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Type 5 diabetes mellitus: A comprehensive review of malnutrition-associated diabetes

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Abstract
Type 5 diabetes mellitus (T5DM), historically described as malnutrition-related diabetes mellitus (MRDM), is a distinct form of diabetes associated with chronic undernutrition, particularly during early life and adolescence. It is characterized by impaired insulin secretion, pancreatic dysfunction, and abnormalities in glucose metabolism in individuals with a history of nutritional deprivation. Unlike type 1 diabetes mellitus, which is primarily associated with autoimmune destruction of pancreatic beta cells, and type 2 diabetes mellitus, which is predominantly characterized by insulin resistance, T5DM is generally associated with inadequate pancreatic development and reduced insulin-producing capacity. The condition has historically been reported in low- and middle-income countries, particularly in populations experiencing poverty, food insecurity, recurrent infections, and inadequate dietary intake. Although the condition was removed as a separate category from the World Health Organization's diabetes classification in 1999 because of insufficient evidence, the concept has regained attention through renewed research and international discussions. This review examines the historical background, epidemiology, proposed pathophysiological mechanisms, clinical manifestations, diagnostic considerations, nutritional determinants, complications, and management strategies associated with T5DM. Particular attention is given to the role of protein-energy malnutrition, micronutrient deficiencies, pancreatic dysfunction, and early-life nutritional deprivation in the development of diabetes. The review also highlights the importance of individualized nutritional rehabilitation, appropriate insulin therapy, prevention of hypoglycaemia, and multidisciplinary healthcare approaches. Improved diagnostic criteria, epidemiological investigations, and clinical research are essential for establishing the disease as a clearly defined clinical entity and developing evidence-based management guidelines.

Keywords: Type 5 diabetes mellitus, malnutrition-related diabetes, protein-energy malnutrition, insulin deficiency, pancreatic dysfunction, nutritional rehabilitation, micronutrient deficiency

Introduction

Diabetes mellitus is a heterogeneous group of metabolic disorders characterized by persistent hyperglycaemia resulting from impaired insulin secretion, insulin action, or both (Galicia-Garcia *et al*., 2020) [8]. Traditionally, diabetes has been classified into type 1 diabetes mellitus, type 2 diabetes mellitus, gestational diabetes mellitus, and other specific types (Alberti and Zimmet *et al*., 1998) [1]. However, increasing evidence suggests that nutritional deprivation and early-life malnutrition may contribute to a distinct form of diabetes that differs clinically and metabolically from conventional diabetes categories. This condition is commonly referred to as malnutrition-related diabetes mellitus (MRDM) or type 5 diabetes mellitus (T5DM) (Vaiserman, 2014) [28].

Type 5 diabetes is particularly relevant in developing countries where childhood undernutrition, chronic food insecurity, inadequate protein intake, and recurrent infections remain significant public health concerns (Hossain *et al*., 2025) [10]. The disease has historically been described among young, lean individuals with low body mass index, poor nutritional status, and evidence of impaired pancreatic insulin secretion (Wadivkar *et al*., 2025) [29]. Unlike typical type 2 diabetes, affected individuals may not demonstrate substantial insulin resistance or obesity. Instead, inadequate development or functional capacity of pancreatic beta cells may contribute to reduced insulin production and impaired glucose regulation (Kahn, 2003) [15].

The relationship between malnutrition and diabetes is complex because nutritional deficiency can influence pancreatic development, hormonal regulation (dos Reis Araujo *et al*., 2024) [5], skeletal muscle metabolism, hepatic glucose production, and insulin sensitivity. Early-life nutritional deprivation may produce long-term metabolic alterations through developmental programming and changes in endocrine function (McMillen and Robinson, 2005) [17]. Furthermore, inadequate dietary protein and essential micronutrients may interfere with pancreatic tissue development and insulin synthesis (Tewari *et al*., 2026) [27].

The renewed recognition of T5DM has important implications for clinical nutrition, diabetes prevention, and public health (Prajitno and Sutanto, 2025) [21]. Conventional diabetes treatment approaches may not be entirely appropriate for severely undernourished individuals because excessive insulin administration, inadequate caloric intake, and limited nutritional reserves may increase the risk of hypoglycaemia and other metabolic complications (Chen and Lu, 2026) [4]. Therefore, understanding the nutritional and physiological characteristics of this condition is essential for developing appropriate diagnostic and therapeutic approaches.

Historical Background and Classification

The concept of malnutrition-associated diabetes has evolved over several decades. In 1955, Hugh-Jones described a distinctive form of diabetes among young, lean individuals in Jamaica, characterized by severe hyperglycaemia and a relatively low tendency towards ketosis. This condition was initially described as J-type diabetes. Similar clinical observations were subsequently reported in India and other developing countries, where chronic undernutrition and protein-energy deficiency were common (Misra *et al*., 2025) [18].

In 1985, the World Health Organization (WHO) included malnutrition-related diabetes mellitus (MRDM) as a separate category in its diabetes classification. The condition was broadly associated with protein-deficient pancreatic diabetes and fibrocalculous pancreatic diabetes. However, in 1999, the WHO removed MRDM as a distinct category because the available scientific evidence was insufficient to establish a direct causal relationship between malnutrition and diabetes.

The condition received renewed international attention following advances in metabolic research and clinical investigations. In January 2025 [10], an international consensus meeting held in Vellore, India, proposed the nomenclature Type 5 Diabetes Mellitus (T5DM) to recognize a distinct form of diabetes associated with chronic undernutrition and impaired pancreatic insulin secretion (Wadivkar *et al*., 2025) [29]. Subsequently, the International Diabetes Federation (IDF) formally endorsed this classification during the IDF World Diabetes Congress held in Bangkok, Thailand, in April 2025 [2] (International Diabetes Federation [IDF], 2025) [12]. This recognition represents an important development in understanding diabetes associated with chronic nutritional deprivation and highlights the need to distinguish it from conventional forms of diabetes mellitus. Nevertheless, standardized diagnostic criteria, evidence-based treatment protocols, and comprehensive management guidelines are still under development, emphasizing the need for further clinical research and international collaboration (IDF, 2025; Wadivkar *et al*., 2025) [10, 29].

Epidemiology and Global Distribution

Type 5 Diabetes Mellitus (T5DM) is primarily associated with populations experiencing prolonged nutritional deprivation, socioeconomic disadvantage, and inadequate access to healthcare. The condition has been predominantly reported in low- and middle-income countries (LMICs), particularly in South Asia and sub-Saharan Africa (Wadivkar *et al*., 2025 [29]; International Diabetes Federation [IDF], 2025) [12]. Countries such as India, Bangladesh, Pakistan, Uganda, Ethiopia, Nigeria, and other regions of sub-Saharan Africa have reported undernutrition-associated diabetes phenotypes, although country-specific prevalence estimates remain limited (Wadivkar *et al*., 2025; Shukla *et al*., 2025) [26, 29].

The disease generally manifests in young adults, often before the age of 30 years, although the underlying nutritional deprivation may originate during fetal development, infancy, childhood, or adolescence. Individuals may have a history of low birth weight, childhood stunting, and prolonged protein-energy malnutrition. Early-life nutritional deprivation is considered an important characteristic of this phenotype (Wadivkar *et al*., 2025) [29]. In contrast to conventional type 2 diabetes mellitus, affected individuals frequently present with a low body mass index (BMI), commonly below 18.5 kg/m², reduced total body fat, and impaired pancreatic insulin secretion rather than the prominent insulin resistance typically associated with type 2 diabetes (Wadivkar *et al*., 2025) [29].

The epidemiological assessment of T5DM remains challenging because of variations in historical diagnostic approaches, nutritional assessment methods, population characteristics, and healthcare infrastructure. Furthermore, individuals with this phenotype may be misclassified as having type 1 or type 2 diabetes because of overlapping clinical manifestations. The absence of universally standardized diagnostic criteria and reliable population-based surveillance has restricted the availability of accurate prevalence estimates (Wadivkar *et al*., 2025; IDF, 2025) [29].

The IDF's recognition of T5DM in 2025 [29] has highlighted the need for improved epidemiological surveillance, population-based investigations, and the development of standardized diagnostic protocols. The disease is particularly relevant in communities experiencing persistent undernutrition alongside the increasing burden of metabolic disorders associated with nutritional transition. These overlapping nutritional challenges emphasize the importance of integrating nutritional rehabilitation, diabetes prevention, and accessible healthcare services into public health strategies (IDF, 2025; Wadivkar *et al*., 2025) [29].

Etiology and Risk Factors

The development of T5DM is considered multifactorial, involving nutritional, developmental, environmental, socioeconomic, and metabolic factors. Chronic undernutrition is an important proposed contributing factor, although the precise mechanisms and individual susceptibility require further investigation (Shil et al., 2025) [25].

1. Protein-Energy Malnutrition

Protein-energy malnutrition is considered one of the major nutritional factors associated with T5DM. Inadequate dietary protein intake during critical periods of growth may interfere with pancreatic development and the functional capacity of insulin-producing beta cells. Protein deficiency can also influence the synthesis of enzymes, hormones, and structural proteins involved in normal metabolic regulation (Şahin Anılgan and Atar-Uğurlu, 2026) [24].

Long-term protein insufficiency may reduce lean body mass and impair glucose utilization by skeletal muscles. Reduced pancreatic insulin secretory capacity, combined with inadequate metabolic reserves, may contribute to persistent abnormalities in glucose homeostasis (Lopez-Pedrosa *et al*., 2024) [16].

2. Early-Life Nutritional Deprivation

Nutritional deprivation during pregnancy, infancy, and childhood may influence the development of metabolic organs. The developmental origins of health and disease (DOHaD) hypothesis suggests that adverse nutritional conditions during early development can produce long-term physiological and metabolic alterations (Hoffman *et al*., 2021) [9].

Inadequate maternal nutrition may influence fetal pancreatic development, while childhood undernutrition may interfere with beta-cell maturation and subsequent insulin production.

These developmental changes may remain evident during adulthood, even when nutritional intake improves (Jacovetti and Regazzi, 2022) [14].

3. Micronutrient Deficiencies

Micronutrients are essential for pancreatic function, antioxidant defence, insulin signalling, and glucose metabolism. Deficiencies of zinc, magnesium, selenium, vitamin D, and other essential nutrients may contribute to impaired metabolic regulation (Dubey *et al*., 2020) [6].

- **Zinc:** Participates in insulin synthesis, storage, and secretion.
- **Magnesium:** Supports insulin signalling and glucose metabolism.
- **Selenium:** Contributes to antioxidant defence and cellular protection.
- **Vitamin D:** May influence pancreatic beta-cell function and calcium-dependent insulin secretion.
- **Iron:** Both deficiency and excess can affect metabolic health; excessive iron accumulation is particularly relevant in certain pancreatic disorders.

However, the presence of micronutrient deficiencies alone is insufficient to establish a diagnosis of T5DM.

4. Socioeconomic and Environmental Factors

Poverty, inadequate dietary diversity, poor maternal nutrition, limited healthcare access, recurrent gastrointestinal infections, and unsafe drinking water may indirectly increase nutritional vulnerability. Food insecurity can result in prolonged inadequate intake of energy, protein, and essential micronutrients, particularly during childhood and adolescence (Elegbeleye *et al*., 2025) [7].

5. Genetic and Epigenetic Influences

Genetic susceptibility and epigenetic modifications may contribute to individual differences in the response to nutritional deprivation. Alterations in DNA methylation, gene expression, mitochondrial function, and cellular stress responses have been proposed as possible mechanisms. However, the specific genetic and epigenetic pathways responsible for T5DM have not yet been fully established (Burdge *et al*., 2007) [3].

Pathophysiology of Type 5 Diabetes Mellitus

The central proposed pathophysiological characteristic of T5DM is inadequate insulin secretion associated with reduced pancreatic beta-cell functional capacity. Unlike type 2 diabetes, where insulin resistance is generally a major component, T5DM is predominantly considered an insulin-deficient phenotype with relatively preserved peripheral insulin sensitivity (Şahin Anılgan and Atar-Uğurlu, 2026) [24].

1. Impaired Pancreatic Beta-Cell Development

The pancreas plays a central role in maintaining glucose homeostasis through insulin secretion from beta cells. Early-life nutritional deprivation may interfere with pancreatic growth, beta-cell proliferation, and functional maturation. Consequently, the total functional beta-cell reserve may be reduced, limiting the ability of the pancreas to produce sufficient insulin when glucose concentrations increase (Röder *et al*., 2016).

2. Reduced Insulin Secretion

Insulin secretion is essential for maintaining normal blood glucose concentrations. In T5DM, impaired insulin production and secretion may result in reduced glucose uptake by peripheral tissues and increased hepatic glucose output. This contributes to persistent hyperglycaemia despite the absence of substantial obesity or classical insulin resistance (Rahman *et al*., 2021) [22].

3. Oxidative Stress and Mitochondrial Dysfunction

Chronic nutritional deprivation may influence mitochondrial activity and cellular antioxidant mechanisms. Mitochondrial dysfunction can impair ATP generation, which is required for glucose-stimulated insulin secretion. Increased oxidative stress may further damage pancreatic cells and interfere with normal cellular signalling (Packer, 2020) [20].

4. Endoplasmic Reticulum Stress

The endoplasmic reticulum is involved in protein synthesis, folding, and cellular homeostasis. Nutritional deficiencies and metabolic stress may disrupt these processes, potentially affecting insulin synthesis and beta-cell survival. Prolonged cellular stress may further reduce the functional capacity of pancreatic tissue (Wang and Kaufman, 2016) [30].

5. Altered Glucose Metabolism

Individuals with T5DM may demonstrate substantial hyperglycaemia despite relatively preserved hepatic and peripheral insulin sensitivity. The reduced availability of insulin can impair glucose disposal and contribute to increased hepatic glucose production. A comparatively low tendency towards diabetic ketoacidosis has also been described in historical and contemporary clinical reports, although this feature should not be considered universal or sufficient for diagnosis (Hryncewicz *et al*., 2026) [11].

Overall, T5DM represents a proposed metabolic phenotype in which nutritional deprivation, impaired pancreatic development, and reduced insulin secretory reserve interact to disturb glucose regulation.

Clinical Manifestations and Characteristics

The clinical presentation of Type 5 Diabetes Mellitus (T5DM) varies according to the duration and severity of nutritional deprivation, the extent of pancreatic dysfunction, and the individual's overall metabolic condition. Individuals commonly present with a low body mass index (BMI), reduced body weight, and a history of prolonged protein-energy malnutrition or early-life nutritional deprivation, with the onset of diabetes frequently occurring during adolescence or early adulthood. Reduced muscle mass, poor physical development, and sarcopenia may also be observed, reflecting inadequate nutritional reserves and impaired tissue development. A major metabolic characteristic of T5DM is persistent hyperglycaemia resulting from reduced pancreatic beta-cell functional capacity and inadequate endogenous insulin secretion, while peripheral insulin sensitivity is considered relatively preserved compared with conventional type 2 diabetes mellitus. Some affected individuals demonstrate a comparatively lower tendency towards ketosis and diabetic ketoacidosis than patients with classical type 1 diabetes, although this characteristic is not universal. Common clinical symptoms may include fatigue, polyuria, polydipsia,

unexplained weight loss, dehydration, general weakness, and reduced physical performance. Furthermore, prolonged hyperglycaemia may contribute to microvascular complications, including diabetic retinopathy, nephropathy, and neuropathy, as well as macrovascular complications affecting cardiovascular health. However, low BMI or a history of malnutrition alone is insufficient to establish a diagnosis of T5DM; therefore, comprehensive evaluation of nutritional history, endogenous insulin secretion, pancreatic function, autoimmune markers, and other potential causes of diabetes is necessary for appropriate clinical classification (Wadivkar *et al*., 2025; World Health Organization, 1999) [29, 32].

Diagnostic Evaluation

The diagnosis of T5DM requires a systematic evaluation of clinical presentation, nutritional history, biochemical parameters, and alternative causes of insulin deficiency. There is increasing recognition of this phenotype; however, universally standardized diagnostic criteria remain under development.

1. Clinical and Nutritional Assessment

A comprehensive nutritional and anthropometric assessment is essential for evaluating individuals suspected of having Type 5 Diabetes Mellitus (T5DM), as it helps identify previous and ongoing nutritional deficiencies associated with impaired glucose metabolism. A detailed dietary history should include childhood feeding practices, maternal nutritional status during pregnancy, history of low birth weight, food insecurity, recurrent infections, dietary diversity, and previous episodes of severe protein-energy malnutrition. Particular attention should be given to the long-term intake of energy, protein, vitamins, and essential minerals, as inadequate nutritional intake during critical periods of growth may influence pancreatic development and insulin secretory capacity. Anthropometric measurements should include body mass index (BMI), waist circumference, mid-upper arm circumference (MUAC), body weight, height, and body composition assessment, wherever feasible. These measurements help evaluate undernutrition, muscle mass depletion, central adiposity, and overall nutritional status. Furthermore, serial monitoring of body weight and anthropometric changes may provide valuable information regarding nutritional rehabilitation and metabolic health. A combination of dietary assessment, clinical history, and anthropometric evaluation can therefore support the identification of nutritional risk factors and assist in the comprehensive clinical assessment of T5DM (World Health Organization, 1995; World Health Organization, 2006 [31, 33]; International Diabetes Federation, 2025) [12].

2. Biochemical Investigations

Biochemical investigations play an important role in evaluating glycaemic status, pancreatic beta-cell function, metabolic abnormalities, and nutritional deficiencies in individuals suspected of having Type 5 Diabetes Mellitus (T5DM). Important investigations include fasting blood glucose and postprandial blood glucose for assessing immediate glycaemic control, glycated haemoglobin (HbA1c) for evaluating long-term glucose regulation, and the oral glucose tolerance test (OGTT) for identifying impaired glucose tolerance and abnormal glucose metabolism. Fasting and stimulated C-peptide measurements, along with fasting insulin concentrations, may help assess endogenous insulin secretory capacity and distinguish insulin deficiency from insulin resistance. Additionally, lipid profile, renal function tests, and liver function tests are useful for identifying associated metabolic abnormalities and evaluating potential complications. Assessment of micronutrient status, particularly serum magnesium, zinc, and vitamin D, may also be considered to identify nutritional deficiencies that could influence metabolic and pancreatic function. Reduced C-peptide concentrations may indicate impaired endogenous insulin secretion; however, these findings should be interpreted alongside concurrent blood glucose concentrations, renal function, nutritional status, and the overall clinical presentation. Since specific diagnostic criteria for T5DM are still evolving, these investigations should be considered supportive clinical assessments rather than disease-specific diagnostic tests (American Diabetes Association Professional Practice Committee, 2025 [2]; International Diabetes Federation, 2025) [12].

3. Autoimmune Assessment

Autoimmune markers, including glutamic acid decarboxylase antibodies (GAD65), insulinoma-associated antigen-2 antibodies (IA-2), and zinc transporter 8 antibodies (ZnT8), may help distinguish T5DM from autoimmune type 1 diabetes. The absence of these antibodies supports the proposed phenotype but does not independently establish the diagnosis.

4. Differential Diagnosis

Table 1: Comparative Clinical and Metabolic Characteristics of Type 1, Type 2, and Proposed Type 5 Diabetes Mellitus for Differential Diagnosis

Feature	Type 1 diabetes	Type 2 diabetes	Proposed Type 5 diabetes
Main mechanism	Autoimmune beta-cell destruction	Insulin resistance and beta-cell dysfunction	Undernutrition-associated insulin deficiency
Typical body composition	Variable	Frequently overweight, but variable	Often lean with reduced muscle mass
Insulin secretion	Markedly reduced	Variable	Reduced
Insulin resistance	Variable	Commonly increased	Relatively preserved
Autoantibodies	Frequently present	Generally absent	Generally absent
Nutritional history	Not defining	Not defining	History of undernutrition is important
Ketoacidosis	Common risk	Less common	Historically reported as less frequent

Other important differential diagnoses include monogenic diabetes, chronic pancreatitis, fibrocalculous pancreatic diabetes, cystic fibrosis-related diabetes, and other forms of secondary diabetes. Therefore, an individual's low BMI and

history of malnutrition should not automatically lead to classification as T5DM.

Nutritional Management and Therapeutic Approaches

The management of T5DM requires an integrated approach involving nutritional rehabilitation, glycaemic regulation, correction of nutritional deficiencies, and long-term monitoring. Since the condition is associated with reduced insulin secretory capacity and nutritional vulnerability, treatment strategies should be individualized according to the patient's metabolic status, nutritional requirements, and clinical complications.

1. Nutritional Rehabilitation

Nutritional rehabilitation is a fundamental component of management. The primary objective is to restore adequate nutritional status, improve muscle mass, correct deficiencies, and support metabolic function.

A balanced diet should provide adequate energy, high-quality protein, essential fatty acids, vitamins, and minerals. Individuals with severe undernutrition require careful nutritional assessment and gradual nutritional rehabilitation to reduce the risk of refeeding syndrome.

Dietary recommendations may include:

- Adequate energy intake according to age, body weight, physical activity, and nutritional status.
- High-quality protein from milk, eggs, fish, poultry, soybeans, pulses, and other suitable sources.
- Complex carbohydrates from whole grains, millets, vegetables, and pulses.
- Healthy fats from nuts, seeds, vegetable oils, and other unsaturated fat sources.
- Adequate dietary fibre to support gastrointestinal health and glucose regulation.
- Regular meals with appropriate carbohydrate distribution throughout the day.
- Adequate fluid intake according to individual clinical requirements.

2. Protein Supplementation

Protein plays an important role in tissue repair, muscle development, enzyme production, and metabolic regulation. Adequate protein intake may help improve nutritional reserves and support recovery from protein-energy malnutrition.

Potential dietary sources include soybean, lentils, chickpeas, milk, eggs, fish, and nuts. Protein requirements should be individualized, particularly in patients with associated kidney disease or other complications.

3. Micronutrient Supplementation

Table 2: Essential Micronutrients, Their Physiological Functions, and Dietary Sources Relevant to Nutritional Management of Type 5 Diabetes Mellitus (T5DM)

Nutrient	Major physiological role	Potential dietary sources
Zinc	Insulin synthesis and cellular metabolism	Pumpkin seeds, legumes, nuts
Magnesium	Glucose metabolism and insulin signalling	Green leafy vegetables, whole grains
Selenium	Antioxidant defence	Fish, eggs, cereals
Vitamin D	Calcium regulation and metabolic function	Fortified foods, eggs, fatty fish
Vitamin B12	Neurological function and red blood cell formation	Milk, eggs, fish
Iron	Oxygen transport and energy metabolism	Pulses, green leafy vegetables, meat

4. Pharmacological Management

Pharmacological treatment should be determined according to the degree of hyperglycaemia, endogenous insulin secretion, nutritional condition, and risk of hypoglycaemia.

Insulin may be necessary in individuals with substantial insulin deficiency. However, insulin doses require careful adjustment because individuals with limited nutritional reserves and relatively preserved insulin sensitivity may be vulnerable to hypoglycaemia. Intensive insulin treatment without adequate nutritional support may create additional clinical risks.

Oral glucose-lowering medications may be considered in selected individuals depending on residual beta-cell function and other metabolic characteristics. However, the safety and effectiveness of different pharmacological approaches specifically for T5DM require further clinical investigation. Medication selection should therefore be undertaken by qualified healthcare professionals.

5. Physical Activity and Lifestyle Modification

Physical activity should be introduced according to nutritional status and physical capacity. Individuals with severe undernutrition should initially focus on nutritional rehabilitation and gradual restoration of muscle strength.

Appropriate activities may include walking, stretching, resistance exercises, and supervised strength-training programmes. Adequate dietary intake should accompany increased physical activity to prevent further loss of body weight and muscle mass.

6. Monitoring and Follow-Up

Regular clinical monitoring is essential to assess treatment effectiveness and prevent complications. Important parameters include fasting and postprandial glucose, HbA1c, body weight, BMI, muscle mass, dietary intake, blood pressure, renal function, and lipid profile. Screening for diabetic retinopathy, neuropathy, and kidney disease should follow appropriate diabetes care recommendations.

Complications Associated with Type 5 Diabetes

Although T5DM is associated with a relatively preserved tendency towards ketosis in some reported populations, persistent hyperglycaemia can produce serious long-term complications. The coexistence of nutritional deficiencies may further increase vulnerability to infections, impaired tissue repair, and physical disability.

1. Microvascular Complications

Chronic hyperglycaemia may damage small blood vessels, contributing to diabetic retinopathy, nephropathy, and peripheral neuropathy. Early screening and appropriate glycaemic management are essential to reduce the risk of progressive organ damage.

2. Macrovascular Complications

Diabetes may increase the risk of cardiovascular diseases, including coronary artery disease, stroke, and peripheral vascular disorders. Although the cardiovascular risk profile of T5DM requires further investigation, conventional cardiovascular risk assessment remains important.

3. Nutritional and Musculoskeletal Complications

Persistent undernutrition may contribute to sarcopenia, reduced bone mineral density, muscle weakness, and impaired physical development. The combination of diabetes and inadequate nutritional reserves may negatively influence recovery from infections and other illnesses.

4. Increased Susceptibility to Infections

Protein-energy malnutrition and micronutrient deficiencies may impair immune responses. Individuals with poorly controlled diabetes may experience additional susceptibility to infections and delayed wound healing.

5. Psychological and Social Complications

The coexistence of chronic disease, poverty, food insecurity, and limited access to healthcare may increase psychological stress and reduce treatment adherence. The financial burden of long-term diabetes management may further affect affected individuals and their families.

Prevention and Public Health Strategies

The prevention of T5DM requires attention to nutritional health throughout the life course, particularly during pregnancy, infancy, childhood, and adolescence. Since early-life undernutrition is considered an important contributing factor, preventive interventions should begin before the development of metabolic abnormalities.

Maternal and Child Nutrition: Adequate maternal nutrition, appropriate breastfeeding practices, complementary feeding, and access to nutrient-dense foods are essential for normal growth and pancreatic development.

Food Security: Government-supported food distribution programmes, nutritional supplementation, and community-based food security initiatives can help reduce chronic nutritional deprivation.

Dietary Diversification: Promotion of pulses, legumes, cereals, millets, vegetables, fruits, dairy products, eggs, and other locally available nutrient-dense foods can improve dietary quality.

Nutrition Education: Community-based nutrition education programmes should emphasize balanced diets, protein adequacy, micronutrient intake, and healthy food preparation practices.

Early Screening: Individuals with a history of severe undernutrition, unexplained hyperglycaemia, low body weight, and impaired insulin secretion may benefit from appropriate metabolic evaluation.

Healthcare Accessibility: Strengthening primary healthcare services, improving access to glucose monitoring, and providing affordable nutritional and pharmacological interventions are essential for reducing disease-associated complications.

In countries such as India, integrating nutritional assessment with existing maternal and child health programmes may provide an important opportunity to reduce the long-term metabolic consequences of undernutrition.

Conclusion

Type 5 diabetes mellitus represents an important and historically under-recognized form of diabetes associated with chronic undernutrition, particularly during critical periods of growth and development. Unlike conventional type 2 diabetes, which is primarily associated with insulin resistance, T5DM is characterized by impaired insulin secretion and relatively preserved insulin sensitivity. Early-life nutritional deprivation, protein-energy malnutrition, micronutrient deficiencies, and possible developmental alterations in pancreatic beta-cell function are considered important contributing factors. The renewed recognition of this condition by the International Diabetes Federation in 2025 [12] provides an opportunity to improve clinical awareness, research, and healthcare strategies for nutritionally vulnerable populations. Nutritional rehabilitation, adequate protein and energy intake, correction of micronutrient deficiencies, individualized glucose-lowering treatment, and regular clinical monitoring are essential components of comprehensive management. Nevertheless, standardized diagnostic criteria, reliable epidemiological evidence, and disease-specific therapeutic guidelines remain necessary. Greater integration of nutrition science, endocrinology, and public health interventions may help improve the prevention and management of T5DM, particularly in low- and middle-income countries.

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