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Diabetes mellitus in children

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1. Introduction:

One of the most common metabolic diseases, diabetes mellitus (DM) has been on the rise worldwide in recent decades. Type 2 diabetes mellitus (DM2) is the most common form and is characterized by insulin resistance and an inadequate compensatory response of insulin secretion. Type 1 diabetes mellitus (DM1) is characterized by progressive absolute insulin deficiency and can be identified by genetic and pancreatic islet autoimmunity markers.

As a natural consequence of diabetes, patients may experience complications such as diabetic ketoacidosis, hyperosmolar hyperglycemic state, and chronic microvascular (retinopathy, nephropathy, peripheral and autonomic neuropathy) and macro vascular (coronary atherosclerotic vascular, cerebral and peripheral vascular disease) problems, all of which have a detrimental effect on patients' quality of life and probability of survival. This disease claims the lives of almost 1 million people annually, mostly in areas with low incomes.

The purpose of this article is twofold: first, to bring attention to the concerning increase in the number of pediatric diabetes diagnoses; and second, to present a current review of the pathophysiology, development, and management of the disease to help in the planning of responses to what is destined to emerge as a significant public health concern in the not-too-distant future.

2. Causes of Type 1 and Type 2 Diabetes in children:

Diabetes mellitus type 2 (T2DM) is the more frequent sort and the one used to guide treatment decisions; type 1 diabetes is the less common kind. The patient's age, family history, and body type are all factors that are considered in this classification system, along with the patient's clinical presentation and laboratory results, namely antibodies. Some individuals cannot be conclusively classified as having type 1 or type 2 diabetes at diagnosis, and this system of categorization does not fully capture the clinical variability of patients. Both type 1 and type 2 diabetes are characterized by a gradual reduction in beta-cell activity, which results in hyperglycemia. This decline in beta-cell function can be influenced by both genetic and environmental factors.

In people who are genetically predisposed to type 1 diabetes, environmental exposure can trigger the autoimmune destruction of pancreatic beta-cells, leading to a significant reduction or elimination of insulin production. Although the risk is increased by a factor of fifteen for those who have close family members with diabetes, the overall incidence of the disease is between 4% and 8% (30% to 50% in monozygotic twins). It is more common for young persons with type 1 diabetes to also acquire thyroid illness, celiac disease, and other autoimmune disorders. There are several heritable genes that impact the likelihood of developing type 1 diabetes; so far, researchers have identified around 60 risk loci. The higher frequency of susceptibility genes among certain racial and ethnic groupings can explain the elevated incidence of type 1 diabetes in certain groups (e.g., Sardinians and Scandinavians).

In type 2 diabetes, the pancreas secretes insulin, but the body's insulin resistance means that the amount of insulin produced isn't enough to meet the body's increasing need. The onset of hyperglycemia symptoms, which occur around the time of peak physiological pubertal insulin resistance, is prevalent in adolescents who have been compensated for their illness in the past. The disorder is not caused by the immune system destroying beta cells, but rather by a complex interplay of several environmental and genetic factors.

Distinct from both types of diabetes in children (type 1 and type 2) and adults (type 2), type 2 diabetes is its own entity. In younger individuals, beta-cell malfunction and the development of complications associated with diabetes progress at a faster rate.

Type 2 diabetes risk factors:

- Obesity
- Native American, Black, Hispanic, Asian American, and Pacific Islander heritage
- Family history (60 to 90% have a 1st- or 2nd-degree relative with type 2 diabetes)

As the underlying genetic defect is passed down in an autosomal dominant form, patients with monogenic diabetes typically have a family history of the disease. In type 2 diabetes, insulin resistance and immune-mediated beta-cell death do not occur. Most cases manifest before the age of 25.

3. Developmental Pathophysiology of Childhood Diabetes:

A lack of insulin causes hyperglycemia and poor glucose utilization in skeletal muscle in type 1 diabetes. Fat and muscle are broken down by the body to create energy. Acidosis and, in the worst-case situation, death, are possible outcomes of the breakdown of fat, which leads to the creation of ketones. (diabetic ketoacidosis [DKA]).

Hyperglycemic hyperosmolar state (HHS), sometimes called hyperosmolar hyperglycemic nonketotic syndrome (HHNK), is characterized by severe hyperosmolar dehydration; nevertheless, only about a quarter of children with type 2 diabetes exhibit DKA. Patients are more likely to experience HHS during periods of high stress or infection, when they do not adhere to their recommended treatment programs, or when they are already taking drugs that have a negative impact on glucose metabolism, such as corticosteroids. Various metabolic abnormalities, including those associated with insulin resistance, may coexist with type 2 diabetes when the patient is diagnosed.

- Dyslipidemia (leading to atherosclerosis) (leading to atherosclerosis)
- Hypertension
- Ovary cysts and polycystic ovary syndrome.
- Sleep apnea with obstruction
- Definition of NASH (nonalcoholic fatty liver disease) (fatty liver)

The risk of cardiovascular disease is greatly amplified by atherosclerosis, which often first appears in early adulthood but can sometimes begin in infancy and adolescence.

When it comes to monogenic causes of diabetes, the underlying abnormalities can vary. Most of the time, the pancreatic beta-cell function is regulated by transcription factors that have defects, such as hepatic nuclear factor 4-alpha [HNF-4-] and hepatic nuclear factor 1-alpha [HNF-1]. Although insulin secretion decreases with aging (but does not disappear entirely), hyperglycemia worsens and insulin resistance does not exist. Another form of hereditary diabetes is caused by glucosesterase issues. Normal insulin production and appropriate glucose tolerance do not significantly worsen age-related fasting hyperglycemia caused by glucosidase anomalies.

4. Diabetic Signs and Symptoms in Children:

The ins and outs of type 1 diabetes can vary from asymptomatic high blood sugar levels (hyperglycemia) to diabetic ketoacidosis, a potentially deadly condition. Polydipsia, polyuria, and frequency of urine that persists for several days to weeks is the hallmark of symptomatic hyperglycemia in children, which is far more prevalent than acidosis. An increase in the frequency of wet or heavy diapers, among children who have not yet learned to use the restroom independently, is known as polyuria. Almost half of the children with increased catabolism also have weight loss, in addition to stunted growth. Ketonemia is associated with a number of symptoms, including but not limited to: weakness, nausea, vomiting, and blurred vision (due to the lens and vitreous humour being in a hyperosmolar condition).

Type 2 diabetes has a wide range of possible symptoms. Oftentimes, children show no symptoms or only mild ones, and the disease is only discovered through routine screening. Despite this prevalent misperception, some children have a severe form of symptomatic hyperglycemia (also known as HHS or diabetic ketoacidosis [DKA]).

4.1 Complications of diabetes in children:

Patients with type 1 diabetes often have diabetic ketoacidosis, with prevalence ranging from 1--10% annually. This is typically due to the patient failing to take their insulin as prescribed. Additional factors that increase the likelihood of developing DKA include previous bouts of DKA, stressful social situations, depression or other psychological problems, coexisting sickness, and the use of an insulin pump (because of a kinked or dislodged catheter, poor insulin absorption due to infusion site inflammation, or pump malfunction). Clinicians can aid in mitigating risk by disseminating information and offering guidance.

Children with diabetes and their families are disproportionately affected by mental health problems. There is a significant percentage of children (up to 50%) who suffer from some sort of mental health issue. Adolescents who are trying to manage their weight often suffer from eating problems and resort to unhealthy measures like skipping insulin injections. Poor glycemic control can also stem from psychological issues that make it difficult for youngsters to follow their prescribed food and/or medication schedules. To better understand and treat the psychosocial factors that contribute to poor glycemic control, a multidisciplinary team should include social workers and mental health professionals.

Symptoms of vascular problems almost never present themselves clinically in young children. However,

poor glycemic control is the biggest long-term risk factor for the development of vascular problems in type 1 diabetes, and these changes in pathology and function may already be present a few years after the onset of the disease. Diabetes can cause a variety of microvascular problems, including as nephropathy, retinopathy, and neuropathy. Children with type 2 diabetes are more likely to experience microvascular complications than those with type 1 diabetes, and with type 2 diabetes, these consequences may already be apparent at diagnosis or early in the disease's progression. Although neuropathy is more common in children whose diabetes has been present for a long time (5 years) and whose condition is poorly managed (glycosylated hemoglobin [HbA1c] > 10%), it can also occur in young children whose diabetes has been present for a relatively short time and is well managed. A stroke, heart attack, or coronary artery disease are all examples of macro vascular problems.

5. Childhood diabetes diagnosis:

Diagnosis of diabetes and prediabetes in children and adolescents is similar to that in adults, and relies on the presence or absence of symptoms in addition to fasting or random plasma glucose levels and/or HbA1c levels (see Table: Diagnostic Criteria for Diabetes Mellitus and Impaired Glucose Regulation). Traditional diabetic symptoms and blood glucose levels can help doctors make a diagnosis of diabetes. Fasting plasma glucose 126 mg/dL (7.0 mmol/L); fasting is defined as no caloric intake for 8 hours. Random plasma glucose 200 mg/dL (11.1 mmol/L).

If diabetes can be diagnosed using other methods, an oral glucose tolerance test is unnecessary and should be avoided. When necessary, 75 grammes of glucose dissolved in water (1.75 g/kg) should be used for the test. The test has the potential to aid in the diagnosis of type 2 or monogenic diabetes in children who are symptom-free, have little symptoms, or whose symptoms are atypical.

For the most accurate diagnosis of type 2 diabetes, the HbA1c criterion should be used, and hyperglycemia should be verified. HbA1c screening test findings should be interpreted with caution, even though they are widely utilized for the diagnosis of type 2 diabetes in children. Several studies have questioned the validity of using HbA1c as a screening test because of its limited sensitivity for detecting children with dysglycemia, and the data favoring HbA1c as a screening tool are drawn from adults (prediabetes or diabetes mellitus). Alternative measures, such as fructosamine, may be more appropriate in children with hemoglobinopathies, such as sickle cell disease.

5.1 Primitive testing and inspection:

An electrolyte and glucose blood test, together with a urinalysis, should be the first line of testing for patients suspected of having diabetes but who otherwise appear healthy. Calcium, magnesium, phosphorus, and hematocrit levels, as well as a venous or arterial blood gas, are also measured and tested for in patients who are critically ill.

5.2 Diagnosis of diabetes type:

Types of diabetes should be confirmed with other tests like

- levels of C-peptide and insulin (if not already taking insulin)
- A1c levels (if not already done)
- Pancreatic islet cell protein autoantibody testing

Glutamic acid decarboxylase, insulin, insulinoma-associated protein, and zinc transporter ZnT8 are among enzymes that can be targeted by autoantibodies. Over 90% of people with a new diagnosis of type 1 diabetes have at least one of these autoantibodies; in contrast, the absence of antibodies is highly predictive of type 2 diabetes. Ten to twenty percent of children with the type 2 diabetes phenotype have autoantibodies and are categorized as type 1 diabetes because they are more likely to need insulin therapy and are at greater risk of developing additional autoimmune illnesses.

Recognizing monogenic diabetes is crucial because its therapy is distinct from that of type 1 and type 2 diabetes. Children with a strong family history of diabetes who do not exhibit any of the classic features of type 2 diabetes, such as mild fasting (100 to 150 mg/dL [5.55 to 8.32 mmol/L]) or postprandial hyperglycemia, being young and not obese, and lacking autoantibodies or signs of insulin resistance, should be considered for the diagnosis (eg, acanthosis nigricans). Monogenic diabetes can be confirmed through genetic testing. Some types of monogenic diabetes can worsen with age, thus this screening is crucial.

5.3 Testing for complications and other disorders:

Antibody testing for celiac disease, thyroxine, and thyroid antibodies should be performed on patients with type 1 diabetes to rule out the possibility of other autoimmune illnesses. It is recommended that subsequent testing for thyroid disease and celiac disease be performed every 1–2 years. There is no need for routine screening for other autoimmune disorders that may occur in children with type 1 diabetes, including primary adrenal insufficiency (Addison disease), rheumatologic disease (e.g. rheumatoid arthritis, systemic lupus erythematosus, psoriasis), other gastrointestinal disorders (e.g. inflammatory bowel disease, autoimmune hepatitis), and skin disease (e.g. vit

Because children with type 2 diabetes frequently have comorbidities such as fatty liver, hyperlipidemia, and hypertension at diagnosis (unlike those with type 1 diabetes, in whom complications develop over many years), it is important to perform liver tests, a fasting lipid profile, and a urine micro albumin: creatinine ratio at the time of diagnosis. It's especially important to check kids who show signs of complications:

- Check for nonalcoholic steatohepatitis if you're overweight
- If you snore or nod off throughout the day, you might have obstructive sleep apnea.

- If you have hirsutism, acne, or irregular periods, you may have polycystic ovary syndrome.

5.4 Screening for diabetes:

Screening for type 2 diabetes or prediabetes by testing HbA1c is recommended for children at risk who are asymptomatic and less than 18 years old. This screening should begin at the age of 10 (or earlier if puberty was experienced earlier) and be repeated every three years.

A child is at risk if they are overweight (BMI > 85th percentile for age and sex, or weight for height > 85th percentile) and have at least 2 of the following:

- History of type 2 diabetes among first- or second-degree relatives
- Afro-American, African-American, Hispanic, Asian, and Pacific Islander ancestry
- Telltale insulin resistance symptoms and related disorders (eg, acanthosis nigricans, hypertension, dyslipidemia, polycystic ovary syndrome, or small-for-gestational-age birth weight)
- Cases of diabetes or gestational diabetes in the mother.

6. children's Diabetic Care:

The goals of treatment are to normalize blood glucose levels while decreasing the number of hypoglycemia episodes and to prevent or delay the development and progression of problems; intensive education and treatment in childhood and adolescence may assist achieve these goals.

Certain socioeconomic characteristics are related to poor glycemic control and increased hospitalization rates. Low-income and non-Hispanic Black children continue to be at higher risk of complications and unfavorable outcomes due to poor glycemic control, despite technological advancements that have improved the quality of care and glycemic control for many patients with diabetes. Optimal glycemic control in children with type 1 diabetes may be affected by social determinants of health such as socioeconomic level, neighborhood and physical environment, dietary environment, health care, and social context.

6.1 Lifestyle modifications:

Some examples of healthy lifestyle changes that assist patients in general are:

- eating at set times and maintaining a steady caloric intake
- Reducing consumption of processed foods and animal fats
- The importance of doing more exercise

In most cases, it's preferable to refer to one's eating regimen as a "meal plan" or "good food selections" rather than Promoting heart-healthy diets that are low in cholesterol and saturated fats is the main focus. Carbohydrate counting (in which parents estimate the quantity of carbohydrate in an upcoming meal and use that amount to determine the pre-prandial insulin dose) and basal-bolus regimens have altered the

meal planning process for people with type 1 diabetes. There are no hard and fast rules on what a person should eat under this plan. Instead than prescribing a theoretically optimal diet that the child is unlikely to follow, meal plans are based on the child's real eating habits, and insulin dose is matched to actual carbohydrate intake. The insulin: carbohydrate ratio varies from person to person and also changes with factors including age, exercise level, sexual maturity, and duration of diabetes. The ability to precisely tailor insulin dosages has been made possible by recent technological developments. An approximate age guideline would be:

- From infancy up to five years old, 1 unit of insulin every 30 g of carbohydrate is recommended.
- Insulin dosage for children 6-12: 1 unit every 15 g of carbohydrate
- Insulin dosage for adolescents: 1 unit for every 5-10 grammes of carbohydrate

Patients with type 2 diabetes should be urged to lose weight to improve insulin sensitivity. Children between the ages of 3 and 13 have caloric needs that can be roughly estimated as 1000 + (100 child's age in years). Eating better and controlling weight can be as easy as taking the following steps.

- Reducing consumption of processed foods and beverages rich in added sugar (eg, processed candies and high fructose corn syrups)
- meal skipping is discouraged
- Reducing the size of meals and snacks
- Reducing access to high-calorie, high-fat foods Raising fibre consumption through increased consumption of fruits and vegetables

6.2 Glucose and HbA1c target levels:

To strike a compromise between the necessity to normalize glucose levels and the danger of hypoglycemia, plasma glucose targets (see Table: Glucose and HbA1c Target Levels in Children and Adolescents with Type 1 Diabetes) are defined. The goal for patients after the honeymoon period (those without any remaining beta-cell function) is to have at least half of their blood glucose readings within the normal range (70–180 mg/dL [3.9–10 mmol/L]) and at least ten percent below range.

Age, length of diabetes, availability of diabetes technology (e.g., insulin pumps, continuous monitoring systems), comorbid conditions, and psychosocial situations should all be taken into account while setting treatment goals. Aggressive treatment efforts can be hampered by the possibility of hypoglycemia in children who either are ignorant of the condition or are too young to recognise its signs. HbA1c target levels 6.5% [48 mmol/mol] should be reserved for select patients in whom they may be achieved without substantial hypoglycemia and without detrimental affects on well-being, whereas a less strict target level

(7.5% [58 mmol/mol]) should be explored for such patients.

Lower HbA1c levels during adolescence and young adulthood are associated with a lower risk of vascular problems, hence over time, the HbA1c target levels for children and adolescents with type 1 diabetes have been lowered in an effort to reduce complications. Even though most kids should have a HbA1c target of 7% (53 mmol/mol), a lot of kids and teens still don't.

HbA1c levels can be reduced through the use of continuous glucose monitoring (CGM) systems or increased self-monitoring of blood glucose levels (up to 6 to 10 times per day) because patients are better able to adjust insulin for meals, have an improved ability to correct hyperglycemic values, and possibly detect hypoglycemia earlier, preventing overcorrection (ie, excessive carbohydrate intake as treatment for hypoglycemia, resulting in hyperglycemia). When used correctly, CGM that is scanned intermittently can replace self-monitoring of blood glucose and insulin therapy.

The percentage of time that blood glucose levels are within the normal range (the time-in-range) is correlated well with HbA1c levels. Commonly used in conjunction with HbA1c, time-in-range is a treatment goal for evaluating the success of an insulin regimen. An adjustment of 0.8 percentage points in HbA1c is about equivalent to a 10% shift in time-in-range. HbA1c levels of 5.9% (41 mmol/mol), 6.7% (50 mmol/mol), 7.5% (58 mmol/mol), and 9% (75 mmol/mol) are all associated with time-in-ranges of 80%, 70%, 60%, and 40%, respectively (1).

CGM provides information related to adherence, information related to glycemic variability, information related to glucose management indicator, and information related to time-in-range in addition to information related to average sensor glucose, time-above-range (> 180 mg/dL [> 10 mmol/L]), and time-below-range (70 mg/dL [3.9 mmol/L]). In addition, CGM provides information related to time-in-range (eg, active CGM time, days worn).

It is recommended that CGM measurements generated from use over the most recent 14 days be utilized in conjunction with HbA1c level. Data obtained through CGM can be reported in a format that is standardized. The ambulatory glucose profile, often known as the AGP, is a standardized report that includes the mean glucose, the amount of time spent within range, and the amount of time spent below range. When utilizing the AGP to monitor glycemia, a goal of time-in-range of > 70% with a time-below-range of 4% can be used as a glycemic control objective. This goal can be used in conjunction with the aim of a HbA1c target of 7% (53 mmol/mol), which is another glycemic control goal. In addition, there is a report known as the glucose management indicator, which calculates an estimated HbA1c based on the mean glucose levels measured by a CGM and uses data that is at least 14 days old.

The HbA1c target levels for children and adolescents with type 2 diabetes are the same as the targets for type 1 diabetes, which are less than 7% (less than 53 mmol/mol). In people who have type 2 diabetes, the target level of glucose in their blood while they are fasting should be less than 130 mg/dL (7.2 mmol/L).

Children who do not meet the objectives for HbA1c and/or fasting glucose are potential candidates for enhanced treatment (eg, with insulin, liraglutide). Patients who have had diabetes for a shorter period of time and those who are treated with lifestyle interventions or metformin alone and achieve significant weight loss may be candidates for more stringent targets for haemoglobin A1c (less than 6.5%, or less than 48 mmol/mol) and fasting blood glucose (less than 110 mg/dL, or less than 6.1 mmol/L).

6.3 Controlling the side effects of type 1 diabetes:

Among children on an aggressive insulin regimen, hypoglycemia is a common but serious complication. Multiple episodes of moderate hypoglycemia occur often in youngsters, and most of them treat themselves with 15 g of fast-acting carbs (eg, 4 oz of juice, glucose tablets, hard candies, graham crackers, or glucose gel).

About 30% of children each year experience hypoglycemia, with most having had an episode by the age of 18. Severe hypoglycemia is defined as an episode requiring the aid of another person to provide carbs or glucagon. If neuroglycopenic symptoms (such as erratic behaviour, confusion, or trouble concentrating) prevent you from taking in any food or liquids, you could try taking some carbohydrates orally. Seizures, unconsciousness, and even death can result from untreated hypoglycemia. When a child's blood sugar drops below a certain threshold or drops rapidly, a real-time continuous glucose monitor can sound an alarm and save their life (see Monitoring glucose and HbA1c levels).

Intercurrent sickness is the most common cause of ketonuria/ketonemia, but insufficient insulin treatment or missed doses can also lead to this complication. Early detection of ketones in the urine or capillary blood using ketone test strips is important for preventing the development of diabetic ketoacidosis and reducing the likelihood of a kid or family member requiring admission to an emergency room or hospital. Testing for ketones in the blood rather than the urine may be the preferred method in certain cases, including in younger children, individuals with recurrent DKA, insulin pump users, and those for whom collecting a urine sample is problematic. If your child becomes unwell (regardless of their blood sugar level) or if their blood sugar is abnormally high (usually > 240 mg/dL [13.3 mmol/L]), you should have them tested for ketones. When combined with other symptoms such as abdominal discomfort, vomiting, drowsiness, or rapid breathing in children, a urine ketone level of 1.5 mmol/L or higher, or a blood ketone level of > 1.5 mmol/L, can indicate DKA. Ketone levels in the blood or urine that are below 1.5 mmol/L also need to be addressed.

When ketones are detected, additional short-acting insulin is given to the child every two to three hours (usually 10 to 20 percent of the entire daily dose) until the ketones are gone. It's important to prevent dehydration, thus extra fluids should be given as well. Sick-day management refers to the process of monitoring blood ketones and administering extra fluids and insulin when a person is ill and/or hyperglycemic. If the child's clinical status worsens, or if ketones worsen or don't resolve after 4 to 6

hours, parents should phone their doctor or head to the emergency room (eg, respiratory distress, continued vomiting, change in mental status).

6.4 Type 2 diabetes treatment:

Modifying one's diet and level of physical activity are crucial, just as they are for people with type 1 diabetes.

Children with more advanced diabetes (HbA1c > 9% [> 75 mmol/mol]) or DKA are begun on insulin therapy, which may involve glargine, detemir, or premixed insulin. Metformin is typically initiated concurrently if acidosis is absent. As endogenous insulin production improves during the first weeks of treatment, insulin doses may be reduced rapidly; in many cases, insulin may be discontinued few weeks after achieving satisfactory metabolic control.

Only metformin, an insulin sensitizer, is currently FDA-approved for use in individuals with hyperglycemia who are younger than 18. Some teenagers may benefit from the use of other oral medications approved for adults, although these options are more expensive and there is less data supporting their use in young people. To reduce the risk of side effects including nausea and diarrhoea, metformin should be taken at a low dose at first. The recommended starting dose is 500 mg once daily for 1 week, with subsequent increases of 500 mg per week for the following 3 to 6 weeks until the maximum target dose of 1000 mg twice day is reached. Maintaining a HbA1c level of 7% (53 mmol/mol) is the target of treatment, with a target of 6.5% (48 mmol/mol) being optimal. If metformin alone is insufficient, basal insulin or liraglutide should be added to the treatment plan. About half of adolescents with type 2 diabetes who initially respond to metformin alone end up needing insulin. Rapid-acting prandial insulin may be added to the treatment plan if individuals still aren't meeting their goals while on metformin and basal insulin combination therapy.

HbA1c levels can be lowered with the use of glucagon-like peptide-1 (GLP-1) receptor agonists such liraglutide and extended-release exenatide in children and adolescents aged 10 and up with type 2 diabetes. Injectable noninsulin antihyperglycemics like these decrease gastric emptying and increase insulin release in response to elevated blood sugar levels. 0.6 mg of subcutaneous liraglutide once daily is the starting dose, with 0.6 mg weekly increases possible up to 1.8 mg once day if needed for control. Patients may be more likely to take their weekly subcutaneous 2 mg dose of extended-release exenatide. Weight loss is facilitated by both medications, possibly through reduced appetite and delayed stomach emptying. Nausea and vomiting are the most prevalent gastrointestinal side effects of GLP-1 agonists. If HbA1c goals aren't fulfilled after 3 months of treatment with metformin alone, liraglutide and exenatide can be administered instead or in addition. The aggressive treatment of type 2 diabetes may include the use of liraglutide and exenatide instead of or in addition to insulin.

7. Conclusion:

Types of diabetes mellitus (diabetes) in children are like those in adults, but children also have unique psychosocial challenges that can make managing their condition more difficult.

Two-thirds of all newly diagnosed cases of childhood diabetes are of the type 1 variety. One in every 350 children will be diagnosed by age 18; the frequency has recently been rising, especially in children younger than 5 years old, making it one of the most frequent chronic childhood disorders. Type 1 diabetes can develop at any age, but it is most common in children between the ages of 4 and 6 and again between the ages of 10 and 14.

Although previously uncommon, type 2 diabetes in children has been on the rise alongside childhood obesity rates (see obesity in children). Symptoms are most common after adolescence, specifically between the ages of 15 and 19. (see obesity in adolescents).

Previously known as MODY, monogenic forms of diabetes are rare (between 1 and 4 percent of all occurrences) and distinct from types 1 and 2.

Prediabetes is characterized by blood glucose levels that are higher than normal but do not yet meet diagnostic criteria for diabetes due to poor glucose regulation. However, in teenagers who continue to gain weight, prediabetes is more likely to develop into full-fledged diabetes rather than resolving on its own (reversal to normal after 2 years in 60% of those with prediabetes). The metabolic syndrome is linked to prediabetes (impaired glucose regulation, dyslipidemia, hypertension, obesity).

References:

- Botero, D., & Wolfsdorf, J. I. (2005). Diabetes mellitus in children and adolescents. Archives of medical research, 36(3), 281-290.
- Neu, A., Bürger-Büsing, J., Danne, T., Dost, A., Holder, M., Holl, R. W., ... & Ziegler, R. (2019). Diagnosis, therapy and follow-up of diabetes mellitus in children and adolescents. Experimental and Clinical Endocrinology & Diabetes, 127(S 01), S39-S72.
- Ergun-Longmire, B., & Maclaren, N. K. (2015). Etiology and pathogenesis of diabetes mellitus in children.
- Kaufman, F. R. (2002). Type 2 diabetes mellitus in children and youth: a new epidemic. Journal of Pediatric Endocrinology and Metabolism, 15(Supplement), 737-744.
- Pereira, P. F., Alfenas, R. D. C. G., & Araújo, R. M. A. (2014). Does breastfeeding influence the risk of developing diabetes mellitus in children? A review of current evidence. Jornal de pediatria, 90, 7-15.
- Kao, K. T., & Sabin, M. A. (2016). Type 2 diabetes mellitus in children and adolescents. Australian family physician, 45(6), 401-406.
- Cakan, N., Kizilbash, S., & Kamat, D. (2012). Changing spectrum of diabetes mellitus in children: challenges with initial classification. Clinical pediatrics, 51(10), 939-944.
- Sperling, M. A. (2005). Diabetes mellitus in children. Pediatric Clinics, 52(6), xv-xvi.
- Yau, M., Maclaren, N. K., & Sperling, M. A. (2021). Etiology and pathogenesis of diabetes mellitus in children and adolescents. *Endotext [Internet]*.
- Springer, S. C., Silverstein, J., Copeland, K., Moore, K. R., Prazar, G. E., Raymer, T., ... & Flinn, S. K. (2013). Management of type 2 diabetes mellitus in children and adolescents. *Pediatrics*, *131*(2), e648-e664.