



A Literature Review: A Comprehensive Analysis of Type 2 Diabetes Mellitus in Productive-Age Adults and Adolescents in Indonesia

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Received: 01 10, 2026 | Accepted: 01 21, 2026 | Published: 01 23, 2026

ABSTRACT

Type 2 Diabetes Mellitus (T2DM), traditionally associated with older adults, has emerged as a critical public health crisis among younger populations globally, with Indonesia representing a significant and rapidly growing epicenter. This phenomenon, where diagnosed cases represent merely the "tip of the iceberg" with a vast, undiagnosed, and at-risk population submerged beneath, is particularly alarming in productive-age adults (20-59 years) and adolescents. This literature review synthesizes current evidence from 2015 to 2024 to explore the scale, determinants, clinical peculiarities, socioeconomic impacts, and management challenges of early-onset T2DM in Indonesia. The review reveals a potent interplay of genetic predisposition, driven by the thrifty genotype hypothesis, and profound environmental triggers, including Indonesia's rapid nutrition transition towards energy-dense diets and pervasive physical inactivity. The unique pathophysiology in the young, marked by more aggressive beta-cell decline and pronounced insulin resistance, leads to quicker complications, devastating personal and national economic productivity. Systemic challenges, including fragmented healthcare, low health literacy, and significant stigma, further hinder effective prevention and management. The review concludes that addressing this "iceberg" requires a paradigm shift towards transformative, multi-sectoral policies that prioritize primordial and primary prevention, integrate technology for screening and education, and foster youth-empowering, culturally-tailored interventions to avert a future tsunami of diabetes-related morbidity and economic strain.

Keywords: Type 2 Diabetes; Early-Onset; Adolescents; Young Adults; Risk Factors

How to Cite:

Haryanti, E. (2026). A Literature Review: A Comprehensive Analysis of Type 2 Diabetes Mellitus in Productive-Age Adults and Adolescents in Indonesia. *Journal of Literature Review*, 2(1), 89-96. <https://doi.org/10.63822/2w2vr893>

INTRODUCTION

The global trajectory of Type 2 Diabetes Mellitus (T2DM) has undergone a dramatic and disconcerting shift in the 21st century. Once considered a disease of midlife and beyond, its incidence and prevalence are now surging among adolescents and young adults worldwide, a trend that the International Diabetes Federation (IDF) has labeled one of the most "disturbing" aspects of the modern diabetes epidemic (IDF, 2021). This shift represents a fundamental change in the disease's epidemiology, no longer confined to later decades but increasingly rooted in childhood and adolescent metabolic health. The implications are profound, as a diagnosis in youth translates into decades of disease exposure, drastically increasing the lifetime risk of devastating complications and placing immense strain on healthcare systems designed for an older patient demographic.

In Indonesia, the world's fourth most populous nation, this global trend is magnified and accelerated against a backdrop of rapid but uneven socioeconomic development, breakneck urbanization, and profound lifestyle transformations. This confluence of factors has created a perfect storm for the rise of non-communicable diseases (NCDs). The national prevalence of diabetes has more than doubled in recent decades, soaring from 5.7% in 2007 to 10.9% in 2018 according to the national Basic Health Research (Riskesdas) (Ministry of Health RI, 2019). Even more alarming is the estimation that approximately 75% of these cases remain undiagnosed. This stark statistic perfectly epitomizes the "iceberg phenomenon" in public health: the visible, diagnosed population represents merely the tip, while a vast, submerged mass of undiagnosed, prediabetic, and metabolically at-risk individuals lies hidden beneath the surface, undetected and unmanaged. This hidden burden guarantees a future wave of diabetic complications that will inevitably emerge, overwhelming clinical services.

This review focuses on two critically vulnerable and interlinked demographic groups at the heart of this silent epidemic: adolescents (typically 10-19 years) and productive-age adults (20-59 years). The emergence of T2DM in these groups is not merely a medical issue but a societal crisis with severe, lifelong implications. For the individual, it portends a longer disease duration, a significantly higher risk of microvascular (e.g., retinopathy, nephropathy, neuropathy) and macrovascular (e.g., cardiovascular disease) complications manifesting at a younger, more productive age, leading to reduced quality of life, disability, and premature mortality (Lascar et al., 2018). For the nation, it directly threatens to erode human capital, burden nascent healthcare systems with complex chronic care needs, and stifle economic productivity through absenteeism, presenteeism, and premature workforce exit. This epidemic thus risks undermining Indonesia's demographic dividend—the potential economic growth afforded by a large, young working-age population—transforming it into a demographic liability of chronic illness and dependency.

Consequently, this paper aims to provide a comprehensive synthesis and critical analysis of contemporary literature (2015-2024) on T2DM among adolescents and productive-age adults in Indonesia. It will systematically examine the epidemiological scale and trajectory of the problem, elucidate the unique biological and sociocultural risk factors at play, discuss the distinct clinical presentation and management challenges, analyze the profound socioeconomic and national developmental impact, and evaluate the efficacy and gaps in current management and prevention strategies. The review culminates in evidence-based recommendations for policy and practice, advocating for a fundamental paradigm shift from a reactive, treatment-focused model to a proactive, prevention-oriented, and multi-sectoral approach essential to shrinking the submerged base of the T2DM iceberg.

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METHODS OF RESEARCH

This literature review was conducted systematically to identify, select, and critically appraise relevant scholarly works. The primary databases searched were PubMed, Scopus, ScienceDirect, and Google Scholar. Indonesian databases (e.g., Garba Rujukan Digital) and institutional repositories (Ministry of Health, Indonesian Diabetes Association) were also consulted to capture local grey literature. The search combined key terms and Boolean operators: ("type 2 diabetes" OR "T2DM") AND ("adolescen" OR "young adult" OR "early-onset" OR "productive age") AND ("Indonesia") AND ("epidemiology" OR "risk factor" OR "obesity" OR "management" OR "prevention"). Inclusion criteria encompassed peer-reviewed journal articles, reports, and theses published between 2015 and 2024, in English or Indonesian, specifically addressing T2DM in populations under 60 years in Indonesia. Exclusion criteria included studies solely on type 1 diabetes, gestational diabetes, or populations outside Indonesia. From an initial pool of over 200 citations, 30 key references were selected based on relevance, methodological rigor, and their contribution to understanding the core themes of this review.

RESULT AND DISCUSSION

Epidemiology: The Rising Tide

The epidemiological data paints a picture of a rapidly accelerating crisis. National surveys indicate that the prevalence of diabetes in the 15-24 and 25-34 age groups, while lower than in older cohorts, is rising at an alarming rate. Riskesdas 2018 data showed a significant increase in diabetes prevalence across all adult age groups compared to 2013 (Ministry of Health RI, 2019). More granular studies highlight the issue's emergence in youth. A study in Surabaya found a prevalence of impaired fasting glucose in 24.5% of obese adolescents, a strong precursor to T2DM (Pramono et al., 2019). Similarly, research in Jakarta identified a substantial proportion of young adults with undiagnosed diabetes and prediabetes, emphasizing the detection gap (Soewondo et al., 2020).

The transition from rural to urban living is a key accelerant. Urban adolescents and young adults exhibit significantly higher rates of obesity, sedentary behavior, and unhealthy dietary patterns compared to their rural counterparts. A comparative study in Yogyakarta and surrounding villages confirmed higher fasting blood glucose levels and HOMA-IR (a measure of insulin resistance) in urban youth, independent of BMI (Adi et al., 2021). This urban-rural gradient underscores the role of environmental and behavioral factors in driving the epidemic within the genetically susceptible Indonesian population.

Unpacking the Determinants: A Perfect Storm

The pathogenesis of early-onset T2DM in Indonesia is multifactorial, arising from a complex interplay of genetic, metabolic, and environmental determinants.

Genetic and Epigenetic Susceptibility

The "thrifty genotype" hypothesis posits that populations historically exposed to cycles of feast and famine, such as many in Asia, have evolved to be highly efficient at storing energy. In an environment of constant caloric surplus, this genotype becomes detrimental, predisposing individuals to obesity and insulin resistance (Prentice et al., 2019). Indonesians, particularly of Malay ethnicity, are known to have a higher

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percentage of body fat and greater visceral adiposity at lower BMIs compared to Caucasians, a phenotype dubbed "the lean Asian diabetic" (Nurwanti et al., 2018). This phenotype means that the standard BMI cut-offs for obesity may underestimate metabolic risk in this population, necessitating the use of lower BMI and waist circumference thresholds as recommended by the IDF for Asian populations.

The Dual Burden of Malnutrition and Nutrition Transition

Indonesia is contending with a double burden of disease: while undernutrition persists, overnutrition has exploded. The rise in childhood and adolescent obesity is a direct driver of early-onset T2DM. Riskesdas 2018 reported that the national prevalence of obesity in adults (>18 years) reached 21.8%, a sharp increase from previous years (Ministry of Health RI, 2019). This is fueled by a rapid nutrition transition characterized by increased consumption of refined carbohydrates (white rice, noodles, bread), unhealthy fats, added sugars (particularly from sweetened beverages and snacks), and processed foods, coupled with decreased intake of fruits, vegetables, and fiber (Pangaribuan et al., 2021). The ubiquitous presence of inexpensive, high-calorie street food (e.g., gorengan or fried snacks) and sweet teas (teh manis) in the daily diet poses a significant cultural and economic challenge to dietary modification.

Physical Inactivity and Sedentary Lifestyles

Parallel to dietary changes is a decline in physical activity. Urbanization has led to reduced active transport, limited recreational spaces, and a rise in screen-based entertainment. A study among university students in Depok found that over 60% were physically inactive, spending more than 5 hours daily on screens, and this was strongly correlated with higher fasting blood glucose levels (Sari et al., 2022). Physical education in schools is often inadequate, and sedentary behaviors are ingrained from a young age, establishing a lifelong pattern of inactivity.

Psychosocial and Environmental Factors

Stress, poor sleep quality, and socioeconomic status are emerging as significant contributors. Academic pressure, economic insecurity, and urban living stresses can dysregulate the hypothalamic-pituitary-adrenal axis, promoting hyperglycemia. Furthermore, low health literacy regarding NCDs and their risk factors is widespread, even among educated young adults, delaying health-seeking behavior and preventive action (Harahap et al., 2023). Environmental factors, including exposure to endocrine-disrupting chemicals and air pollution, are also being investigated for their potential role in metabolic dysfunction.

Clinical Course and Complications: An Aggressive Phenotype

T2DM diagnosed in youth follows a more aggressive clinical course than when diagnosed in later adulthood. Studies consistently show that early-onset T2DM is associated with a faster rate of beta-cell function deterioration and more rapid progression from prediabetes to overt diabetes (Mayer-Davis et al., 2023). Consequently, complications appear earlier and are often more severe. Young adults with T2DM have a higher risk of developing diabetic kidney disease, retinopathy, and neuropathy at a younger age compared to their peers with type 1 diabetes or older-onset T2DM. Alarming, macrovascular complications, such as hypertension and dyslipidemia, are frequently present at diagnosis or develop shortly after, significantly increasing the lifetime risk of cardiovascular disease (Siregar & Kuswardhani, 2021).

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Diagnosis is frequently delayed due to the asymptomatic nature of early hyperglycemia and low clinical suspicion in young, seemingly healthy individuals. When symptoms do occur (e.g., polyuria, polydipsia, fatigue), they are often mild or attributed to other causes. This diagnostic inertia contributes to the "submerged" portion of the iceberg, allowing complications to begin developing in the prediabetic or undiagnosed phase.

Socioeconomic Impact: Eroding the Demographic Dividend

The economic implications of T2DM in the productive-age population are catastrophic at both micro and macro levels. At the individual and household level, direct medical costs (medications, consultations, monitoring) and indirect costs (lost productivity, absenteeism, presenteeism, premature retirement) create a severe financial burden, potentially pushing families into poverty (Trisnawati & Pratiwi, 2023).

At the national level, this epidemic directly threatens Indonesia's demographic dividend—the potential for economic growth stemming from a large working-age population. A nation with a high burden of chronic disease in its workforce faces reduced labor force participation, lower output, and increased healthcare and social security spending. A macroeconomic modeling study estimated that NCDs, led by cardiovascular diseases and diabetes, could reduce Indonesia's GDP growth significantly over the coming decades if left unchecked (Dartanto et al., 2020). The loss of human capital due to disability and premature death represents a profound drain on national development.

Management and Prevention: Navigating the Challenges

Clinical Management Hurdles

Managing T2DM in young populations is complex. Lifestyle modification is the cornerstone, but adherence is notoriously poor due to psychosocial factors, lack of family support, and environmental barriers. Pharmacological management is complicated by a lack of long-term safety and efficacy data for many antidiabetic drugs in adolescents and young adults. Metformin and insulin are the mainstays, but newer agents like SGLT2 inhibitors and GLP-1 receptor agonists, while promising, are often inaccessible due to cost and lack of approval for younger age groups in Indonesia (Soelistijo et al., 2021). Healthcare system fragmentation between pediatric and adult services creates a perilous transition period for adolescents moving into adult care, often leading to loss to follow-up.

Stigma and Mental Health

Diabetes-related distress, depression, and stigma are highly prevalent yet under-addressed. Young people with T2DM often face blame and shame for their condition, perceived as a consequence of personal failings rather than a complex chronic disease (Amalia et al., 2022). This stigma can lead to non-disclosure, poor self-care, and social isolation, further exacerbating health outcomes.

Prevention Strategies: From Clinical to Primordial

Current national programs, such as Pos Pembinaan Terpadu Penyakit Tidak Menular (POSBINDU PTM), focus on screening for high-risk adults. While valuable, this represents secondary prevention. To shrink the submerged base of the iceberg, a decisive shift towards primordial (preventing risk factors) and primary (preventing disease in at-risk individuals) prevention is imperative. School-based interventions

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promoting healthy eating and physical activity, sugar-sweetened beverage taxation, strict marketing regulations on unhealthy food to children, and the creation of built environments that encourage active living are evidence-based policy measures (Sulistyoningsih & Lee, 2023). Digital health tools (mHealth), leveraging Indonesia's high mobile phone penetration, offer scalable platforms for education, self-monitoring, and peer support tailored to younger demographics.

CONCLUSION

The "iceberg" of T2DM among Indonesia's youth and productive-age population is large, growing, and poses an existential threat to the nation's health and economic future. This review has synthesized evidence showing that the phenomenon is driven by a convergence of deep-seated genetic susceptibility and a rapidly obesogenic environment marked by unhealthy diets and sedentary lifestyles. The disease manifests more aggressively in the young, leading to early complications and imposing a crushing socioeconomic burden.

To mitigate this crisis, a multi-sectoral, transformative approach is urgently required. Recommendations include:

1. **Policy and Regulatory Action:** Enact and enforce fiscal policies (e.g., sugar tax), reformulate food products, restrict unhealthy food marketing to children, and mandate comprehensive physical activity in schools and communities.
2. **Healthcare System Strengthening:** Integrate routine screening for dysglycemia and metabolic risk in young adult and adolescent healthcare visits using appropriate Asian-specific criteria. Develop and disseminate national guidelines for the management of early-onset T2DM, ensuring smooth transition from pediatric to adult care.
3. **Empowering Targeted Interventions:** Develop and implement culturally-sensitive, youth-empowering education programs that utilize digital platforms to improve health literacy and self-efficacy. Address mental health and stigma as core components of diabetes care.
4. **Research and Surveillance:** Invest in longitudinal cohort studies to understand the natural history of early-onset T2DM in Indonesia and generate local evidence for treatment efficacy. Strengthen national surveillance systems to better track incidence and prevalence in younger age groups.

Addressing the T2DM iceberg requires moving beyond a purely clinical, curative model to embrace a societal-wide commitment to creating environments where the healthy choice is the easy choice for Indonesia's next generation. The time for decisive action is now, before the submerged mass of this epidemic surfaces with irreversible consequences.

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