

Understanding the Epidemiology and Prevention of Type 2 Diabetes Mellitus in Adults: A Public Health Perspective

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ABSTRACT

Type 2 diabetes mellitus (T2DM) is a rapidly growing global public health challenge and accounts for approximately 90–95% of all diabetes cases worldwide. Its increasing prevalence is driven by demographic, genetic, behavioral, and environmental factors. This review summarizes the major epidemiological determinants of T2DM among adults, including non-modifiable factors such as age, family history, ethnicity, and genetic predisposition, as well as modifiable factors including obesity, physical inactivity, unhealthy diet, tobacco use, alcohol consumption, and socioeconomic status. The review also highlights evidence-based preventive measures, emphasizing lifestyle modification, weight management, healthy dietary practices, regular physical activity, early screening of high-risk individuals, and public health interventions. Understanding these determinants is essential for designing effective prevention strategies that reduce disease incidence and associated complications. A comprehensive approach integrating individual behavioral changes with population-level policies is critical to addressing the growing burden of T2DM. The global burden of T2DM has increased substantially over recent decades owing to rapid urbanization, aging populations, sedentary lifestyles, and rising obesity rates. The disease is associated with significant morbidity, mortality, and healthcare costs due to complications such as cardiovascular disease, nephropathy, neuropathy, and retinopathy. Since many determinants of T2DM are preventable, understanding its epidemiology is fundamental for developing effective prevention strategies. This review examines the epidemiological determinants and evidence-based preventive measures for T2DM in the adult population.

Keywords: Type 2 diabetes mellitus, Epidemiology, Risk factors, Prevention, Obesity, Physical activity, Adult population and Lifestyle modification

How to cite this article: Singh S, Rauthan A, Bhandari V, Singh V, Chauhan R. Understanding the Epidemiology and Prevention of Type 2 Diabetes Mellitus in Adults: A Public Health Perspective. *Int J Drug Deliv Technol.* 2026;16(71s): 583-586. DOI: 10.25258/ijddt.16.71s.69

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is one of the most significant non-communicable diseases (NCDs) of the twenty-first century and represents a major challenge to global health systems. It is a chronic metabolic disorder characterized by insulin resistance and progressive pancreatic β -cell dysfunction, resulting in persistent hyperglycaemia. More than 90% of all diabetes cases are attributed to T2DM, making it the predominant form of diabetes worldwide. The increasing prevalence of T2DM has been closely associated with rapid urbanization, population ageing, unhealthy dietary habits, physical inactivity, obesity, socioeconomic transition, and genetic susceptibility. These factors have contributed to a dramatic rise in diabetes incidence across both developed and developing countries.¹

According to the International Diabetes Federation (IDF) Diabetes Atlas, 11th Edition (2025), approximately 589 million adults aged 20–79 years are living with diabetes globally, representing 11.1% (1 in every 9 adults) of the world's adult population. This number is projected to increase to 853 million by 2050, reflecting a 46% rise if current trends continue. Importantly, more than 90% of these cases are type 2 diabetes, and nearly 252 million adults remain undiagnosed, increasing their risk of severe complications due to delayed diagnosis and

treatment. The burden of diabetes is disproportionately concentrated in low- and middle-income countries (LMICs), where nearly three-quarters of all adults with diabetes reside. Rapid economic development in these countries has been accompanied by lifestyle changes, including increased consumption of energy-dense processed foods, reduced physical activity, and rising obesity prevalence. These epidemiological transitions have accelerated the incidence of T2DM and placed considerable strain on healthcare systems with limited resources.^{2,3}

Diabetes is also a leading contributor to premature mortality and disability worldwide. The IDF estimates that diabetes is responsible for more than 3.4 million deaths annually, primarily through complications such as cardiovascular disease, chronic kidney disease, stroke, diabetic retinopathy, neuropathy, and lower-limb amputations. In addition to its health burden, diabetes imposes substantial economic costs. Global diabetes-related healthcare expenditure exceeded US\$1 trillion for the first time in 2024, highlighting the enormous financial burden on individuals, families, and healthcare systems. The increasing prevalence of obesity has emerged as one of the strongest drivers of the global diabetes epidemic. Sedentary lifestyles, excessive caloric intake, consumption of sugar-sweetened beverages, tobacco use,

psychosocial stress, and environmental factors collectively contribute to insulin resistance and metabolic dysfunction. Consequently, T2DM is increasingly diagnosed among younger adults and even adolescents, a trend that was previously uncommon. World Health Organization (WHO) recognizes diabetes as one of the major non-communicable diseases responsible for significant morbidity and mortality worldwide. Effective prevention through healthy lifestyle modification, early diagnosis, and risk-factor management has therefore become a global public health priority. Comprehensive strategies involving governments, healthcare professionals, communities, and individuals are essential to reduce the growing burden of T2DM.^{4,5}

The Global Burden of Disease (GBD) 2021 study further demonstrated that the burden of diabetes has increased in every Indian state from 1990 to 2021, with substantial increases in prevalence, mortality, and disability-adjusted life years (DALYs). The GBD analysis also reported marked interstate variation, with southern and western states continuing to experience the highest burden, while several northern states showed rapidly increasing prevalence.³

Asia has emerged as the epicentre of the global diabetes epidemic, accounting for the largest proportion of adults living with T2DM. The rapid increase in diabetes prevalence across Asian countries has been attributed to rapid urbanization, industrialization, demographic ageing, nutritional transition, and declining physical activity. In addition, Asian populations possess unique genetic and metabolic characteristics that predispose them to insulin resistance and β -cell dysfunction at relatively lower body mass indices (BMI) compared with Western populations.

The South-East Asia and Western Pacific regions together account for hundreds of millions of adults living with diabetes, making these regions major contributors to the global disease burden. Countries such as India, China, Pakistan, Bangladesh, Indonesia, and Malaysia have experienced particularly rapid increases in T2DM prevalence over the past two decades. This trend is expected to continue because of ongoing urban migration, increasing obesity, unhealthy dietary patterns, and reduced physical activity. Asian populations often develop T2DM approximately 5–10 years earlier than Western populations and at lower BMI levels. This phenomenon has been attributed to greater visceral adiposity, increased insulin resistance, impaired β -cell function, and genetic susceptibility. Consequently, many Asian adults develop diabetes despite having BMI values that would not be classified as obese using conventional international criteria. This has prompted several expert organizations to recommend lower BMI cut-off values for identifying high-risk Asian populations.^{6,7}

The prevalence of diabetes in Asia is further influenced by socioeconomic inequalities, limited access to preventive healthcare services, inadequate awareness, delayed diagnosis, and poor glycaemic control. Rapid changes in dietary behaviour, including increased consumption of refined carbohydrates, processed foods, saturated fats, and sugar-sweetened beverages, together with sedentary occupations, have substantially increased the risk of obesity and T2DM throughout the region.

The growing burden of diabetes in Asia has significant implications for healthcare systems because the disease affects economically productive age groups and contributes to increased healthcare expenditure, disability, and premature mortality. Effective public health interventions focusing on lifestyle modification, obesity prevention, regular screening of high-risk individuals, and improved access to primary healthcare are therefore essential to reduce the future burden of T2DM across Asian countries.

India has emerged as one of the country's most severely affected by the global diabetes epidemic and is often referred to as the "diabetes capital of the world" because of its large population living with diabetes. Rapid urbanization, population ageing,

unhealthy dietary habits, reduced physical activity, increasing obesity, and socioeconomic transition have contributed substantially to the increasing prevalence of type 2 diabetes mellitus (T2DM) across the country. These epidemiological changes have transformed diabetes into a major public health challenge, resulting in increased healthcare expenditure, disability, premature mortality, and reduced quality of life.

The largest nationally representative study conducted in India is the ICMR–INDIAB national cross-sectional study, which surveyed more than 113,000 adults from all 28 states, two Union Territories, and the National Capital Territory of Delhi between 2008 and 2020. The study estimated the weighted prevalence of diabetes among Indian adults to be 11.4% (95% CI 10.2–12.5), corresponding to approximately 101 million adults living with diabetes. Furthermore, 15.3% of adults (approximately 136 million people) were identified as having prediabetes, indicating a large population at high risk of developing T2DM in the near future.^{6,7}

The ICMR–INDIAB study also demonstrated considerable geographic variation in diabetes prevalence across the country, with southern states reporting higher prevalence than several northern and northeastern states. Urban populations consistently showed a higher prevalence of diabetes than rural populations; however, the prevalence in rural India has increased rapidly during the past decade because of lifestyle changes and increasing obesity. Among Indian states, Goa, Kerala, Tamil Nadu, Puducherry, Chandigarh, and Delhi reported some of the highest prevalence estimates, whereas several central and northeastern states had comparatively lower prevalence.^{7,8}

State Scenario

Uttar Pradesh has experienced a continuous increase in diabetes burden over the past two decades. Although its prevalence remains lower than that of several southern states, its very large population results in one of the highest absolute numbers of adults living with diabetes in India. Rapid urbanization, dietary transition, obesity, and physical inactivity are important contributing factors. Karnataka is among the states with a relatively high prevalence of T2DM, particularly in highly urbanized districts. Increasing obesity, sedentary occupations, dietary changes, and population ageing have contributed to the growing burden of diabetes. Tamil Nadu has consistently reported one of the highest diabetes prevalences in India. Landmark epidemiological studies, including the Chennai Urban Rural Epidemiology Study (CURES) and the ICMR–INDIAB study, have shown that diabetes affects both urban and rural populations, although prevalence remains higher in urban areas. Kerala has one of the highest diabetes prevalences in India because of its ageing population, high prevalence of overweight and obesity, and increasing lifestyle-related risk factors. Diabetes frequently coexists with hypertension and dyslipidaemia, increasing the burden of cardiovascular disease. Maharashtra continues to report a high prevalence of diabetes, especially in urban regions such as Mumbai and Pune. Recent studies indicate increasing prevalence in semi-urban and rural populations as well.^{6,7,8,9}

The considerable variation in diabetes prevalence across Indian states reflects differences in demographic characteristics, urbanization, socioeconomic development, healthcare access, and behavioural risk factors. These findings highlight the need for state-specific prevention strategies alongside national diabetes control programmes.

Rationale

Type 2 diabetes mellitus (T2DM) has become one of the most important public health challenges worldwide due to its rapidly increasing prevalence, long-term complications, and socioeconomic consequences. The continuous rise in diabetes incidence is primarily driven by population ageing, urbanization,

unhealthy dietary patterns, physical inactivity, increasing obesity, and lifestyle transitions associated with economic development. Although advances in diagnosis and treatment have improved diabetes management, the increasing number of affected individuals highlights the urgent need for effective preventive approaches.

The growing burden of T2DM is particularly concerning because the disease contributes substantially to premature mortality and disability through complications such as cardiovascular disease, chronic kidney disease, diabetic retinopathy, neuropathy, and lower-limb amputation. Diabetes is also associated with increased healthcare expenditure and reduced productivity, creating a significant economic burden for individuals, families, and healthcare systems. The Global Burden of Disease (GBD) study has demonstrated that diabetes has become one of the leading contributors to global disability-adjusted life years (DALYs).

A major reason for concern is that a considerable proportion of T2DM cases can be prevented or delayed through early identification of risk factors and appropriate lifestyle interventions. Evidence from landmark prevention trials has demonstrated that modification of behavioural risk factors, particularly weight reduction, increased physical activity, and dietary improvement, can significantly reduce progression from prediabetes to diabetes.

Despite the availability of effective preventive strategies, many individuals at high risk remain undiagnosed and do not receive timely interventions. This emphasizes the importance of understanding the epidemiological determinants of T2DM to identify vulnerable populations and develop targeted prevention programmes. Therefore, a comprehensive review of the determinants and preventive measures of T2DM among adults is essential to support evidence-based public health planning and reduce the future burden of disease.

Significance of Study

The significance of studying epidemiological determinants and preventive measures of T2DM lies in the increasing global and regional variation in disease occurrence. The development of T2DM is influenced by a complex interaction between genetic susceptibility, demographic characteristics, metabolic abnormalities, behavioural factors, and environmental conditions. Understanding these factors enables healthcare professionals and policymakers to identify high-risk groups and implement appropriate prevention strategies.

The importance of this topic is particularly relevant in low- and middle-income countries, including India, where rapid demographic and nutritional transitions have resulted in a substantial increase in diabetes prevalence. The ICMR–INDIAB national study reported that more than 1 00 million adults in India are living with diabetes, with considerable variation between states and between urban and rural populations. These findings highlight the need for region-specific prevention strategies rather than a uniform approach.

Studying the determinants of T2DM also contributes to improving early detection and risk assessment. Identification of modifiable factors such as obesity, physical inactivity, unhealthy diet, smoking, hypertension, and dyslipidaemia provides opportunities for preventive interventions before the onset of irreversible metabolic changes. Furthermore, recognizing social and environmental determinants, including socioeconomic status, food availability, education, and healthcare accessibility, helps develop comprehensive strategies addressing the broader causes of diabetes.

The significance of preventive measures is supported by strong evidence from clinical trials demonstrating that lifestyle modification can substantially reduce diabetes incidence among high-risk individuals. The Diabetes Prevention Program showed that intensive lifestyle intervention reduced the incidence of

T2DM by 58%, establishing lifestyle modification as the foundation of diabetes prevention.

Therefore, understanding the epidemiological determinants and preventive approaches of T2DM is essential for reducing disease incidence, preventing complications, improving quality of life, and achieving national and global targets for non-communicable disease control.

Transition to Epidemiological Determinants and Preventive Measures

The increasing burden of T2DM cannot be explained by a single factor; rather, it results from the interaction of multiple epidemiological determinants operating at individual, community, and population levels. These determinants include non-modifiable factors such as age, sex, ethnicity, and genetic predisposition, along with modifiable factors including obesity, dietary patterns, physical inactivity, tobacco use, alcohol consumption, hypertension, dyslipidaemia, and psychosocial stress. Ageing is a major non-modifiable determinant because insulin sensitivity decreases and pancreatic β -cell function declines with advancing age. Genetic susceptibility and family history also play important roles, with individuals having a first-degree relative with diabetes demonstrating increased risk of developing T2DM. Ethnic differences further influence diabetes risk, with Asian populations developing diabetes at lower body mass indices due to greater visceral adiposity and increased insulin resistance.

Among modifiable determinants, obesity, particularly central obesity, is considered one of the strongest predictors of T2DM. Excess adipose tissue contributes to inflammation, insulin resistance, and impaired glucose metabolism. Physical inactivity and unhealthy dietary patterns further increase diabetes risk by promoting weight gain and metabolic dysfunction. These behavioural factors provide important targets for prevention programmes.

Preventive measures for T2DM involve a continuum of interventions. Primary prevention aims to prevent disease development through promotion of healthy diets, regular physical activity, weight management, smoking cessation, and creation of supportive environments. Secondary prevention focuses on early identification of individuals with prediabetes and effective management of metabolic risk factors to prevent progression to diabetes. At the population level, prevention requires multispectral approaches including health education, improved food policies, increased availability of healthy foods, promotion of physical activity-friendly environments, and strengthening of primary healthcare services. These strategies are essential because individual behavior change alone is insufficient to address the complex social and environmental factors contributing to the diabetes epidemic.

Based on this evidence, the present review focuses on the epidemiological determinants of T2DM among adults and evaluates preventive measures that can be implemented at individual, healthcare, and population levels to reduce the growing burden of diabetes.

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