 2 inhibitors may be added. Further, insulin may be used alone or with oral medications [7; 20]. A combination of metformin plus rosiglitazone has been found to be more effective than metformin alone [34]. Use of medications not approved by the FDA for youth with type 2 diabetes is not recommended outside research trials [20].

The most common and serious side effect of using insulin is hypoglycemia. An important consideration in any age group, it is of special concern in children because they are believed to be less careful about preventing and recognizing the symptoms [62]. When insulin is used, parents and children must be educated on the signs, symptoms, causes, and treatment of hypoglycemia (***Table 7***).

TREATMENT OF MENSTRUAL IRREGULARITIES ASSOCIATED WITH PCOS

Oral contraceptive agents with low androgenic activity are often prescribed to normalize menstrual cycles in cases of PCOS. Metformin can also increase menstrual regularity. Often prescribed in tandem, oral contraceptives and metformin appear to work synergistically in normalizing reproductive function. Metformin should be prescribed with caution in sexually active young women with PCOS, as this could increase the risk for unplanned pregnancy. Counseling on abstinence, safer sex practices, and birth control options is strongly indicated in teens.

REDUCTION AND MONITORING OF LONG-TERM COMPLICATIONS

ROUTINE MONITORING

The prevention and control of long-term complications in young patients with diabetes is of vital importance due to the increased risks associated with earlier disease onset. The coexistence of obesity, hypertension, and dyslipidemia, which are common in children with type 2 diabetes, greatly increases the risk for cardiovascular disease. Because of the seriousness of these complications, hypertension and dyslipidemia must be aggressively treated and should be considered as important as blood glucose control. These comorbidities are often already present at the time of diagnosis. Therefore, the ADA recommends that blood pressure measurement, fasting lipid profile, microalbuminuria assessment, and dilated eye exam be performed at the time of diagnosis [20]. In addition to cardiovascular risk, hypertension is a risk factor for the development of eye and kidney disease. Routine preventive care can often delay or slow the progression of complications by ensuring early treatment. The routine preventive care schedule recommended for all patients with diabetes consists of [3; 7; 20]:

- Annual dilated eye exam or less frequent monitoring when advised by an eye care professional
- Annual screening for early, microscopic protein loss from the kidneys (microalbuminuria)
- Annual lipid panel if lipids are abnormal, or if LDL-C levels remain less than 100 mg/dL, repeat lipid profile every five years
- Blood pressure monitoring at each office visit
- Foot exam at each office visit, including annual test for sensation using a monofilament
- Hemoglobin A_{1c} test every three months

HYPERTENSION TREATMENT

Careful control of blood pressure is imperative for the prevention of early-onset cardiac and renal disease in this population [20]. One large study concluded that strict blood pressure management in adults with type 2 diabetes was related to a significant reduction in cardiovascular morbidity, including a 44% reduction in stroke and a 56% reduction in heart failure [63]. Therefore, blood pressure should be monitored regularly and treated aggressively in children with diabetes when either the diastolic or systolic reading is consistently at or above the 95th percentile for age, sex, and height [20]. Nonpharmacologic measures to reduce blood pressure include dietary intervention and physical activity aimed at weight control. Angiotensin-converting enzyme (ACE) inhibitors or angiotensin receptor blockers (ARBs) should be initiated for treatment of confirmed hypertension. Patients of childbearing potential should be advised that these medications have potential teratogenic effects and pregnancy should be avoided while taking them [20].

ACE inhibitors are generally considered first-line pharmacologic agents to treat hypertension in young people with type 2 diabetes [20]. These agents are preferred because, in addition to their lowering effects on blood pressure, they are known to have an independent renal protective function when microalbuminuria is present.

DYSLIPIDEMIA TREATMENT

Dyslipidemia outweighs all other risk factors for the development of cardiovascular disease in adults with type 2 diabetes. There is increasing evidence that the atherosclerotic process is present in childhood, beginning as early as 10 years of age [64]. Lipid disorders occur comorbidly in most people with type 2 diabetes, including children. Like hypertension, lipid disorders must be treated aggressively. Optimal goals for children and adolescents are LDL-C less than 100 mg/dL, HDL-C greater than 35 mg/dL, and triglycerides less than 150 mg/dL [20].

First-line therapy for dyslipidemia includes lifestyle management aimed at optimizing glucose control and weight loss through healthy eating and increased physical activity. If LDL-C remains greater than 130 mg/dL after six months of dietary intervention, treatment with statins is indicated, with a goal of LDL-C less than 100 mg/dL [20].

The American Heart Association has established these dietary recommendations for preventing cardiovascular disease [51]:

- Consume an overall diet rich in fruits, vegetables, whole grains, fat-free and low-fat dairy foods, legumes, and lean protein.
- Include fish, especially oily fish, at least twice a week.
- Limit total fat intake to less than 25% to 35% of total calories each day.
- Minimize intake of excess calories, saturated and trans fats, cholesterol, salt, alcohol, and sugar.

DEVELOPMENTAL ISSUES

Type 2 diabetes in young people occurs more commonly in late childhood or adolescence due to hormonal changes during this stage of life. The developmental issues of children during these years can complicate the attainment of therapeutic goals. For example, a young person is more likely to be motivated by the short-term gratification of consuming high-fat snacks while watching television than the long-term benefits of following a healthier food and activity plan. For this reason, members of this age group tend to be poorly adherent to the types of self-care behaviors recommended to manage diabetes.

SCHOOL-AGED CHILD (6 TO 12 YEARS OF AGE)

Parents still take major responsibility for the healthcare needs of school-aged children, including responsibility for what foods are eaten. However, the school-aged child's environment is expanding, with more activities out of the home and away from parents. The importance of the peer group and fear of being different from others are basic developmental issues in this age group. At the same time, these children are especially impressionable to the examples set by parents and other adults. As adolescence approaches, the importance of body image intensifies. Children at this age also begin experimenting with independent decision making and may begin to challenge authority. By 12 years of age, most children can manage their own insulin therapy, but parents must supervise to ensure that doses are not missed or forgotten.

School Concerns

Every child's school should be informed that he or she has type 2 diabetes. While most school professionals understand the fundamentals of type 1 diabetes, many may be unaware of type 2 diabetes as an emerging phenomenon. School personnel may require education on how this disorder differs from type 1 diabetes. For example, they may not understand that a child with diabetes being managed by a food and activity plan will not be at risk for hypoglycemia if he or she skips a snack. On the other hand, if the child uses sulfonylurea medication or insulin to manage diabetes, school personnel must be aware of the potential for hypoglycemia, including its signs, symptoms, causes, prevention, and treatment. By federal regulation, schools must allow children to monitor blood glucose in the classroom and take appropriate action during the school day to prevent or treat hypoglycemia and hyperglycemia. Printed information for school personnel about children with diabetes is available from the ADA [65].

ADOLESCENT (13 TO 18 YEARS OF AGE)

Even without having to face a chronic illness, adolescence is a complex time for many. Major issues during this stage of life include hormonal fluctuations and sexual development, changes in body image, and strong peer influences. The struggle for independence from parents and other authority figures may lead some adolescents to ignore treatments and falsify blood glucose results. Basic identity issues are important during this time and extend into young adulthood. Risk-taking is a characteristic at this stage, and substance abuse is a well-known related problem. Substance misuse may interfere with the treatment plan and can even be the source of dangerous interactions if the patient is using certain types of medications to manage diabetes. Healthcare providers should be aware of these developmental issues and plan to spend quality, one-on-one time with adolescents to explore the barriers to self-care that are perceived by the patient. Parents need support and guidance during this time as well.

Sexual Identity

Sexual development and related identity issues are at the forefront of adolescent development. Responsible management of all women with diabetes who are in the childbearing years includes preconception planning, as poor glycemic control significantly increases the risk for childbirth complications and fetal anomalies. Sexuality education for adolescents should include discussion of abstinence, contraception, and infection prevention. For those who are already sexually active or are planning to become sexually active, methods of contraception should be discussed [66]. Patients being treated with metformin for PCOS should be cautioned that as the symptoms of PCOS subside, fertility normalizes and the risk for pregnancy will significantly increase with unprotected intercourse.

Approaches to Adolescents with Diabetes

Adolescents should be allowed as much control as possible in the management of diabetes while being assisted to set goals. Using food and exercise logs may be useful in this population because they provide a sense of control and feedback that validates their efforts. Because adolescents often resent dependence upon adults, it is counterproductive to strictly supervise their goals and activities. Experts suggest giving young people goals to reach and allowing them to make their own choices about how they will accomplish them [62].

COUNSELING PARENTS OF CHILDREN AND ADOLESCENTS WITH TYPE 2 DIABETES

Having a child with diabetes places stress on the family and usually requires behavioral adjustments. Parents need support because the manner in which they relate to the child with diabetes will affect how the child deals with the disease. Parents need to help their children accept and adjust to the diagnosis and to engage them, along with the entire family in behavior modification. Parents may react with feelings such as guilt or embarrassment, especially if they perceive that they are to blame for the contributing lifestyle features that increased the child's risk for type 2 diabetes. Parents may respond to the stress of having a child with diabetes with a variety of coping behaviors. Two common parental coping strategies, overindulgence and rigidity, represent opposite ends of the continuum.

EVIDENCE-BASED PRACTICE RECOMMENDATION

The National Guideline Alliance recommends giving children and young people with type 2 diabetes and their family members or carers (as appropriate) information about local and/or national diabetes support groups and organizations, and the potential benefits of membership.

(https://www.nice.org.uk/guidance/ng18. Last accessed February 19, 2024.)

Level of Evidence: Expert Opinion

OVERINDULGENCE

Some parents may think that the recommended lifestyle changes may be too difficult for the child to handle. They may also feel sorry for the child and fear that the child is fragile due to his or her illness. In this case, they may respond inappropriately by failing to place limits on the child's eating or by forgoing blood glucose monitoring because it hurts. If parents seem overindulgent, the appropriate intervention is to explore the reasons why they behave this way. Are they afraid? Do they lack confidence? Do they feel guilt? What is their readiness to change? Feelings of fear or lack of confidence can often be overcome with education and support. Teach parents that their behavior may be reinforcing their child's own sense of inadequacy. Always identify the stage of change that the family is in and provide interventions accordingly.

RIGIDITY AND PERFECTIONISM

Some parents may cope by trying to achieve perfection in meeting therapeutic goals. This is manifested by rigid adherence to diet and unrealistically expecting blood glucose values to be within the target range all of the time. In these cases, parents should be educated that their child's self-esteem may be threatened by the overemphasis on treatment. They can also be educated that it is appropriate to make compromises in the meal plan as long as the overall eating pattern is healthy. For example, cake and ice cream for a birthday may add calories and raise blood sugar, but consumption of these types of food can occasionally be accommodated by working them into the entire day's meal plan and by maintaining or increasing physical activity.

Reassure these parents that "ideal" control is not necessary all of the time, and encourage them to work with the child for the best control. Also educate parents that blood glucose target ranges are usually guidelines to strive for and that occasional out-of-range results will not adversely affect health in the long run. Caution them to avoid words like "cheating" and "bad blood sugar," as this may be construed by the child as personal failure or misbehavior. Parents and healthcare providers can help the child avoid some of these detrimental feelings by reminding him or her that the target levels are used as a guide and are not a reflection of failure [67].

TRANSITIONING FROM PEDIATRIC TO ADULT CARE

As youth move from childhood to adolescence, diabetes management is gradually shifted from parent to child. However, this shift often occurs more abruptly as teens enter the developmental stage that theorists refer to as "emerging adulthood"—a critical period between 18 and 25 to 30 years of age [20; 68; 69]. This is generally the time when youth begin to leave their parents' home and must become fully responsible for their diabetes care. These responsibilities include diabetes self-management, making medical appointments, and financing health care (if they are no longer covered by their parents' insurance plans). It is also a time associated with a deterioration in glycemic control; increased occurrence of acute complications; psychosocial, emotional, and behavioral challenges; and the emergence of chronic complications [70; 71; 72; 73]. The transition from pediatric to adult health care often leads to fragmented healthcare delivery, which negatively impacts healthcare quality, cost, and outcomes [74].

To facilitate a seamless transition from pediatric to adult health care, comprehensive, coordinated planning for the transition should begin in early adolescence, preferably at least one year prior to the expected date of transition [20; 75; 76]. A discussion of the challenges faced during this period and specific recommendations for managing them may be found in the ADA position statement *Diabetes Care for Emerging Adults: Recommendations for Transition From Pediatric to Adult Diabetes Care Systems* [71]. Additionally, the Endocrine Society, in collaboration with the ADA and other organizations, has developed transition tools for clinicians, youth, and families that may be accessed at https://www.endocrine.org/improving-practice/transitions [76].

PREVENTION OF TYPE 2 DIABETES IN YOUTH

An important topic of research is to determine if type 2 diabetes can be prevented in high-risk individuals. A landmark study involving more than 3,000 adult participants at 27 centers nationwide has concluded that it can. The DPP found that people with IGT coupled with being overweight were able to prevent or delay the onset of type 2 diabetes through a program of weight loss and moderate physical activity [25]. Additional research is needed to evaluate if similar results can be achieved in children.

Due to the complex social and environmental factors that affect youth with type 2 diabetes, individual lifestyle interventions may not be sufficient [33]. The effort to prevent type 2 diabetes in children requires a public health approach. This involves education and legislation that discourages unhealthy food consumption and sedentary activity patterns while providing for healthier alternatives.

Public education should be family-centered and provide children and parents with knowledge and avenues for behavioral change. Information should be made widely available to teach families the importance of consuming healthy diets and engaging in regular physical activity. Furthermore, the public should be made aware of the detrimental impact that aggressive marketing by fast-food restaurant chains and processed food manufacturers has had upon our public health. Many ads for unhealthy foods are aimed at increasing consumption rather than promoting nutrition. The public should know that the low cost and convenience of enhanced portion sizes (e.g., "all you can eat," "super-size") come at the price of serious risk to health. All of these educational approaches should be multicultural in nature, taking into account the various health beliefs and dietary patterns of the populations directly affected by current rates of obesity and diabetes. Legislative action should focus on developing and implementing school- and community-based programs that result in increasing physical activity and preventing obesity by ensuring that all families have access to healthy foods, quality health care, and safe spaces for physical activity [33]. One study of high-risk obese Latino youth found that completion of a 12-week community-based diabetes prevention program resulted in significant decreases in BMI score, BMI percentile, and waist circumference; increases in cardiorespiratory fitness; and decreases in physical inactivity and dietary fat consumption. The community-based program also resulted in significant improvements in insulin sensitivity and reductions in two-hour glucose levels [77].

The CDC has compiled a set of guidelines designed to help schools develop, implement, and evaluate school-based healthy eating and physical activity policies for students [78]. Schools are prime locations for reaching young people at a time when health habits are being established [67; 79]. The CDC also offers "BAM!" (Body and Mind). BAM is an

online information portal for teachers of students in grades 4 to 8, designed to help these students make healthier lifestyle choices [80]. It is essential that schools provide health education and targeted interventions for at-risk youth. Furthermore, lunch programs should offer healthy choices and strictly limit food that is high in fat and sugar from their cafeterias, food courts, and vending machines. This is especially important today, as many families rely heavily on convenience foods at home, which are often high in fat and low in fiber. Physical education and school-based exercise programs are also very important in promoting the health of our children. Because working parents may not have time to exercise with their children and many children live where it is not safe to exercise outside without adult supervision, it cannot be assumed that children will have access to a physical activity program outside school. If the health of our children is not enough impetus to provide for physical education, further justification comes from neuroscientific studies showing that exercise promotes brain growth and improved cognitive function [81].

SUMMARY AND CONCLUSION

Growth in the number of children being diagnosed with type 2 diabetes is closely related to a significant increase in the rates of overweight and obesity in children. Other risk factors, such as ancestry, family history and gender, are also implicated in the development of type 2 diabetes in youth. Insulin resistance and its relationship to type 2 diabetes has been identified as the primary pathophysiologic factor related to the onset of this disorder. The menacing combination of high insulin levels, high blood pressure, and dyslipidemia in these children is of particular concern, as it greatly increases the risk for early-onset cardiovascular disease and other complications.

Treatment of type 2 diabetes in children and adolescents includes weight loss, increasing physical activity, following a healthy meal plan, and in many cases, medications. Preventing complications such as retinopathy, nephropathy, neuropathy, and cardiovascular disease is a goal of utmost importance in the management of diabetes in young people. A developmental approach is important in offering healthcare interventions to pediatric patients with type 2 diabetes and their families. Furthermore, the importance of family support in managing weight and increasing physical activity is immeasurable. Finally, from a public health perspective, measures to curtail the current growth in the number of children with type 2 diabetes must be taken. The aim of this course has been to provide healthcare professionals with information that will help them understand the causes, treatment, and prevention of this serious problem affecting today's youth.

RESOURCES FOR CHILDREN WITH DIABETES

Organizations that are helpful to parents and children with diabetes can be found locally, nationally, and on the Internet.

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

The website provides comprehensive information on all aspects of diabetes for healthcare providers and the general public. A chat line and community discussions are available. Includes web page for parents and children. "Imagine Camp" is designed to facilitate an at-home, virtual experience connecting kids and families to help them learn new diabetes management skills that build confidence [82].

Callers to the national telephone number can receive information about all aspects of diabetes management. Local programs include diabetes education classes, youth programs, counseling and support groups, and information services.

Juvenile Diabetes Research Foundation International
https://www.jdrf.org
1-800-533-CURE (1-800-533-2873)

This organization is dedicated primarily to funding and research activities related to finding a cure for type 1 diabetes. The website has pages on treating low blood sugar, dealing with children's feelings, and control through diet and exercise that would be helpful to parents of children with type 2 diabetes.

Children with Diabetes
https://childrenwithdiabetes.com

This is a comprehensive online community for children with diabetes and their families. In addition to news features and education, the site has chat rooms, surveys, polls, and an online specialty store for children with diabetes. Assistance in finding a diabetes camp is also available at this site.

KidsHealth
https://kidshealth.org

A child- and teen-friendly website with information on health topics and healthy living. Includes animation, games, and other interactive, developmentally appropriate content.

Implicit Bias in Health Care

The role of implicit biases on healthcare outcomes has become a concern, as there is some evidence that implicit biases contribute to health disparities, professionals' attitudes toward and interactions with patients, quality of care, diagnoses, and treatment decisions. This may produce differences in help-seeking, diagnoses, and ultimately treatments and interventions. Implicit biases may also unwittingly produce professional behaviors, attitudes, and interactions that reduce patients' trust and comfort with their provider, leading to earlier termination of visits and/or reduced adherence and follow-up. Disadvantaged groups are marginalized in the healthcare system and vulnerable on multiple levels; health professionals' implicit biases can further exacerbate these existing disadvantages.

Interventions or strategies designed to reduce implicit bias may be categorized as change-based or control-based. Change-based interventions focus on reducing or changing cognitive associations underlying implicit biases. These interventions might include challenging stereotypes. Conversely, control-based interventions involve reducing the effects of the implicit bias on the individual's behaviors. These strategies include increasing awareness of biased thoughts and responses. The two types of interventions are not mutually exclusive and may be used synergistically.

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