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Research Article

**ASSESSMENT OF KNOWLEDGE, ATTITUDE AND
PRACTICE AMONG DIABETES MELLITUS PATIENTS
ATTENDING A TERTIARY HOSPITAL AND THE IMPACT
OF PHARMACIST-LED EDUCATION****Safiya Siddiqua^{1*}, Praveen Naik², Mohammed Sohail Uddin¹, Deshamalla Samatha¹,
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Abstract:

Diabetes Mellitus is a metabolic disease with a chronic course in the body, whereby hyperglycemia results from problems with the secretion and or functioning of insulin. This condition is accompanied by disturbances in carbohydrate, fat and protein metabolism and leads to severe complications like microangiopathy, macroangiopathy and neuropathy. Diabetes is divided into several types, namely Type 1 Diabetes Mellitus, type 2 DM, Gestational diabetes and others. Type 2 diabetes mellitus accounts for about 90 to 95 percent of all diabetes cases.

The number of people suffering from diabetes is on the rise in the world because of several factors that include the ageing population, urbanization, inactive lifestyles, and the prevalence of obesity. In India, there has been a sharp rise in the number of diabetes cases, which poses a health problem. Diabetes is a slow process, and sometimes, it may go unnoticed, leading to complications during diagnosis.

The parameters considered for the diagnosis of diabetes include HbA1C, fasting plasma glucose tolerance test, and random plasma glucose levels. The management of diabetes is considered effective when good glycemic control is achieved through lifestyle modification, medical nutrition therapy, pharmacological therapy, and monitoring the levels of blood glucose. The education and awareness of patients are considered crucial in the management of diabetes and its prevention of its complications

Keywords: *Diabetes Mellitus, HbA1C, OGTT, Diabetes Ketoacidosis*

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INTRODUCTION:

Diabetes mellitus is a group of metabolic disorders characterised by hyperglycaemia, which is associated with abnormalities in carbohydrate, fat and protein metabolism, and results in chronic complications including microvascular, macrovascular, and neuropathic disorders. There are two main types of Diabetes: Type I Diabetes Mellitus and Type II Diabetes Mellitus, in which 90% of the Diabetes patients develop Type II Diabetes Mellitus.[1] Due to the increase in the number of individuals with type 2 diabetes (T2DM) worldwide, there may be a rising economic burden from the disease globally. It is concerning that despite clinical and financial efforts by organisations and individuals worldwide, the incidence and prevalence of T2DM continue to rise. Additionally, there has been an increase in premature deaths due to T2DM [2]. The number of people with Diabetes is rapidly rising all over the globe due to population overgrowth, aging, urbanization and increasing prevalence of obesity and physical inactivity. The total number of people with Diabetes worldwide will rise from 171 million in the year 2000 to 366 million in the year 2030. India is becoming the Diabetes capital of the world, with 31.7 million diabetics in the year 2000, which is expected to rise to about 80 million in 2030. According to the International Diabetes Federation (IDF), the prevalence of Diabetes is 7.1% in India in the year 2010, with a higher incidence in males when compared to females. [1,2].

The World Health Organisation (WHO) has identified several factors that increase susceptibility to developing T2DM, such as a family history of diabetes, a sedentary lifestyle, obesity, age, a history of gestational diabetes, cardiovascular disease and its risk factors, and certain ethnicities (South Asian, Afro-Caribbean, Hispanic). Importantly, T2DM is characterised by a slow deterioration towards hyperglycaemia. A considerable number of patients present with complications at diagnosis, resulting from a long-standing, uncontrolled hyperglycaemic state.[3] Therefore, proper education and awareness programmes developed according to the needs of the society can improve the knowledge of patients and change their attitude and dietary practices.[4]

CLASSIFICATION OF DIABETES:

Diabetes is diagnosed based on the context in which it is identified, but there can be exceptions to the diagnostic criteria. For example, if a pregnant woman has gestational diabetes that persists even after she gives birth, she will have type 2 diabetes. Another scenario is where a patient is found to be suffering from diabetes because he/she has been

using large doses of steroids, and when he/she stops using the steroids, their glucose levels become normal; however, he/she develops diabetes in the future because of repeated episodes of pancreatitis. Also, a patient who uses thiazide diuretics and is diagnosed with diabetes some years down the line most probably has type 2 diabetes made worse by his/her medications.

HORMONE DEPENDENT DIABETES:(TYPE 1 IDDM):

This type of diabetes in 5-10% of patients who suffer from diabetes, which was formerly known as insulin-dependent diabetes, type 1 diabetes or juvenile-onset diabetes, is due to the cellular-mediated destruction of the pancreatic β -cells. The indicators that show the cellular-mediated destruction of the β -cell include islet cell autoantibodies, insulin autoantibodies, GAD (GAD65) autoantibodies, and tyrosine phosphatases IA-2 and IA-2 β autoantibodies. At least one or more of these autoantibodies are found in 85-90% of patients having fasting hyperglycaemia. Moreover, this particular type of diabetes is associated with HLA in relation to the DQA, DQB and DRB genes.

The rate of destruction of the beta cells differs greatly between individuals. While in some people, for example, in children and infants, the destruction of the cells can happen quickly, in adults, it occurs slowly. In some patients, especially those that are in their childhood period or adolescence, the disease might present itself as ketoacidosis. In some patients, hyperglycaemia could become severe quickly and might cause both hyperglycaemia and ketoacidosis after infections or other stressful conditions occur. In adult individuals, the functioning of the remaining beta cells might not be enough to cause ketoacidosis. In such diabetes, the person must take the necessary insulin doses for survival and is at risk of experiencing ketoacidosis. There is no insulin production in such type of diabetes since there is a lack of C-peptide in the blood. Such type of diabetes can occur at any stage in a person's life even in their 8th and 9th decades. [5]

NON-INSULIN DEPENDENT POLYGENIC DISORDER MELLITUS (TYPE 2 NIDDM):

This kind of diabetes, which constitutes ~90-95% of all individuals suffering from diabetes, also referred to as non-insulin-dependent diabetes, type 2 diabetes, or adult-onset diabetes, comprises all those individuals who suffer from insulin resistance and insulin deficiency. They do not require insulin for survival in at least the beginning and, most likely, throughout their life span. There could be several causes for this kind of diabetes. The causes of this

kind of diabetes are yet unknown. But there is certainly no autoimmune destruction of the β -cell mass, nor do they suffer from any other causes of diabetes mentioned above or below.

Diabetes mellitus type 2 is prevalent amongst individuals who are obese or have an abundance of fat in their abdomens, which results in insulin resistance. Ketoacidosis occurs only when the body experiences stress, such as from infections. Type 2 diabetes can exist without any signs for many years since blood sugar levels rise slowly.

It is also crucial to understand that insulin levels are either normal or elevated in individuals suffering from this disease, even though insulin production by the beta cells of the pancreas is impaired. In essence, this implies that it is not possible to reverse insulin resistance. Exercise and pharmacotherapy can help alleviate insulin resistance; however, insulin resistance remains elevated in most patients.

This health disorder becomes more prevalent with advancing age, obesity, and lack of physical activity. Gestational diabetes in women leads to this disease. Hypertension and dyslipidaemia are major contributing factors to this disease. A significant genetic tendency toward this disease exists; however, the genetics of this health problem are very complex.[6]

GESTATIONAL DIABETES:

This intolerance to aldohexose, which occurs for the first time or is diagnosed during pregnancy, is referred to as physiological Diabetes Mellitus. The WHO women diagnosed with Type 1 Diabetes Mellitus during pregnancy and girls having an undiagnosed asymptomatic form of Type 2 Diabetes Mellitus, which occurred during gestation, are considered to have physiological Diabetes Mellitus (GDM). Physiological Diabetes Mellitus (GDM) (Diabetes that occurs during gestation, not due to diabetes) [6]. This physiological condition that may occur during gestation would cease after giving birth; however, over time, children born to mothers who had GDM are more prone to obesity and type 2 diabetes mellitus, a consequence of exposure to hyperglycaemia in utero.[7]

ALTERNATIVE SPECIFIC SORT (MONOGENIC TYPES):

Most inherited types of polygenic diseases are associated with a mutation in chromosome twelve, which leads to transcription problems in a vital organ referred to as the hepatocyte nuclear factor (HNF)-1a. In other cases, such types of polygenic diseases may be referred to as genetic defects of beta cells. These types of polygenic diseases may sometimes present themselves in an early age, which

may not go beyond twenty-five years. They are also referred to as maturity-onset diabetes of the young (MODY) or diabetes mellitus in youth resistant to ketoacidosis. Other examples include individuals who suffer from other polygenic diseases related to the disease of the exocrine duct gland, like rubor or cystic fibrosis, individuals suffering from conditions related to other endocrinopathies (e.g., acromegaly), and individuals with pancreatic disease because of medication, chemicals, or infections. Some medications may be administered in conjunction with the treatment of HIV/AIDS or organ transplants. Genes that cause difficulties in converting proinsulin to insulin have been identified in some families, and these genes are dominant within a chromosome. These are one hundred percent of diabetes mellitus cases.[7]

EPIDEMIOLOGY OF DIABETES MELLITUS:

Diabetes mellitus is now recognized as a major global public health concern of the 21st century. Over recent decades, its prevalence has risen significantly, mainly due to factors such as rapid urbanisation, increasing rates of obesity, unhealthy eating patterns, reduced physical activity, and an ageing population [8,9]. Currently, hundreds of millions of individuals worldwide are living with diabetes, and this number is expected to rise considerably in the future if effective preventive strategies are not implemented [9,10].

Type 2 diabetes mellitus accounts for the majority of cases, representing approximately 85–90% of the global diabetic population [8,10]. It primarily affects adults and older individuals, with prevalence increasing notably with age [9]. Differences between genders are generally minimal, although in many regions, men show a slightly higher prevalence [10].

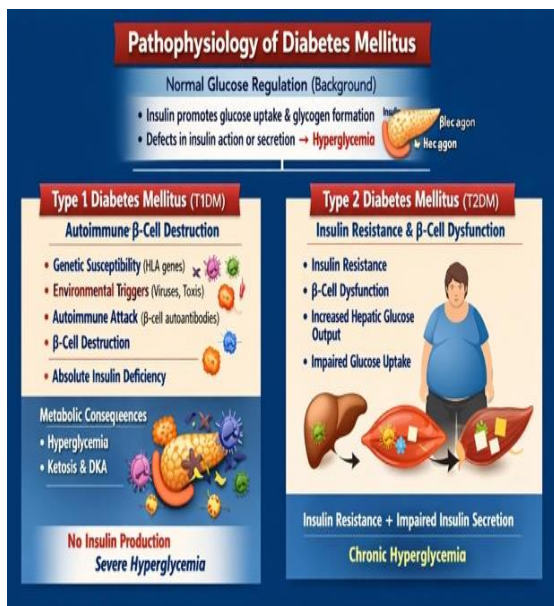
The impact of diabetes is especially pronounced in low- and middle-income countries, where rapid changes in lifestyle are combined with limited access to healthcare services and preventive measures [9,11]. Many individuals with type 2 diabetes remain undiagnosed because the disease often develops gradually and may not present noticeable symptoms in its early stages [8,11]. As a result, diagnosis is often delayed, increasing the likelihood of complications at the time the disease is identified [11].

Diabetes is associated with high levels of morbidity and mortality, largely due to its long-term microvascular and macro vascular complications [8,9]. Cardiovascular diseases are the leading cause of death among diabetic patients, contributing significantly to early mortality [9,10]. The continuously increasing prevalence of diabetes

places a heavy burden on healthcare systems globally, highlighting the need for effective prevention, early diagnosis, and comprehensive management approaches [8,11].

PATHOPHYSIOLOGY OF DIABETES MELLITUS:

Diabetes mellitus is a chronic metabolic condition marked by sustained elevation of blood glucose levels, resulting from impaired insulin secretion, reduced insulin effectiveness, or a combination of both. Insulin plays a crucial role in regulating glucose homeostasis by enabling glucose uptake into peripheral tissues and reducing hepatic glucose production. Disruption of these functions leads to altered metabolism of carbohydrates, lipids, and proteins [12,13].



TYPE 1 DIABETES MELLITUS:

Type 1 diabetes mellitus occurs due to autoimmune destruction of pancreatic β -cells, resulting in a complete lack of insulin production. In the absence of insulin, glucose uptake by insulin-dependent tissues such as muscle and adipose tissue is significantly reduced, while glucose production by the liver continues unabated. This imbalance stimulates increased breakdown of fats, releasing free fatty acids that are converted into ketone bodies in the liver, thereby increasing the risk of diabetic ketoacidosis (DKA). Variations in blood glucose levels can adversely affect the brain and other essential organs [12,14].

TYPE 2 DIABETES MELLITUS:

Type 2 diabetes mellitus is primarily characterised by decreased sensitivity of peripheral tissues to insulin, along with a relative insulin deficiency. Initially, pancreatic β -cells attempt to compensate by enhancing insulin secretion. Over time, continuous metabolic strain leads to β -cell dysfunction and insufficient insulin production. This results in persistent hyperglycaemia, usually without the development of ketosis. In severe or prolonged cases, markedly elevated blood glucose levels may lead to hyperglycaemic hyperosmolar state (HHS), especially in elderly individuals [13–15].

SIGNS AND SYMPTOMS OF DIABETES MELLITUS:

The most commonly observed clinical manifestations of diabetes include the classic triad of polyuria, polydipsia, and polyphagia. Polyuria refers to increased urination caused by osmotic diuresis due to elevated blood glucose levels. This leads to excessive fluid loss, resulting in polydipsia (increased thirst). Polyphagia, or increased hunger, occurs due to the inability of cells to utilise glucose effectively. Unintentional weight loss may also be present, particularly in uncontrolled cases [16,17].

General and Systemic Symptoms:

Patients often experience fatigue and generalised weakness due to impaired glucose utilisation. Blurred vision may occur as a result of osmotic changes affecting the lens of the eye. Additional features include dry mouth, dehydration, and decreased exercise tolerance [16,18].

Skin and Neurological Manifestations:

Diabetes may lead to various skin-related issues and an increased susceptibility to infections. Neurological symptoms such as numbness, tingling, or burning sensations in the hands and feet are common and may indicate peripheral neuropathy [17,19].

Symptoms of Acute Metabolic Complications:

Severe, uncontrolled diabetes can result in acute complications. Diabetic ketoacidosis (DKA), more commonly seen in type 1 diabetes, presents with nausea, vomiting, abdominal pain, rapid breathing, and altered levels of consciousness. Hyperglycaemic hyperosmolar state (HHS), typically associated with type 2 diabetes, is characterised by profound dehydration, confusion, and in severe cases, coma [18,19].



ETIOLOGY:

Diabetes arises from a mix of elements such as heredity, personal habits, and specific health issues. Here are some frequent reasons for diabetes.

AUTOIMMUNE RESPONSE:

In Type 1 Diabetes Mellitus, an autoimmune response occurs when the immune system incorrectly targets and destroys the body's own pancreatic β -cells, causing a complete lack of insulin. This process involves autoantibodies and T cells that mistakenly harm β -cells, leading to increased blood sugar levels and a reliance on external insulin.

GENETIC FACTORS:

Genetic influences are significant in both Type 1 and Type 2 Diabetes, although they operate through different pathways.

Type 1 Diabetes: Genetic factors primarily influence the immune system, causing it to attack the pancreatic β -cells.

Type 2 Diabetes: Genetic factors mainly impact insulin sensitivity or its secretion, often worsened by lifestyle choices.

INSULIN RESISTANCE:

Insulin resistance is a condition where the cells in the body, especially in muscles, fat, and the liver, fail to respond correctly to insulin. Consequently, the body requires more insulin to transport glucose from the bloodstream into the cells. In the long run, this leads to elevated blood sugar levels and may result in Type 2 Diabetes Mellitus.

OBESITY:

Obesity is characterized by an excessive quantity of body fat, generally defined as having a Body Mass Index (BMI) of 30 kg/m² or more. It is a major risk

factor for the onset of Type 2 Diabetes Mellitus (T2DM). When a person is obese, particularly with fat accumulation around the waist, their body becomes less responsive to insulin, leading to insulin resistance. This resistance means that glucose accumulates in the blood instead of being utilized by the body's cells for energy.

INACTIVITY:

A lack of physical activity is a significant risk factor for developing Type 2 Diabetes Mellitus. Being inactive reduces the effectiveness of insulin in the body, leading to insulin resistance. When muscles are not exercised, they absorb less glucose from the bloodstream, causing blood sugar levels to rise. Over time, this can lead to diabetes, obesity, and other metabolic disorders.

HORMONAL CHANGES:

Changes in hormones can trigger diabetes by either reducing insulin effectiveness or secretion or increasing glucose production. The main hormonal problem is a lack of insulin or resistance to it, but excessive amounts of cortisol, growth hormone, glucagon, and catecholamines can also lead to or worsen diabetes.

Hormonal changes are primarily responsible for gestational diabetes, which arises from hormonal shifts during pregnancy.

AGE:

As individuals age, various natural changes in the body's metabolism increase their chances of developing diabetes, particularly Type 2 Diabetes Mellitus.

These age-related aspects influence insulin production, its action, and glucose metabolism.

PREDIABETES:

Prediabetes is a medical condition characterised by blood sugar levels that are higher than normal but not elevated enough to be classified as diabetes mellitus.

It is viewed as a transitional metabolic stage between normal glucose management and Type 2 Diabetes Mellitus, marked by impaired fasting glucose or impaired glucose tolerance.

ENVIRONMENTAL INFLUENCES:

Environmental aspects have a major impact on the development of both type 1 and type 2 diabetes. In the case of type 2 diabetes, lifestyle factors like eating diets rich in processed foods, lack of physical

activity, smoking, and ongoing stress can lead to obesity, insulin resistance, and problems with glucose processing, which raises the likelihood of the disease. Exposure to environmental elements, such as air pollution and chemicals that disrupt hormone function, has been linked to the disruption of insulin signalling and the function of β -cells. For type 1 diabetes, environmental factors like viral infections, a lack of vitamin D, and contact with specific chemicals can trigger an autoimmune reaction against insulin-producing β -cells in individuals who are genetically at risk, resulting in the onset of the disease [20].

DIAGNOSTIC CRITERIA FOR DIABETES MELLITUS :

Diabetes can be identified through any of the following assessments:

A1C (Glycated Haemoglobin): $>6.5\%$

Should be conducted using a method certified by NGSP and aligned with the DCCT assay. Indicates average glucose levels from the past 2 to 3 months. Fasting is not necessary.

Fasting Plasma Glucose (FPG):

$>200\text{mg/dl}$ (7.0mmol/L)

Measured means no food or drink containing calories for at least 8 hours.

2-hour Plasma Glucose (2-h PG) during 75-g OGTT:

$\geq 200\text{ mg/dL}$ (11.1 mmol/L)

Measured 2 hours following a 75-g oral glucose challenge

4 . Random (Casual) Plasma Glucose:

$\geq 200\text{ mg/dL}$ (11.1 mmol/L). In someone exhibiting typical symptoms of high blood sugar or an emergency situation. No need for a repeat test if symptoms are evident

Verification of Diagnosis

Unless there are clear signs of high blood sugar (like an emergency or typical symptoms):

The same test must be done again to verify the diagnosis. If two different tests result in values above the diagnostic limits \rightarrow diagnosis is confirmed If the follow-up test shows levels below the threshold \rightarrow monitor and retest in 3 to 6 months. If results differ \rightarrow retest the one that was above the cutoff point. [21]

MANAGEMENT AND TREATMENT OF DIABETES MELLITUS:

Amputations, vision loss, and severe kidney disease are found in individuals with diabetes. This section will offer a thorough review of various treatment methods and the most recent progress in diabetes management. Addressing complications from diabetes and conducting screenings forms a critical aspect of complete diabetes care, but it cannot be included in this section due to space constraints.

MANAGEMENT OF DIABETES MELLITUS:

The primary goals of effective diabetes management involve reducing symptoms, attaining optimal glycaemic control, and safeguarding against both microvascular and macrovascular complications. Research findings from the United Kingdom Perspective Diabetes Study (UKPDS), DCCT, and ADVANCE studies have shown the significant effects of maintaining good glycaemic control on vascular issues. It is estimated that lowering HbA1c by 1% could lead to a notable decrease in deaths related to diabetes (21%), a reduction in microvascular complications (37%), and a cutback in myocardial infarction (14%).

DIABETES EDUCATION:

Educating patients about diabetes is one of the key responsibilities of healthcare providers. Individuals with diabetes and their families are the most capable of managing a condition that can be heavily influenced by daily changes in stress, exercise, diet, and infections. The education process should include explanations from the physician or educator regarding diabetes, its possible acute and long-term complications, and how these can be identified early, prevented, or managed. Self-monitoring of blood glucose (SMBG) is crucial, particularly for individuals with Type 1 diabetes mellitus (T1DM) and those with Type 2 diabetes mellitus (T2DM) who require insulin, and proper guidelines must be provided for testing and recording results. Patients using insulin should learn how to modify their insulin dosage based on the carbohydrate content of their meals. Intense physical activity can lead to hypoglycaemia, so it is important for patients to be instructed to lower their insulin dose before engaging in vigorous exercise or to consume extra carbohydrates. Blood glucose management targets for older individuals should be adaptable due to their increased risk of hypoglycaemia associated with stricter glycaemic control. Recommendations on personal hygiene, including detailed guidance on foot and dental care, should be shared. Finally, strong efforts must be made to encourage all individuals with diabetes to stop smoking, as diabetic smokers have a higher likelihood of

experiencing severe peripheral vascular disease and debilitating retinopathy.

MEDICAL NUTRITION THERAPY (MNT):

Medical nutrition therapy (MNT) is the method used to customise nutrition plans for individuals with diabetes based on their medical needs, lifestyle choices, and personal circumstances. A balanced diet continues to be a fundamental component of treatment. The American Diabetes Association (ADA) advocates that approximately 45-65% of daily caloric intake should consist of carbohydrates, while 25-35% should come from fats.[22]

REFERENCES:

1. ProQuest Dissertations & Theses. Available from: <https://www.proquest.com/openview/c80d4653547806003fe0f6045d33eaeed/1?pq-origsite=gscholar&cbl=2026366&diss=y>
2. MDPI. Article ID 2977320. Available from: <https://www.mdpi.com/2977320>
3. MDPI. Article ID 2977320. Available from: <https://www.mdpi.com/2977320>
4. International Journal of Research in Medical Sciences. Available from: <https://www.msjonline.org/index.php/ijrms/article/view/2964/2906>
5. American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care*. 2010;33(Suppl 1):S62–S69. Available from: https://diabetesjournals.org/care/article/33/Supplement_1/S62/25777/Diagnosis-and-Classification-of-Diabetes-Mellitus
6. American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care*. 2010;33(Suppl 1):S62–S69. Available from: https://diabetesjournals.org/care/article/33/Supplement_1/S62/25777/Diagnosis-and-Classification-of-Diabetes-Mellitus
7. Dubey A. A review on diabetes mellitus type 1 & type 2. Available from: https://www.researchgate.net/profile/Anubhav-Dubey-2/publication/344478445_A_REVIEW_ON_DIABETES_MELLITUS_TYPE1_TYPE2/links/5f7b51db458515b7cf67d400/A-REVIEW-ON-DIABETES-MELLITUS-TYPE1-TYPE2.pdf
8. Magliano DJ, Boyko EJ; IDF Diabetes Atlas 10th edition scientific committee. Epidemiology of diabetes - ScienceDirect. In: IDF Diabetes Atlas [Internet]. 10th ed. Brussels: International Diabetes Federation; 2021 [cited 2026 Mar 14]. Available from: <https://www.sciencedirect.com/>
9. Sun H, Saeedi P, Karuranga S, Pinkepank M, Ogurtsova K, Duncan BB, et al. IDF Diabetes Atlas: Global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. *Diabetes Res Clin Pract*. 2022;183:109119. doi:10.1016/j.diabres.2021.109119.
10. Lin X, Xu Y, Pan X, Xu J, Ding Y, Sun X, et al. Global, regional, and national burden and trend of diabetes in 195 countries and territories: an analysis from 1990 to 2025. *Sci Rep*. 2020;10(1):14790.
11. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. *Diabetes Care*. 2004;27(5):1047-1053.
12. Skyler JS, Bakeries GL, Bonifacio E, Darsow T, Eckel RH, Groop L, et al. Differentiation of Diabetes by Pathophysiology, Natural History, and Prognosis. *Diabetes*. 2017;66(2):241-255. doi:10.2337/db16-0806.
13. Galicia-Garcia U, Benito-Vicente A, Jebari S, Larrea-Sebal A, Siddiqi H, Uribe KB, et al. Pathophysiology of Type 2 Diabetes Mellitus. *Int J Mol Sci*. 2020;21(17):6275. doi:10.3390/ijms21176275.
14. Kharroubi AT, Darwish HM. Diabetes mellitus: The epidemic of the century. *World J Diabetes*. 2015;6(6):850-867. doi:10.4239/wjd.v6.i6.850.
15. Ozougwu JC, Obimba KC, Belonwu LC, Unakalamba CB. The pathogenesis and pathophysiology of type 1 and type 2 diabetes mellitus. *J Physiol Pathophysiol*. 2013;4(4):46-57.
16. American Diabetes Association. 2. Classification and Diagnosis of Diabetes: Standards of Medical Care in Diabetes—2024. *Diabetes Care*. 2024;47(Supplement_1):S20-S42. doi:10.2337/dc24-S002.
17. Ramachandran A. Know the signs and symptoms of diabetes. *Med J Armed Forces India*. 2014;70(3):269-270. doi:10.1016/j.mjafi.2014.05.002.
18. Baynest HW. Classification, Pathophysiology, Diagnosis and Management of Diabetes Mellitus. *J Diabetes Metab*. 2015;6(5):1-9. doi:10.4172/2155-6156.1000541.
19. Forouhi NG, Wareham NJ. Epidemiology of diabetes. *Medicine*. 2019;47(1):22-27. doi:10.1016/j.mpmed.2018.10.004.
20. Patil M, Haque A, Patil T. A comprehensive review on diabetes mellitus: etiology, diagnosis and pharmacological management. *Int J Pharm Sci*. 2023;1(11):71–80.
21. American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care* [Internet]. 2010;33(Suppl 1):S62–9. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2797383/>

22. Imam, K. (2013). Management and Treatment of Diabetes Mellitus. In: Ahmad, S.I. (eds) Diabetes. Advances in Experimental Medicine and Biology, vol 771. Springer, New York, NY