



CURRENT STATUS OF DIABETES MELLITUS DISEASE & MANAGEMENT & PREVENTION & ITS LATEST TRENDS.

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Abstract : Diabetes is a chronic metabolic disorder that affects how our body regulates blood sugar (glucose) levels. Glucose is an essential source of energy for cells, and insulin, a hormone produced by the pancreas, helps to regulate the amount of glucose in the bloodstream. In individuals with diabetes, there is a problem with insulin production, action, or both, leading to elevated blood glucose levels.

Diabetes is a complex and prevalent chronic condition that affects millions of people worldwide. This project has explored various aspects of diabetes, including its definition, prevalence, types (such as type 1, type 2, and gestational diabetes), and associated complications. We have also examined the physiology of glucose regulation, the role of insulin in glucose metabolism, and the impact of pancreatic dysfunction and insulin resistance on diabetes development.

Moreover, we have discussed the risk factors for developing diabetes, emphasizing the importance of lifestyle modifications, such as healthy eating, regular physical activity, weight management, and smoking cessation, in preventing the onset of type 2 diabetes. We have highlighted the role of diabetes education and support in empowering individuals with diabetes to understand the condition, make informed decisions, and manage their health effectively. Additionally, the project has shed light on the complications associated with diabetes, including cardiovascular disease, kidney disease, neuropathy, and eye complications. We have emphasized the significance of regular medical check-ups, blood sugar monitoring, and adherence to treatment plans in preventing and managing these complications.

Furthermore, we have explored the essential aspects of diabetes management, including medication management, blood sugar control, lifestyle modifications, and stress management. We have discussed the importance of a multidisciplinary approach involving healthcare professionals, such as doctors, nurses, dietitians, and diabetes educators, who provide education, treatment, monitoring, and support to individuals with diabetes. By implementing the knowledge and strategies gained from this project, individuals with diabetes can enhance their quality of life, minimize the risk of complications, and achieve better health outcomes. However, it is crucial to remember that diabetes management is a lifelong journey that requires ongoing education, support, and collaboration between healthcare professionals and individuals with diabetes.

It is evident that diabetes is a complex disease that requires a comprehensive approach to care. The role of healthcare professionals in diabetes management is crucial, as they provide education, treatment, monitoring, and support to individuals with diabetes. By equipping patients with the knowledge and skills necessary for self-management, healthcare professionals empower individuals to make informed decisions about their health and take control of their condition.

IndexTerm: hyperglycemia, INSULIN, GLUCOSE.

INTRODUCTION.

1.1 DIABETES

Diabetes is a chronic metabolic disorder that affects how our body regulates blood sugar (glucose) levels. Glucose is an essential source of energy for cells, and insulin, a hormone produced by the pancreas, helps to regulate the amount of glucose in the bloodstream. In individuals with diabetes, there is a problem with insulin production, action, or both, leading to elevated blood glucose levels.

Diabetes is a chronic metabolic disorder characterized by elevated blood sugar (glucose) levels due to problems with insulin production, action, or both. Insulin, a hormone produced by the pancreas, helps regulate glucose levels in the bloodstream and allows cells to utilize glucose for energy. When there is insufficient insulin or the body cannot effectively use it, glucose builds up in the blood, leading to hyperglycaemia. Over time, having too much glucose in your blood can cause other health problems. Diabetes has significant health and economic implications. It can lead to various complications if not properly managed, including cardiovascular disease, kidney disease, nerve damage, eye problems, and foot ulcers. Managing diabetes involves regular monitoring of blood sugar levels, adopting a healthy diet, engaging in physical activity, taking medication as prescribed (if necessary), and making lifestyle modifications. No matter the way of therapy one decides to fight Diabetes but one has taken steps timely to prevent or manage diabetes.

1.1.1 How Common is Diabetes

According to the Centres for Disease Control and Prevention's *National Diabetes Statistics Report*, an estimated 37.3 million people in the United States, or 11.3% of the population, have diabetes. About 1 in 4 adults with diabetes don't know they have the disease. An estimated 96 million American adults have prediabetes, which means their blood glucose levels are higher than normal but not high enough to be diagnosed as diabetes.

Diabetes is a significant global health concern. According to the International Diabetes Federation (IDF), as of 2021, approximately 463 million adults (20-79 years old) were living with diabetes worldwide. This number is projected to rise to 700 million by 2045 if current trends continue.

Diabetes is a common chronic disease worldwide; in 2011, it affected 366 million people. It is estimated that 592 million people will have the condition by 2035. This growing prevalence is related to increasing economic growth, urbanization, and lifestyle alteration characterized by risk factors such as obesity and sedentary activity. Prediabetes, i.e., impaired fasting blood glucose or impaired glucose tolerance, often occurs about 5 years before the development of type 2 diabetes mellitus (T2DM). People with prediabetes are at 5 to 15% greater risk of progression to T2DM.

Sometimes people call diabetes "a touch of sugar" or "borderline diabetes." These terms suggest that someone doesn't really have diabetes or has a less serious case, but every case of diabetes is serious. Given the increasing prevalence and impact of diabetes, it is crucial to raise awareness, promote prevention strategies, and improve access to care and treatment for individuals living with diabetes worldwide.

1.1.2 Effects

Diabetes can have various effects on the body and overall health. Here are some common effects of diabetes:

1. **High Blood Sugar (Hyperglycaemia):** Elevated blood sugar levels, if not properly managed, can lead to various complications and health issues.
2. **Cardiovascular Complications:** Diabetes increases the risk of cardiovascular diseases, such as heart attacks, strokes, and peripheral artery disease. It can damage blood vessels, leading to atherosclerosis (narrowing and hardening of the arteries) and poor circulation.
3. **Kidney Disease (Diabetic Nephropathy):** Uncontrolled diabetes can cause damage to the kidneys over time, leading to diabetic nephropathy. It can result in reduced kidney function and, in severe cases, kidney failure requiring dialysis or kidney transplantation.

4. Nerve Damage (Diabetic Neuropathy): Prolonged high blood sugar levels can damage the nerves throughout the body, most commonly affecting the feet and legs. Symptoms may include numbness, tingling, pain, or weakness.
5. Eye Problems (Diabetic Retinopathy): Diabetes can cause damage to the blood vessels in the retina, leading to diabetic retinopathy. It can result in vision problems, including blurred vision, vision loss, or even blindness if left untreated.
6. Foot Complications: Diabetes can lead to poor circulation and nerve damage in the feet, increasing the risk of foot ulcers, infections, and, in severe cases, amputation.
7. Increased Infection Risk: Diabetes can weaken the immune system and impair the body's ability to fight infections. People with diabetes may be more susceptible to infections, such as urinary tract infections, skin infections, and gum disease.
8. Skin Conditions: Diabetes can lead to various skin problems, including dry skin, itching, fungal infections, and slow wound healing.
9. Mental Health: Diabetes is associated with an increased risk of mental health issues, such as depression and anxiety.

1.1.3 SYMPTOMS

Some common symptoms of Diabetes are enlisted below:

1. Frequent urination: The need to urinate more often than usual, especially at night (polyuria).
2. Excessive thirst: Feeling constantly thirsty and needing to drink large amounts of fluids (polydipsia).
3. Increased hunger: Persistent hunger and an urge to eat more, even after meals (polyphagia).
4. Unexplained weight loss: Losing weight without trying, despite increased appetite.
5. Fatigue: Feeling tired and lacking energy, even with adequate rest.
6. Blurred vision: Experiencing blurry or distorted vision.
7. Slow healing of wounds: Cuts, bruises, or sores taking longer to heal than usual.
8. Frequent infections: Increased susceptibility to infections, such as urinary tract infections, skin infections, or yeast infections.
9. Tingling or numbness: Tingling or numbness in the hands or feet (neuropathy).
10. Irritability: Feeling irritable or having mood swings.

1.2 PREVALENCE OF DIABETES IN INDIA

Diabetes is a significant public health issue in India, with a high prevalence and increasing burden. According to the International Diabetes Federation (IDF), as of 2021, India had the second-highest number of adults living with diabetes in the world with an estimated 87 million cases, following China.

The prevalence of diabetes in India varies by region, age, gender, and socioeconomic status. In urban areas, the prevalence is higher than in rural areas, and diabetes is more prevalent in men than women. The prevalence of diabetes increases with age, with the highest rates among adults aged 65 years and above. Several factors contribute to the high prevalence of diabetes in India, including rapid urbanization, changing lifestyles, unhealthy diets, lack of physical activity, and genetic susceptibility. In addition, there are disparities in access to healthcare and diabetes education, with many people living with diabetes in India remaining undiagnosed and untreated.

Diabetes-related complications, such as cardiovascular disease, kidney damage, and neuropathy, are also significant concerns in India. It is estimated that around one-third of people with diabetes in India have undiagnosed complications, which can lead to increased morbidity, mortality, and healthcare costs.

The Indian government has taken various initiatives to address the diabetes epidemic, including the National Program for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases, and Stroke (NPCDCS) and the National

Health Policy 2017. However, there is still a need for increased awareness, prevention strategies, and access to care and treatment for diabetes in India.

Here are some key statistics regarding the prevalence of diabetes in India:

1. **Total Prevalence:** It is estimated that around 87 million adults (20-79 years old) in India were living with diabetes in 2021.
2. **Type 2 Diabetes:** Type 2 diabetes accounts for the majority of diabetes cases in India, comprising about 90-95% of all diagnosed cases. The increasing prevalence of Type 2 diabetes in India is primarily attributed to rapid urbanization, sedentary lifestyles, unhealthy diets, and genetic predisposition.
3. **Urban-Rural Divide:** Diabetes is more prevalent in urban areas compared to rural regions. Urbanization has brought about lifestyle changes, including increased consumption of calorie-dense, processed foods, and reduced physical activity levels.
4. **Gestational Diabetes:** The prevalence of gestational diabetes is also a concern in India. It is estimated that around 11-21% of pregnancies in India are affected by gestational diabetes. This poses risks to both the mother and the baby and increases the likelihood of developing Type 2 diabetes in the future.
5. **Undiagnosed Cases:** A significant challenge in India is the large number of undiagnosed diabetes cases. Many individuals remain unaware of their condition due to limited access to healthcare services, lack of awareness, and cultural barriers.

The increasing prevalence of diabetes in India has significant implications for public health and healthcare infrastructure. It highlights the importance of comprehensive diabetes prevention and management strategies, including raising awareness, promoting healthy lifestyles, improving access to quality healthcare, and implementing diabetes screening and early detection programs.

It's worth noting that the prevalence and statistics may vary based on different studies and sources. It is always recommended to refer to the latest data from reputable sources such as the International Diabetes Federation (IDF) or national health organizations for the most accurate and up-to-date information on diabetes prevalence in India.



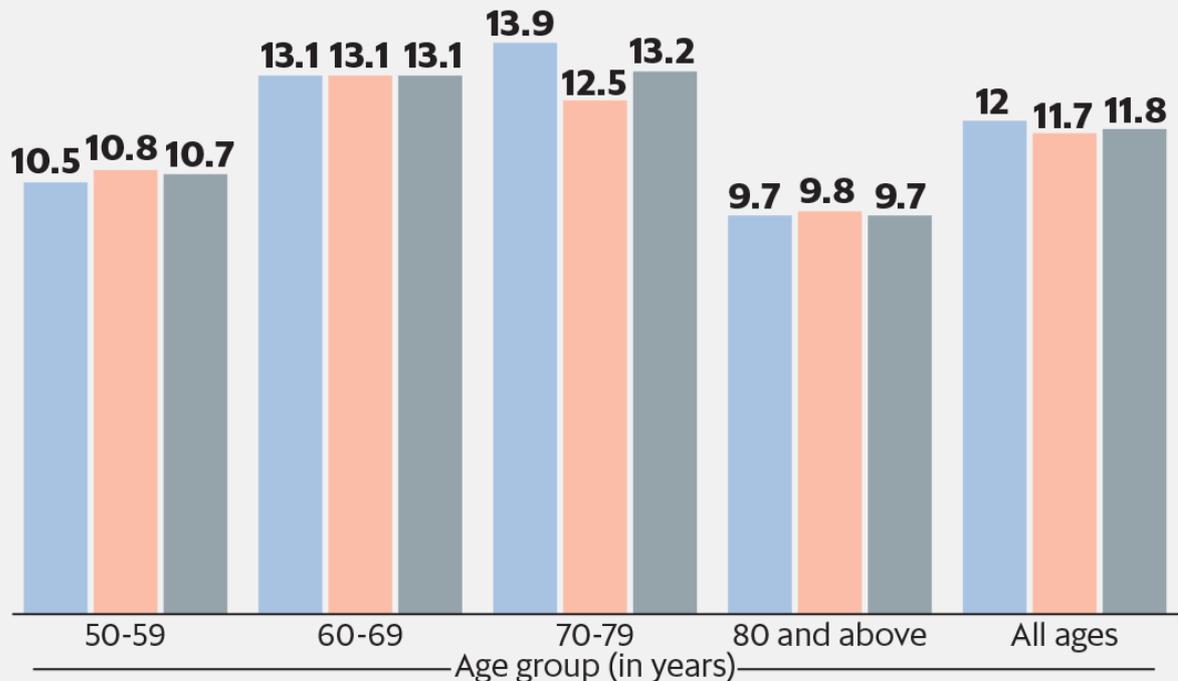
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Health risks

The prevalence of diabetes is 11.8% in people aged above 50, according to a govt survey. Highest prevalence of diabetes was observed in the 70-79 years age group at 13.2%.

Male Female Total (in %)

Age- and gender-wise prevalence of diabetes in population aged ≥ 50 years



Source: National Diabetes and Diabetic Retinopathy Survey report 2019

Fig. 1.1 Age and Gender wise Prevalence of Diabetes in India.

1.3 TYPES OF DIABETES

There are different types of diabetes:

1. Type 1 Diabetes: This autoimmune condition occurs when the immune system mistakenly attacks and destroys the insulin-producing cells in the pancreas. As a result, the body cannot produce sufficient insulin, and individuals with Type 1 diabetes require lifelong insulin replacement therapy. This type accounts for about 5-10% of all diabetes cases. It often develops in children, adolescents, and young adults. The exact cause is unknown, and it is not preventable.

2. Type 2 Diabetes: This is the most common form of diabetes, accounting for the majority of cases. Type 2 diabetes typically develops when the body becomes resistant to the effects of insulin or when the pancreas doesn't produce enough insulin to meet the body's needs. It is often associated with factors such as obesity, sedentary lifestyle, genetic predisposition, and advancing age. Type 2 diabetes can often be managed through lifestyle modifications, oral medications, and, in some cases, insulin therapy. This is the most common form, accounting for about 90% of all diabetes cases. Type 2 diabetes is largely associated with lifestyle factors such as poor diet, physical inactivity, and obesity. It occurs more frequently in middle-aged and older adults, but it is increasingly being diagnosed in younger individuals. The prevalence of Type 2 diabetes is rising rapidly, affecting both developed and developing countries.

3. Gestational Diabetes: This type of diabetes occurs during pregnancy and affects about 1 in 7 births globally. It usually develops in the second or third trimester and resolves after childbirth. It is characterized by high blood glucose levels that develop during pregnancy in women who did not previously have diabetes. Gestational diabetes usually

resolves after childbirth, but affected women and their children are at an increased risk of developing Type 2 diabetes later in life.

4.CFRD:Cystic Fibrosis-Related Diabetes, which is a type of diabetes that affects people with cystic fibrosis (CF), a genetic disorder that affects the lungs, pancreas, and other organs.

CFRD is caused by the damage to the pancreas that occurs in people with CF, which can lead to insulin deficiency and impaired glucose tolerance. The prevalence of CFRD increases with age, and it is estimated that around 20-50% of adults with CF will develop CFRD

The symptoms of CFRD can include increased thirst, frequent urination, weight loss, fatigue, and blurred vision. However, some people with CFRD may not experience any symptoms, which makes screening and early detection important. The management of CFRD typically involves a combination of diet and lifestyle modifications, exercise, insulin therapy, and close monitoring of blood sugar levels. Effective management of CFRD can help to prevent complications and improve overall health outcomes for people with CF. People with CF and their healthcare providers should work closely together to manage CFRD, and regular monitoring and follow-up care are crucial.

Other types of diabetes include:

Prediabetes: This type is the stage before Type 2 diabetes. Your blood glucose levels are higher than normal but not high enough to be officially diagnosed with Type 2 diabetes.

Type 3c diabetes: This form of diabetes happens when your pancreas experiences damage (other than autoimmune damage), which affects its ability to produce insulin. Pancreatitis, pancreatic cancer, cystic fibrosis and hemochromatosis can all lead to pancreas damage that causes diabetes. Having your pancreas removed (pancreatectomy) also results in Type 3c.

Latent autoimmune diabetes in adults (LADA): Like Type 1 diabetes, LADA also results from an autoimmune reaction, but it develops much more slowly than Type 1. People diagnosed with LADA are usually over the age of 30.

Maturity-onset diabetes of the young (MODY): MODY, also called monogenic diabetes, happens due to an inherited genetic mutation that affects how your body makes and uses insulin. There are currently over 10 different types of MODY. It affects up to 5% of people with diabetes and commonly runs in families.

Neonatal diabetes: This is a rare form of diabetes that occurs within the first six months of life. It's also a form of monogenic diabetes. About 50% of babies with neonatal diabetes have the lifelong form called permanent neonatal diabetes mellitus. For the other half, the condition disappears within a few months from onset, but it can come back later in life. This is called transient neonatal diabetes mellitus. **Brittle diabetes:** Brittle diabetes is a form of Type 1 diabetes that's marked by frequent and severe episodes of high and low blood sugar levels. This instability often leads to hospitalization. In rare cases, a pancreas transplant may be necessary to permanently treat brittle diabetes.

Regardless of the type, diabetes requires ongoing management and monitoring to prevent complications. Complications of diabetes include cardiovascular diseases, kidney damage, nerve damage (neuropathy), eye problems (retinopathy), and foot complications. Proper management involves maintaining blood sugar levels within a target range through a combination of medication, dietary changes, regular physical activity, monitoring blood glucose levels, and regular medical check-ups.

It's important to note that while diabetes is a serious condition, with proper management and lifestyle changes, individuals with diabetes can live healthy and fulfilling lives.

1.3.1 Type 1 diabetes

Type 1 diabetes, also known as insulin-dependent diabetes or juvenile diabetes, is a chronic autoimmune condition in which the body's immune system mistakenly attacks and destroys the insulin-producing cells in the pancreas called beta cells. As a result, the pancreas is unable to produce sufficient insulin, leading to high blood sugar levels (hyperglycaemia).

Type 1 diabetes typically develops in childhood or early adulthood, although it can occur at any age. The exact cause of type 1 diabetes is not fully understood, but it is believed to be a combination of genetic and environmental factors.

Symptoms of type 1 diabetes may include:

1. Increased thirst and frequent urination (polydipsia and polyuria)
2. Extreme hunger (polyphagia)
3. Unintentional weight loss
4. Fatigue and weakness
5. Blurred vision
6. Irritability and mood changes
7. Dry mouth and skin
8. Slow healing of wounds and infections

Type 1 diabetes is managed by replacing the missing insulin through daily injections or an insulin pump, monitoring blood sugar levels regularly, following a healthy diet, exercising regularly, and maintaining a healthy lifestyle. It is important for people with type 1 diabetes to work closely with their healthcare team to develop a customized treatment plan and prevent or manage any complications that may arise.

Here are some key points about Type 1 diabetes:

1. **Onset and Age:** Type 1 diabetes often develops during childhood, adolescence, or early adulthood, although it can occur at any age. It is less common than Type 2 diabetes, accounting for approximately 5-10% of all diabetes cases.
2. **Insulin Dependency:** Individuals with Type 1 diabetes require lifelong insulin therapy to survive. Insulin is administered through injections or an insulin pump to help regulate blood sugar levels and enable glucose to enter the body's cells for energy.
3. **Autoimmune Nature:** Type 1 diabetes is considered an autoimmune disease, where the immune system mistakenly attacks and destroys the insulin-producing beta cells in the pancreas. The exact cause of the immune system malfunction is not fully understood, but both genetic and environmental factors are believed to play a role.
4. **Symptoms:** The onset of Type 1 diabetes is usually rapid, with noticeable symptoms that may include frequent urination, excessive thirst, increased hunger, unexplained weight loss, fatigue, blurred vision, and recurrent infections.
5. **Blood Sugar Management:** Proper management of blood sugar levels is crucial in Type 1 diabetes. This involves regular blood glucose monitoring, administering insulin as prescribed, following a balanced diet, engaging in regular physical activity, and making appropriate adjustments to insulin dosage based on individual needs.
6. **Potential Complications:** If blood sugar levels are not properly controlled, Type 1 diabetes can lead to various complications over time. These may include cardiovascular disease, kidney damage (diabetic nephropathy), nerve damage (diabetic neuropathy), eye problems (diabetic retinopathy), and foot complications.
7. **Lifestyle and Support:** Living with Type 1 diabetes requires careful attention to diet, physical activity, stress management, and overall health. Diabetes management often involves a multidisciplinary approach, with support from healthcare professionals, such as endocrinologists, diabetes educators, dietitians, and mental health specialists.
8. **Ongoing Research:** Research efforts are ongoing to better understand the underlying causes of Type 1 diabetes, improve treatments, and explore potential avenues for prevention and cure, including immunotherapies and beta cell transplantation.

It's important for individuals with Type 1 diabetes to have a comprehensive care plan, regular medical check-ups, and access to a support network to effectively manage their condition and maintain good overall health.

1.3.2 Type 2 Diabetes

Type 2 diabetes is a chronic metabolic disorder characterized by high blood sugar levels (hyperglycaemia) due to insulin resistance and/or insufficient insulin production. Unlike type 1 diabetes, which is an autoimmune condition, type 2 diabetes is primarily influenced by lifestyle factors and genetics.

In type 2 diabetes, the body becomes resistant to the effects of insulin, and the pancreas may not produce enough insulin to compensate for this resistance. Insulin is essential for allowing glucose to enter cells and be used as a source of energy. When insulin resistance occurs, glucose accumulates in the bloodstream, leading to elevated blood sugar levels. Over time, the pancreas may also produce less insulin, aggravating the problem.

Type 2 diabetes is more common in people who are overweight or obese, inactive, and have a family history of diabetes. Aging, ethnicity, and certain medical conditions such as high blood pressure and high cholesterol also increase the risk of developing type 2 diabetes.

You are more likely to develop type 2 diabetes if you are age 45 or older, have a family history of diabetes, or are overweight. Physical inactivity, race, and certain health problems such as high blood pressure also affect your chance of developing type 2 diabetes. You are also more likely to develop type 2 diabetes if you have prediabetes or had gestational diabetes when you were pregnant. Learn more about risk factors for type 2 diabetes.

Risk factors for type 2 diabetes include:

1. Obesity or overweight: Excess body weight, particularly around the abdomen, increases the risk of insulin resistance.
2. Sedentary lifestyle: Lack of physical activity can contribute to insulin resistance.
3. Unhealthy diet: High consumption of sugary and processed foods can contribute to the development of type 2 diabetes.
4. Family history: Having a close family member with type 2 diabetes increases the risk.
5. Age: The risk of type 2 diabetes increases with age, especially after 45 years.
6. Ethnicity: Certain ethnic groups, such as African-Americans, Hispanics, Native Americans, and Asians, have a higher predisposition to type 2 diabetes.
7. Gestational diabetes: Women who have had gestational diabetes during pregnancy are at higher risk of developing type 2 diabetes later in life.

Common symptoms of type 2 diabetes include:

1. Frequent urination (polyuria)
2. Increased thirst (polydipsia)
3. Unexplained weight loss or gain
4. Fatigue and weakness
5. Blurred vision
6. Slow healing of wounds
7. Frequent infections, such as urinary tract infections or yeast infections
8. Numbness or tingling in the hands or feet
9. Extreme hunger (polyphagia)
10. Irritability and mood changes

Type 2 diabetes is managed through lifestyle modifications such as losing weight, following a healthy diet, and engaging in regular physical activity. Medications, including oral medications and insulin injections, may also be

prescribed to help control blood sugar levels. Regular monitoring of blood sugar levels, blood pressure, and cholesterol levels is also important to prevent or manage any complications that may arise. It is important for people with type 2 diabetes to work closely with their healthcare team to develop a customized treatment plan.

Early detection and proper management of type 2 diabetes are crucial to prevent complications, such as cardiovascular disease, kidney damage, nerve damage, and eye problems. Regular check-ups, blood sugar monitoring, and working closely with healthcare professionals are important aspects of managing type 2 diabetes effectively.

1.3.3 Gestational diabetes

Gestational diabetes mellitus (GDM) is a type of diabetes that develops during pregnancy. It affects women who previously did not have diabetes but experience high blood sugar levels during pregnancy. Gestational diabetes typically occurs around the 24th to 28th week of pregnancy.

The exact cause of gestational diabetes is not fully understood, but it is believed to be related to hormonal changes during pregnancy that can affect insulin sensitivity. The placenta produces hormones that can interfere with the action of insulin in the mother's body, leading to insulin resistance.

Most women with gestational diabetes do not experience noticeable symptoms. However, some possible signs and symptoms may include:

1. Increased thirst and frequent urination
2. Fatigue
3. Blurred vision
4. Recurrent infections, such as urinary tract infections

Gestational diabetes is diagnosed through a glucose screening test, usually performed between the 24th and 28th weeks of pregnancy. If the screening test suggests elevated blood sugar levels, a follow-up glucose tolerance test may be conducted to confirm the diagnosis.

Managing gestational diabetes involves making healthy lifestyle changes. This includes following a balanced diet, monitoring blood sugar levels, engaging in regular physical activity (as recommended by a healthcare provider), and maintaining a healthy weight. In some cases, insulin or other medications may be required to manage blood sugar levels.

It's important to effectively manage gestational diabetes to reduce the risk of complications for both the mother and the baby. With proper care and monitoring, most women with gestational diabetes are able to have a healthy pregnancy and delivery. After delivery, blood sugar levels typically return to normal, but women who have had gestational diabetes are at an increased risk of developing type 2 diabetes later in life and should be monitored regularly.

1.4 Physiology of Glucose Regulation

Glucose regulation is the process by which the body maintains a stable level of glucose (sugar) in the bloodstream. This is important because glucose is the primary source of energy for the body's cells, and both too much or too little glucose can have harmful effects on the body.

The regulation of glucose is controlled by a complex system that involves several hormones, including insulin, glucagon, cortisol, and epinephrine.

When glucose levels in the bloodstream rise after a meal, the pancreas releases insulin into the bloodstream. Insulin helps glucose enter the body's cells, where it can be used for energy or stored for later use. Insulin also signals the liver and muscle cells to store excess glucose as glycogen. When glucose levels in the bloodstream drop between meals or during periods of fasting, the pancreas releases glucagon. Glucagon signals the liver to break down stored glycogen and release glucose into the bloodstream to maintain blood sugar levels. The liver also plays a critical role in glucose regulation. It can store excess glucose as glycogen, and it can also convert other nutrients, such as amino acids and fats, into glucose through a process called gluconeogenesis.

The hormones cortisol and epinephrine also play a role in glucose regulation. They are released in response to stress and can cause glucose levels in the bloodstream to rise.

Overall, glucose regulation is a complex process that involves several hormones and organs working together to maintain a stable level of glucose in the bloodstream.

The regulation of glucose (sugar) in the body involves a complex interplay between multiple organs, hormones, and processes. Here is an overview of the physiology of glucose regulation:

- a) **Pancreatic Hormones:** The pancreas plays a central role in glucose regulation. It produces two main hormones involved in this process:
 - i. **Insulin:** Insulin is produced by beta cells in the pancreas. Its primary function is to lower blood sugar levels by promoting the uptake of glucose from the bloodstream into cells, particularly muscle and adipose (fat) cells. Insulin also helps store excess glucose in the liver as glycogen for later use.
 - ii. **Glucagon:** Glucagon is produced by alpha cells in the pancreas. It acts in opposition to insulin, raising blood sugar levels. Glucagon stimulates the liver to break down glycogen into glucose and release it into the bloodstream.
- b) **Liver:** The liver plays a vital role in maintaining glucose balance. It stores excess glucose as glycogen through a process called glycogenesis when blood sugar levels are high. Conversely, it releases glucose into the bloodstream through glycogenolysis when blood sugar levels drop, stimulated by glucagon. The liver can also produce new glucose from other substances, such as amino acids (gluconeogenesis).
- c) **Muscle and Adipose Tissue:** Muscles and adipose tissue are important sites for glucose uptake. Insulin facilitates the transport of glucose into muscle cells, where it can be used as an energy source or stored as glycogen. Adipose tissue takes up glucose for storage as triglycerides.
- d) **Hormonal Regulation:** In addition to insulin and glucagon, other hormones play a role in glucose regulation. These include:
 - i. **Epinephrine (adrenaline):** Released during times of stress or physical exertion, it stimulates the breakdown of glycogen in the liver, raising blood sugar levels.
 - ii. **Cortisol:** A hormone released by the adrenal glands in response to stress, cortisol promotes glucose production by stimulating gluconeogenesis in the liver.
 - iii. **Growth hormone:** Released by the pituitary gland, growth hormone reduces glucose uptake in muscle and fat cells, sparing glucose for the brain and promoting the breakdown of fats.
- e) **Intestinal Absorption:** After a meal, carbohydrates are broken down into glucose in the digestive system. Glucose is then absorbed from the intestines into the bloodstream and transported to various tissues for energy or storage.
- f) **Feedback Mechanisms:** Glucose regulation is tightly controlled by feedback mechanisms to maintain stable blood sugar levels. When blood glucose levels are high, insulin is released to lower it. Conversely, when blood glucose levels are low, glucagon is released to raise it.

These are simplified explanations of the complex physiology of glucose regulation. The intricate balance between insulin, glucagon, liver function, and other hormonal factors ensures that blood sugar levels are maintained within a relatively narrow range for optimal health and energy production in the body.



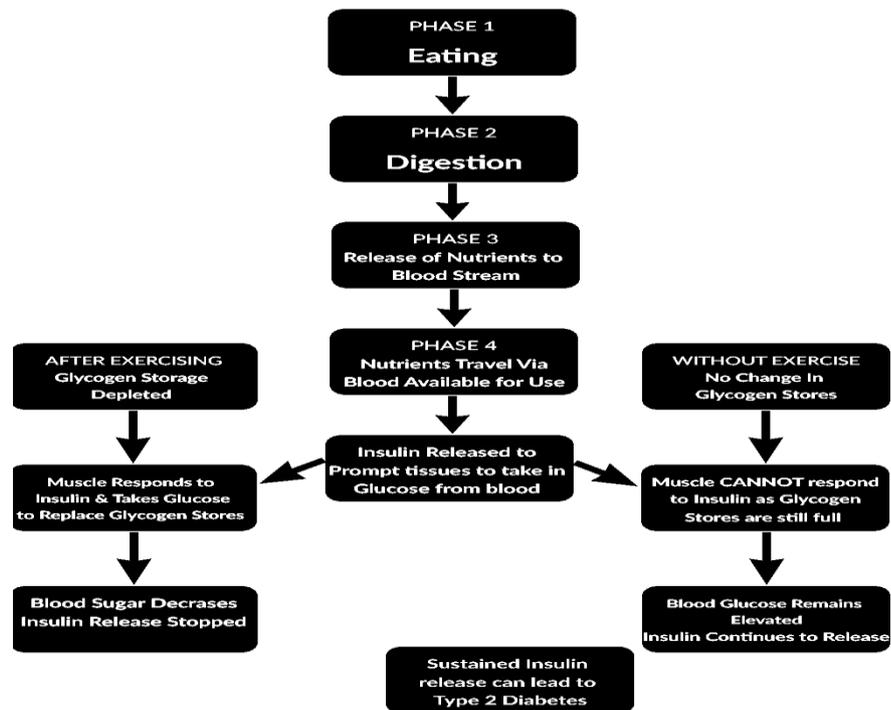


Fig. 1.2 How Glucose Transforms and get used in Body.

1.5 Role of insulin in glucose metabolism

Insulin plays a critical role in glucose metabolism by facilitating the uptake, utilization, and storage of glucose in various tissues throughout the body. Insulin is produced and secreted by beta cells in the pancreas in response to rising blood glucose levels after a meal. Here are the key roles of insulin in glucose metabolism:

1. Uptake of Glucose:

- Insulin facilitates the uptake of glucose into cells, primarily in muscle and adipose tissue. This is achieved through the translocation of glucose transporters (GLUTs) to the cell membrane.
- Insulin stimulates the translocation of GLUT4 transporters to the cell membrane in muscle and adipose tissue. GLUT4 transporters act as channels that allow glucose to enter the cells.
- The increased presence of GLUT4 transporters in the cell membrane enhances the uptake of glucose from the bloodstream into the cells.

2. Glycolysis and Glucose Utilization:

- Once inside the cell, glucose undergoes glycolysis, a metabolic pathway that breaks down glucose into pyruvate. This process generates ATP, which serves as the energy currency of the cell.
- Insulin promotes the glycolytic process, allowing glucose to be effectively metabolized and utilized for energy production.
- In muscle cells, insulin stimulates glucose uptake and glycolysis, supporting muscle contraction and energy production during physical activity.
- In the liver, insulin suppresses gluconeogenesis, the process of glucose synthesis from non-carbohydrate sources, and promotes glycogen synthesis. This helps maintain blood glucose levels within a normal range and prevents excessive glucose production.

3. Glycogen Synthesis:

- Insulin stimulates the storage of excess glucose as glycogen in the liver and muscle cells.
- In the liver, insulin activates enzymes that promote glycogen synthesis, converting glucose into glycogen for storage.
- In muscle cells, insulin also stimulates glycogen synthesis, replenishing glycogen stores that can be used as an energy source during physical activity.

4. Inhibition of Glucose Production:

- Insulin inhibits glucose production in the liver by suppressing gluconeogenesis. It reduces the breakdown of amino acids and glycerol, which are used as substrates for glucose synthesis.
- By suppressing gluconeogenesis, insulin helps to prevent excessive glucose release into the bloodstream and maintains blood glucose levels within a normal range.

5. Lipid Metabolism:

- Insulin plays a role in lipid metabolism by promoting the uptake, utilization, and storage of lipids (fats).
- Insulin enhances the uptake of fatty acids into adipose tissue, where they are converted into triglycerides for storage.
- Insulin inhibits the breakdown of stored triglycerides, preventing excessive release of fatty acids into the bloodstream.
- Insulin also stimulates lipogenesis, the process of converting excess glucose into fatty acids for storage in adipose tissue.

6. Protein Metabolism:

- Insulin affects protein metabolism by stimulating protein synthesis and inhibiting protein breakdown.
- Insulin promotes the uptake of amino acids into cells, facilitating protein synthesis and contributing to tissue growth and repair.
- Insulin inhibits proteolysis, the breakdown of proteins, helping to preserve lean muscle mass.

In summary, insulin plays a crucial role in glucose metabolism by facilitating the uptake of glucose into cells, promoting its utilization for energy production, and regulating its storage as glycogen. Insulin also influences lipid and protein metabolism, supporting the uptake, utilization, and storage of lipids and promoting protein synthesis while inhibiting their breakdown. By orchestrating these processes, insulin helps to maintain blood glucose levels, supports energy production, and regulates overall metabolic homeostasis in the body.

Overall, insulin acts as a key regulator of glucose metabolism, ensuring that glucose is efficiently utilized for energy production, stored as glycogen, and preventing excessive glucose production in the liver. Its actions help to maintain stable blood glucose levels and provide the necessary energy for cellular functions throughout the body.

1.6 Pancreatic dysfunction and insulin resistance

Pancreatic dysfunction and insulin resistance are two key factors that contribute to the development of diabetes.

1. Pancreatic Dysfunction:

- ❖ Pancreatic dysfunction refers to a condition in which the pancreas is unable to function properly, particularly in the production and release of insulin.
- ❖ Type 1 Diabetes: In type 1 diabetes, pancreatic dysfunction occurs due to an autoimmune response in which the body's immune system mistakenly targets and destroys the insulin-producing beta cells in the pancreas. As a result, the pancreas produces little to no insulin.
- ❖ Type 2 Diabetes: In type 2 diabetes, pancreatic dysfunction is characterized by a progressive decline in beta cell function and a decrease in insulin production. While the exact cause is not fully understood, factors such as genetic predisposition, obesity, and chronic inflammation contribute to the impaired function of beta cells.
- ❖ Pancreatic dysfunction leads to insufficient insulin levels in the body, resulting in decreased glucose uptake by cells and elevated blood glucose levels.

2. Insulin Resistance:

- ❖ Insulin resistance refers to a condition in which the body's cells become less responsive to the effects of insulin, requiring higher levels of insulin to facilitate glucose uptake.
- ❖ Insulin resistance is a hallmark of type 2 diabetes, although it can also occur in individuals with prediabetes or as a result of other underlying medical conditions.
- ❖ Several factors contribute to the development of insulin resistance, including obesity, sedentary lifestyle, unhealthy diet (high in refined carbohydrates and saturated fats), genetics, and certain hormonal imbalances.

- ❖ In insulin resistance, cells, particularly those in muscle, liver, and adipose tissue, fail to respond effectively to insulin's signals, leading to reduced glucose uptake. This triggers a compensatory response from the pancreas, resulting in increased insulin production.

3. Interplay between Pancreatic Dysfunction and Insulin Resistance:

- ❖ Pancreatic dysfunction and insulin resistance are interconnected and often occur together in type 2 diabetes.
- ❖ Insulin resistance puts increased demand on the pancreas to produce more insulin in order to overcome the reduced cellular response. Initially, the pancreas compensates by producing higher levels of insulin.
- ❖ Over time, the combination of insulin resistance and pancreatic dysfunction leads to a progressive decline in beta cell function. The pancreas is unable to sustain the increased insulin production required to overcome insulin resistance, resulting in inadequate insulin levels.
- ❖ The reduced insulin levels, along with persistent insulin resistance, lead to impaired glucose regulation, resulting in elevated blood glucose levels characteristic of type 2 diabetes.
- ❖ Ultimately, the interplay between pancreatic dysfunction and insulin resistance contributes to the development and progression of type 2 diabetes, with the pancreas being unable to meet the body's insulin needs.

Managing pancreatic dysfunction and insulin resistance often involves a combination of lifestyle modifications, such as regular physical activity, healthy eating habits, weight management, and, in some cases, medications to improve insulin sensitivity or stimulate insulin secretion. Close monitoring and support from healthcare professionals are essential to effectively manage these conditions and maintain blood glucose control.

In summary, pancreatic dysfunction and insulin resistance both play important roles in the development of diabetes. In type 1 diabetes, pancreatic dysfunction results in a complete deficiency of insulin production, while in type 2 diabetes, pancreatic dysfunction and insulin resistance contribute to elevated blood glucose levels. Understanding the mechanisms underlying these processes is essential for the development of effective prevention and treatment strategies for diabetes.

1.7 RISK FACTOR FOR DEVELOPING DIABETES

Several risk factors contribute to the development of diabetes. While some factors are beyond an individual's control, such as genetics and age, others are modifiable through lifestyle changes. Here are the key risk factors for developing diabetes:

1. **Age:** The risk of developing diabetes increases with age. Type 2 diabetes is more common in adults, especially those over the age of 45. However, due to the rising rates of obesity and sedentary lifestyles, type 2 diabetes is increasingly affecting younger individuals as well.
2. **Family History and Genetics:** Having a family history of diabetes increases the risk of developing the disease. Certain genes can also contribute to an individual's susceptibility to diabetes. However, genetic predisposition alone is not sufficient, and lifestyle factors play a significant role.
3. **Obesity and Body Weight:** Excess body weight, particularly abdominal obesity, is strongly associated with an increased risk of type 2 diabetes. Obesity leads to insulin resistance and the dysfunction of beta cells in the pancreas, impairing insulin production and utilization. Lack of physical activity and leading a sedentary lifestyle contribute to weight gain and insulin resistance, further elevating the risk of developing diabetes.
4. **Sedentary Lifestyle:** Lack of physical activity and a sedentary lifestyle contribute to the development of type 2 diabetes. Regular exercise helps maintain a healthy weight, improves insulin sensitivity, and reduces the risk of diabetes.
5. **Unhealthy Diet:** Poor dietary choices, such as consuming high-calorie foods, sugary beverages, and processed foods that are high in refined carbohydrates and unhealthy fats, increase the risk of developing diabetes. A diet rich in fruits, vegetables, whole grains, lean proteins, and healthy fats is recommended for diabetes prevention.
6. **Gestational Diabetes:** Women who have had gestational diabetes during pregnancy are at a higher risk of developing type 2 diabetes later in life. Their children also have a higher risk of obesity and developing diabetes.
7. **Ethnicity:** Certain ethnic groups, including African-Americans, Hispanic/Latino Americans, Native Americans, and Asian-Americans, have a higher risk of developing diabetes. This increased risk is partly due to genetic factors and higher rates of obesity and insulin resistance within these populations.
8. **Hypertension and High Cholesterol:** Having high blood pressure and high cholesterol levels can increase the risk of diabetes. These conditions are often associated with obesity and insulin resistance.

9. **Polycystic Ovary Syndrome (PCOS):** PCOS is a hormonal disorder common in women of reproductive age. It is characterized by insulin resistance, obesity, and hormonal imbalances, which increase the risk of developing type 2 diabetes.

It's important to note that while these risk factors increase the likelihood of developing diabetes, they do not guarantee its occurrence. Many individuals without these risk factors can still develop diabetes, and having these risk factors does not mean one will inevitably develop the disease. Adopting a healthy lifestyle, managing weight, engaging in regular physical activity, and making dietary changes can significantly reduce the risk of developing diabetes, even in individuals with multiple risk factors.

1.8 Complications Associated with Diabetes

High sugar levels in your blood over a long period of time can seriously damage your blood vessels. If your blood vessels aren't working properly, blood can't travel to the parts of your body it needs to. This means your nerves won't work properly either and means you lose feeling in parts of your body. Once you've damaged the blood vessels and nerves in one part of your body, you're more likely to develop similar problems in other parts of your body. So, if your feet are damaged, serious heart problems can follow.

We know that the higher your **HbA1c** level, the more you're at risk of developing complications. HbA1c is glycated haemoglobin. This is made when glucose, which we call sugar, sticks to your blood cells and builds up in your blood. It's measured by a blood test that shows your average blood sugar levels over the last three months. A high HbA1c means you have too much sugar in your blood.

Even a slightly high HbA1c increases your risk.

But it's not just about blood sugars. High blood pressure, smoking and a lot of fat in your blood (cholesterol) can all damage your blood vessels and put you even more at risk.

1.8.1 Chronic complications

These are long-term problems that can develop gradually, and can lead to serious damage if they go unchecked and untreated.

- **Eye Problems (retinopathy):** Some people with diabetes develop an eye disease called diabetic retinopathy which can affect their eyesight. If retinopathy is picked up – usually from an eye screening test - it can be treated and sight loss prevented.
- **Foot Problems:** Diabetes foot problems are serious and can lead to amputation if untreated. Nerve damage can affect the feeling in your feet and raised blood sugar can damage the circulation, making it slower for sores and cuts to heal. That's why it's important to tell your GP if you notice any change in how your feet look or feel.
- **Heart attack and Stroke:** When you have diabetes, high blood sugar for a period of time can damage your blood vessels. This can sometimes lead to heart attacks and strokes.
- **Kidney Problems (nephropathy):** Diabetes can cause damage to your kidneys over a long period of time making it harder to clear extra fluid and waste from your body. This is caused by high blood sugar levels and high blood pressure. It is known as diabetic nephropathy or kidney disease.
- **Nerve Damage (neuropathy):** Some people with diabetes may develop nerve damage caused by complications of high blood sugar levels. This can make it harder for the nerves to carry messages between the brain and every part of our body so it can affect how we see, hear, feel and move.
- **Gum disease and other mouth problems:** Too much sugar in your blood can lead to more sugar in your saliva. This brings bacteria which produces acid which attacks your tooth enamel and damages your gums. The blood vessels in your gums can also become damaged, making gums more likely to get infected.

- **Related conditions, like Cancer:** If you have diabetes, you're more at risk of developing certain cancers. And some cancer treatments can affect your diabetes and make it harder to control your blood sugar.
- **Sexual Problems in Women:** Damage to blood vessels and nerves can restrict the amount of blood flowing to your sexual organs so you can lose some sensation. If you have high blood sugar, you are also more likely to get thrush or a urinary tract infection.
- **Sexual Problems in Men:** The amount of blood flowing to your sexual organs can be restricted which may cause you to have difficulty getting aroused. It may lead to erectile dysfunction, sometimes called impotence.

1.8.2 Acute complications

These can happen at any time and may lead to chronic, or long-term, complications.

- **Hypos** – when your blood sugars are too low
- **Hypers**– when your blood sugars are too high
- **Hyperosmolar Hyperglycaemic State (HHS)**– a life-threatening emergency that only happens in people with **type 2 diabetes**. It's brought on by severe dehydration and very high blood sugars.
- **Diabetic ketoacidosis (DKA)**: This complication mainly affects people with Type 1 diabetes or undiagnosed T1D. It happens when your body doesn't have enough insulin. If your body doesn't have insulin, it can't use glucose for energy, so it breaks down fat instead. This process eventually releases substances called ketones, which turn your blood acidic. DKA is a life-threatening emergency where the lack of insulin and high blood sugars leads to a build-up of ketones. This causes laboured breathing, vomiting and loss of consciousness. DKA requires immediate medical treatment.

3.1 Management

Diabetes is a complex condition, so its management involves several strategies. In addition, diabetes affects everyone differently, so management plans are highly individualized.

Diabetes management involves various strategies and lifestyle modifications aimed at controlling blood sugar levels, preventing complications, and promoting overall well-being. Here are key aspects of diabetes management:

The main aspects of managing diabetes include:

- **Blood sugar monitoring:** Monitoring your blood sugar (glucose) is key to determining how well your current treatment plan is working. It gives you information on how to manage your diabetes on a daily — and sometimes even hourly — basis. You can monitor your levels with frequent checks with a glucose meter and finger stick and/or with a continuous glucose monitor (CGM). You and your healthcare provider will determine the best blood sugar range for you.
- **Oral diabetes medications:** Oral diabetes medications (taken by mouth) help manage blood sugar levels in people who have diabetes but still produce some insulin — mainly people with Type 2 diabetes and prediabetes. People with gestational diabetes may also need oral medication. There are several different types. Metformin is the most common.
- **Insulin:** People with Type 1 diabetes need to inject synthetic insulin to live and manage diabetes. Some people with Type 2 diabetes also require insulin. There are several different types of synthetic insulin. They each start to work at different speeds and last in your body for different lengths of time. The four main ways you can take insulin include injectable insulin with a syringe (shot), insulin pens, insulin pumps and rapid-acting inhaled insulin.
- **Diet:** Meal planning and choosing a healthy diet for you are key aspects of diabetes management, as food greatly impacts blood sugar. If you take insulin, counting carbs in the food and drinks you consume is a large part of management. The amount of carbs you eat determines how much insulin you need at meals. Healthy eating habits can also help you manage your weight and reduce your heart disease risk.
- **Exercise:** Physical activity increases insulin sensitivity (and helps reduce insulin resistance), so regular exercise is an important part of management for all people with diabetes. Aim for at least 150 minutes of moderate-intensity aerobic activity per week, along with strength training exercises at least twice a week.

- **Weight Management:** Maintain a healthy weight or work towards achieving a weight that is appropriate for you. If overweight or obese, losing weight can improve insulin sensitivity and blood sugar control. Consult a registered dietitian or healthcare provider for personalized guidance on weight management.
- **Stress Management:** Practice stress management techniques, such as mindfulness, meditation, deep breathing exercises, or engaging in activities you enjoy. High stress levels can affect blood sugar levels, so it's important to find healthy coping mechanisms.
- **Regular Healthcare Check-ups:** Schedule regular visits with your healthcare provider for diabetes management and preventive screenings. Get regular check-ups for monitoring blood pressure, cholesterol levels, kidney function, and eye and foot health.
- **Diabetes Education and Support:** Seek diabetes education programs or classes to learn about self-care, healthy habits, and managing your condition effectively. Join support groups or connect with others living with diabetes to share experiences, seek advice, and receive emotional support.

Remember, diabetes management is a lifelong commitment, and it's important to work closely with your healthcare team to develop a personalized plan that suits your needs. By maintaining good self-care practices and making positive lifestyle choices, you can effectively manage diabetes and reduce the risk of complications.

Due to the increased risk for heart disease, it's also important to maintain a healthy:

- Weight.
- Blood pressure.
- Cholesterol.

Table 3.1: Blood Glucose Levels Chart.

Person's Category	Fasting State		Postprandial
	Glucose Minimum Value(mg/dl)	Glucose Maximum Value(mg/dl)	2-3 Hours after Eating (mg/dl)
Hypoglycaemia	-	<59	<60
Early hypoglycaemia	60	79	60-70
Normal	80	100	<140
Early Diabetes	101	126	140-200
Diabetic	>123	-	>200

3.2 ORAL MEDICATIONS

Oral diabetes medications (taken by mouth) help manage blood sugar (glucose) levels in people who have diabetes but still produce some insulin — mainly people with Type 2 diabetes and prediabetes.

The most effective management of Type 2 diabetes involves:

- Lifestyle and diet modifications.
- Exercise.
- Medications.

Together, you and your healthcare provider will determine a treatment plan that works best for you. You may also work with a dietitian. You'll need to see your provider regularly to adjust your treatment as needed.

Providers may prescribe more than one oral diabetes medication at a time to achieve the best blood glucose management. You can take some oral diabetes medications alongside insulin injections.

People with gestational diabetes may also need to take oral medication (metformin) if dietary changes and exercise don't help enough to keep their blood sugar levels within range.

3.2.1 How do medicines work

All oral diabetes medications share one goal: To help lower blood glucose levels (and your A1c) to a healthy range. A significant contributor to the development of Type 2 diabetes (and gestational diabetes) is insulin resistance.

Insulin resistance, also known as impaired insulin sensitivity, happens when cells in your muscles, fat and liver don't respond as they should to insulin. Insulin is a hormone your pancreas makes. It allows your body to turn the glucose (sugar) you consume from food into energy. This is an essential, life-sustaining process.

As a result of insulin resistance, your pancreas has to release more insulin to try to keep your blood sugar levels in a healthy range. If your pancreas can't release enough insulin, your blood sugar levels rise, causing hyperglycaemia (high blood sugar). Long-term hyperglycaemia can cause several health issues.

Insulin resistance is a complex phenomenon. Oral diabetes medications work in different ways to lower blood sugar, including helping your pancreas produce more insulin. Beyond medication, exercise is a key part of naturally reducing insulin resistance.

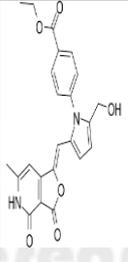
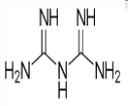
3.2.2 Types of anti-diabetic medicines

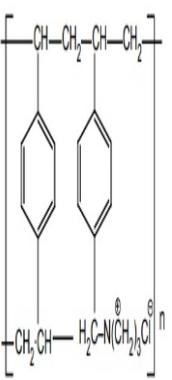
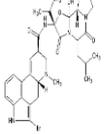
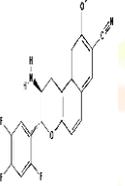
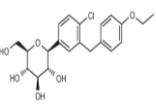
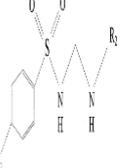
There are several different classes of diabetes medications that work in different ways to help manage blood sugar levels. They include:

- Alpha-glucosidase inhibitors.
- Biguanides.
- Bile acid sequestrants (BASs).
- Dopamine-2 agonists.
- DPP-4 inhibitors (gliptins).
- Meglitinides (glinides).
- SGLT2 inhibitors.
- Sulfonylureas.
- Thiazolidinediones (TZDs).

These are some FDA approved drugs used for treatment of diabetes, which are enlisted in table below-

Table 3.2: Drugs with their targets for symptomatic treatment of diabetes.

S.N	Drug class	Molecular structure	Molecular target	Adverse effects	Mechanism	Generic name	Brand name
1.	Alpha-glucosidase Inhibitors		Intestinal enzyme that absorbs carbohydrate rates	Stomach Pain Diarrhoea Gas Abnormal Liver Tests	These pills help your body digest sugar more slowly.	Miglitol Acarbose	Glyset Precose
2.	Biguanides		inhibit mitochondrial complex I	Diarrhoea Gas Indigestion Feeling Weak Nausea and Vomiting Headache	These pills stop your liver from making too much sugar (glucose). They also help the sugar get into your cells.	Metformin	Glucophage Fortamet

3.	Bile Acid Sequestrants		interrupt the enterohepatic circulation of bile acids	Constipation Dyspepsia (Upset Stomach/ Indigestion) Nausea	It is not clear how this pill works for diabetes.	Colselvelam	Welchol
4.	Dopamine Receptor Agonists		Dopamine	Nausea Headache Feel Very Tired Feel Dizzy Vomiting	This pill affects a chemical called dopamine in your cells. It is not clear how this pill works for diabetes.	Bromocriptine	Cycloset
5.	DPP-4 Inhibitors		incretin hormones	Upper Respiratory Infection Headache	These pills help your body release more insulin.	Sitagliptin Saxagliptin Alogliptin Linagliptin	Januvia Nesina Tadjenta Onglyza
6.	Meglitinides		Pancreatic beta cells	Hypoglycemia	These pills help your body make more insulin around mealtime.	Repaglinide Nateglinide	Prandin Starlix
7.	SGLT2 Inhibitors		decrease the renal threshold for glucose (RTG),	Vaginal Yeast Infections Urinary Tract Infections Changes in Urination	These pills affect the kidney to increase the amount of sugar that goes out in the urine.	Dapagliflozin Canagliflozin Empagliflozin	Farxiga Invokana Jardiance
8.	Sulfonylureas		pancreatic beta cells	Hypoglycemia (blood sugar that is too low) Weight Gain Headache Dizziness	These pills help your body make more insulin.	Glimepride Glipizide Tolbutamide Tolazamide	Amaryl Glipizide

9.	Thiazolidinediones		intracellular metabolic pathways	Fluid Retention Weight Gain Heart Failure (heart cannot pump blood well) Anaemia (low red blood cell counts) Upper Respiratory Tract Infection	These pills help the cells in your body use glucose.	Pioglitazone Rosiglitazone	Actos Avandia
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3.2.2.1 Alpha-glucosidase inhibitors

Alpha-glucosidase inhibitors help lower blood sugar levels by blocking the breakdown of starches and some forms of sugar in your intestines. Starch is a carbohydrate in foods like potatoes, bread and rice. Carbohydrates (starch and sugar) increase your blood glucose levels the most compared to other nutrients (protein and fat) you get from food.

Side effects of alpha-glucosidase inhibitors may include gas (flatulence), bloating and diarrhoea.

Alpha-glucosidase inhibitors include:

- Acarbose (Precose®).
- Miglitol (Glyset®).

3.2.2.2 Biguanides

Biguanides lower blood glucose levels by decreasing the amount of glucose your liver produces and releases into your bloodstream. They also help lower blood glucose levels by making your muscle tissue more sensitive to insulin so it can absorb glucose for energy.

Side effects may include diarrhoea, upset stomach and a metallic taste in your mouth.

Metformin is the main type of biguanide. Its brand names include:

- Glucophage®.
- Glucophage XR®.
- Glumetza®.
- Fortamet®.
- Riomet®.

3.2.2.3 Bile acid sequestrants (BASs)

Bile acid sequestrants are primarily cholesterol-lowering drugs. They can also help lower blood glucose levels, though researchers don't know exactly how they do it. These drugs can be helpful since people with diabetes often have high cholesterol.

BASs help remove LDL cholesterol (low-density lipoproteins or the "bad" cholesterol). The drug prevents bile acid in your stomach from being absorbed into your blood. Your liver then needs the cholesterol from your blood to make more bile acid. This process lowers your cholesterol level

Side effects may include gas and constipation.

The main BAS medication for Type 2 diabetes is colesevelam (Welchol®).

3.2.2.4 Dopamine-2 agonists
Dopamine-2 agonists reset your hypothalamic circadian rhythm, which obesity can affect. This reset helps reverse insulin resistance and causes a decrease in glucose production in your liver.

Bromocriptine (Cycloset®) is the only U.S. Food and Drug Administration (FDA)-approved dopamine-2 agonist to help treat Type 2 diabetes.

3.2.2.5 DPP-4 inhibitors (gliptins)

DPP-4 inhibitors (gliptins) help improve blood sugar levels by preventing the breakdown of GLP-1, a compound in your body.

GLP-1 naturally reduces blood glucose levels, but it normally breaks down and stops working very quickly. By interfering with this process, DPP-4 inhibitors allow GLP-1 to remain active in your body longer, lowering blood sugar levels only when they're elevated. They can also increase satiety (feeling full after eating).

Possible side effects of DPP-4 inhibitors include headaches and gastrointestinal issues.

DPP-4 inhibitors include:

- Alogliptin (Nesina®).
- Linagliptin (Tradjenta®).
- Saxagliptin (Onglyza®).
- Sitagliptin (Januvia®).

3.2.2.6 Meglitinides (glinides)

Meglitinides are medications that stimulate your pancreas to release insulin. You take them before each meal to help prevent your blood sugar from increasing too much from the food. Because they increase insulin production, you're more at risk for low blood sugar (hypoglycaemia).

Meglitinides include:

- Nateglinide (Starlix®).
- Repaglinide (Prandin®).

3.2.2.7 SGLT2 inhibitors

SGLT2 inhibitors help lower blood glucose levels by sending extra glucose out of your body through your pee (urine). Glucose in your bloodstream passes through your kidneys. From there, the glucose can go into your pee or back into your body. SGLT2 inhibitors block your body's ability to reabsorb glucose.

Side effects of SGLT2 inhibitors can include urinary tract infections (UTIs) and vaginal yeast infections. It can cause a serious complication called diabetes-related ketoacidosis (DKA), but this is rare.

SGLT2 inhibitors include:

- Canagliflozin (Invokana®).
- Dapagliflozin (Farxiga®).
- Empagliflozin (Jardiance®).

3.2.2.8 Sulfonylureas

Sulfonylureas stimulate your pancreas to release more insulin. Because they increase insulin production, you're more at risk for low blood sugar (hypoglycaemia).

All sulfonylurea drugs have similar effects on blood sugar levels, but they differ in side effects and interactions with other drugs. Sulfonylureas can interact with alcohol and cause vomiting, flushing or sickness. Ask your provider if you're concerned about these side effects.

Sulfonylureas include:

- Glimepiride (Amaryl®).
- Glipizide (Glucotrol® and Glucotrol XL®).
- Glyburide (Micronase®, Glynase®, Glycron® and Diabeta®).

3.2.2.9 Thiazolidinediones (TZDs)

Thiazolidinediones help your muscle and fat tissues be more sensitive to insulin. They also reduce glucose production in your liver.

TZDs can cause water retention and increase the risk of heart failure in some people.

Thiazolidinediones include:

- Rosiglitazone (Avandia®).
- Pioglitazone (Actos®).

3.3 Administration

Glipizide is a 2.5 mg to 10 mg tablet, taken as a single dose or in two divided doses, 30 minutes before breakfast. Glimepiride is available as 1 mg, 2 mg, or 4 mg tablets, taken once a day with breakfast or twice a day with meals. For patients at increased risk for hypoglycaemia, such as older patients or those with chronic kidney disease, the initial dose could be as low as 0.5 mg daily. Glyburide is available as 1.25 mg, 2.5 mg, or 5 mg tablets, taken as a single dose or two divided doses.

Repaglinide is available as 0.5 mg, 1 mg, or 2 mg tablets, taken orally in two to three divided doses per day.

Metformin is the initial drug of choice in patients with type 2 diabetes mellitus. It is given orally in 500 to 1000 mg tablets twice a day.

Alpha-glucosidase inhibitors are available as 25 mg, 50 mg, or 100 mg tablets, given three times a day just before meals.

Pioglitazone is given as 15 mg, 30 mg, or 45 mg tablets daily. Rosiglitazone, while rarely used, is given as 2 mg, 4 mg, or 8 mg daily.

Among the **DPP- 4 inhibitors**, linagliptin is available as 5 mg daily. Vildagliptin is given as 50 mg once or twice weekly, Sitagliptin as 25 mg, 50 mg, or 100 mg once daily, and Saxagliptin as 2.5 mg or 5 mg once daily.

Among the **SGLT2 inhibitors**, canagliflozin is initially given as 100 mg daily, which is gradually increased to 300 mg daily, dapagliflozin as 5 mg or 10 mg daily, and empagliflozin as 10 mg or 25 mg daily.

Cycloset has an initial dose of 0.8 mg once daily, which is gradually increased to the usual dose of 1.6 mg to 4.8 mg once daily.

3.4 Adverse Effect

The following are adverse effects of various hypoglycaemic drugs:

Sulfonylureas: Syncope (less than 3%), dizziness (2% to 7%), nervousness (4%), anxiety (less than 3%), depression (<3%), hypoesthesia (less than 3%), insomnia (<3%), pain (<3%), paresthesia (less than 3%), drowsiness (2%), headache (2%), diaphoresis (less than 3%), pruritus (1% to less than 3%), hypoglycaemia (less than 3%), increased lactate dehydrogenase, diarrhoea (1% to 5%), flatulence (3%), dyspepsia (less than 3%), and vomiting (less than 3%).

Repaglinide: Hypoglycaemia (16% to 31%), weight gain, headache (9% to 11%), upper respiratory tract infection (10% to 16%), and cardiovascular ischemia (4%).

Metformin: Gastrointestinal upset such as diarrhoea (12% to 53%), nausea and vomiting (7% to 26%), flatulence (4% to 12%), chest discomfort, flushing, palpitation, headache (5% to 6%), chills, dizziness, taste disorder, diaphoresis, nail disease, skin rash, vitamin B12 deficiency. Also, in less than 1% of patients, it causes lactic acidosis, which can be life-threatening, and is precipitated by conditions predisposing to hypoperfusion and hypoxemia, such as severe renal failure (eGFR less than 30 ml/min/1.73 m²).

Thiazolidinediones: Edema (less than or equal to 27%), hypoglycaemia (less than or equal to 27%), cardiac failure (less than or equal to 8%), headache, bone fracture (less than or equal to 5%), myalgia (5%), sinusitis (6%), and pharyngitis.

Alpha-glucosidase inhibitors: Adverse effects include flatulence (74%) that tends to decrease with time, diarrhoea (31%), abdominal pain (19%), and increased serum transaminases (less than or equal to 4%).

DPP4 inhibitors:

- Sitagliptin: Hypoglycaemia (1%), nasopharyngitis (5%), increased serum creatinine, acute pancreatitis (including hemorrhagic or necrotizing forms), and acute renal failure.
- Saxagliptin: Peripheral edema (4%), headache (7%), hypoglycaemia (6%), urinary tract infection (7%), lymphocytopenia (2%), and acute pancreatitis.
- Linagliptin: Hypoglycaemia (7%), increased uric acid (3%), increased serum lipase (8%; more than three times upper limit of normal), nasopharyngitis (7%), and acute pancreatitis.

SGLT-2 inhibitors: Dyslipidemia (3%), hyperphosphatemia (2%), hypovolemia (1%), nausea, fungal vaginosis (7% to 8%), urinary tract infection (6%), increased urine output (3% to 4%), dysuria (2%), influenza (2% to 3%), bone fracture (8%), and renal impairment.

Cycloset: Dizziness, fatigue, headache, constipation, rhinitis, nausea, and weakness.

3.5 Contraindications

The following are contraindications for different classes of oral hypoglycaemic drugs

- **Metformin:** Hypersensitivity to the drug, severe renal dysfunction (eGFR less than 30 mL/minute/1.73 m²), and metabolic acidosis, including diabetic ketoacidosis.
- **Sulfonylureas:** Hypersensitivity to the drug or sulfonamide derivatives, type 1 diabetes mellitus, and diabetic ketoacidosis.
- **Pioglitazone:** Hypersensitivity to the drug, New York Heart Association Class III or IV heart failure, serious hepatic impairment, bladder cancer, history of macroscopic hematuria, and pregnancy.
- **Alpha-glucosidase inhibitors:** Hypersensitivity to acarbose, diabetic ketoacidosis, cirrhosis, inflammatory bowel disease, ulcers of the intestine, partial intestinal obstruction, digestive and absorptive issues
- **SGLT 2 inhibitors:** History of serious hypersensitivity to the drug, end-stage renal disease (ESRD), and patients on dialysis.
- **DPP-4 inhibitors:** Dose adjustment of saxagliptin is needed for eGFR less than 45 mL/min/1.73 m² with the dose of 2.5 mg once daily. For sitagliptin, a low dose of 25 mg daily is given in patients with a creatinine clearance of less than 30 ml/min/1.73 m² and .is contraindicated in patients on hemodialysis or peritoneal dialysis. Linagliptin does not need any dose adjustment
- **Cycloset:** Allergy to the drug, breastfeeding, and syncopal migraine

3.6 Injectable insulin

People with Type 1 diabetes must take synthetic insulin to manage the condition and to live. This may involve using:

- Multiple daily injections (MDI) of insulin.
- An insulin pump.
- Inhalable insulin.

There's no pill form of insulin

The role of insulin in the body

It may be easier to understand the importance of insulin therapy if you understand how this naturally occurring hormone usually works in the body and what happens if you have diabetes.

If you don't have diabetes, insulin helps:

- **Regulate blood sugar levels.** After you eat, carbohydrates break down into glucose, a sugar that is the body's primary source of energy. Glucose then enters the bloodstream. The pancreas responds by producing insulin, which allows glucose to enter the body's cells to provide energy.
- **Store excess glucose for energy.** After you eat — when insulin levels are high — excess glucose is stored in the liver in the form of glycogen. Between meals — when insulin levels are low — the liver releases glycogen into the bloodstream in the form of glucose. This keeps blood sugar levels within a narrow range.

If you have diabetes:

Your glucose levels will continue to rise after you eat because there's not enough insulin to move the glucose into your body's cells. People with type 2 diabetes don't use insulin efficiently (insulin resistance) and don't produce enough insulin (insulin deficiency). People with type 1 diabetes make little or no insulin.

Untreated, high blood glucose can eventually lead to complications such as blindness, nerve damage and kidney damage.

Goals of insulin Therapy

If you have type 1 diabetes, insulin therapy is vital for replacing the insulin your body doesn't produce. Sometimes, people with type 2 diabetes or gestational diabetes need insulin therapy if other treatments haven't been able to keep blood glucose levels within the desired range. Insulin therapy helps prevent diabetes complications by keeping your blood sugar within your target range.

3.6.1 Types of insulin

There are several types of insulin available that vary in how quickly and how long they can control blood sugar. Frequently your doctor may recommend combining more than one type of insulin. To determine which types of insulin you need and how much you need, your doctor will consider factors such as the type of diabetes you have, your glucose levels, how much your blood sugar fluctuates throughout the day and your lifestyle.

The general types of insulin therapy include:

- **Long-, ultralong- or intermediate-acting insulin.** When you're not eating, your liver releases glucose so the body continually has energy. Long, ultra-long or intermediate-acting insulin helps the body use this glucose and keeps glucose levels from rising too high.

Examples of these insulins are glargine (Lantus, Toujeo, others), detemir (Levemir), degludec (Tresiba) and NPH (Humulin N, Novolin N, Novolin ReliOn Insulin N). These insulins work for between eight and 40 hours, depending on the type.

- **Rapid- or short-acting insulin.** These insulins are ideal for preventing blood sugar spikes after you eat. They begin to work much faster than long-acting or intermediate-acting insulins do, sometimes in as little as three minutes. But they work for a much shorter period of time, usually about two to four hours.

Examples of these insulins include aspart (NovoLog, Fiasp), glulisine (Apidra), lispro (Humalog, Admelog) and regular (Humulin R, Novolin R, Myxredlin, ReliOn R).

Insulin delivery options

Insulin doesn't come in pill form because the digestive system would break it down before it had a chance to work. But there are several choices for insulin delivery. Your doctor can help you decide which fits best with your lifestyle and treatment needs.

Options include:

- **Shots or pens.** Insulin can be injected into the fat just below your skin with a syringe and needle or a penlike device that hold insulin with a needle attached. How often depends on the type of diabetes you have your blood sugar levels and how often you eat. It may be multiple times each day.
- **Insulin pump.** An insulin pump pushes small, steady doses of rapid-acting insulin into a thin tube inserted underneath your skin. These doses are delivered repeatedly throughout the day. There are several different kinds of insulin pumps available.

Insulin therapy can sometimes be demanding, but it's an effective way to lower blood sugar levels. If you have any trouble with your insulin regimen, such as difficulty avoiding very low or very high blood sugar levels, be sure to talk to your doctor to see if any adjustments need to be made. By choosing an insulin regimen that fits your needs and lifestyle, you can prevent diabetes complications and lead an active, healthy life.

3.7 Lifestyle Modifications

Lifestyle modifications can be an effective way to manage diabetes and prevent or delay the onset of complications. Here are some key lifestyle modifications for diabetes:

1. **Healthy Diet:** A healthy diet is an essential component of diabetes management. Individuals with diabetes should consume a balanced diet rich in fruits, vegetables, whole grains, lean protein, and healthy fats. It's also essential to limit foods high in saturated and trans fats, added sugars, and salt.

2. **Regular Exercise:** Regular physical activity is essential for managing diabetes. Exercise can help lower blood sugar levels, improve insulin sensitivity, reduce blood pressure, and improve cardiovascular health. It's recommended to engage in at least 150 minutes of moderate-intensity aerobic exercise per week.
3. **Weight Management:** Maintaining a healthy weight is important for diabetes management. Weight loss can help improve blood sugar control and reduce the risk of complications. A healthy diet and regular exercise can help achieve and maintain a healthy weight.
4. **Quit Smoking:** Smoking is associated with an increased risk of complications in individuals with diabetes. Quitting smoking can help improve diabetes management and reduce the risk of complications.
5. **Limit Alcohol Intake:** Alcohol consumption can affect blood sugar levels and increase the risk of complications. It's essential to limit alcohol intake and consume alcohol in moderation.
6. **Manage Stress:** Stress can affect blood sugar levels and make diabetes management more challenging. Managing stress through techniques such as meditation, yoga, or deep breathing can help improve diabetes management.
7. **Regular Medical Check-ups:** Regular medical check-ups and appointments with a healthcare professional are crucial to managing diabetes. Your healthcare provider will monitor your blood sugar levels, blood pressure, cholesterol, and kidney function and adjust your treatment plan as needed.
8. **Monitoring Blood Sugar Levels:** Regular self-monitoring: Check blood sugar levels as recommended by your healthcare provider and adjust your treatment plan accordingly. Continuous Glucose Monitoring (CGM): Consider using a CGM device to track blood sugar levels continuously and identify trends or patterns.

Lifestyle modifications can be an effective way to manage diabetes and prevent or delay the onset of complications. It's important to work closely with a healthcare professional to develop a personalized diabetes management plan that incorporates lifestyle modifications and other appropriate treatments.

3.8 Diabetes Prevention

Diabetes prevention focuses on adopting a healthy lifestyle and managing risk factors to reduce the chances of developing the condition. Here are some key strategies for preventing or delaying the onset of diabetes:

1. Healthy Eating:

- Follow a balanced diet: Consume a variety of nutrient-dense foods, including fruits, vegetables, whole grains, lean proteins, and healthy fats.
- Limit sugary foods and beverages: Minimize the intake of sugary snacks, sodas, and other high-sugar foods that can contribute to weight gain and increase the risk of diabetes.

2. Regular Physical Activity:

- Engage in regular exercise: Aim for at least 150 minutes of moderate-intensity aerobic activity or 75 minutes of vigorous activity per week.
- Incorporate strength training: Include resistance exercises to build muscle strength and improve insulin sensitivity.
- Stay active throughout the day: Reduce sedentary time and incorporate physical activity into daily routines.

3. Weight Management:

- Maintain a healthy weight: Achieve and maintain a body weight within the normal range for your height and build.
- Lose weight if overweight: If overweight, losing as little as 5-10% of body weight can significantly reduce the risk of developing diabetes.

4. Balanced Blood Pressure and Cholesterol Levels:

- Monitor blood pressure: Keep blood pressure within the normal range (typically below 120/80 mmHg).
- Maintain healthy cholesterol levels: Manage cholesterol levels by adopting a heart-healthy diet and, if needed, taking medication as prescribed.

5. Avoid Smoking and Limit Alcohol Consumption:

- Quit smoking: Smoking increases the risk of diabetes and cardiovascular complications. Seek support and resources to quit smoking.
- Moderate alcohol consumption: If you drink alcohol, do so in moderation and be aware of its potential effects on blood sugar levels.

6. Diabetes Screening:

- Regular check-ups: Attend routine medical check-ups and screenings to monitor blood sugar levels, blood pressure, and other risk factors.
- Know your risk: If you have a family history of diabetes or other risk factors, discuss it with your healthcare provider to determine if additional screening is necessary.

7. Health Education and Awareness:

- Stay informed: Learn about diabetes, its risk factors, and prevention strategies through reputable sources and educational programs.
- Diabetes education programs: Consider attending diabetes prevention programs or lifestyle modification programs that provide guidance and support.

It's important to note that while lifestyle changes can significantly reduce the risk of developing diabetes, they may not guarantee prevention in every case. Some factors, such as genetics and age, are beyond our control. Regular medical check-ups and discussions with healthcare professionals are crucial for identifying and managing individual risk factors effectively.

Table3.3: Some Diabetes Prevention Studies and their Summary.

Study	Number of Participants	Intervention	Treatment	Risk Reduction
Da Qing IGT and Diabetes Study	577	Diet and exercise	6 Years	34-69%
Finnish Diabetes Prevention Study	522	Diet and exercise	3 Years	58%
Diabetes Prevention Program	3234	Diet, exercise and metformin	2.8 Years	31-58%
Indian Diabetes Prevention Programme	531	Diet, exercise and metformin	3 Years	26.4-28.4%
Predimed	3541	Mediterranean Diet with: EVOO Nuts versus control diet	4 Years	40% 18% Prediabetes as a secondary endpoint

Future Researches and Development

4.1 New Approaches

With the advancing world and widespread of diabetes several new researches are carried out throughout the world, and some of them actually turns out to be really efficacious and safe as well. A few of those new approaches and new drugs are enlisted.

4.1.1 Targeting the Pancreatic cells

Increasingly, a cure for type 1 diabetes has come into focus; this curative outlook is focused on replacing the beta cells rather than supplying the body with insulin. The first reported evidence of meal-regulated insulin secretion by differentiated stem cells earlier in 2021 with interim results from a multicentre clinical trial period the implants of 20 patients consist of pancreatic endoderm cells derived from human pluripotent stem cells; the safety, tolerability, and efficacy of the implants were tested in 26 patients in phase I/II trial. Despite the absence of relevant clinical outcomes, the study demonstrates an important milestone, demonstrating the ability of pancreatic endoderm cells (PECs) to mature into glucose-responsive, insulin-producing mature beta cells in vivo in patients with type 1 diabetes.

4.1.2 Immunotherapy

Another curative approach to type 1 diabetes is strategies for suppressing or evading the immune system. This is because type 1 diabetes is caused by a disproportionate autoreactive response of the immune system that can no longer tolerate itself. An organism's ability to self-tolerate depends on the balance between central, peripheral, and organ-specific immune regulation. A disruption to this homeostasis results in auto-reactivity. Antigen-specific immunotherapy is the administration of autoantigens, which, in the context of type 1 diabetes, involves islet-antigen-specific tolerization of CD4+ and CD8+ T cells. This can be achieved through several tolerogenic mechanisms, the most prevalent of which is the restoration of regulatory T cells, effector T-cells, etc. Tolerization refers to the tolerance of the immune system to a particular antigen. In the context of diabetes, the antigen is on the surface of the beta cells. The ways that this can be achieved are multifaceted, with immunotherapies working differently.

Some immunotherapies are centred on targeting the B cells, while others ameliorate the activities of both B-cells and killer T cells, so they cannot induce those destructive effects. Some treatments may also augment the effect of regulatory T cells to prevent pancreatic auto-reactivity.

4.1.3 Dietary supplements

A French biotech company, Valbiotis, has developed a dietary supplement comprising a combination of extracts from five plants. In July 2019, they announced positive results from a phase IIA study of their compound which sought to evaluate its efficacy in pre-diabetic populations compared to regular treatment.

4.1.4 Protein Inhibitors for T2DM

Apabetalone (RVX-208) is a small molecule inhibitor of bromodomain and extra-terminal (BET) proteins. This is a histone acetylation reader that is responsible for causing pro-inflammatory and pro-atherosclerotic gene transcription. Once they are bound to chromatin, BETs can recruit chromatin remodeling and transcription elongation factors which allow transcription via RNA polymerase. As they play a vital role in the transcription of cytokine response genes implicated in inflammation,

vascular function, and lipid metabolism, inhibiting their activity could help treat chronic inflammatory and metabolic diseases such as diabetes. This treatment has completed phase II clinical trials in pre-diabetic models.

4.1.5 Hormone Therapy

For those currently diagnosed with type 2 diabetes, a pharmaceutical drug that can activate the production of hepatic insulin-sensitizing substance (HISS) is in the pipeline. This hormone is known as hepatalin. In the absence of adequate insulin, hepatalin stimulates the body's ability to partition glucose into the muscle. The future of diabetes treatment is evolving, with new treatment paradigms targeting various aspects of the pathological causes of both type one and type 2 diabetes. Currently regarded as an epidemic by the World Health Organization, with an estimated 700 million individuals predicted to be affected by 2045, there currently remains an unmet need. As such, the global diabetes drug market is projected to reach 68 billion by 2026, prompting the emergence of revolutionary technologies and pharmaceuticals to cure or significantly improve the efficacy of currently available standard-of-care, traditional insulin-based treatment.

4.2 New Drugs

There are a variety of new medications that have been developed for the treatment and management of diabetes, conditions where too much sugar ends up in the blood.

4.2.1 Glp-1 Agonists

Glucagon-like peptide-1 agonists are a class of medications utilized in the treatment of type 2 diabetes and obesity. Glucagon-like peptide-1 and glucose-dependent insulinotropic polypeptide (GIP), both incretin hormones inactivated by dipeptidyl peptidase-4 (DPP-4), stimulate insulin secretion after an oral glucose load via the incretin effect. In type 2 diabetes, this process can become blunted or even be absent; however, the utilization of pharmacological levels of GLP-1 can revive insulin excretion. The benefits of this form of therapy to treat type 2 diabetes include delayed gastric emptying and inhibiting the production of glucagon from pancreatic alpha cells if blood sugar levels are high. Furthermore, GLP-1 receptor agonists can decrease pancreatic beta-cell apoptosis while promoting their proliferation.

Some commonly prescribed GLP-1 receptor agonists with their dosing frequency:

- Dulaglutide - once weekly
- Albiglutide - once weekly
- Liraglutide - once daily
- Semaglutide - one weekly subcutaneously, daily orally
- Exenatide BID - twice daily
- Exenatide QW - once weekly
- Lixisenatide - once daily
- Tirzepatide - once weekly

4.2.2 Mounjaro

U.S. Food and Drug Administration approved Mounjaro (tirzepatide) injection to improve blood sugar control in adults with type 2 diabetes, as an addition to diet and exercise. Mounjaro was effective at improving blood sugar and was more effective than the other diabetes therapies with which it was compared in clinical studies.

Glucagon-like peptide-1 (GLP-1) and glucose-dependent insulintropic polypeptide (GIP) are hormones involved in blood sugar control. Mounjaro is a first-in-class medicine that activates both the GLP-1 and GIP receptors, which leads to improved blood sugar control. Mounjaro is administered by injection under the skin once weekly, with the dose adjusted as tolerated to meet blood sugar goals.

Mounjaro received priority review designation for this indication. A priority review designation directs overall attention and resources to the evaluation of applications for drugs that, if approved, would be significant improvements in the safety or effectiveness of the treatment, diagnosis or prevention of serious conditions.

The FDA granted the approval of Mounjaro to Eli Lilly and Co.

4.2.3 Kerendia

Kerendia (finerenone) was approved in July 2021. It is used to treat the loss of kidney function, or chronic kidney disease, in adults with type 2 diabetes. It also aims to reduce the risk of kidney failure, heart attack, and death due to heart conditions.

4.2.4 Teplizumab

U.S. Food and Drug Administration approved Tzield (teplizumab-mzwv) injection to delay the onset of stage 3 type 1 diabetes in adults and pediatric patients 8 years and older who currently have stage 2 type 1 diabetes.

Tzield binds to certain immune system cells and delays progression to stage 3 type 1 diabetes. Tzield may deactivate the immune cells that attack insulin-producing cells, while increasing the proportion of cells that help moderate the immune response. Tzield is administered by intravenous infusion once daily for 14 consecutive days.

4.2.5 Bexagliflozin

The FDA approved bexagliflozin, an oral SGLT2 inhibitor, to improve glycemic control for adults with type 2 diabetes. Bexagliflozin is approved for adults with type 2 diabetes with an estimated glomerular filtration rate greater than 30 mL/min/1.73 m². Bexagliflozin is not recommended for patients with type 1 diabetes or for treating diabetic ketoacidosis.

Bexagliflozin is a highly selective sodium–glucose co-transporter 2 (SGLT2) inhibitor. SGLT2 is located in the proximal renal tubule, a part of the kidney where most reabsorption takes place, and they transport glucose and sodium from the tubular lumen to the epithelium. By inhibiting SGLT2, bexagliflozin reduces glucose reabsorption in the kidney and promotes its excretion in urine. Therefore, in patients with type 2 diabetes mellitus (T2DM), bexagliflozin reduces blood glucose levels independently of insulin sensitivity.

4.3 Conclusion

Diabetes is a complex and prevalent chronic condition that affects millions of people worldwide. This project has explored various aspects of diabetes, including its definition, prevalence, types (such as type 1, type 2, and gestational diabetes), and associated complications. We have also examined the physiology of glucose regulation, the role of insulin in glucose metabolism, and the impact of pancreatic dysfunction and insulin resistance on diabetes development.

Moreover, we have discussed the risk factors for developing diabetes, emphasizing the importance of lifestyle modifications, such as healthy eating, regular physical activity, weight management, and smoking cessation, in preventing the onset of type 2 diabetes. We have highlighted the role of diabetes education and support in empowering individuals with diabetes to understand the condition, make informed decisions, and manage their health effectively. Additionally, the project has shed light on the complications associated with diabetes, including cardiovascular disease, kidney disease, neuropathy, and eye complications. We have emphasized the significance of regular medical check-ups, blood sugar monitoring, and adherence to treatment plans in preventing and managing these complications.

Furthermore, we have explored the essential aspects of diabetes management, including medication management, blood sugar control, lifestyle modifications, and stress management. We have discussed the importance of a multidisciplinary approach involving healthcare professionals, such as doctors, nurses, dietitians, and diabetes educators, who provide education,

treatment, monitoring, and support to individuals with diabetes. By implementing the knowledge and strategies gained from this project, individuals with diabetes can enhance their quality of life, minimize the risk of complications, and achieve better health outcomes. However, it is crucial to remember that diabetes management is a lifelong journey that requires ongoing education, support, and collaboration between healthcare professionals and individuals with diabetes.

It is evident that diabetes is a complex disease that requires a comprehensive approach to care. The role of healthcare professionals in diabetes management is crucial, as they provide education, treatment, monitoring, and support to individuals with diabetes. By equipping patients with the knowledge and skills necessary for self-management, healthcare professionals empower individuals to make informed decisions about their health and take control of their condition.

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