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# METABOLIC DISORDERS IN CHILDHOOD: FOCUS ON D IABETES MELLITUS

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**ABSTRACT :**

This article talks about diabetes in kids. It's a long-term health problem where their bodies don't handle sugar right because they don't have enough insulin or their bodies can't use it well. The article explains how common it is, what causes it, how it messes with the body, what the symptoms are, how to diagnose it, and how to treat it. It focuses on really understanding and controlling the disease. The article says finding it early, teaching kids and families about it, and changing habits a re super important to avoid problems later on and help kids live healthier lives.

**Keywords**: Diabetes, kids, insulin, sugar, type 1, type 2, treatment, problems.

## Introduction

Diabetes is a really common long-term health issue kids can get all over the globe. It's a bunch of different problems that all lead to high blood suga r because the body isn't making enough insulin, isn't using it right, or both. More and more kids are getting diabetes, which is becoming a big worry for everyone's health. Type 1 diabetes is what you see most in kids. But, since more kids are obese and not getting enough exercise, type 2 diabetes is also showing up more often. If you want to give kids the best care, it's important to learn about how diabetes works, how to spot it, and how to handle it.

## Etiology

Diabetes in kids is a long-term health issue where blood sugar stays too high. It happens when the body has trouble with insulin, either not making enou gh, not using it right, or both. A bunch of stuff causes it, like genes, things around them, and sometimes a virus. The two main types are Type 1 and Type 2, and they start in different ways.

**1. Genes**

If it runs in the family: Type 1 diabetes can be passed down. Some genes make it more likely, especially if other family members have it. Like, if mom has Type 1, the kid has a 3–5% chance of getting it. If dad has it, the kid's chances are 6–8%.

Weird gene stuff: Sometimes, a change in one gene messes with how insulin is made.

**2. Body attacking itself (Type 1 Diabetes)**

Immune system gone wrong: Type 1 happens when the body's defense system mistakenly wipes out the cells in the pancreas that create insulin.

Antibodies: Certain signals in the blood can point to this attack.

What kicks it off: For some kids with the right genes, a virus or something in their area might trigger the immune system to kill those insulin cells.

**3. What's around them**

Virus stuff: Some viruses might trick the body into attacking the pancreas.

What they eat early on: Giving babies certain foods too early might be risky.

Bad stuff in the air or food: Being around strong toxins might harm the pancreas and cause problems.

**4. Weight and Insulin Issues (Type 2 Diabetes)**

Kids being overweight: More fat can mess with how insulin works, so the body makes more. Eventually, the pancreas gets tired and can't keep up.

Not moving much: Sitting around a lot makes insulin work worse and leads to weight gain.

Food: Eating too much junk food can cause Type 2 in some kids.

**5. Body Changes**

Growing up: Hormones during puberty can throw off insulin for a bit, which can show diabetes in those who are already at risk.

Body stress: Being overweight or having other health problems can hurt how insulin works.

**6. Mom Stuff**

Diabetes during pregnancy: If mom had diabetes while pregnant, the kid is more likely to have weight issues and Type 2 later on.

Growth issues before birth: Babies who didn't grow normally in the womb might have fewer insulin cells and struggle with insulin later in life.

## Pathogenesis

Diabetes in kids usually happens when their bodies don't make enough insulin, or the insulin doesn't work right, or both. This leads to high blood sugar all the time. It can be Type 1 or Type 2 diabetes, and they both work differently.

### *Type 1 Diabetes*

This is the most common type in kids. It's like the body's defense system gets confused and attacks the cells in the pancreas that make insulin (called beta cells).

How it happens:

1. Genes play a role:

Some kids have genes, mostly in the HLA area (HLA-DR3, HLA-DR4, DQ alleles), that make them more likely to have their bodies attack their own beta cells.

2. Things in the world can set it off:

Things like infections from viruses (like coxsackievirus, mumps, or rubella), drinking cow's milk too early, and not getting enough vitamin D might c ause the body to start attacking itself in kids who are already likely to get it.

3. Body Attacks Itself:

The body makes things called autoantibodies (like anti-GAD, ICA, and insulin autoantibodies) that find and kill the beta cells in the pancreas over time.

4. Beta Cells Die:

As the beta cells slowly die off, the body makes less and less insulin. When about 80–90% of the beta cells are gone, the body is in big trouble due to the lack of insulin.

5. What happens then:

Cells can't get enough glucose → high blood sugar

Fat breaks down faster → ketones form → ketoacidosis

Too much glucose in the urine → dehydration and electrolyte imbalance

### *Type 2 Diabetes*

This is less common in kids, but it's happening more often because more kids are obese and not active.

How it happens:

1. Insulin Doesn't Work Well:

The body's tissues (like muscle, liver, and fat) stop responding to insulin, mostly because of obesity and too many free fatty acids.

2. Pancreas Gets Tired:

At first, the pancreas tries to fix the issue by making more insulin, but after a while, the beta cells get tired and can't keep up.

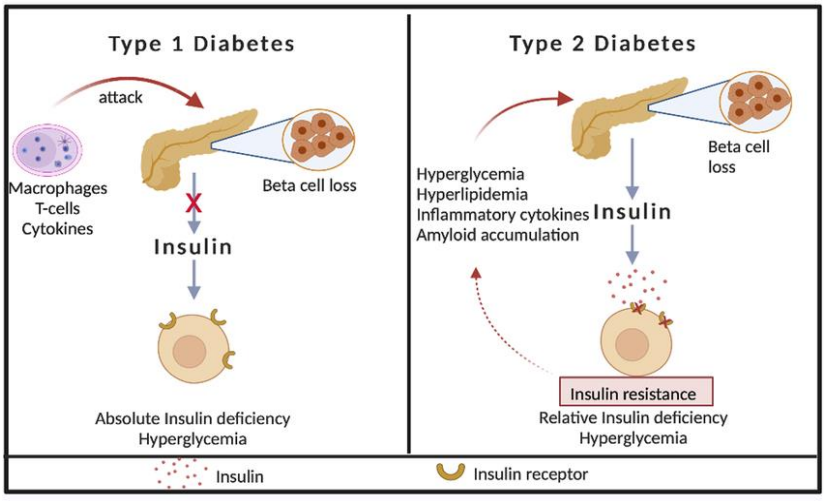
3. Blood Sugar Problems:

The insulin doesn't work well, and the pancreas can't make enough, so blood sugar stays high.

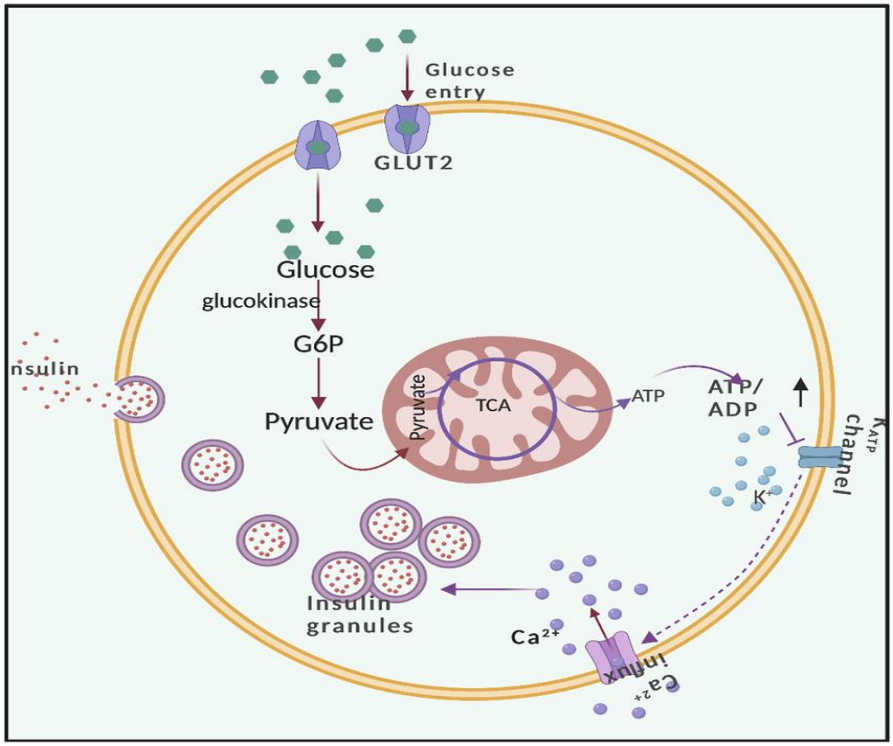
4. Things that Cause It:

Genes, bad diet, not enough exercise, and hormones changing during puberty (which make insulin resistance worse).

**Differential representation of *Type 1* and *Type 2 diabetes mellitus* :**



**Schematic representation of pathway of diabetes mellitus:**




## Epidemiology

Diabetes is a really common long-term illness for kids and teens all over the world. It's been popping up more and more these days, like both Type 1 and Type 2. This is because of genes, where you live, and how you live.

**1. Big Picture Look**

When kids get diabetes, it's usually Type 1 or Type 2. Type 1 is most of the time, like 85–95% of cases. Type 2 wasn't common in children very long ago, but now it's showing up as weight issues and not getting enough exercise is happening more often. The number of Type 1 cases worldwide goes up by about 3–5% each year, mostly in kids under 15.

**2. How Often It Happens**

How common Type 1 is depends on where you are. It's highest in Northern Europe (like Sweden and Finland), medium in the US and parts of Asia, and lo west in places like sub-Saharan Africa and South America. They think around the world, about 1 in 300 to 1 in 500 kids will have Type 1 by the time they're 18. Type 2 is also happening more now, especially in countries still developing and among certain groups of people, like those from Africa, Hispanic countries, and Asia.

**3. Who Gets It and When**

Type 1 can start at any age, but it usually shows up when kids are between 5 and 15. It might be slightly more common in boys, but that changes based on where you live. Type 2 usually happens when teens are going through puberty because their hormones change and their body doesn't react to insulin as well.

**4. Where You Live Matters**

How common diabetes is in kids changes a lot depending on geography. It's high in Northern Europe (like the UK, Finland, and Sweden), medium in North America, and going up super fast in Asia, the Middle East, and Latin America. This might have to do with what people eat, what's in the environment, viral infections, and how much vitamin D people get.

**5. What Makes It More Likely**

Genes: If someone in your close family has diabetes, you're more likely to get it too.

What's around you: Things like viral infections, poisons, and drinking cow's milk when you're a baby might cause Type 1.

How you live: Sitting around too much, eating too many calories, and being overweight are causing more cases of Type 2 in kids.

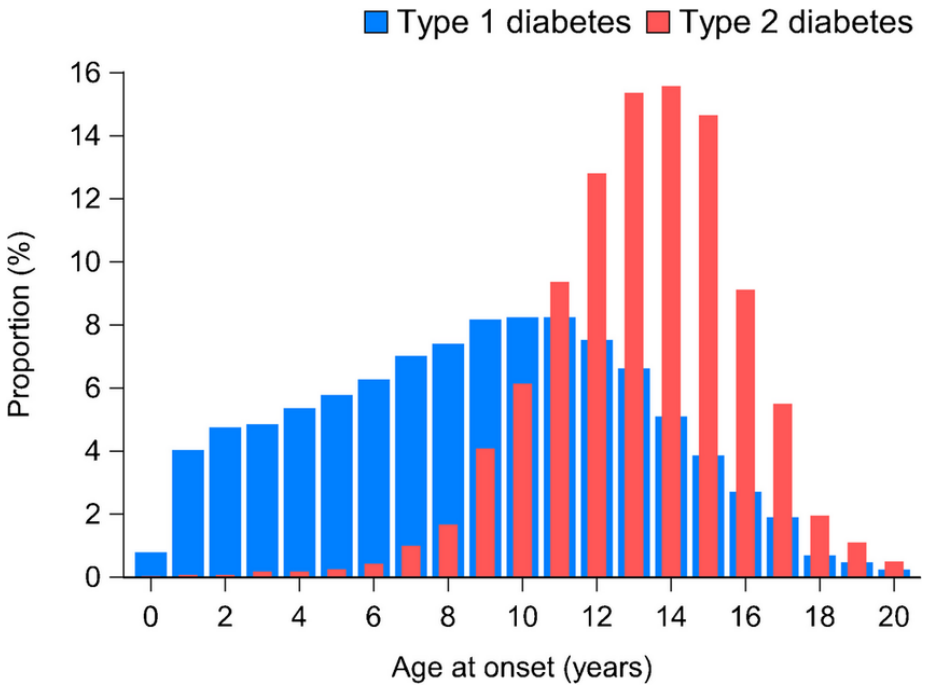
City life: Kids in cities are more likely to get it because of their lifestyle compared to kids in the countryside.

**6. Problems It Causes**

Kids dying from diabetes is not very common in rich countries because they're better at finding it and treating it with insulin. But if it takes too long to find it or people can't get insulin, that can still cause kids to die from something called diabetic ketoacidosis (DKA) in countries that are still developing. Over time, things like problems with their eyes and kidneys can show up sooner if people don't have good control over their diabetes.

**7. What's Happening in Countries Still Developing**

More kids are getting Type 1 and Type 2 diabetes in countries that are still developing. Money problems, not being able to get to the doctor easily, and n ot knowing enough about it mean it's found late, and things don't go as well.




**Graphical representation of diabetes mellitus**

## Classification

Diabetes in kids is a bunch of conditions where blood sugar is too high for a long time. This happens when the body doesn't make enough insulin, doesn't use it well, or both. There are different kinds, depending on what causes it.

**1. Type 1 Diabetes (T1DM)**

What it is: The body's immune system attacks and destroys the cells in the pancreas that make insulin, so the body can't make insulin at all.

Types:

Immune-related (Type 1A): The body makes antibodies that attack the pancreas.

Not immune-related (Type 1B): The pancreas is destroyed, but not because of antibodies. This is more common in some groups of people.

When it starts: Usually in teens and kids.

What it's like: It starts suddenly, can cause ketoacidosis (a dangerous condition), and needs insulin shots for life.

**2. Type 2 Diabetes (T2DM)**

What it is: The body doesn't use insulin well, and eventually, it might not make enough.

What causes it: Usually related to being overweight, not getting enough exercise, and genes.

When it starts: More and more teens and kids are getting it.

What it's like: It starts slowly, doesn't usually cause ketosis, and sometimes can be controlled with pills at first.

**3. Monogenic Diabetes (Single Gene Problems)**

This is caused by problems with one gene that affects how the pancreas works.

Maturity-Onset Diabetes of the Young (MODY): Passed down through families

Usually causes mild to medium-high blood sugar; usually doesn't need insulin shots.

Common gene problems: HNF1A, GCK, HNF4A.

Neonatal Diabetes:Shows up in the first 6 months of life. Can be temporary or permanent.

Caused by problems with the KCNJ11, ABCC8, or INS genes.

**4. Secondary Diabetes**

What it is: High blood sugar caused by other health problems or meds.

Causes:

- Hormone problems: Cushing's syndrome, acromegaly.
- Pancreas problems: Pancreatitis, cystic fibrosis.
- Caused by drugs: Steroids, antipsychotics, chemotherapy.
- Genetic Conditions: Down syndrome, Turner syndrome, Prader-Willi syndrome.

## Clinical Manifestation

When kids get diabetes, it usually shows up when their blood sugar is super high because their body isn't dealing with insulin right. This can happen fast with Type 1 diabetes or creep up slowly with Type 2.

What you'll usually see:

1. Peeing a Lot (Polyuria): Too much sugar goes into the pee, pulling extra water with it.
2. Super Thirsty (Polydipsia): All that peeing makes them dehydrated, so they drink a ton more.
3. Always Hungry (Polyphagia): Even with high blood sugar, their body can't use it properly, so they feel hungry all the time.
4. Losing Weight: They might drop weight even if they're eating normally. This is because their body is breaking down fat and muscle for energy.
5. Tired and Weak: Their cells don't get enough sugar, so they don't have the energy to do stuff.
6. Blurry Vision: High blood sugar messes with the shape of the eye's lens, making their vision blurry temporarily.
7. Bedwetting: Kids who used to stay dry at night might start wetting the bed again because they're peeing so much.
8. Getting Sick A Lot: They might get lots of skin, pee infections, or fungal infections because high sugar levels help germs grow and weaken their immu ne system.

**Type 1 Diabetes Stuff:**

Comes on Quick: Symptoms pop up in just a few weeks or days.

Acid Buildup (Ketoacidosis): If it gets bad, they might feel sick, throw up, have tummy pain, have breath that smells fruity (like nail polish remover), breathe really deep, and get dehydrated. This is serious and needs a doctor right away.

**Type 2 Diabetes Stuff:**

Sneaks Up Slowly: Symptoms take their time showing up, so you might not notice them.

Usually Overweight: Most kids with this are carrying extra weight.

Dark Skin Patches (Acanthosis Nigricans): Dark, thick skin patches, usually on the neck or armpits, can mean their body isn't responding to insulin correctly.

Slow to Heal: Cuts and scrapes might take longer to heal because of blood flow and immunity problems.

**How to Tell if It's Diabetes**

Doctors check for diabetes based on symptoms and lab tests that blood sugar is high and insulin isn't doing its job.

1. Doctor Checkup:

Usually, people think about diabetes when youngsters show signs of being very thirsty, peeing a lot, losing weight and feeling exhausted. They may feel sick, they might throw up, breathe fast, and get dehydrated

2. Lab work

Blood Sugar:

1. Fasting Blood Sugar (FBS): Measured after not eating for 8 hours.

`Diabetes: FBS ≥ 126 mg/dL twice`

2. Random Blood Sugar: At any time

Diabetes: Above 200 mg/dL with symptoms.

3. Oral Glucose Tolerance Test (OGTT): Drink glucose and test 2 hours later.

Diabetes: Above 200 mg/dL.

4. A1C: gives the average blood sugar levels for the last 2 to 3 months.

Diabetes: Above 6.5%

## Management

Taking care of kids with diabetes means keeping their blood sugar in check so they grow right, don't get sick, and live a good life. It takes a team of doctors, diet experts, nurses, shrinks, and family.

**1. How to Handle It**

Keep blood sugar steady, but don't let it get too low. Help kids grow and feel good. Stop them from getting really sick (like with DKA or low blood sugar) or having problems later on. Teach them and their families how to handle diabetes themselves.

**2. What You Need to Do**

Give Insulin: This is the main thing for kids with type 1 diabetes. The idea is to copy how a normal body releases insulin. There are different kinds that work fast, slow, or in between, like Lispro, NPH, or Glargine. You can use shots or a pump to give the insulin. The amount is usually around 0.5–1.0 units for each kg of body weight every day, but you change it based on blood sugar numbers.

Food Plan: Kids need enough calories to grow and play. It should be a mix of:

* Carbs: About half of the calories (like whole grains)
* Protein: A little less
* Fats: Even less (the good kind)

Try to eat food with lots of fiber and skip the sugary stuff. Eat meals at the same times you give insulin shots. Counting carbs can help you change insulin shots when meal times change.

Get Moving: Playing and sports make insulin work better and help keep weight in check. Kids should move for at least an hour a day—walking, biking, whatever. Check blood sugar before and after so it doesn't get too low. They might need a snack before doing hard stuff.

Check Blood Sugar: Use a blood sugar meter all the time—like 4–6 times a day (before eating, before bed, when sick). A continuous monitor can show blood sugar all the time and make things easier. Get an A1c test every 3 months; under 7.5% is the goal for kids.

Teach and Support: Families need to learn a lot to stick with the plan.

* How to give and store insulin.
* How to spot and treat low blood sugar and DKA.
* How to plan meals and activity.

If kids are stressed, talking to someone can help, especially for teens.

Type 2 Diabetes

The big key is changing habits: losing weight with food and exercise. Cut out sugary drinks and junk food. Meds that helps and sometimes they start on insulin if blood sugar isn't controlled or if there are ketones. Check for high blood pressure, bad cholesterol, and liver problems regularly.

When Sick:

Keep giving insulin, even if they don't want to eat. Check blood sugar and ketones more often. Make sure they drink enough liquids and eat easy-to-digest food with carbs. If they throw up or have high sugar all the time, check with the doctor.

Check for Problems:

Once a year:

* Eyes: Check for damage (after 5 years of diabetes or after age 10).
* Kidneys: Check urine.
* Nerves: Check for nerve problems.

Check thyroid and cholesterol. Keep blood pressure and cholesterol good.

**3. Keep Checking In**

Visit the doctor every few months to see how they're growing and how well the diabetes is controlled. Change insulin amounts when they hit puberty, get sick, or change their life. Encourage them to stick with the plan and deal with it well.

## Complications

Diabetes in kids can cause problems that pop up fast or stick around for a while. These issues mostly happen when blood sugar is high for too long, t hings aren't balanced in their bodies, or they're not getting the right treatment. Catching it early and taking good care of it is super important to dodge serious stuff and keep them growing like they should.

**1. Problems That Pop Up Fast**

a. Diabetic Ketoacidosis (DKA)

What it is: A really bad thing where there's not enough insulin, so the body starts breaking down fat, which makes nasty stuff called ketones build up. It's life-threatening.

What it looks like: Feeling sick to your stomach, throwing up, tummy hurting, not enough water in the body, breathing deep and fast, breath smelling like fruit, and acting weird.

What causes it: Missing insulin shots, being sick, or stressed out.

What can happen: Brain swelling, shock, body chemicals getting out of whack, and even death if no one fixes it.

b. Low Blood Sugar (Hypoglycemia)

What it is: When blood sugar dips too low, usually under 70. It happens if they get too much insulin or skip meals.

What it feels like: Sweating, shaking, feeling dizzy, headache, confused, or passing out.

If it's bad: They could have seizures or go into a coma if they don't get help quick.

c. Hyperosmolar Hyperglycemic State (HHS)

Not common in kids, usually shows up in Type 2 diabetes. It's when blood sugar is super high, they're dried out, but not many ketones. They might act strange or even pass out.

**2. Problems That Stick Around**

Having high blood sugar for a long time can mess with lots of body parts, causing issues with blood vessels and other stuff.

*a. Small Blood Vessel Problems*

1. Diabetic Retinopathy

Hurts the little blood vessels in the eye, making it hard to see or even go blind. Usually shows up after 5–10 years of diabetes that's not under control. Gotta get eyes checked regularly.

2. Diabetic Nephropathy

The kidneys get hurt because of damage to tiny filters. They might pee out small amounts of protein early on, but it can turn into long-term kidney problems. Keeping glucose and blood pressure down helps slow it down.

3. Diabetic Neuropathy

Nerve damage, makes you tingle, feel numb, or have pain, mostly in the legs. It can also mess with stuff like going to the bathroom or how your gut works.

*b. Big Blood Vessel Problems*

After a while, big blood vessels get beat up, which can cause hardening of the arteries, high blood pressure, and heart issues way too early. Not common when you're a kid, but the risk goes up if they're overweight and not taking care of themselves.

*c. Growth and Puberty Issues*

If diabetes is out of control, they might not grow or start puberty when they should because they're not getting enough energy. Girls might have lady-time problems, too.

*d. Infections*

High blood sugar makes it harder to fight off germs, so they get more infections from bacteria and fungus, like skin, pee, or mouth infections.

*e. Brain and Thinking Problems*

If they have too many low blood sugar episodes or DKA, it can mess with how their brain grows and how well they learn, especially when they're really little.

**3. Feelings Problems**

Having a long-term illness can make them nervous, sad, and want to hide away from people. Talking to someone and getting support is a big deal.

## Prevention

To keep kids from getting diabetes, it's all about cutting down risks, living healthy, and spotting those at risk early. How we prevent it changes depending on if it's Type 1 or Type 2, because they start in different ways.

**1. Stopping Type 1 Diabetes**

Since Type 1 diabetes is mainly an autoimmune thing, we can't promise to stop it completely. But, here are some things that might help lower the risk or make it start later:

a. Before It Starts

Breastfeeding: Try to breastfeed only for at least 6 months. It helps their immune system grow strong and might lower the risk of diabetes.

Hold Off on Cow's Milk Early: Don't give cow's milk before 12 months, could mess with their immune response if they're likely to get diabetes.

Introduce Foods Slowly: Start giving solids around 6 months and mix it up.

Avoid Infections: Get kids their shots early on, this keeps them from getting sick with things (like mumps or rubella) that can cause the body to attack cells in the pancreas.

Watch Out for Stress and Bad Stuff: Keep them away from bad stuff in the environment, like toxins and infections, that can hurt pancreas cells.

b. Catching It Early

Check for Autoantibodies: If diabetes runs in the family, check for these.

Keep an Eye On Things: If they have autoantibodies, watch their blood sugar and C-peptide levels regularly.

Try Out Immune Treatments: See if certain treatments (like anti-CD3 antibodies or oral insulin) can slow down the disease.

**2. Stopping Type 2 Diabetes**

Kids can avoid Type 2 diabetes since it's linked to what they do and what's around them.

a. Eat Healthy

Give them good food with lots of fruits, veggies, whole grains, and lean protein. Don't give them too many sweets, sugary drinks, or processed snacks. Help them eat the right amounts and have meals often.

b. Be Active

Kids should get at least an hour of exercise every day, that makes them sweat. Biking, swimming, running, or sports can help them stay at a good weight and make their bodies use insulin better.

c. Stay at a Good Weight

Keep kids from getting too heavy by feeding them a balanced diet and making sure they exercise. Check their BMI now and then at school and doctor visits.

d. Less Sitting Around

Don't let them watch TV, use the computer, or be on their phone for more than 2 hours a day.

e. Get Family and School Involved

Teach families how to live healthy. Support health programs at school and make sure kids get regular physical education.

f. Find High-Risk Groups Early

Check kids who are overweight or obese (especially if they have family with diabetes). Check kids with signs of metabolic syndrome (high blood pressure, bad cholesterol).

**3. Stopping Problems Later**

For kids who already have diabetes:

* Keep Blood Sugar in Check: Use insulin or medicine if needed.
* Eat and Exercise Right: Stick to a diabetic diet and workout plan.
* Get Checked Regularly: Check their eyes, kidneys, and nerves for problems.
* Support Them: Give the kid and family emotional support and teach them about diabetes.

## Prognosis

How well kids with diabetes do depends on the kind of diabetes they have, how old they were when they found out, and how well their blood sugar's been controlled over time. If they catch it early, keep things in check, and handle it right, most kids with diabetes can have great lives.

**1. How Type 1 Diabetes Looks Down the Road**

* Big Picture: Type 1 diabetics can be healthy for a long time if they keep their blood sugar normal with insulin, diet, and exercise.
* Quick View: They'll do great if they avoid ketoacidosis and hypoglycemia. But if they find out late or don't get standard insulin, it's not so good.
* Long View: Keeping blood sugar in check is what matters most. If diabetes isn't controlled, they might get eye, kidney, or nerve problems as teens or adults. Insulin pumps, glucose monitors, and teaching patients have helped them live longer.

* Lifestyle: Teaching and support can make them stick to their plan and feel better about their condition.

**2. How Type 2 Diabetes Looks Down the Road**

* Big Picture: It's different for everyone, but it depends on changing their lifestyle and getting treatment fast.
* Quick View: It's usually not too bad at first, but it can get worse if they're still overweight and eating badly.
* Long View: Problems like high blood pressure, bad cholesterol, and kidney issues can show up faster than in adults. They're also at risk for heart problems when they're young. Exercise, a good diet, and staying at a healthy weight can help in the long run.

**3. How Monogenic and Secondary Diabetes Look Down the Road**

* Monogenic (MODY, Neonatal Diabetes): It depends on the gene change. Some types (like GCK-MODY) are mild and don't need insulin. Others n eed lifelong treatment but can be managed with good care.
* Secondary Diabetes: It depends on what's causing the diabetes. If they can control the main problem (like pancreatitis or Cushing's syndrome), their blood sugar might go back to normal.

**4. What Changes How Well They Do**

* Good Signs: Getting treatment early. Checking blood sugar often. Sticking to insulin or other medicines. Exercising and eating well. Having good health, healthcare, and family support.
* Bad Signs: Getting diabetic ketoacidosis often. Not sticking to their treatment. Blood sugar staying high. Having other autoimmune diseases or being overweight.

**5. How Long They'll Live and What to Expect**

With today's care and training, kids with diabetes can live almost as long as kids without it. Keeping blood sugar under control from childhood can help them avoid problems later on. New studies on artificial pancreases and islet cell transplants might give them even better lives in the future.

## Conclusion

Diabetes in kids can be tough, so catching it early is important. Good care means a team effort, teaching kids about it, and offering support. New gadgets for giving insulin and checking blood sugar can make life better for these kids.

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