

# TRENDS AND CHARACTERISTICS OF YOUNG POPULATION TYPE-2 DIABETES MELLITUS IN MALAYSIA: A SYSTEMATIC REVIEW

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**Abstract.** Type 2 diabetes mellitus is an increasing public health challenge in Malaysia, with national data showing a substantial rise in prevalence over the past decade. Of particular concern is the growing burden of type 2 diabetes mellitus among younger populations, which is associated with longer disease duration and a higher risk of complications. However, existing evidence remains fragmented due to heterogeneity in study designs and variations in the definitions of young populations. This systematic literature review aimed to synthesise available evidence on the trends and characteristics of type 2 diabetes mellitus among young populations in Malaysia, focusing on prevalence patterns, demographic and ethnic disparities, clinical characteristics, complications, and associated risk factors. A systematic literature review was conducted using secondary data from a precompiled evidence report generated through a semantic search of the academic literature. Studies were screened using predefined eligibility criteria for the age of the population, study design, and relevance to the epidemiology of type 2 diabetes mellitus in Malaysia. Eighteen studies published between 2016 and 2025 were included. Due to substantial heterogeneity across studies, findings were synthesised using a narrative approach. The review identified a consistent upward trend in the prevalence of type 2 diabetes mellitus in Malaysia, increasing from approximately 11–12% in the mid-2000s to 18.3% in 2019. Among younger populations, prevalence more than doubled between 2006 and 2015, with cases accounting for 11.0%-37.5% of all patients, depending on the study setting. Young population disease was characterised by higher obesity prevalence, poorer glycaemic control, and earlier development of microvascular complications. It marked ethnic disparities, with individuals of Indian ethnicity consistently exhibiting the highest prevalence. This review demonstrates a rapidly increasing burden of type 2 diabetes mellitus among young populations in Malaysia, characterised by adverse clinical profiles and significant demographic disparities.

**Keywords:** *type 2 diabetes mellitus, young population diabetes, prevalence trends, Malaysia*

## Introduction

Type 2 diabetes mellitus (T2DM) has emerged as a significant public health concern in Malaysia, with a substantial and consistent increase in prevalence reported over the past decade (Akhtar et al., 2022). National data and large-scale epidemiological studies indicate that the overall prevalence of T2DM among Malaysian adults has risen markedly, reflecting rapid urbanisation, lifestyle transitions, and increasing obesity rates across the population (Foo et al., 2023). This upward trend poses significant challenges to the healthcare system, particularly as diabetes-related complications continue to contribute to morbidity, mortality, and escalating healthcare costs. Of particular concern

is the rising burden of T2DM among younger populations, commonly referred to as young population T2DM, which is generally defined as a diagnosis before the age of 40 years. Evidence synthesised in recent Malaysian studies demonstrates that the prevalence of T2DM among individuals aged 39 years and below has more than doubled between 2006 and 2015. Youth-specific data further highlight that diabetes is no longer confined to older age groups, with measurable prevalence already present among late adolescents and young adults, including those aged 18–19 and 20–24 years.

This epidemiological shift signals an earlier onset of metabolic disease, with implications for longer disease duration and cumulative exposure to hyperglycaemia. (Lingeswary et al., 2024). Young population T2DM in Malaysia is increasingly recognised as a distinct and more aggressive disease phenotype compared to usual-onset T2DM. Studies consistently report higher rates of obesity, poorer glycaemic control, and earlier development of microvascular complications among individuals diagnosed at a younger age. Clinical data indicate that young population patients exhibit higher mean glycated haemoglobin (HbA1c) levels and lower achievement of metabolic targets, despite treatment. Furthermore, complication profiles reveal increased prevalence of retinopathy, nephropathy, and end-stage kidney disease among younger patients when compared with those diagnosed later in life. These findings underscore the long-term clinical and economic consequences of early disease onset. Marked demographic and ethnic disparities further characterise the epidemiology of T2DM in Malaysia. The burden of disease is disproportionately higher among individuals of Indian ethnicity, followed by Malays and Chinese, a pattern that persists across multiple study designs and geographical settings. Gender differences in overall prevalence appear less pronounced; however, registry data suggest that women constitute a substantial proportion of young population T2DM cases in specific clinical cohorts. In addition, socioeconomic and environmental factors, including neighbourhood-level deprivation and urban living, have been associated with higher diabetes prevalence, highlighting the complex interplay between genetic susceptibility and contextual risk factors.

Several modifiable and non-modifiable risk factors have been consistently linked to the development and progression of T2DM in the young population in Malaysia. Obesity and elevated body mass index emerge as the dominant attributable risk factors, while a strong family history of diabetes is highly prevalent among young population cases. Lifestyle-related factors such as physical inactivity and smoking, along with comorbid conditions including hypertension and dyslipidaemia, further contribute to poor glycaemic control and increased complication risk. Despite ongoing management efforts, overall metabolic control among Malaysian patients with T2DM remains suboptimal, particularly in younger age groups. Although numerous studies have examined aspects of T2DM epidemiology in Malaysia, variations in study design, population definitions, diagnostic criteria, and sampling methods have resulted in heterogeneous prevalence estimates and fragmented evidence. In particular, inconsistencies in how the young population with T2DM is defined complicate direct comparisons across studies and limit the precise quantification of temporal trends (Xie et al., 2022). These methodological differences highlight the need for a comprehensive synthesis of existing evidence to provide a more transparent and coherent understanding of the magnitude and characteristics of T2DM among young people in Malaysia. Therefore, this systematic literature review aims to synthesise available evidence on trends in T2DM prevalence among young populations in Malaysia, with a specific focus

on epidemiological patterns, demographic and ethnic disparities, clinical characteristics, complications, and associated risk factors. By consolidating findings from diverse study settings and designs, this review seeks to provide an integrated overview of T2DM in young people in the Malaysian context and to highlight the growing clinical and public health significance of this condition.

## **Materials and Methods**

This article was conducted as a systematic literature review (SLR) to synthesise existing evidence on trends and characteristics of type 2 diabetes mellitus (T2DM) among the young population in Malaysia. The review was designed and reported in accordance with established principles of systematic evidence synthesis, with reporting guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. All methodological steps and analyses were strictly based on the data and information contained within the provided source document, without the inclusion of additional studies or external data.

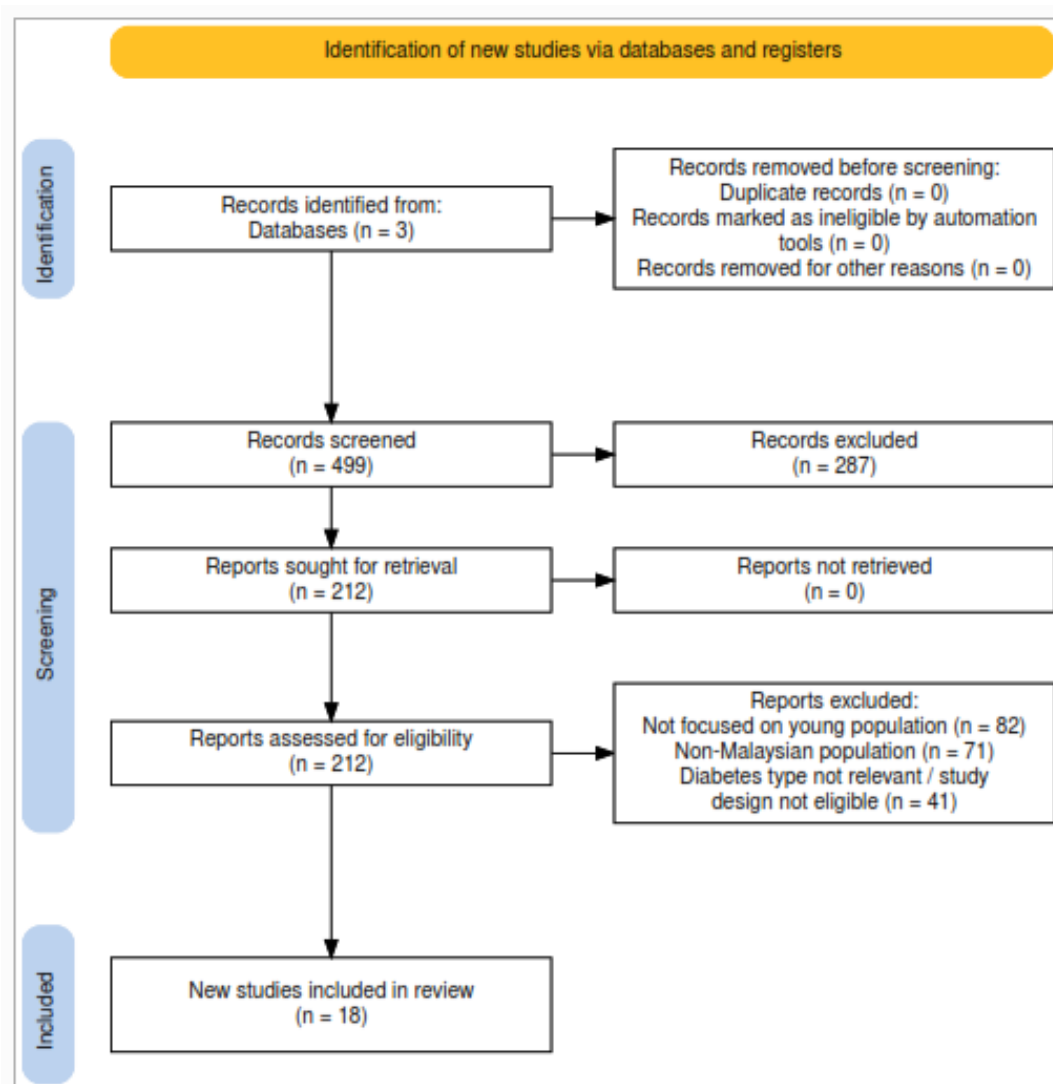
### ***Study design, data source and search strategy***

This study employed a systematic literature review design using secondary data derived from previously published studies. The review focused on identifying, screening, and synthesising epidemiological evidence related to T2DM prevalence and trends among young populations in Malaysia. No primary data collection was undertaken. The data source for this systematic literature review was a pre-compiled evidence report generated through a semantic literature search using the Elicit search engine, which aggregates results from three major electronic databases: Scopus, PubMed, and Web of Science. The search was conducted to identify studies examining trends in the prevalence of type 2 diabetes mellitus among young populations in Malaysia. The search strategy was guided by the research question: “What are the trends in type 2 diabetes prevalence among young populations in Malaysia over the past decade?” During this database search, a total of 499 records were identified. No additional records were obtained from trial registers or other sources. All records retrieved through this search were screened and assessed for eligibility in accordance with the PRISMA 2020 framework. The present review relied exclusively on the studies identified and synthesised in this pre-compiled evidence report, without including additional studies.

### ***Eligibility criteria and study selection process***

Studies were selected for inclusion based on predefined eligibility criteria applied during the abstract and full-text screening stages. The inclusion criteria were as follows: (1) Studies involving populations in Malaysia that included young individuals, generally defined as those aged 35 years or younger or diagnosed with T2DM before the age of 40 years. (2) Studies reporting epidemiological data on T2DM, including prevalence, incidence, or temporal trends. (3) Studies conducted or published from 2015 to 2025. (4) Acceptable study designs included cross-sectional studies, cohort studies, population-based surveys, registry-based studies, systematic reviews, and meta-analyses. (5) Studies focusing specifically on type 2 diabetes mellitus. Exclusion criteria included case reports, case series, clinical trials, studies focusing exclusively on type 1

diabetes or gestational diabetes, and studies conducted solely in highly specialised clinical settings without population-based relevance. The study selection process is illustrated in the PRISMA flow diagram (*Figure 1*). A total of 499 records were initially identified through a semantic literature search conducted using the Elicit search engine. After removal of duplicates and preliminary screening, 212 records were deemed potentially relevant and proceeded to full-text assessment. Following full-text review, 18 studies met the predefined eligibility criteria and were included in the final qualitative synthesis. Reasons for exclusion at the full-text stage included irrelevance to young-onset type 2 diabetes mellitus, non-Malaysian study populations, and study designs not aligned with this review's objectives. The study selection process consisted of two stages: abstract screening followed by full-text screening. During abstract screening, 212 studies met the inclusion criteria and were advanced to full-text review. Following a detailed full-text assessment, 18 studies fulfilled all eligibility requirements and were included in the final synthesis. The overall study selection process was documented using a PRISMA flow diagram.



**Figure 1.** PRISMA 2020 flow diagram of the study selection process.

### **Data extraction, data synthesis and quality considerations**

Data extraction was performed systematically based on predefined extraction domains. The extracted information included study period, definition of young population, study design, geographic scope, sample characteristics, prevalence estimates, trend analyses, subgroup findings, and reported risk factors. Extraction was conducted using structured instructions to ensure consistency across studies, as detailed in the source document. A narrative synthesis approach was employed to summarise and integrate findings from the included studies. Due to substantial heterogeneity in study designs, population definitions, and outcome measurements, quantitative meta-analysis was not undertaken. Instead, results were synthesised thematically, focusing on prevalence trends, demographic and ethnic disparities, clinical characteristics of young population T2DM, associated complications, and identified risk factors. The quality of evidence was considered descriptively based on study design, data sources, and reported heterogeneity. Previous meta-analytic findings within the included studies indicated high heterogeneity, which was acknowledged as a limitation in interpreting pooled prevalence estimates. No additional risk-of-bias assessment was conducted beyond what was reported in the included studies.

## **Results and Discussion**

### **Characteristics of included studies**

Table 1 summarises the characteristics of the 18 studies included in this systematic literature review. The included studies were published between 2016 and 2025, with data collection periods spanning from 1990 to 2024, reflecting a broad temporal coverage. Methodologically, the studies employed diverse designs, predominantly cross-sectional and registry-based approaches, as well as retrospective cohort analyses, ecological studies, narrative reviews, and systematic reviews with meta-analysis. The geographic scope of the included studies ranged from national population-based surveys and registries to state- and city-specific settings, including Selangor, Klang Valley, Johor, Terengganu, Kelantan, Putrajaya, and Pahang (Amsah et al., 2022). Sample sizes varied substantially, from small clinic-based audits to large registry cohorts involving more than 288,000 participants, highlighting considerable heterogeneity in study scope and representativeness (Wan et al., 2023). Most studies defined young-onset type 2 diabetes mellitus as a diagnosis before the age of 40 years, although several relied on age-stratified analyses or broader age ranges. This heterogeneity in study design and population definition reflects the varied methodological approaches used to investigate young-onset T2DM in the Malaysian context.

**Table 1.** Characteristics of included studies in the systematic literature review.

No.	Author (Year)	Study Design	Geographic Scope	Definition of Young Population
1	Wong et al. (2020)	Cross-sectional (NHMS)	National	Age groups (18–44 years)
2	Akhtar et al. (2022)	Systematic review & meta-analysis	National	Age categories (20–45 years)
3	Lim et al. (2016)	Retrospective cross-sectional	Selangor (clinic-based)	Diagnosis <40 years
4	Foo et al. (2023)	Cross-sectional	Klang Valley	Diagnosis <40 years
5	Wan et al. (2023)	Retrospective cohort (registry)	National	Young population <40 years
6	Hasbullah et al. (2021)	Cross-sectional	Terengganu	Age 18–29 years

7	Xie et al. (2022)	Ecological study	National	Age 15–39 years
8	Kamal et al. (2024)	Cross-sectional	Klang Valley	Age 15–32 years
9	Lingeswary et al. (2024)	Retrospective cohort	National (registry)	Diagnosis <40 years
10	Amsah et al. (2022)	Cross-sectional	Pahang	Age-stratified (young adults)
11	Awang et al. (2022)	Cross-sectional	Kelantan	Age-stratified
12	Kazlauskaitė et al. (2023)	Registry-based analysis	National	Not explicitly defined
13	Chew et al. (2016)	Cross-sectional	Johor	Age-stratified
14	Ganasegeran et al. (2024)	Ecological study	District-level (national)	Not specified
15	Ismail et al. (2025)	Cross-sectional	Putrajaya	Age-stratified
16	Lee et al. (2020)	Cross-sectional	Urban Malaysia	Young adults (<40 years)
17	Tan et al. (2022)	Cross-sectional	National	Age-stratified

### Definitions of young population

Table 2 highlights substantial heterogeneity in the operational definitions of young-onset type 2 diabetes mellitus across the included studies. The most frequently adopted definition classified young-onset T2DM as a diagnosis before age 40 (Mohd Redzuan et al., 2025). However, several studies employed age-range-based definitions, including 15–39 years (Amsah et al., 2022), 18–29 years (Chew et al., 2016) and 15–32 years (Oo et al., 2020). In addition, some studies did not explicitly define young-onset T2DM but instead provided age-stratified analyses within broader adult populations (Awang et al., 2022). This variability in age definitions complicates direct comparison of prevalence estimates and contributes to heterogeneity in reported findings across studies.

**Table 2. Operational definitions of “Young Population” used in the included studies.**

No.	Author (Year)	Definition Type	Age Range / Criterion Used
1	Wong et al. (2020)	Age-group-based	18–44 years
2	Akhtar et al. (2022)	Age-group-based (meta-analysis)	20–45 years
3	Lim et al. (2016)	Diagnosis-based	Diagnosis before 40 years
4	Foo et al. (2023)	Diagnosis-based	Diagnosis before 40 years
5	Wan et al. (2023)	Diagnosis-based	Young population T2DM <40 years
6	Hasbullah et al. (2021)	Age-group-based	18–29 years
7	Xie et al. (2022)	Age-group-based	15–39 years
8	Kamal et al. (2024)	Age-group-based	15–32 years
9	Lingeswary et al. (2024)	Diagnosis-based	Diagnosis before 40 years
10	Amsah et al. (2022)	Age-stratified	Young adults (not explicitly defined)
11	Awang et al. (2022)	Age-stratified	Adult population with age subgroups
12	Kazlauskaitė et al. (2023)	Not explicitly defined	Registry-based age clustering
13	Chew et al. (2016)	Age-stratified	Adult population with age subgroups
14	Ganasegeran et al. (2024)	Not specified	District-level prevalence
15	Ismail et al. (2025)	Age-stratified	Adult population with age subgroups
16	Lee et al. (2020)	Diagnosis / age-based	Young adults <40 years
17	Tan et al. (2022)	Age-stratified	Adult population with age subgroups

### Overall prevalence trends of type 2 diabetes mellitus in Malaysia

Table 3 summarises the temporal trends in the overall prevalence of type 2 diabetes mellitus in Malaysia, based on national surveys and meta-analytic evidence. Data from the National Health and Morbidity Survey (NHMS) indicate a consistent increase in prevalence from approximately 11–12% between 2006 and 2011 to 18.3% in 2019, with some analyses reporting prevalence as high as 21.2% in 2015, depending on diagnostic criteria and study methodology. This upward trend was further supported by findings from a systematic review and meta-analysis, which demonstrated a statistically significant increase in pooled diabetes prevalence between earlier (1995–2010) and more recent (2011–2020) periods (Akhtar et al., 2022). Collectively, these findings confirm a substantial and sustained rise in the national burden of T2DM in Malaysia.

**Table 3. Temporal trends in overall type 2 diabetes mellitus prevalence in Malaysia.**

Survey Year / Study Period	Reported Prevalence (%)	Data Source / Study
2006	11.4	
2011	11.2–15.2	
2015	17.5–21.2	NHMS
2019	18.3	NHMS (Akhtar et al., 2022)
1995–2010	Pooled lower prevalence	Meta-analysis (Akhtar et al., 2022)
2011–2020	Significantly higher pooled prevalence	

### Prevalence of type 2 diabetes mellitus among young populations

Table 4 summarises the prevalence of type 2 diabetes mellitus among young populations in Malaysia across different age groups and study settings. National survey data indicate that the prevalence of T2DM among individuals aged 39 years and below more than doubled between 2006 and 2015. However, absolute prevalence among adolescents and young adults remains lower than that observed in older age groups. Youth-specific prevalence estimates reported rates of 2.0% among individuals aged 18–19 years and 4.9% among those aged 20–24 years in 2011. Urban-based cross-sectional studies in the Klang Valley reported prevalence estimates of approximately 4.5% among young adults (Hasbullah et al., 2021). In clinical and registry-based settings, young-onset T2DM accounted for 11.0%–37.5% of all T2DM cases, depending on the healthcare setting and study population, highlighting the growing contribution of younger individuals to the national diabetes burden (Kamal et al., 2024; Awang et al., 2022).

**Table 4. Prevalence of type 2 diabetes mellitus among young populations in Malaysia.**

Study / Data Source	Age Group / Definition of Young Population	Reported Prevalence / Proportion
NHMS	18–19 years	2.0%
NHMS	20–24 years	4.9%
NHMS	≤39 years	More than doubled (2006–2015)
Kamal et al. (2024)	15–32 years (urban young adults)	≈4.5%
Lim et al. (2016)	Diagnosis <40 years	11.0% of all T2DM cases
Foo et al. (2023)	Diagnosis <40 years	14.6% of all T2DM cases
Wan et al. (2023)	Young-onset <40 years	Up to 37.5% of all T2DM cases

### Demographic and ethnic disparities

Table 5 summarises key demographic and ethnic disparities in the prevalence of type 2 diabetes mellitus in Malaysia. Across multiple studies, individuals of Indian ethnicity consistently exhibited the highest prevalence, followed by Malays and Chinese. Overall, gender differences in T2DM prevalence were not consistently observed; however, registry-based evidence suggested a higher proportion of females among young-onset cases in selected cohorts. In addition, urban residence and socioeconomic disadvantage were associated with higher prevalence, highlighting the influence of demographic and contextual factors on the distribution of T2DM in Malaysia. Pronounced ethnic disparities in T2DM prevalence were consistently observed. Individuals of Indian ethnicity demonstrated the highest prevalence, ranging from 25.1% to 31.4%, followed by Malays (15.3%–21.6%) and Chinese (12.9%–15.4%) across multiple studies (Ganasegeran et al., 2024; Kazlauskaite et al., 2023). Lower prevalence estimates were reported among Bumiputera and other ethnic groups (Akhtar et al., 2022). Gender differences in overall prevalence were less consistent. Meta-analytic findings indicated no significant difference between men and women (Akhtar et al., 2022), although registry-based studies reported a higher proportion of females among young population T2DM cases, particularly in intensive insulin therapy cohorts (Lingeswary et al., 2024).

**Table 5. Demographic and ethnic disparities in type 2 diabetes mellitus prevalence in Malaysia.**

Demographic Variable	Key Findings	Supporting Studies
Ethnicity – Indian	Highest T2DM prevalence (≈25.1%–31.4%)	Kazlauskaite et al. (2023); Akhtar et al. (2022)
Ethnicity – Malay	Intermediate prevalence (≈15.3%–21.6%)	Akhtar et al. (2022); Wong et al. (2020)
Ethnicity – Chinese	Lower prevalence compared to Malays and Indians (≈12.9%–15.4%)	Akhtar et al. (2022); Wong et al. (2020)
Other ethnic groups / Bumiputera	Generally, lower prevalence estimates	Akhtar et al. (2022)
Gender (overall prevalence)	No consistent significant difference between males and females	Akhtar et al. (2022)
Gender (young-onset T2DM)	Higher proportion of females in selected registry-based cohorts	Lingeswary et al. (2024)
Urban vs rural setting	Higher prevalence reported in urban populations	Kamal et al. (2024); Wong et al. (2020)
Socioeconomic context	Higher district-level prevalence associated with socioeconomic disadvantage	Ganasegeran et al. (2024)

### **Clinical characteristics and complications of young population T2DM**

Table 6 compares the clinical characteristics and complication profiles of young-onset and usual-onset type 2 diabetes mellitus. Across multiple studies, young-onset T2DM was consistently associated with longer disease duration, higher obesity prevalence, poorer glycaemic control, and lower achievement of metabolic targets. In addition, young-onset patients exhibited a higher prevalence of microvascular complications, including retinopathy, nephropathy, neuropathy, and end-stage kidney disease. These findings support the characterisation of young-onset T2DM as a more aggressive disease phenotype than usual-onset T2DM. Young population T2DM was associated with a more adverse clinical profile compared with usual-onset disease. Studies consistently reported higher obesity rates, longer disease duration, and poorer glycaemic control among younger patients (Lingeswary et al., 2024; Foo et al., 2023). Mean HbA1c levels were higher in the young population with T2DM, and achievement of recommended metabolic targets was substantially lower (Wan et al. 2023). Complications were common and occurred earlier in the disease course. Young population T2DM patients exhibited a higher prevalence of retinopathy, nephropathy, neuropathy, and end-stage kidney disease compared with those diagnosed later in life. (Lingeswary et al., 2024). Registry-based analyses further identified distinct T2DM subtypes with differing complication profiles, highlighting heterogeneity within the young population (Kazlauskaite et al., 2023).

**Table 6. Comparison of clinical characteristics and complications between young-onset and usual-onset T2DM.**

Clinical Domain	Young-Onset T2DM	Usual-Onset T2DM	Supporting Studies
Age at diagnosis	<40 years	≥40 years	Foo et al. (2023); Wan et al. (2023); Lim et al. (2016)
Disease duration	Longer	Shorter	Lingeswary et al. (2024); Foo et al. (2023)
Obesity prevalence	Higher	Lower	Lingeswary et al. (2024); Foo et al. (2023)
Glycaemic control (HbA1c)	Poorer (higher mean HbA1c)	Better (lower mean HbA1c)	Lingeswary et al. (2024); Wan et al. (2023)
Achievement of metabolic targets	Lower	Higher	Wan et al. (2023)
Retinopathy	More prevalent	Less prevalent	Foo et al. (2023); Lim et al.

Nephropathy	More prevalent	Less prevalent	al. (2016) Foo et al. (2023); Lim et al. (2016)
Neuropathy	More prevalent	Less prevalent	Foo et al. (2023)
End-stage kidney disease	Higher risk	Lower risk	Kazlauskaitė et al. (2023); Lim et al. (2016)
Disease heterogeneity/subtypes	Greater heterogeneity	Less pronounced	Kazlauskaitė et al. (2023)

**Risk factors associated with young population T2DM**

Table 7 summarises the key risk factors associated with young-onset type 2 diabetes mellitus in Malaysia. Across studies, obesity and elevated body mass index consistently emerged as the most prominent modifiable risk factors, while a strong family history of diabetes was highly prevalent among young-onset cases, reported in more than 80% of patients in selected cohorts (Foo et al., 2023; Xie et al., 2022; Hasbullah et al., 2021). Additional factors associated with young-onset T2DM and poorer glycaemic control included physical inactivity, smoking, hypertension, and dyslipidaemia (Awang et al., 2022). Furthermore, socioeconomic disadvantage and neighbourhood-level vulnerabilities were linked to higher district-level prevalence, highlighting the multifactorial and context-dependent nature of young-onset T2DM in the Malaysian setting (Ganasegeran et al., 2024).

**Table 7. Key risk factors associated with young-onset type 2 diabetes mellitus in Malaysia.**

Risk Factor Category	Specific Risk Factor	Evidence Summary	Supporting Studies
Anthropometric	Obesity / Elevated BMI	Consistently reported as the strongest modifiable risk factor associated with early disease onset and poor glycaemic control.	Foo et al. (2023); Xie et al. (2022); Hasbullah et al. (2021)
Genetic / Familial	Family history of diabetes	Highly prevalent among young-onset cases; reported in >80% of patients in selected cohorts	Foo et al. (2023); Wan et al. (2023)
Lifestyle-related	Physical inactivity	Associated with increased risk of young-onset T2DM and poorer metabolic outcomes	Awang et al. (2022)
Lifestyle-related	Smoking	Linked to poor glycaemic control and higher complication risk	Awang et al. (2022)
Cardiometabolic	Hypertension	Frequently reported comorbidity among young-onset T2DM patients	Lingeswary et al. (2024); Foo et al. (2023)
Cardiometabolic	Dyslipidaemia	Commonly co-exists with young-onset T2DM and contributes to adverse metabolic profiles.	Lingeswary et al. (2024); Foo et al. (2023)
Socioeconomic / Environmental	Socioeconomic disadvantage	Higher district-level prevalence associated with neighbourhood-level deprivation	Ganasegeran et al. (2024)
Environmental	Urban residence	Higher prevalence observed in urban populations compared with rural settings.	Kamal et al. (2025); Wong et al. (2020)

This systematic literature review provides an integrated interpretation of existing evidence on the epidemiology and characteristics of type 2 diabetes mellitus among young populations in Malaysia. Across diverse study designs, data sources, and settings, the findings consistently demonstrate a rising burden of early-onset disease, accompanied by adverse metabolic profiles, early development of complications, and pronounced demographic and ethnic disparities (Akhtar et al., 2022; Wong et al., 2020). Taken together, these findings suggest a meaningful shift in the age distribution of type 2 diabetes mellitus in Malaysia, reflecting broader epidemiological transitions observed in rapidly developing middle-income countries. One of the most striking observations from this review is the sustained increase in overall prevalence of type 2 diabetes mellitus at the national level, rising from approximately 11–12% in the mid-2000s to nearly one-fifth of the adult population by 2019 (Akhtar et al., 2022; Wong et al., 2020). Significantly, this upward trend was not limited to older age groups.

Evidence from national surveys and registry-based analyses indicates that the prevalence among individuals aged 40 years or less more than doubled between 2006 and 2015, signalling an emerging public health concern related to early disease onset (Wong et al., 2020). Although absolute prevalence among younger populations remains lower than that of older adults, the rapid rate of increase suggests that younger age groups are increasingly contributing to the national diabetes burden.

When placed in the context of existing regional and global literature, the Malaysian experience mirrors trends reported across Asia, where early-onset type 2 diabetes mellitus has been linked to rapid urbanisation, dietary transitions, and declining levels of physical activity. Urban-based studies from Malaysia further support this interpretation, reporting higher prevalence among young adults residing in metropolitan areas, particularly in settings characterised by sedentary lifestyles and obesogenic environments (Kamal et al., 2024). These observations align with theoretical frameworks of epidemiological transition, in which non-communicable diseases increasingly affect younger populations as societies undergo economic and social transformation. The clinical profile of young population type 2 diabetes mellitus emerging from this review suggests a more aggressive disease phenotype compared with usual-onset disease. Multiple studies consistently reported higher rates of obesity and poorer glycaemic control among younger patients, with mean glycated haemoglobin levels exceeding recommended targets despite pharmacological treatment (Lingeswary et al., 2024; Foo et al., 2023). From a life-course perspective, earlier disease onset implies prolonged exposure to hyperglycaemia and metabolic dysregulation, thereby increasing the cumulative risk of microvascular and macrovascular complications over time (Wan et al., 2023; Lim et al., 2016). This interpretation is supported by registry-based evidence demonstrating suboptimal metabolic control and earlier manifestation of complications among younger patients compared with those diagnosed later in life.

Complication patterns identified in this review further reinforce concerns regarding the long-term burden of early-onset disease. Studies consistently reported higher prevalence of microvascular complications, including retinopathy, nephropathy, and neuropathy, among young population patients (Foo et al., 2023; Lim et al., 2016). In addition, registry analyses highlighted increased rates of severe albuminuria and progression to end-stage kidney disease among younger individuals, suggesting accelerated disease progression despite shorter chronological age (Kazlauskaite et al., 2023). These findings challenge traditional assumptions that complications predominantly arise after prolonged disease duration in older adults and underscore the need for earlier and more intensive management strategies among younger patients. Ethnic disparities represent another salient feature of the epidemiology of type 2 diabetes mellitus in Malaysia. Across multiple studies and data sources, individuals of Indian ethnicity consistently exhibited the highest prevalence, followed by Malays and Chinese (Akhtar et al., 2022; Wong et al., 2020). This pattern persisted across national surveys, cohort studies, and registry-based analyses, suggesting a robust and enduring disparity. Theoretical explanations for these differences often emphasise the interaction between genetic susceptibility and environmental exposures, including dietary practices, physical activity patterns, and socioeconomic factors. In the Malaysian context, these disparities highlight the importance of culturally sensitive and ethnically tailored prevention and intervention strategies.

The review also identified a consistent set of modifiable and non-modifiable risk factors associated with young population type 2 diabetes mellitus and poor glycaemic

control. Obesity and elevated body mass index emerged as the most prominent contributors to early disease onset, reflecting the central role of excess adiposity in the pathogenesis of insulin resistance (Foo et al., 2023; Hasbullah et al., 2021). A strong family history of diabetes was frequently reported among young population cases, underscoring the contribution of genetic predisposition (Xie et al., 2022). Lifestyle factors, including physical inactivity and smoking, as well as cardiometabolic comorbidities such as hypertension and dyslipidaemia, further compounded the risk of poor metabolic control (Awang et al., 2022). Importantly, emerging evidence also points to the influence of socioeconomic and neighbourhood-level vulnerabilities on diabetes prevalence, highlighting the role of broader social determinants of health in shaping disease patterns (Ganasegeran et al., 2024). Despite overall consistency in findings, interpreting prevalence trends and clinical characteristics is complicated by substantial heterogeneity across studies. Variations in operational definitions of young populations, diagnostic criteria, sampling strategies, and study settings contributed to wide-ranging prevalence estimates and high heterogeneity reported in meta-analytic assessments (Akhtar et al., 2022). While these methodological differences limit precise quantification of disease burden, they do not detract from the overarching conclusion that type 2 diabetes mellitus among young populations is increasing in Malaysia. Instead, they highlight the need for standardised definitions and harmonised data collection methods to enhance comparability across studies.

From a public health and healthcare systems perspective, the findings of this review have important implications. The increasing contribution of younger individuals to the diabetes burden suggests that current prevention and management strategies, which have traditionally focused on older adults, may be insufficient to address the long-term consequences of early-onset disease (Wan et al., 2023; Wong et al., 2020). Strengthening surveillance systems, promoting earlier detection among younger age groups, and implementing targeted interventions that address behavioural, environmental, and social determinants are critical to mitigating future disease burden. Furthermore, prioritising longitudinal research designs and adopting standardised definitions of young-onset disease will be essential to advancing understanding and informing evidence-based policy and clinical decision-making in Malaysia.

## Conclusion

This systematic literature review provides a comprehensive synthesis of evidence demonstrating a substantial and sustained increase in the prevalence of type 2 diabetes mellitus (T2DM) in Malaysia over the past decade, with a particularly concerning rise among younger populations. National survey data, registry-based analyses, and systematic reviews consistently indicate that overall T2DM prevalence has increased markedly, while the proportion of individuals diagnosed before age 40 has increased significantly over time (Wan et al., 2023; Akhtar et al., 2022; Wong et al., 2020). The findings of this review highlight T2DM in the young population as a distinct and clinically important disease entity in the Malaysian context. Compared with usual-onset T2DM, young-onset T2DM is characterised by higher obesity rates, poorer glycaemic control, longer disease duration, and earlier development of diabetes-related complications (Lingeswary et al., 2024; Foo et al., 2023; Lim et al., 2016). These features suggest a more aggressive disease trajectory, with significant implications for long-term morbidity and healthcare utilisation.

Pronounced demographic and ethnic disparities further define the epidemiology of T2DM in Malaysia. Individuals of Indian ethnicity consistently exhibit the highest prevalence, followed by Malays and Chinese, underscoring the influence of population-specific risk profiles (Akhtar et al., 2022; Wong et al., 2020). In addition, modifiable risk factors such as obesity, physical inactivity, smoking, and comorbid conditions, including hypertension and dyslipidaemia, were repeatedly associated with poor glycaemic control and increased complication risk, while a strong family history of diabetes was highly prevalent among young population cases (Foo et al., 2023; Awang et al., 2022; Hasbullah et al., 2021). Although heterogeneity in study design, population definitions, and diagnostic criteria limits precise quantification of prevalence trends, the overall direction of evidence is consistent and compelling. The increasing burden of young population T2DM, coupled with suboptimal metabolic control and high complication rates, indicates that current prevention and management efforts may be insufficient to curb the long-term impact of diabetes among younger Malaysians (Wan et al., 2023; Akhtar et al., 2022). In conclusion, this review underscores the growing public health and clinical significance of T2DM in the young population in Malaysia. The rising prevalence, early disease onset, and adverse clinical profiles observed among younger individuals highlight the need for heightened recognition of this condition within national diabetes strategies and clinical practice. Continued surveillance and evidence-based approaches are essential to address the evolving diabetes landscape in Malaysia (Foo et al., 2023; Wong et al., 2020).

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### **Conflict of interest**

The author(s) declare that there is no conflict of interest regarding the publication of this article.

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