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Type 2 Diabetes Mellitus: A Comprehensive Review of Epidemiology, Pathophysiology, Clinical Management and Homoeopathic Perspective

Dr. Laxmi G Tolamatti[1], Dr. Neeta[2]
[1]*Intern, BVVS Homoeopathic Medical College and Hospital Bagalkot*
[2]*Assistant Professor, Department of Human Anatomy, BVVS Homoeopathic Medical College and Hospital Bagalkot*

Abstract: ***Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder characterized by insulin resistance and progressive pancreatic β-cell dysfunction, posing a major global health burden. The increasing prevalence of T2DM is associated with genetic factors, obesity, sedentary lifestyle, unhealthy dietary habits, and psychosocial determinants. The disease contributes significantly to morbidity and mortality through its microvascular and macrovascular complications[1,2]. This review aims to provide a comprehensive overview of the epidemiology, pathology, clinical features, diagnosis, and management of T2DM. [1,4] The underlying pathophysiological mechanisms, including insulin resistance, inflammation, and impaired glucose metabolism, are discussed. Conventional management strategies such as lifestyle modification, pharmacological treatment, and long-term monitoring are also highlighted. [1] From a Homoeopathic perspective, emphasis is placed on individualization, constitutional assessment, and totality of symptoms. Homoeopathy considers psychological, environmental, and susceptibility factors influencing disease expression. [7,8,9]An integrated and patient-centered approach may support comprehensive care and improve quality of life in individuals with T2DM.***

Keywords: Type 2 Diabetes Mellitus, Epidemiology, Pathophysiology, Insulin Resistance, Clinical Management, Homoeopathy, Individualized Medicine, Prevention.

I. INTRODUCTION

Diabetes Mellitus refers to a group of metabolic disorders characterized by chronic hyperglycaemia resulting from defects in insulin secretion, insulin action, or both. [6] Type 2 Diabetes Mellitus accounts for approximately 90–95% of all cases of diabetes and has emerged as one of the leading non-communicable diseases globally.[1]

T2DM develops gradually through a combination of insulin resistance and inadequate compensatory insulin secretion by pancreatic β-cells.[3,4] Genetic predisposition, obesity, physical inactivity, unhealthy dietary habits, and environmental influences contribute to disease development.[4]

The disease imposes a substantial economic burden on healthcare systems because of its chronic nature and associated complications.[2] Effective prevention, timely diagnosis, comprehensive management, and patient education are essential to reduce morbidity and mortality.[1]

From a homoeopathic perspective, diabetes is considered a constitutional disorder requiring individualized treatment based on the patient's mental, emotional, and physical characteristics. [7,9] Homoeopathy aims to stimulate the body's self-regulatory mechanisms while emphasizing lifestyle modification and holistic care.[8]

II. OBJECTIVES OF THE REVIEW

1) To provide a comprehensive overview of Type 2 Diabetes Mellitus.
2) To discuss the epidemiology and risk factors associated with T2DM.
3) To describe the pathophysiology and clinical features of the disease.
4) To review current diagnostic criteria and conventional management strategies.
5) To explore the homoeopathic approach in the management of T2DM.
6) To summarize commonly indicated homoeopathic medicines used in diabetic patients.
7) To emphasize the importance of integrated and patient-centred care.

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III. EPIDEMIOLOGY

Type 2 Diabetes Mellitus has become a major global health challenge.

A. Global Burden

According to the International Diabetes Federation (IDF), diabetes affects hundreds of millions of individuals worldwide.
The prevalence is expected to increase substantially over the coming decades.
Developing countries contribute significantly to the rising burden due to rapid urbanization and lifestyle changes.

Year	Survey	Male	Female	Key findings
2022	Global burden analysis	11.2%	10.3%	Global diabetes prevalence in adults increased to approximately 14%, more than double compared with 1990.
2023	Global diabetes epidemiology review	11.4%	10.6%	Approximately 506 million individuals worldwide were affected by Type 2 Diabetes Mellitus.
2024	International Diabetes Federation (IDF) Atlas	11.55%	10.68%	More than 800 million adults globally were estimated to have diabetes, with a significant proportion remaining untreated.
2025	Global burden forecast study	Greater disease burden in males	Increasing trend among females	T2DM prevalence increased by approximately 290.5% since 1990; incidence reached 23.9 million new cases and mortality reached 1.6 million cases globally.

IV. BURDEN IN INDIA

India is among the countries with the highest number of individuals living with diabetes.
Increasing prevalence has been observed in both urban and rural populations.
Earlier age of onset and increased susceptibility among South Asians have been documented.

Year	Survey	Male	Female	Major findings
2023-2024	Pan-India multicentric diabetes registry (n=25,077)	12,793 (51.1%)	12,284 (48.9%)	Slight male predominance; majority of patients were >50 years and from urban populations
2024	HbA1c-based epidemiology study (Pan-India)	Higher prevalence among males	Lower prevalence among females	Nearly 1 in 2 screened individuals had diabetes or prediabetes
2024	ICMR–INDIAB dietary and metabolic survey	Higher risk associated with obesity and lifestyle factors in males	Increasing prevalence among females due to urbanization and obesity	Dietary patterns significantly influenced diabetes risk
2025	Indian burden projection studies	Male prevalence remained slightly higher	Increasing trend in females	India continues to have one of the highest diabetes burdens globally

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V. RISK FACTORS

A. Non-modifiable factors

- Advancing age.
- Family history of diabetes.
- Ethnic predisposition.
- History of gestational diabetes.

B. Modifiable factors

- Obesity, particularly central obesity.
- Sedentary lifestyle.
- Unhealthy dietary practices.
- Smoking.
- Excessive alcohol consumption.
- Hypertension.
- Dyslipidaemia.

VI. PUBLIC HEALTH IMPORTANCE

Type 2 Diabetes Mellitus contributes significantly to disability-adjusted life years and healthcare expenditure. The disease is associated with serious complications including cardiovascular disease, nephropathy, retinopathy, neuropathy, and lower limb amputations.

Strategies focusing on prevention, early diagnosis, lifestyle interventions, and patient education are essential components of public health initiatives aimed at reducing the burden of diabetes.

VII. PHYSIOLOGY OF GLUCOSE HOMEOSTASIS

Glucose homeostasis refers to the maintenance of blood glucose levels within a narrow physiological range. It is regulated primarily by insulin and glucagon.

A. Role of Insulin

Insulin is a peptide hormone secreted by the β-cells of the pancreas in response to elevated blood glucose levels.

B. Functions of Insulin

- Facilitates glucose uptake by skeletal muscles and adipose tissue.
- Promotes glycogen synthesis in the liver and muscles.
- Inhibits hepatic glucose production.
- Stimulates protein synthesis.
- Enhances fat storage and inhibits lipolysis.
- Maintains normal blood glucose levels.

C. Role of Glucagon

Glucagon is secreted by pancreatic α-cells when blood glucose levels decrease.

D. Functions of Glucagon

- Stimulates glycogen breakdown (glycogenolysis).
- Promotes glucose production from non-carbohydrate sources (gluconeogenesis).
- Increases blood glucose concentration during fasting.

E. Other Hormones Influencing Glucose Regulation

Cortisol , Growth hormone, Catecholamines (epinephrine and norepinephrine) ,Thyroid hormones

These hormones oppose insulin action and are collectively known as counter-regulatory hormones.

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VIII. CLASSIFICATION OF DIABETES MELLITUS[1]

According to the American Diabetes Association (ADA), diabetes mellitus is classified into:

1) Type 1 Diabetes Mellitus
- Autoimmune destruction of pancreatic β-cells.
- Absolute insulin deficiency.
- Usually occurs in children and young adults.

2) Type 2 Diabetes Mellitus
- Combination of insulin resistance and relative insulin deficiency.
- Most common form of diabetes.
- Usually associated with obesity and sedentary lifestyle.

3) Gestational Diabetes Mellitus
- Diabetes diagnosed during pregnancy.
- Usually resolves after delivery.
- Increases the future risk of Type 2 diabetes.

4) Other Specific Types
- Monogenic diabetes syndromes.
- Diseases of the exocrine pancreas.
- Drug-induced diabetes (e.g., glucocorticoids).
- Endocrine disorders associated with hyperglycaemia.

IX. ETIOLOGY OF TYPE 2 DIABETES MELLITUS

Type 2 diabetes develops due to the interaction of genetic susceptibility and environmental influences.

A. Genetic Factors
- Strong familial predisposition.
- Increased risk among first-degree relatives.
- Multiple genes (Type 2 Diabetes Mellitus is polygenic in nature, with several susceptibility genes including TCF7L2, PPARG, KCNJ11, ABCC8, SLC30A8, FTO, IRS1,CAPN10, CDKAL1, and HHEX contributing to insulin resistance and β-cell dysfunction.)[4] Contribute to disease development.

B. Environmental and Lifestyle Factors

a)Obesity
- Central (abdominal) obesity is strongly associated with insulin resistance.
- Excess adipose tissue releases inflammatory mediators that impair insulin action.

b)Physical Inactivity
- Reduced glucose utilization by muscles.
- Promotes weight gain and insulin resistance.

c)Unhealthy Diet
- High-calorie diets rich in refined carbohydrates and saturated fats increase the risk.

d)Advancing Age
- Insulin sensitivity decreases with age.
- β-cell function gradually declines.

e)Other Risk Factors
- Hypertension.
- Dyslipidaemia.
- Polycystic ovarian syndrome (PCOS).
- History of gestational diabetes.
- Smoking.
- Sleep disturbances.

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X. PATHOPHYSIOLOGY OF TYPE 2 DIABETES MELLITUS

The two fundamental defects in Type 2 Diabetes Mellitus are:[3,4]

- Insulin resistance.
- Progressive β-cell dysfunction.

A. Development of Insulin Resistance

(Target tissues become less responsive to insulin)-
Major tissues affected:

a) Skeletal muscle
• Reduced glucose uptake
• Impaired glycogen synthesis
• Reduced glucose utilization
b) Liver
• Increased hepatic glucose production
• Failure of insulin to suppress gluconeogenesis
• Increased fasting glucose levels
c) Adipose tissue
• Increased lipolysis
• Increased free fatty acid release
• Further worsening of insulin resistance

B. Compensatory β-cell response-

• Pancreatic β-cells initially increase insulin secretion
• Hyperinsulinemia develops to maintain normal glucose levels

C. Progressive β-cell dysfunction/failure

• Glucotoxicity
• Lipotoxicity
• Oxidative stress
• Amyloid deposition in pancreatic islets
• Genetic predisposition
↓
Persistent hyperglycemia develops

XI. CONSEQUENCES OF CHRONIC HYPERGLYCAEMIA

Persistent elevation of blood glucose results in:

1) Microvascular Complications
- Retinopathy.
- Nephropathy.
- Neuropathy.

2) Macrovascular Complications
- Coronary artery disease.
- Cerebrovascular disease.
- Peripheral arterial disease.

3) Other Complications
- Increased susceptibility to infections.
- Poor wound healing.
- Diabetic foot problems.

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Diagnostic Criteria-(American Diabetes Association)-[1]

1. Fasting Plasma Glucose (FPG)
- Normal: <100 mg/dL
- Prediabetes: 100–125 mg/dL
- Diabetes: ≥126 mg/dL

2. Two-Hour Plasma Glucose during Oral Glucose Tolerance Test (OGTT)
- Normal: <140 mg/dL
- Prediabetes: 140–199 mg/dL
- Diabetes: ≥200 mg/dL

3. HbA1c
- Normal: <5.7%
- Prediabetes: 5.7–6.4%
- Diabetes: ≥6.5%

4. Random Plasma Glucose
- ≥200 mg/dL in the presence of classic symptoms of hyperglycaemia.

Additional Investigations-

Urine Analysis
• Detection of glucose, ketones, and protein
• Helps identify glycosuria, ketoacidosis, and nephropathy

Lipid Profile
• Total cholesterol, LDL, HDL, triglycerides
• Evaluates cardiovascular risk

Renal Function Tests (RFT)
• Blood urea, serum creatinine, estimated GFR
• Assesses kidney function

Liver Function Tests (LFT)
• Measures liver enzymes and hepatic function
• Useful before initiating certain medications

Fundus Examination
• Detects diabetic retinopathy and retinal changes (Microaneurysms,retinal hemorrhage, Hard exudate,cotton wool spot,macular edema).

Electrocardiography (ECG)
• Evaluates cardiac abnormalities and ischemic heart disease

Urine Albumin–Creatinine Ratio (UACR)
• Detects microalbuminuria and early diabetic nephropathy

Foot Examination
• Assesses neuropathy, ulcers, vascular status, and risk of diabetic foot complications

XII. CONVENTIONAL MANAGEMENT-[1,6]

The goals of treatment are to achieve glycaemic control, prevent complications, and improve quality of life.

1) Lifestyle Modification
- Dietary Management
- Balanced diet rich in fibre.
- Restriction of refined carbohydrates.
- Portion control.
- Limitation of saturated fats.
- Physical Activity
- At least 150 minutes of moderate-intensity aerobic exercise weekly.

- Resistance training 2–3 times per week.
- Weight Reduction
- Even 5–10% weight loss improves insulin sensitivity.
- Smoking and Alcohol
- Smoking cessation.
- Restriction of alcohol intake.

2) Pharmacological Management

- Metformin
- Glimepiride.
- Sitagliptin.
- Other antibiotics

XIII. HOMOEOPATHIC MEDICINES USED IN TYPE 2 DIABETES MELLITUS-[7,8,10]

Type 2 Diabetes Mellitus is viewed in homoeopathy as a manifestation of a deeper constitutional imbalance affecting the whole individual.

Management is based on the principle of individualization, considering the patient's mental, emotional, and physical symptoms rather than blood glucose levels alone. A detailed case-taking, including family history, lifestyle, cravings, thermal reactions, and associated complaints, is essential for remedy selection. Constitutional remedies such as Syzygium jambolanum, Phosphoric Acid, Lycopodium clavatum, and Phosphorus may be indicated according to symptom similarity. Miasmatic evaluation often reveals a predominance of the sycotic miasm. Homoeopathic treatment aims to improve the patient's overall health, vitality, and resistance to complications. It should be used alongside appropriate diet, exercise, regular monitoring of blood glucose, and conventional medical care for comprehensive diabetes management.

A. Syzygium jambolanum Indications

• Excessive thirst (polydipsia)
• Frequent and profuse urination (polyuria)
• Marked hyperglycaemia and glycosuria
• Extreme weakness and emaciation
• Diabetic skin eruptions and ulcers
• Slow wound healing

B. Uranium nitricum Indications

• Excessive hunger with weight loss
• Intense thirst
• Polyuria with sugar in urine
• Nausea and gastric irritation
• Progressive weakness and emaciation
• Burning sensations and kidney involvement

C. Phosphoric acid Indications

• Diabetes following grief, emotional stress, or mental exhaustion
• Mental apathy and indifference
• Physical debility and fatigue
• Excessive urination
• Memory weakness
• Nervous exhaustion

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D. Phosphorus Indications
• Great thirst for cold water
• Burning sensations in hands and feet
• General weakness and exhaustion
• Tingling and numbness (neuropathy)
• Increased appetite
• Anxiety and fearfulness

E. Lycopodium clavatum Indications
• Craving for sweets
• Flatulence and abdominal bloating
• Digestive disturbances
• Weakness with emaciation of upper body
• Increased thirst and urination
• Right-sided complaints

F. Sulphur Indications
• Burning of palms and soles
• Increased appetite with weakness
• Dry skin and itching
• Heat aggravation
• Diabetic skin problems and ulcers
• General weakness

G. Natrum muriaticum Indications:
• Excessive thirst
• Craving for salt
• Weakness and weight loss
• Diabetes associated with grief or emotional suppression
• Headache and dryness of mucous membranes

H. Arsenicum album Indications
• Great weakness and restlessness
• Intense thirst with small frequent sips
• Burning pains relieved by warmth
• Anxiety and fear
• Diabetic ulcers and gangrene tendency

I. Cephalandra indica Indications
• Excessive thirst and hunger
• Polyuria with weakness
• Dryness of mouth
• Progressive emaciation
• General debility

J. Lactic acid Indications
• Excessive appetite and nausea
• Increased thirst
• Weakness with diabetes in obese individuals
• Rheumatic symptoms associated with diabetes

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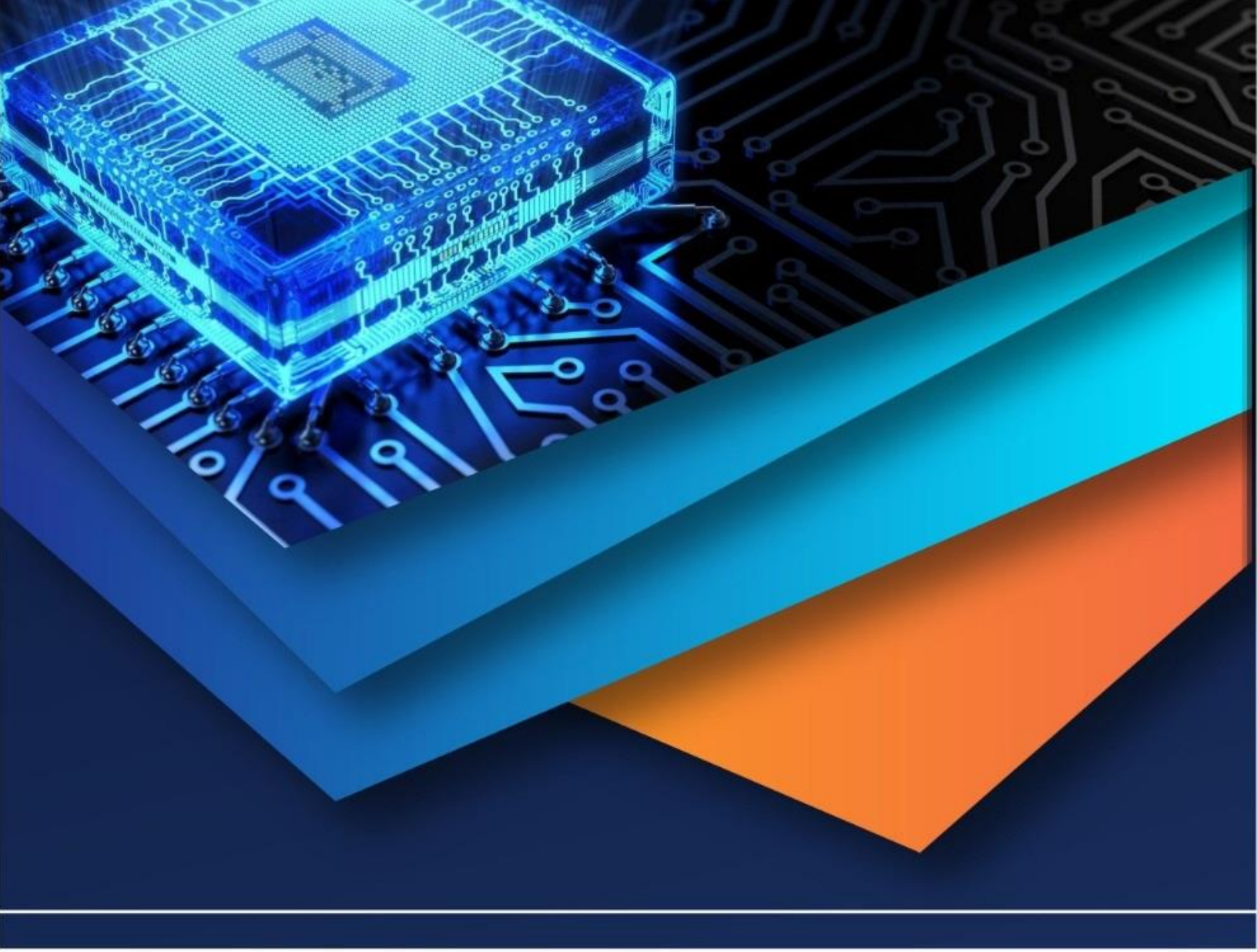
XIV. CONCLUSION

Type 2 Diabetes Mellitus is a major public health challenge associated with substantial morbidity and mortality.[1,2] Early diagnosis, appropriate lifestyle changes, regular monitoring, and individualized treatment are essential to achieving optimal outcomes.[1] Conventional therapies remain the cornerstone of management, while homoeopathy may provide supportive holistic care [7,9] when practiced responsibly. An integrative approach focusing on patient education and comprehensive management may contribute to improved quality of life among individuals with Type 2 Diabetes Mellitus.

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