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Research Article

Diabetes Mellitus: Understanding the Disease, Its Diagnosis, and Management Strategies in Present Scenario

Shivam Agarwal[1], Anurag Mishra[2], Dr. Praveen Katiyar[3], Chandan Kumar[4], Ms. Shailendri Kushwaha[5], Himanshu kumar[6]

[1]Assistant Professor, Teerthanker Mahaveer University, College of Paramedical Sciences, Moradabad.*
[2]Ph.D. Scholar, School of Health Sciences, Chhatrapati Shahu ji Maharaj University, Kanpur.
[3]Assistant Professor, School of Health Sciences, Chhatrapati Shahu ji Maharaj University, Kanpur.
[4]Ph.D. scholar, School of Health Sciences, Chatrapati Shahu Ji Maharaj University Kanpur
[5]Ph.D. Scholar, School of Health Sciences, CSJM University Kanpur
[6]Assistant Professor, Arogyam Institute of Paramedical and Allied Science Roorkee

Abstract:
Diabetes Mellitus, often called diabetes mellitus, is a chronic disease that is characterized by a high blood sugar level. This problem occurs when the body cannot produce enough insulin or cannot effectively use the insulin it produces. Insulin is a substance produced by the pancreas that controls the uptake of glucose into cells and eventually its conversion into energy. Diabetes has many forms, such as "type 1 DM", "type 2 DM" and last not least but "gestational DM". Good blood sugar control includes keeping blood sugar levels in the target range through a healthy diet, regular exercise, medications (if needed), and blood sugar monitoring. Regular physical examinations, including eye and foot examinations, are important for detecting and managing potential problems. Although diabetes cannot be cured, appropriate treatment and lifestyle changes can provide good control, enabling people with diabetes to lead healthy and productive lives. An appropriate diabetes management plan should be developed in collaboration with the physician.

Keywords: Diabetes, type 1 and type 2 DM, insulin, lifestyle changes

***Author for correspondence: Email:** drpraveenkatiyar@gmail.com*

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INTRODUCTION:

Preventing diabetes holds great significance in the current market landscape due to various reasons (Faghilimnai et al., 2006; Ezzati et al., 2016). Firstly, the prevalence of diabetes has reached alarming levels globally, leading to soaring healthcare costs (WHO, 2016). By focusing on prevention, healthcare systems can reduce the financial burden associated with managing diabetes and its complications (Kumar and Kumar 2015). Secondly, type 2 DM, which is responsible for the majority of instances, is closely related to lifestyle factors like poor diet, sedentary behavior, and obesity (ElSayed et al., 2023). These risk factors are highly prevalent in the current market landscape, making prevention crucial in helping individuals adopt healthier lifestyles and reduce their diabetes risk (Leon et al., 2023).

Moreover, preventing diabetes is essential for improving long-term health outcomes (Rewers et al., 2015; Sato et al., 2009; Skyler et al., 2017). Diabetes is a chronic disorder that significantly upsurges the risk of various health problems such as cardiovascular illness, kidney disease, nerve damage, and vision problems (American Diabetes Association, 2006; Bogun et al., 2020). Prevention efforts can help individuals avoid or delay the onset of these complications, leading to better long-term well-being and improved quality of life (Greenbaum et al.,

2012). From a public health perspective, diabetes prevention initiatives play a vital role (Ben-Skowronek, 2021). By reducing the incidence of diabetes, these initiatives alleviate the strain on healthcare systems, promote healthier communities, and enhance overall population health (Selvin, 2016). They also align with the broader goal of reducing the burden of non-communicable diseases, which is a priority for many governments and healthcare organizations worldwide.

Preventing diabetes empowers individuals by promoting self-management and proactive health behaviors. Prevention strategies often focus on empowering individuals to take control of their health through lifestyle modifications, providing education, and support (American Diabetes Association, 2014). By promoting healthy behaviors and enabling informed choices about diet, physical activity, and overall well-being, prevention initiatives empower individuals to make positive changes beyond just diabetes prevention (Chung et al., 2020).

Overall, prioritizing diabetes prevention in the current market landscape is essential for reducing healthcare costs, improving long-term health outcomes, promoting public health, empowering individuals, and embracing corporate social responsibility (Gale, 2006). By emphasizing prevention, individuals, communities, and businesses can make significant strides in combating the diabetes epidemic and promoting a healthier future (Umpierrez & Korytkowski, 2016).

Definition & Classification

As per American Diabetes Association (ADA) DM is-

"Diabetes is a group of metabolic diseases characterized by hyperglycemia caused by defects in insulin secretion, insulin action, or both. The persistent hyperglycemia in diabetes is associated with long term damage, dysfunction and failure of many organs, particularly the eyes, kidneys, nerves, heart and blood vessels."

(*Diabetes Care* 2004;27(suppl_1): s5–s10)

Classification

Classification of DM given in Table 01.

As per American Diabetes Association (Diabetes care 2023) It can be classified as:

Sno.	Classification	Also known as	Cause
01	Type 1	Insulin dependent or Juvenile onset diabetes.	due to autoimmune b-cell destruction, usually leading to absolute insulin deficiency, including latent autoimmune diabetes of adulthood
02	Type 2	Non-Insulin dependent or adult-onset diabetes	due to a non-autoimmune progressive loss of adequate b-cell insulin secretion frequently on the background of insulin resistance and metabolic syndrome
03	Specific Type		due to other causes, e.g., monogenic diabetes syndromes (such as neonatal diabetes and maturity-onset diabetes of the young), diseases of the exocrine pancreas (such as cystic fibrosis and pancreatitis), and drug- or chemical-induced diabetes (such as with glucocorticoid use, in the treatment of HIV/AIDS, or after organ transplantation.
04	Gestational	GDM	diagnosed in the second or third trimester of pregnancy that was not clearly overt diabetes prior to gestation.

Table 01: Classification of Diabetes Mellitus as per American Diabetes Association (Diabetes Care Volume 46, Supplement 1, January 2023, Page-51

Diagnosis

As per ADA, its determination is based on blood glucose patterns, fasting plasma glucose levels, or 2-hour plasma glucose (Show in Table 02) or A1C patterns during a 75 g oral glucose test.

Diagnosis of diabetes-criteria
FPG>126 mg/dl (7.0 mmol/L). Fasting is defined as no caloric intake for at least 8 h.*
or
2-h PG > 200 mg/dl (11.1 mmol/L) during OGTI. The test should be performed as described by WHO, using a glucose load containing the equivalent of 75 g anhydrous glucose dissolved in water.*
or
A 1C 6.5% (48 mmol/mol). The test should be performed in a laboratory using a method that is NGSP certified and standardized to the DCCT assay.*
or
In a patient with classic symptoms of hyperglycemia or hyperglycemic crisis, a random plasma glucose > 200 mg/dl (11.1 mmol/L).
DCCT, Diabetes Control and Complications Trial; FPG, fasting plasma glucose; OGTT, oral glucose tolerance test; NGSP, National Glycohemoglobin Standardization Program; WHO , World Health Organization; 2-h PG, 2-h plasma glucose.*In the absence of unequivocal hyperglycemia, diagnosis requires two abnormal test results from the same sample or in two separate test samples.
Table- 2,Diagnosis of Diabetes, Source-Diabetes Care Volume 46,Supplement 1,January 2023,Page-521

Type 1 and type 2 DM are complex diseases that may have different clinical symptoms and progress. Correct classification of diabetes is important for determining proper treatment. However, some people are unsure whether they have type 1 or type 2 DM at the time of diagnosis. The assumption that type 2 diabetes is seen only in adults and type 1 diabetes only in children is incorrect because both diseases can be seen in any age group. Polyuria and polydipsia are common symptoms in children with type 1 diabetes, half of whom have diabetic ketoacidosis (DKA) (Rewers et al., 2015; Alonso et al., 2020; Jensen et al., 2020).

The onset of type 1 diabetes in adults may be more variable and may not show symptoms in children. Some older people are also temporarily affected by their need for insulin (Pradhan et al., 2007; Sato et al., 2009). Various features can be used to distinguish type 1 diabetes from type 2 diabetes. These include younger age at diagnosis (usually less than 35 years), low BMI (>25 kg/m2), weight loss, ketoacidosis, and glucose levels below 360 mg/dl (20 mmol/L) (Holt et al., 2021). The onset of type 1 DM may be more variable in adults and in children may be asymptomatic Some adults are also temporarily affected by their insulin requirements (Pradhan et al, 2007; Sato et al, 2009). Various features can be used to distinguish type 1 DM from type 2 DM. These include younger age at diagnosis (usually less than 35 years), low BMI (>25 kg/m2), weight loss, ketoacidosis, and glucose levels below 360 mg/dl (20 mmol/L) (Holt et al. et al., 2021).

Type 1 and type 2 DM each diabetes involves loss of beta cell size and/or function leading to hyperglycemia. Genetic and environmental factors play a role in the development of both types of DM. While the rate of occurrence can vary, people with all types of DM are at risk for long-term complications when hyperglycemia occurs. In the future, customized therapies for diabetes will develop through better information on the diverse pathways that cause β-cells death or dysfunction. Improved characterization of those pathways will help in identifying individualized treatment plans that may goal precise mechanisms underlying diabetes. This personalized technique for diabetes treatment has the capability to improve results and reduce the adversities in affected persons (Skyler et al., 2017).

Type-1 DM

T1DM also called as insulin-dependent diabetes or juvenile diabetes, is an unusual type of diabetes that accounts for only 5-10% of all diabetes cases. It is usually diagnosed in childhood or adolescence but can occur in adults as well. People with type 1 DM need insulin therapy to survive because their bodies cannot produce insulin on their own, and this is thought to be a T-cell-mediated autoimmune disease that causes specific damage to the insulin-producing pancreatic beta cells and disease progression. Insulin deficiency accounts for more than 95% of type 1 DM in most children with diabetes (Association, 2013; Atkinson et al., 2014). In type 1 DM, the rate of destruction of beta cells varies, with some being rapid (mostly in infants and children) and others slow (also in adults) (Bogun

et al., 2020; Greenbaum et al., 2012). The disease development is affected by many factors, including age at which autoantibodies first appear, the number of autoantibodies present, and the specificity and titter of autoantibodies.

Blood Sugar and HbA1C levels begin to rise before diabetes is treated, meaning diabetic ketoacidosis (DKA) can be diagnosed before diabetes starts. Three different stages of type 1 diabetes can be identified (Show in Table 03). These levels provide a basis for research and management decisions as they help differentiate patients and identify appropriate treatments (Skyler et al, 2017; Insel et al, 2015).

Table 03: Different stages of Type 1 DM on the basis of their characteristics and diagnostic criteria.

	Stage 1	Stage 2	Stage 3
Characteristics	• Autoimmunity • Normoglycemia • Presymptomatic	• Autoimmunity • Dysglycemia • Presymptomatic	• Autoimmunity • Overt hyperglycemia • Symptomatic
Diagnostic Criteria	• Multiple islet • Autoantibodies • No IGT or IFG	• Islet autoantibodies (usually multiple) • Dysglycemia: IFG and/or IGT • FPG 100-125 mg/dl (5.6-6.9 mmol/L) • 2-h PG 140-199 mg/dl (7.8-11.0 mmol/L) • HbA1C 5.7-6.4% (39-47 mmol/mol) or >-10% increase in HbA1C	

PPG-fasting plasma glucose; IFG-impaired fasting glucose; GT-Impaired glucose tolerance; 2-h PG- 2-h plasma glucose.

Source- Diabetes Care Volume 46,Supplement 1,January 2023,Page-520

Immune-mediated diabetes can happen at any age, in spite of the fact that it is most common in childhood and youth. The beginning side effect of the malady is frequent ketoacidosis, particularly in more youthful people. Be that as it may, others may encounter mellow to extreme fasting hyperglycaemia or ketoacidosis amid times of stretch or contamination. Indeed, people in their 80s and 90s can create this frame of diabetes (Association, 2014). Individuals with sort 1 diabetes have an expanded hazard of creating other immune system clutter such as Addison's infection, Hashimoto's thyroiditis, Graves' infection, celiac sprue, immune system hepatitis, vitiligo, and malignant frailty. Usually, they share comparative fundamental instruments in which the resistant framework erroneously assaults the body's possessed tissues (Nuha et al., 2023). Difference between Immune-Mediate and Idiopathic Type 1 DM given in Table 04.

Table 04 : Immune-Mediated & Idiopathic Type 1 DM

Immune-mediated Type 1 DM	Idiopathic Type 1 DM
Type 1 DM is characterized by the immune system destroying beta cells in the pancreas. These immune system biomarkers include the presence of autoantibodies against insulin, tyrosine phosphatase IA-2 and IA-2B, and glutamic acid decarboxylase (GAD65), which can be tested in vivo and in vitro in the blood of Diabetic patients. In fact, 85-90% of people with diabetes have one or more of these autoantibodies. The diagnosis of type 1 diabetes is usually based on the presence of fasting hyperglycemia and the detection of autoantibodies. This disease is also associated with human leukocyte antigen (HLA) genes, specifically the DQA and DQB genes and the DRB gene. These genes may prevent or inhibit the development of the disease (American Diabetes Association, 2014). Type 1 diabetes can be associated with monogenic polyglandular autoimmune syndromes, including conditions such as immunosuppression, polyendocrinopathy, enteropathy, and X-linked (IPEX) syndrome. Other symptoms that may be associated with type 1 diabetes are caused by mutations in the autoimmune regulation (AIRE) gene. Both of these genetic disorders are rare but can produce many autoimmune diseases, including type 1 diabetes (Ben-Skowronek, I. 2021; Frommer L, 2019).	The term idiopathic is used to express problems of unknown etiology. In rare cases of type 1 DM, the cause of the disease is idiopathic and does not affect autoimmunity. These individuals have persistent hypoinsulinemia and are at risk for ketoacidosis, but show no evidence of autoimmunity. This subtype is rare and occurs most often in people of African or Asian descent. In some cases, patients with type 1 diabetes who are negative for autoantibodies may develop diabetic ketoacidosis (DKA) and varying degrees of insulin deficiency. This is called ketosis-prone diabetes and is more common in people of African and Asian descent (Balasubramanyam, A. et al. 2008).

Prediabetes

Prediabetes is a term used to describe individuals with abnormal carbohydrate metabolism whose plasma glucose does not meet the diagnosis of diabetes (Selvin, 2016; Selvin et al., 2013). This may appear as impaired fasting glucose, glucose tolerance, and/or HbA1c levels of 5.7-6.4% (39-47 mmol/mol) (Show in Table 05) (Association, 2022). It is often associated with obesity (mainly abdominal), as well as dyslipidemia with hypertension. People with prediabetes are at higher risk for Cardiac diseases and other problems. So, the presence of it requires evaluation of all cardiovascular diseases, including blood pressure, monitoring of cholesterol levels and lifestyle (physical activity and diet).

Table 05 : Criteria for screening for diabetes or prediabetes in asymptomatic adults

Population	Testing Considerations
1. Overweight or Obese Adults (BMI > 25 kg/m^2 or Asian American > 23 kg/m^2)	• First-degree relative with diabetes • High-risk race/ethnicity (e.g., African American, Latino, Native American, Asian American, Pacific Islander) • History of CVD • Hypertension (>130/80 mmHg or on therapy for hypertension) • HDL cholesterol level <35 mg/dL • (0.90 mmol/L) and/or a triglyceride level >250 mg/dL (2.82 mmol/L) • Individuals with polycystic ovary syndrome • Physical inactivity • Other clinical conditions associated with insulin resistance (e.g., severe obesity, acanthosis nigricans)
2. People with prediabetes A105.7°/0 [39mmol/mol], IGT, or IFG)	• Tested yearly
3. People diagnosed with gestational diabetes mellitus	• Lifelong testing at least every 3 years
4. All other people	• Testing should begin at age 35 years
5. If results are normal	• Testing should be repeated at a minimum of 3-year intervals, with consideration of more frequent testing depending on initial results and risk status

CVD, cardiovascular disease; GDM, gestational diabetes mellitus; IFG, impaired fasting glucose; IGT, impaired glucose tolerance.

Source – Diabetes Care Volume 46, Supplement 1, January 2023, Page - 524

Type 2 DM

Type 2 diabetes is a chronic, non-communicable disease that affects ninety to ninety-five percent of people with diabetes. It is often called non-insulin-dependent diabetes or Adult-onset diabetes. sufferers with T2DM frequently have insulin resistance and relative insulin deficiency. The disorder can be managed through a number of methods that include behavioural and medication therapy. Unlike type 1 DM, people with T2DM usually do not need to use insulin initially or throughout their lives (Nuha et al., 2023; Rodriguez et al., 2016).

Type 2 DM has many causes, but the underlying mechanisms are not completely understood. Like type 1 DM, T2DM does not involve the autoimmune destruction of beta cells. Instead, inflammation may be associated with many factors that cause disturbances in insulin secretion, such as genetics and metabolic stress (Chung et al., 2020; Gale, 2006; Schwartz et al., 2016). Most sufferers with type 2 DM are overweight or obese, and moderate weight reduction improves glycaemia and decreases the need for blood sugar-lowering drugs29

Losing 3-7% of body weight can decrease the threat of diabetes and improve blood sugar levels in people with diabetes (Nuha et al., 2023). DKA rarely occurs alone in type 2 diabetes and is usually promoted by an infection, another ailment like myocardial infarction, or certain medications such as corticosteroids, atypical antipsychotics, and SGLT2 inhibitors (Umpierrez and Korytkowski, 2016; Fadini et al., 2017). Risk elements for the progression of type 2 DM (Show in Table 06) include age, obesity, physical inactivity, gestational diabetes, high blood pressure, dyslipidaemia, and genetic

predisposition (Show in Table 06). The genetics of kind 2 diabetes is currently beneath extreme research.

Type 2 DM often remains undiagnosed for years because symptoms come on slowly and may not be as severe as the patient may notice. This puts them at high risk of complications. Although insulin levels are normal or increased in these patients, there is a fault in glucose-stimulated insulin secretion that is not sufficient to compensate for the insulin. Weight loss or medication may improve the condition, but insulin secretion rarely returns to normal (Carmody, D. et al. 2016).

Table 06: Additionally, there are some important factors to consider when testing for type 2 diabetes and prediabetes in individuals without symptoms (ElSayed et al., 2023).

Parameter	Description
Age	Age is a significant risk factor for diabetes. Testing should start by age 35, and screening is recommended for overweight or obese adults with one or more diabetes risk factors, regardless of age.
BMI and Ethnicity	For Asian Americans, BMI cut-off should be 23 kg/m2 for diabetes risk, as data shows increased sensitivity. Using a lower cut-off would lead to low specificity. One-third to one-half of diabetes cases in Asian Americans remain undiagnosed.
Medications	Certain medications, such as glucocorticoids, thiazide diuretics, some HIV medications, and atypical antipsychotics, increase the risk of diabetes and should be considered when deciding whether to screen.
HIV	Individuals with HIV on antiretroviral (ARV) therapies are at higher risk for developing prediabetes and diabetes and may require a screening protocol. A 1 C test may not be recommended for diagnosis. Weight loss through healthy nutrition and physical activity may reduce the progression toward diabetes. Preventive health care is critical for reducing the risks of complications.
Testing Interval	The appropriate interval between screening tests is not known. The 3-year interval is recommended to reduce the number of false-positive tests and retest false-negative tests before complications develop. Shorter intervals may be useful for high-risk individuals.
Community Screening	Screening should be carried out within a healthcare setting because of the need for follow-up and treatment. Community screening outside a health care setting is generally not recommended but may be considered in specific situations where an adequate referral system is established.
Screening in Dental Practices	Screening in a dental setting and referral to primary care to improve the diagnosis of prediabetes and diabetes has been explored. Further research is needed to demonstrate the feasibility, effectiveness, and cost- effectiveness of screening in this setting.

Source – Diabetes Care Volume 46, Supplement 1, January 2023

Specific Types of Diabetes

Genetic defects in beta cells

Another type of diabetes involves genetic defects in beta cell function, formerly known as MODY (Maturity-Onset Diabetes of Youth). Impaired insulin secretion is characterized by minimal or no defects in its function. It is characterized by autosomal dominantly inherited early-onset hyperglycemia with at least 13 genetic alterations that occur before the age of 25 and account for a small proportion (<5%) of diabetes (Bodic, et, al., 1996; Moran, A. et al. 2018).

Genetic defects in Insulin action

Some genetic abnormalities can affect insulin action and cause abnormal blood sugar levels. Mutations in the insulin receptor gene can cause insulin resistance and result in a range of metabolic abnormalities, from mild hyperglycemia to severe

diabetes. Acanthosis nigricans, virilization, and ovarian cysts may occur. Leprechaun syndrome and Robson-Mendenhall syndrome are two childhood disorders associated with these mutations. On the other hand, insulin-resistant lipotrophic diabetes is thought to be caused by defects in post-receptor signalling(Ben-Skowronek, I. 2021).

Endocrinopathies

Certain hormones like GH, cortisol, glucagon, and adrenaline can counteract the effects of insulin. Conditions characterized by excessive production of these hormones, such as acromegaly, Cushing's syndrome, glucagonoma, and pheochromocytoma, can induce diabetes in individuals who already have insulin secretion issues (Moran, A. et al. 2018).

Pancreatic Diabetes

Pancreatic DM refers to deterioration in insulin secretion caused by the abnormal structure and function of the pancreas and is often misdiagnosed as type 2 DM. When this occurs in the case of pancreatic exocrine dysfunction, it is also referred to as "type 3c diabetes" or "pancreoprivic diabetes". The umbrella term "pancreatic diabetes" is better to cover different etiology groups. The causes of pancreatic DM are diverse and include pancreatitis, trauma, infection, hemochromatosis, tumours, genetic disorders, and cystic fibrosis (Selvin, E. 2016; "UK prospective diabetes study 7: Response of fasting plasma glucose to diet therapy in newly presenting type II diabetic patients" 1990; Moran, A. et al. 2018).

Post pancreatitis diabetes mellitus (PPDM)

PPDM can arise from either a solitary episode of pancreatitis or a recurring one. A notable characteristic of PPDM is the existence of exocrine pancreatic insufficiency, which is determined through tests such as the stool elastase 1 test or direct function test. To diagnose the condition and assess the state of the pancreas, techniques like endoscopic ultrasound, MRI, or computed tomography can be employed. Unlike type 1 diabetes, PPDM is not linked to autoimmune markers (American Diabetes Association 2014).

Post-transplantation Diabetes Mellitus

Diabetes after transplantation can develop into PTDM or new-onset diabetes after transplantation (NODAT). PTDM occurs regardless of when diabetes started, while NODAT refers to new post-transplant diabetes, excluding pre transplant diabetes and hyperglycaemia, which resolves after hospital discharge. Although the use of immunosuppressive medication is the main cause of PTDM. Risk factors for PTDM include the risk of diabetes and specific changes for transplant such as the use of immunosuppressive drugs. Hyperglycemia usually occurs in the early post-transplant phase and PTDM is diagnosed when the patient is still on maintenance doses of immunosuppressive therapy and does not have acute infection. PTDM patients have higher rates of rejection, infection, and readmission (Thomas, M. C. et al. 2000; Zhang, X. et al. 2010; IDF diabetes atlas 2022).

Drug or Chemical-induced Diabetes

Some drugs and chemicals can restrict insulin release or its action leading to drug-induced diabetes. Pancreatic beta cells may be damaged by some toxins, e.g., vacor and pentamidine. In addition, drugs such as corticosteroids and niacin can also restrict insulin secretion. Diabetes-associated islet cell antibodies and insulin deficiency may develop in patients treated with alpha-interferon (Moran, A. et al. 2018).

Gestational Diabetes Mellitus

GDM was previously defined as a level of glucose intolerance, regardless of severity, first diagnosed during pregnancy. However, there is evidence that many patients with GDM are prediagnosed with hyperglycemia during pregnancy (Cole, J. B. and Florez, J. C. 2020). The degree of hyperglycemia is important in the assessment of maternal and foetal risks. Now the prevalence of obesity and diabetes has led to a higher incidence of type 2 diabetes inolder females in the reproductive age group, resulting in an increased number of females suffering with Type 2 diabetes among first trimester of pregnancy. The diagnostic criteria used to define undiagnosed diabetes in the first trimester are the same as those used in the general population (Knapp, et. al., 2019). Poor glucose metabolism in the first trimester is manifested by a blood glucose level of 110 mg/dL (6.1 mmol/L) or an HbA1C of 5.9% (39 mmol/mol) may increase the risk of pregnancy and child outcomes such as preeclampsia, macrosomia, shoulder dystocia and perinatal death. These individuals may also require insulin therapy and may be at increased risk for GDM after pregnancy. However, an HbA1C level of 5.7% has not been shown to be associated with adverse physical outcomes (Thomas, M. C. et al. 2000). The HbA1C is unreliable for screening for GDM or pre-existing diabetes at or after 15 weeks of gestation.

Diabetes Mellitus-Epidemiology

GDM was previously defined as a level of glucose intolerance, regardless of severity, first diagnosed during pregnancy. However, there is evidence that many patients with GDM are prediagnosed with hyperglycemia during pregnancy (Cole, J. B. and Florez, J. C. 2020). The degree of hyperglycemia is important in the assessment of maternal and fetal risks. Now the prevalence of obesity and diabetes has led to a higher incidence of type 2 diabetes inolder females in the reproductive age group, resulting in an increased number of females suffering with Type 2 diabetes among first trimester of pregnancy. The diagnostic criteria used to define undiagnosed diabetes in the first trimester are the same as those used in the general population Knapp, et. al., 2019). Poor glucose metabolism in the first trimester is manifested by a blood glucose level of 110 mg/dL (6.1 mmol/L) or an HbA1C of 5.9% (39 mmol/mol) may increase the risk of pregnancy and child outcomes such as preeclampsia, macrosomia, shoulder dystocia and perinatal death. These individuals may also require insulin therapy and may be at increased risk for GDM after pregnancy. However, an HbA1C level of 5.7% has not been shown to be associated with adverse physical outcomes (Thomas, M. C. et al. 2000). The HbA1C is unreliable for screening for GDM or pre-existing diabetes at or after 15 weeks of gestation. As per the IDF Diabetes Atlas (10th edition), adults (20-79 years) worldwide living with living with diabetes have reached around 537 million and are expected to

increase to 643 million in 2030 and 783 million by 2045. In low- and middle-income countries, about 50% of people with diabetes go undiagnosed. Diabetes kills about 3.7 million people each year. Type 1 diabetes affects more than one person. Worldwide, 2 million children and adolescents (0-19 years) and 21 million newborns are affected by diabetes during pregnancy. About 77 million adults above the age of 18 in India have type 2 DM, and more than 50 percent of them do not know they have diabetes. The Middle East and North Africa (MENA) region has the highest number of diabetes patients (16.2%) and is expected to reach 136 million by 2045. Type 1 diabetes will affect 193,000 children and teenagers by 2045.

Complications of Diabetes Mellitus

Diabetes is such a disease and the patient always has complications, it can be macrovascular and microvascular (Show in Table 07). The most important complication of DM is cardiovascular disease (CVD), which kills 65% of DM patients despite various treatments (Zhang, X. et al. 2010).

Table 07 : Complications of Diabetes Mellitus

Metabolic acute complications	**Systemic late complications**
These are short-term and include, • Hyperglycemia • Ketoacidosis • Hyperosmolar non-ketonic diabetic coma • Lactic acidosis (LA) • Hypoglycaemia	**A-Vascular** 1. **Microvascular-** retinopathy, neuropathy, nephropathy (ElSayed, N. A. et al. 2023b) 2. **Macrovascular-** coronary heart disease, peripheral arterial diseases, and cerebrovascular diseases. B- **Non-vascular complications:** Gastrointestinal (gastroparesis, diarrhea), Genitourinary (uropathy/sexual dysfunction), dermatology, infections, cataracts, glaucoma, peripheral disease, and long-standing diabetes may be associated with hearing loss (Lin, K.-Y. et al. 2021).

Diabetic Nephropathy:

Also known as diabetic kidney disease, is a progressive disease in which kidney function is reduced due to high blood sugar. In general, diabetic nephropathy occurs 10 years after type 1 diabetes and can occur when type 2 diabetes is diagnosed. The incidence of kidney disease in type 1 and type 2 diabetes is equal (~30%). Chronic kidney disease (CKD) is diagnosed with increased urinary albumin excretion and decreased eGFR (Knapp, et al. 2019; Thomas, M. C. et al. 2000; Papatheodorou, K. et al. 2015)

Diabetic Retinopathy:

Diabetic retinopathy or diabetic eye disease is a vascular complication of type T1DM and T2DM that can lead to blindness. In developing countries, the primary cause of blindness among adults aged 20-74 is attributed to two main factors: the higher prevalence of diabetes and the increased life expectancy of individuals in those regions. Diabetes also increases the risk of other eye diseases such as glaucoma and cataracts. During the initial stages of diabetic retinopathy, the occurrence of hyperglycemia and disrupted pathways leads to oxidative stress and neurodegeneration. This process

contributes to the development and progression of the disease. Pregnant women with diabetes mellitus are at risk for diabetic retinopathy, which can develop during pregnancy but usually resolves after delivery (ElSayed, N. A. et al. 2023b; Lin, K.-Y. et al. 2021; Jenkins, A. J. et al. 2015; Chandrasekaran et. al. 2021; Adeoti, C. et al. 2012)

Neuropathy: Diabetic neuropathy refers to a group of conditions with many symptoms caused by nerve damage caused by diabetes. The most common type is distal symmetric polyneuropathy affecting peripheral nerves in the lower extremities. Other subtypes include autonomic neuropathy, atypical neuropathy, and nondiabetic neuropathy common in diabetes. More than half of people with diabetes develop neuropathy, which increases the risk of muscle weakness. Symptoms affect the nervous system and peripheral nerves and are often characterized by numbness, tingling, loss of smell, and pain at night in a "glove" hand and socks pattern. Motor neuron dysfunction and autonomic nervous system abnormalities, such as orthostatic hypotension and gastrointestinal problems, are also common in people with diabetic neuropathy eGFR (Knapp, et al. 2019; Thomas, M. C. et al. 2000; ElSayed, et al. 2023).

Cardiovascular Disease:

People with diabetes have an increased risk of cardiovascular d isease (CVD), which causes serious illness and death in these people. A notable phenomenon observed in some individuals with diabetes is the development of left ventricular dysfunction, despite the absence of coronary artery disease, hypertension, or vascular disease. This observation was initially reported by Rubler et al. and subsequently referred to as diabetic cardiomyopathy. It is recognized as a complication associated with atherosclerotic cardiovascular disease (ASCVD), diabetes, coronary heart disease (CHD), cerebrovascular disease, and peripheral artery disease. Heart failure, a significant contributor to cardiovascular disease morbidity and mortality, is more prevalent in individuals with diabetes (Knapp, et al. 2019; Thomas, M. C. et al. 2000; Papatheodorou, K. et al. 2015; ElSayed, et al. 2023).

Diabetic Foot:

It is a serious complication of diabetes, a chronic disease that is often incurable. This condition results from a combination of neuropathy and varying degrees of vascular disease, leading to lower extremity swelling, ulceration, and/or deep tissue damage, with patients at risk of amputation and death. Foot ulcers and amputations are diabetes-related complications caused by peripheral neuropathy, peripheral artery disease, and foot deformities (Adeoti, C. et al. 2012; ElSayed, et al. 2023; Forbes, et. al. 2013).

Management of Diabetes Mellitus:

Effective management of diabetes is crucial in preventing the onset and progression of complications associated with the condition. This entails meticulous control of exogenous insulin administration and regular monitoring of glucose levels to maintain them within the recommended targets (van Netten, J. J. et al. 2016). Diabetes management encompasses both pharmacological and non-pharmacological approaches to ensure optimal outcomes.

Non-Pharmacological Management of Diabetes Mellitus:

1. **Eat healthy food:** According to the ADA, individuals with diabetes are advised to follow a dietary pattern that is low in saturated and trans fats, while being high in fiber. Additionally, their diet should be rich in whole grains, fruits, and vegetables. The IDF recommends a similar approach, emphasizing the importance of a balanced and varied diet.
2. **Physical Activity:** Both the ADA and IDF emphasize the significance of regular physical activity in the management of diabetes. The ADA recommends a minimum of 150 minutes of aerobic activity per week, along with engaging in strength training exercises at least twice a week. On the other hand, the IDF recommends approximately 30 minutes of physical activity on most days of the week, coupled with resistance training at least twice a week.
3. **Weight Management:** Both the American Diabetes Association (ADA) and the International Diabetes Federation (IDF) underline the significance of weight management for individuals with diabetes. While the ADA suggests that even a modest weight gain of 5-7% of body weight can yield health benefits, the IDF recommends that adults with diabetes aim for a body mass index (BMI) below 25 kg/m². These guidelines stress the importance of achieving and maintaining a healthy weight to improve overall health outcomes in individuals living with diabetes.
4. **Blood Sugar Monitoring:** The ADA and IDF recommend continuous blood glucose monitoring as an important part of diabetes management as it helps people with diabetes track their progress and make informed decisions about treatment.
5. **Diabetes Education and Support:** Both the ADA and IDF emphasize the importance of diabetes education and support for people with diabetes, including access to healthcare providers, self-management services, and a support group.
6. **Smoking:** Both the ADA and the IDF recommend that people with diabetes quit smoking because smoking increases the risk of diabetes (Wang, A. et al. 2020).

Conclusion

This study contributes to the field by presenting a theoretical and methodological framework that has broad applicability. The key findings of the study focus on the epistemological discourse surrounding the use of bibliometric analysis. Specifically, the study examines publication trends, identifies the most active countries and productive authors, and highlights the most influential papers. Additionally, the study investigates how researchers build upon each other's work through bibliographical coupling and co-citation networks. Furthermore, the study explores the expansion of knowledge over time by analyzing keyword co-occurrence networks and overlays. Overall, this study provides a better understanding of the link between, Information, advancement of knowledge, and the importance of bibliometric analysis in various research fields.

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