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Review Article

Diabetes Mellitus Overview 2024

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ABSTRACT

Diabetes Mellitus (DM) is a chronic, progressive metabolic disorder characterized by persistent hyperglycemia, arising from defects in insulin secretion, insulin action, or both. Affecting millions globally, DM is a significant public health challenge contributing to high morbidity and mortality rates. This review article explores the classification of DM, highlighting the differences between Type 1, Type 2, and gestational diabetes, alongside rarer forms. Key risk factors such as genetic predisposition, obesity, age, and lifestyle choices are discussed, underlining their contribution to the rising global incidence. The article also delves into the complications associated with uncontrolled diabetes, including microvascular and macrovascular issues, as well as the psychological burden. Modern diagnostic techniques, including the Hemoglobin A1c test and oral glucose tolerance test, are explained. Treatment strategies, from lifestyle interventions to pharmacological treatments like insulin therapy and GLP-1 receptor agonists, are presented to illustrate the comprehensive management of the disease. The review concludes by emphasizing the importance of early diagnosis and long-term glucose control to prevent complications and improve patient outcomes.

Keywords: Diabetes Mellitus, Gestational, Insulin

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1. INTRODUCTION

Diabetes Mellitus (DM) is a chronic, progressive metabolic disorder characterized by persistent hyperglycemia (elevated blood glucose levels). This condition arises due to defects in insulin secretion, insulin action, or a combination of both (1). Insulin is a hormone produced by the pancreas that regulates blood glucose levels. Diabetes impairs the body's ability to use or produce insulin effectively, leading to a range of short-term and long-term complications. DM is one of the most common endocrine (hormone-related) disorders globally and represents a significant public health challenge, contributing to substantial morbidity, mortality, and economic burden (2).

2. TYPES OF DIABETES MELLITUS

Diabetes Mellitus is classified into four main types:

a. Type 1 Diabetes (T1DM)

An autoimmune condition where the body's immune system mistakenly attacks and destroys the insulin-producing beta cells in the pancreas, leading to insulin deficiency. This form of diabetes is most diagnosed in children, adolescents, and young adults, although it can occur at any age. Individuals with

T1DM require lifelong insulin therapy to manage their condition (3).

b. Type 2 Diabetes (T2DM)

The most prevalent form of diabetes, accounting for approximately 90% of all diabetes cases. T2DM is characterized by insulin resistance, where the body's cells do not respond effectively to insulin. Over time, the pancreas may also lose its ability to produce sufficient insulin to meet the body's needs. T2DM is typically associated with aging, obesity, physical inactivity, and unhealthy lifestyle factors, such as poor dietary habits (3).

c. Gestational Diabetes Mellitus (GDM)

A form of diabetes that develops during pregnancy and typically resolves after childbirth. Women with a history of GDM have an increased risk of developing type 2 diabetes later in life. GDM is associated with an increased risk of complications for both the mother and the developing fetus (3,4).

d. Other Specific Types

These include genetic defects in beta-cell function, genetic defects in insulin action, diseases of the exocrine pancreas (e.g., cystic fibrosis), and drug- or chemical-induced diabetes (e.g., Steroid Induced Diabetes Mellitus). These less common forms of diabetes may have varying degrees of severity and treatment requirements (4,5).

3. EPIDEMIOLOGY

Diabetes Mellitus represents a significant global health challenge, with its prevalence increasing dramatically over the past few decades. According to the International Diabetes Federation (IDF), as of 2021, approximately 537 million adults (20-79 years) were living with diabetes worldwide, representing 10.5% of the global adult population. This number is projected to rise to 643 million by 2030 and 783 million by 2045 if current trends continue. The burden of diabetes is not evenly distributed across the globe, with about 90% of adults with diabetes living in low- and middle-income countries undiagnosed (6). The rising prevalence is attributed to various factors, including population growth, aging, urbanization, increasing obesity rates, and physical inactivity. It's important to note that nearly half of all people living with diabetes are undiagnosed, highlighting the need for improved screening and early detection programs.

4. RISK FACTORS

Several risk factors contribute to the development of diabetes (6,7) :

- **Genetic Predisposition**: Having a close family member with diabetes significantly increases an individual's susceptibility to developing the disease.

- **Obesity**: Excess body fat, particularly around the abdominal region, is a major contributor to insulin resistance and the development of Type 2 diabetes.

- **Physical Inactivity**: Lack of regular physical activity is linked to an increased risk of Type 2 diabetes.

- **Age**: The risk of developing type 2 diabetes increases with age, particularly after 45 years.

- **Dietary Habits**: A diet high in processed foods, sugary beverages, and low in fiber is associated with a higher risk of developing diabetes.

- **Ethnicity**: Certain ethnic groups, such as African Americans, Hispanics, Native Americans, and Asian Americans, have a disproportionately higher risk of developing diabetes.

- **History of Gestational Diabetes**: Women who have had gestational diabetes during pregnancy have an increased likelihood of developing type 2 diabetes later in life.

- **Stress and Mental Health:** Chronic stress and mental health issues can affect blood sugar levels and contribute to unhealthy lifestyle choices, increasing diabetes risk (6,7).

5. COMPLICATIONS

Diabetes, particularly when poorly controlled, can lead to a range of serious complications, which can be broadly categorized as:(6,7)

a. Microvascular Complications

- **Diabetic Retinopathy**: Damage to the blood vessels of the retina, which can lead to vision impairment and blindness.

- **Diabetic Nephropathy**: Kidney damage, resulting in chronic kidney disease and potential progression to renal failure.

- **Diabetic Neuropathy**: Nerve damage, particularly in the peripheral nerves, causing pain, numbness, and muscle weakness.

b. Macrovascular Complications

- **Cardiovascular Disease**: Diabetes significantly increases the risk of heart disease, stroke, and peripheral artery disease.

- **Diabetic Foot**: Due to poor circulation and nerve damage, diabetic patients are at an increased risk of developing foot ulcers, infections, and potential limb amputations.

c. Other Complications

- **Infections**: Diabetes can impair the immune system, leading to a higher susceptibility to infection and that's why diabetics and immunocompromised patients must go to the medical laboratory for serum ferritin level analysis, to decrease its levels and lower the probability of experiencing serious complications in different infections as COVID-19 (8), according to a study, there is an increase in serum ferritin in people with diabetes, and this rise may play a role in both the pathogenesis of the condition and the complications of its consequences. Therefore, it is recommended that individuals with pre-diabetes and diabetes undergo routine monitoring for serum ferritin levels (9).

- **Inflammations:**
Increased C-reactive protein (CRP) levels have been linked to excess body weight since adipocytes produce tumor necrosis factor α (TNF-α) and interleukin 6 (IL-6), which are pivotal factors for CRP stimulation (10-12).
CRP is one of the possible targets for T2DM progression and understanding the connection between insulin and inflammation may be helpful in clinical treatment and prevention approaches (10).

- **Mental Health Issues**: Individuals with diabetes have an increased risk of developing depression and anxiety (6,7).

6. DIAGNOSIS

Diabetes is typically diagnosed through several clinical tests that assess blood glucose levels:

- **Fasting Plasma Glucose (FPG)**: Measures blood glucose after fasting for at least 8 hours. A result ≥ 126 mg/dL (7.0 mmol/L) indicates diabetes.

- **Oral Glucose Tolerance Test (OGTT)**: A person consumes a glucose-rich drink after fasting, and blood glucose levels are measured after 2 hours. A result ≥ 200 mg/dL (11.1 mmol/L) indicates diabetes.

- **Hemoglobin A1c (HbA1c)**: Reflects the average blood glucose levels over the past 2-3 months. A result ≥ 6.5% (48 mmol/mol) indicates diabetes.

- **Random Plasma Glucose**: A blood glucose level ≥ 200 mg/dL (11.1 mmol/L) at any time of the day, along with symptoms of hyperglycemia (e.g., excessive thirst, frequent urination), also indicates diabetes (7,13).

- **Fructosamine**: a glycated protein used as an alternative marker for monitoring blood glucose control in individuals with diabetes. While Hemoglobin A1c (HbA1c) reflects average blood glucose levels over the past 2-3 months,

Fructosamine provides information about glucose control over a shorter period, typically 2-3 weeks (14,15).

- **New Cytological Method:** microscopic qualitative analysis of the oral epithelium cytological smears in which a statistical relationship exists between the sugar level and the number of cells in the oral cavity (16), this method needs more evaluation to be valid in the medical laboratory.

- **Oxidative stress:**

  Total antioxidant capacity (TAC) and malondialdehyde (MDA) are two important biomarkers used in the context of diabetes mellitus (DM) to assess oxidative stress and damage (17).

7. TREATMENT

Managing diabetes involves a combination of lifestyle modifications, medication, and ongoing monitoring of blood glucose levels:

a. Lifestyle Changes

- **Diet**: Adopting a balanced, diabetes-friendly diet that focuses on controlling carbohydrate intake and includes a variety of fruits, vegetables, lean proteins, and whole grains.

- **Physical Activity**: Regular exercise improves insulin sensitivity and helps maintain a healthy weight.

- **Weight Management**: Weight loss in overweight or obese individuals can significantly improve blood sugar control.

b. Pharmacological Treatment

- **Insulin Therapy**: Essential for managing type 1 diabetes and may be necessary for some individuals with Type 2 diabetes, especially in later stages of the disease.

- **Oral Medications**: Several classes of oral drugs are available to manage Type 2 diabetes, including metformin, sulfonylureas, DPP-4 inhibitors, GLP-1 agonists, and SGLT2 inhibitors.

- **Other Therapies**: Some individuals with Type 2 diabetes may require injectable medications, such as GLP-1 receptor agonists, to help control blood glucose levels (18).

c. Monitoring

Regular monitoring of blood glucose levels, using techniques like self-monitoring, continuous glucose monitoring, and periodic HbA1c tests, is essential for assessing the effectiveness of the treatment plan and making necessary adjustments (19).

Conflict OF Interests

The author declares no conflicts of interest.

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