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Analysis of the Direct Medical Cost Burden of Type 2 Diabetes Mellitus Patients with and Without Complications in Indonesia Based on 2023 JKN Claims Data

Lily Indriani Octovia[A], Lambok DR Tampubolon[B]

Abstract

This study aimed to analyse and compare the direct medical costs of patients with T2DM with and without complications in Indonesia using 2023 BPJS Kesehatan claims data, applying a prevalence-based Cost of Illness (COI) approach from the payer's perspective. This descriptive study used total sampling of 10,299 patients with T2DM (ICD-10: E11.x) who met the inclusion criteria and had received either outpatient or inpatient care. Complication status was determined using diagnosis codes based on the Diabetes Complications Severity Index and hypoglycaemia codes. Descriptive analysis was conducted to examine patient characteristics, complication profiles, and annual direct medical costs by complication status, sex, province, type of service, and ward class. The results showed that 55.1% of patients had complications, while 44.9% had no complications. The median age was 65 years, and most patients were female (60.3%). The mean annual direct medical cost for all patients was IDR 685 ± 1,808 million. Unexpectedly, the non-complication group had a higher mean cost (IDR 1,016 ± 2,116 million) than the complication group (IDR 415 ± 1,457 million), indicating substantial cost variation and possible differences in claims patterns. Inpatient care was the main cost driver (IDR 951 ± 2,127 million), far exceeding outpatient care (IDR 104 ± 186 million). Among inpatients, class III patients had the highest mean cost (IDR 2,273 ± 3,080 million) despite lower baseline tariffs. These findings highlight the importance of strengthening primary care, chronic disease management, and claims governance, as well as improving diagnostic recording, to enhance efficiency and support the sustainability of JKN financing.

Keywords: *Type 2 Diabetes Mellitus, Direct Medical Cost, Cost of Illness, Complications, BPJS Kesehatan.*

INTRODUCTION

Type 2 diabetes mellitus (T2DM) has become one of the most pressing challenges in modern public health. Its impact can no longer be understood solely in clinical terms related to glycaemic control; it must also be viewed as a systemic issue affecting patients' quality of life, population productivity, long-term care needs, and the sustainability of health financing. The rising number of people living with diabetes across countries reflects broader shifts in lifestyle, urbanisation, population

[A]*Universitas Kristen Krida Wacana, Jakarta, Indonesia, Email: lily.indriani@gmail.com*
[B]*Universitas Kristen Krida Wacana, Jakarta, Indonesia, Email: lambok.ricardo@ukrida.ac.id*

ageing, and increasing obesity prevalence. The 11th edition of the International Diabetes Federation (IDF) Diabetes Atlas reported that the global number of people with diabetes reached 589 million in 2025 and is projected to increase to 853 million by 2050. In Southeast Asia, the prevalence is expected to rise by 73%, from 106.9 million in 2024 to 184.5 million in 2050. Indonesia ranks fifth worldwide, with approximately 20.4 million people living with diabetes, a sharp increase from the estimated 10.7 million cases in 2021. These figures indicate that diabetes is no longer a limited health concern but a major epidemiological and fiscal challenge, including in Indonesia (Sri Astuti Marpaung et al., 2022).

Most diabetes cases are classified as T2DM, which accounts for approximately 90–95% of all cases worldwide. This condition is characterised by insulin resistance, impaired pancreatic beta-cell function, and progressively worsening chronic hyperglycaemia. Its progressive nature often delays detection in the early stages, yet it leads to substantial long-term consequences when disease control remains inadequate. In many cases, patients are diagnosed only after requiring more complex treatment or after complications have already affected target organs. Accordingly, T2DM demands not only continuous clinical management but also a health system capable of ensuring sustained treatment, monitoring, patient education, and long-term risk-factor control. In this sense, the disease itself carries substantial cost implications even before severe complications arise (Tan & Wong, 2023; Tian et al., 2025).

The burden increases markedly when chronic hyperglycaemia persists and leads to complications. In T2DM, vascular and metabolic damage may manifest as microvascular complications, such as nephropathy, retinopathy, and neuropathy; macrovascular complications, including coronary heart disease, heart failure, peripheral arterial disease, and cerebrovascular disorders; as well as acute metabolic complications such as severe hypoglycaemia. Each of these complications has distinct clinical and economic consequences (Satibi et al., 2019). Retinopathy requires ophthalmological monitoring, laser therapy, and in some cases surgery, neuropathy increases the risk of diabetic foot ulcers, infection, and amputation, cardiovascular and cerebrovascular complications often require hospitalisation, invasive procedures, rehabilitation, and intensive treatment. Severe hypoglycaemia, although acute in onset, may also necessitate emergency care and hospital admission, and complications therefore reflect not only worsening clinical status but also a sharp escalation in healthcare resource use (Singh et al., 2025; Sun et al., 2022).

From a health systems perspective, T2DM is associated with a complex pattern of service utilisation. Patients require a combination of primary care, specialist outpatient services, regular diagnostic monitoring, long-term pharmacological therapy, and, in many cases, inpatient care. These needs tend to increase with age, disease duration, comorbidity, and the onset of complications. In health economics, T2DM is widely recognised as a high-cost chronic disease because it requires

repeated contact with healthcare facilities and can generate episodes of care with substantial expenditure. The direct medical costs of diabetes include medications, laboratory testing, physician consultations, medical procedures, inpatient care, and interventions related to complications (Al-Salmawi, 2024; Sandra et al., 2023). In the later stages of the disease, costs are driven less by routine diabetes management than by complications and the hospitalisations they entail. This suggests that inadequate disease control at the primary care level may ultimately lead to far greater expenditure at the referral level.

This issue is particularly important in Indonesia, where most healthcare financing is managed through the National Health Insurance system (*Jaminan Kesehatan Nasional*, JKN), administered by BPJS Kesehatan. As the principal payer within the national health system, BPJS Kesehatan covers diabetes care through capitation payments at primary healthcare facilities and through INA-CBGs-based reimbursement and non-CBGs components at referral facilities. Given the extensive coverage of insured members and the continued rise in service utilisation, T2DM has consistently ranked among the conditions with the highest claim expenditures. This has major strategic implications. As diabetes prevalence increases, the national financing system must cover not only routine care but also expensive complications, recurrent hospitalisations, and cost variation across regions and types of facilities. Within this context, analysing the cost of diabetes care is not merely an academic exercise; it is essential for assessing medium- and long-term fiscal risk within the JKN system (Putri, Andayani, et al., 2019; Saeedi et al., 2019).

Previous studies have shown that T2DM imposes a substantial economic burden in Indonesia. Hidayat et al. (2022), using JKN claims data from 2016, found that approximately 74% of total direct medical costs for T2DM were attributable to patients with complications, and that the mean cost per patient in this group was nearly twice that of patients without complications. These findings indicate that complications are a major driver of diabetes-related expenditure. (Parker et al., 2024) estimated the annual cost per T2DM patient in Bulungan Regency at approximately IDR 7.3 million, with direct medical expenditure accounting for the largest share. Other hospital-based studies have also reported discrepancies between actual treatment costs and INA-CBGs tariffs, particularly among patients with complications or more complex treatment needs, the Indonesian literature points to a consistent conclusion: diabetes generates a substantial economic burden, and complications intensify that burden considerably (Ong et al., 2023).

Earlier studies have several limitations, and most were conducted at the hospital or regional level, and therefore do not adequately capture national cost patterns. Some focused exclusively on outpatient or inpatient care without integrating both forms of service into a single analytical framework. Others examined specific cost components, such as oral antidiabetic therapy or differences between actual costs and INA-CBGs tariffs, without situating their findings within a broader map of the

national cost burden from the payer's perspective. Additional limitations include variation in study design, definitions of complications, observation periods, and data sources, which make direct comparison across studies difficult, these gaps highlight the need for updated analyses based on national claims data, particularly to understand how the cost structure of T2DM is evolving within a JKN system that is itself undergoing change (Mosadeghrad et al., 2022; Oktora & Butar, 2022).

The period from 2016 to 2023 represents an important phase in the development of healthcare financing in Indonesia. During this time, several structural changes occurred that may have affected the cost pattern of T2DM care. These include revisions to INA-CBGs tariffs, changes in service tariff standards, expansion of BPJS Kesehatan membership to more than 250 million people, strengthening of the referral-back program (*Program Rujuk Balik*), further development of chronic disease services, and the digitalisation of claims systems. Together, these changes may have altered the distribution of costs across service types, regions, and patient groups. Longer survival among patients with T2DM may increase the cumulative burden of complications, meaning that utilisation patterns and cost components observed in 2023 cannot simply be assumed to mirror those found in earlier datasets. Updated claims data are therefore essential to ensure that cost analysis reflects current conditions in healthcare delivery and financing (Mansour et al., 2023; Mlynarska et al., 2025).

A prevalence-based Cost of Illness (COI) approach provides an appropriate framework for addressing this need. This approach estimates the economic burden incurred within a specific period for the entire population receiving care, making it well suited to chronic diseases such as T2DM. From the payer's perspective, COI can identify the magnitude of costs borne by the system during a given year, determine which patient groups account for the greatest expenditure, and indicate where cost-containment strategies should be directed. Although it is not intended to assess intervention efficiency in the manner of cost-effectiveness analysis, it serves as a valuable starting point for mapping the economic burden of disease (Lestari, 2025). Such evidence is especially useful because policymakers require an empirical basis for setting financing priorities, evaluating payment design, and strengthening complication-prevention strategies aimed at improving long-term efficiency.

The economic assessment of T2DM should not stop at total expenditure alone. Variation in costs by complication status, type of service, ward class, sex, and region also carries important strategic implications. Differences in costs across provinces may reflect variation in access to care, facility capacity, referral patterns, or diagnostic coding practices. The predominance of inpatient costs may signal weak disease control at the primary care level or delayed detection of complications. Disparities in cost across ward classes may raise questions about case severity, intensity of intervention, and tariff design (Kim et al., 2022). These issues matter because effective financing policy requires more than recognising that a disease is expensive; it also requires understanding

where costs are concentrated, how they arise, and which interventions are most appropriate to contain them. Cost analysis of T2DM should therefore be viewed not merely as an estimate of economic burden but as a means of identifying cost drivers within the health system.

Against this background, the present study was undertaken to address these knowledge gaps. Using JKN claims data from 2023, this study analyses and compares the direct medical costs of patients with T2DM with and without complications in Indonesia from the perspective of BPJS Kesehatan. The approach enables cost mapping by complication status, patient characteristics, type of service, province, and ward class. The study is expected to provide an updated picture of the cost burden of T2DM within the JKN system while also examining whether current patterns differ from those reported previously. More broadly, the findings are expected to strengthen the evidence base for more efficient diabetes financing, clarify the urgency of reinforcing primary care and chronic disease management programs, and support the formulation of health financing policies that are more responsive to the fiscal pressures imposed by high-cost chronic diseases. Accordingly, this study aims to analyse and compare the costs of care for patients with T2DM with and without complications in Indonesia in 2023, while also assessing the strategic implications for the sustainability of financing within the JKN system.

LITERATURE REVIEW

Type 2 Diabetes Mellitus: Pathophysiology, Prevalence, and Disease Burden

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterised by hyperglycaemia resulting from a combination of insulin resistance in peripheral tissues and progressive pancreatic beta-cell dysfunction. In the early stages, compensatory hyperinsulinaemia may maintain blood glucose within the normal range; over time, however, the secretory capacity of beta cells declines, leading to relative or absolute insulin deficiency and persistent chronic hyperglycaemia (Khoe et al., 2020). T2DM accounts for approximately 90–95% of all diabetes cases and is closely associated with obesity, high-calorie diets, physical inactivity, and genetic predisposition (Iwasaki et al., 2025; Jankauskas et al., 2021).

The risk factors for T2DM can be divided into modifiable and non-modifiable factors. Modifiable factors include obesity, unhealthy dietary patterns, low levels of physical activity, and exposure to certain diabetogenic agents, whereas non-modifiable factors include age, ethnicity, and a family history of diabetes (Hu et al., 2021; Huebner & Flessa, 2022). In Indonesia, epidemiological evidence indicates that obesity and hypertension are the two strongest predictors of T2DM prevalence at the population level (Gregg et al., 2019).

The prevalence of T2DM continues to rise globally, particularly in low- and middle-income countries. According to the 11th edition of the IDF Diabetes Atlas published in 2025, there were 589 million people

living with diabetes worldwide, and this number is projected to increase to 853 million by 2050. Southeast Asia is expected to experience one of the steepest increases, with prevalence rising by 73% between 2024 and 2050. Indonesia ranks fifth globally, with approximately 20.4 million people living with diabetes, representing a sharp increase from the estimated 10.7 million cases in 2021 (Magliano, Boyko, and IDF Diabetes Atlas 11th Edition Scientific Committee, 2025). This increase is largely driven by rapid urbanisation, dietary shifts toward high-calorie foods, and declining physical activity among the working-age population.

Persistent uncontrolled hyperglycaemia causes multi-organ damage through several pathophysiological mechanisms, including the formation of advanced glycation end products (AGEs), oxidative stress, and chronic inflammation, all of which damage the vascular endothelium and target tissue structures (Farmaki et al., 2020; Galicia-Garcia et al., 2020). These mechanisms form the biological basis for the development of diabetes-related complications, which in turn substantially increase healthcare costs.

Complications of Type 2 Diabetes Mellitus

Complications of T2DM are generally classified into three major categories based on the mechanism and site of damage: microvascular, macrovascular, and metabolic complications. These complications are a major determinant of both clinical burden and healthcare expenditure in people with diabetes (Dunn et al., 2025; Fadila, Andayani, et al., 2025).

Microvascular complications result from damage to small blood vessels caused by chronic hyperglycaemia, leading to thickening of the capillary basement membrane and impaired tissue perfusion. The three main manifestations are diabetic nephropathy, neuropathy, and retinopathy. Diabetic nephropathy progresses from microalbuminuria to proteinuria and declining renal function; in advanced stages, it may require renal replacement therapy such as dialysis or transplantation, both of which impose very high per-patient costs (Daryabor et al., 2020; Deshpande & Jadhav, 2025). Diabetic neuropathy, particularly peripheral neuropathy, presents with pain, tingling, and loss of protective sensation in the lower limbs, thereby increasing the risk of foot ulcers, infection, and amputation. Autonomic neuropathy may affect cardiovascular, gastrointestinal, and urogenital function, significantly reducing quality of life (Butt et al., 2024; Cheng et al., 2022). Diabetic retinopathy is a leading cause of blindness among working-age adults. Its proliferative form may cause vitreous haemorrhage and retinal detachment, while diabetic macular oedema may lead to progressive central visual impairment. Global projections suggest that the burden of diabetic retinopathy will continue to grow through 2030 as diabetes prevalence rises and glycaemic control remains suboptimal in many populations (Barbosa et al., 2026).

Macrovascular complications arise from atherosclerosis in large blood vessels, a process accelerated by hyperglycaemia, dyslipidaemia, hypertension, and the prothrombotic state commonly associated with

T2DM. These complications include coronary artery disease, myocardial infarction, heart failure, ischaemic and haemorrhagic stroke, and peripheral arterial disease. Patients with T2DM have a two- to fourfold higher risk of coronary heart disease and a two- to sixfold higher risk of stroke compared with individuals without diabetes (Alvianto & Pribadi, 2025; Bandgar et al., 2025). Systematic reviews have shown that cardiovascular disease is highly prevalent among individuals with T2DM and becomes more common with advancing age and longer disease duration (Alshammari et al., 2025; Asante et al., 2023). Heart failure in patients with diabetes, driven not only by coronary atherosclerosis but also by diabetic cardiomyopathy, contributes to more frequent hospitalisation and longer lengths of stay, thereby substantially increasing cumulative costs (Ahmad et al., 2022). Peripheral arterial disease, which may present as intermittent claudication and progress to critical limb ischaemia, is also strongly associated with overall cardiovascular morbidity and mortality (Wahyudi, Panggabean, et al., 2024).

Acute metabolic complications in T2DM primarily involve severe hypoglycaemia resulting from inappropriate insulin dosing, intense physical activity, or reduced carbohydrate intake. It is estimated that 30–60% of patients with T2DM experience at least one episode of hypoglycaemia each year (Galicia-Garcia et al., 2020), while severe hypoglycaemia occurs in approximately 1–3% of patients annually, with higher rates observed among older adults and long-term insulin users (Lestari, 2025). Severe hypoglycaemia requires emergency management and may lead to serious outcomes, including impaired consciousness, seizures, and coma.

Evidence shows that patients with complications—especially macrovascular complications such as cardiovascular disease and nephropathy requiring dialysis—consume substantially more healthcare resources than those without complications, particularly in terms of hospitalisation, diagnostic investigations, and specialist treatment (Parker et al., 2024; Saeedi et al., 2019).

Direct Medical Costs and the JKN Financing System

Direct medical costs refer to all expenditures directly related to the provision of healthcare services, including inpatient care, medications, diagnostic examinations, medical procedures, physician consultations, and intensive care (Al-Salmawi, 2024; Sandra et al., 2023). In health economic studies, this component is often the main focus because it can be measured accurately through insurance claims records. In high-income countries, direct medical costs account for approximately 74% of the total economic burden of diabetes, while in low-income countries the proportion is about 56% (Singh et al., 2025; Sri Astuti Marpaung et al., 2022).

Indonesia applies a diagnosis-related group payment system known as Indonesia Case-Based Groups (INA-CBGs) within the National Health Insurance programme (*Jaminan Kesehatan Nasional*, JKN). This

system is adapted from Diagnosis Related Groups (DRGs) and enables prospective payment to healthcare facilities based on case groups rather than itemised services. Each case group is assigned a predetermined tariff that covers all service components within a single episode of care, with adjustments based on ward class (I, II, III), hospital type (public or private), and regional adjustment indices (Ministry of Health of the Republic of Indonesia, 2016). In addition to INA-CBGs, non-CBGs components include medications outside the national formulary, specialised medical devices, and additional procedures reimbursed separately from the package tariff (Tan & Wong, 2023).

Several studies in Indonesia have documented discrepancies between INA-CBGs tariffs and the actual costs incurred by hospitals, particularly in complex cases involving multiple complications. (Parker et al., 2024) reported meaningful differences between actual inpatient costs and INA-CBGs tariffs in several districts in Central Java. Negara et al. (2021), in a study conducted at Pandan Arang Regional Hospital in Boyolali, confirmed similar findings, identifying length of stay and disease severity as the main factors contributing to the gap. (Ong et al., 2023) also found that for high-cost diagnoses, INA-CBGs tariffs were often lower than actual treatment costs, a situation that may affect both service quality and hospital financial sustainability. More recent evidence from (Saeedi et al., 2019) showed that among patients with T2DM and cardiovascular or renal complications, actual treatment costs exceeded INA-CBGs tariffs in both groups, reflecting a financing deficit from the provider's perspective.

For primary care services, BPJS Kesehatan applies a capitation system under which first-level healthcare facilities are paid a fixed monthly amount per enrolled participant for 155 diagnoses, including type 1 and type 2 diabetes. This arrangement is intended to encourage promotive and preventive care (Ministry of Health of the Republic of Indonesia, 2024). Two chronic disease management programmes within JKN are particularly relevant: the Referral Back Programme (*Program Rujuk Balik*, PRB), which allows clinically stable patients to obtain chronic medications at primary care facilities without repeated hospital referral, and the Chronic Disease Management Programme (*Program Pengelolaan Penyakit Kronis*, Prolanis), which provides education, health monitoring, and group-based activities for patients with diabetes and hypertension. These programmes are designed to improve disease control and prevent complications, thereby potentially reducing long-term costs.

The Cost of Illness Approach in the Economic Analysis of Diabetes

The Cost of Illness (COI) approach is a method used in health economic evaluation to identify and quantify the economic burden imposed by a disease on individuals, society, and the health system as a whole (Khoe et al., 2020). In the case of chronic conditions such as T2DM, which are characterised by high prevalence and sustained effects on healthcare spending and productivity, COI studies are an important tool for policy advocacy and financing planning (Lestari, 2025).

There are two main approaches in COI studies. The prevalence-based approach estimates the costs incurred during a specific period, usually one year, for the entire population living with the disease during that period. This approach is commonly used to estimate the economic burden of chronic, non-fatal conditions. The incidence-based approach estimates costs over the full course of illness for newly diagnosed cohorts, from diagnosis to recovery or death, and is more appropriate for assessing the long-term impact of prevention (Galicia-Garcia et al., 2020). The choice of approach depends on the purpose of the analysis and data availability. For estimating the actual annual cost burden from the payer's perspective, the prevalence-based approach is generally more relevant and practical.

The analytical perspective in COI studies determines which cost components are included. A societal perspective captures all costs regardless of who bears them. A payer perspective focuses on costs borne by financing institutions such as governments or insurers. A provider perspective estimates costs from the standpoint of hospitals or healthcare facilities. A patient perspective includes out-of-pocket spending and indirect costs borne by patients and their families (Dunn et al., 2025). This study adopts the payer perspective, specifically that of BPJS Kesehatan, because BPJS claims data provide the most systematic and comprehensive source of information on the cost of T2DM services in Indonesia and are directly relevant to national healthcare financing policy.

A systematic review of diabetes-related COI studies in Indonesia by (Patty et al., 2021) found that diabetes imposes a substantial economic burden, with direct medical costs representing the dominant component. Both microvascular and macrovascular complications were identified as major contributors to total costs, exceeding the costs of T2DM care without complications. The review also highlighted considerable variation in methods and analytical perspectives across studies, as well as limitations in geographic coverage and sample size in much of the available literature.

Strategic Management in the Control of Healthcare Costs

Within the framework of strategic management, cost management is understood as an integral part of organisational decision-making aimed at achieving long-term goals effectively and sustainably. Strategic cost management uses cost information to understand cost structures, identify cost drivers, and evaluate the efficiency of resource utilisation, extending well beyond short-term expenditure control (Al-Salmawi, 2024). In the healthcare sector, effective cost-control strategies require a comprehensive understanding of the health system context, including the roles of hospitals, service providers, and payers (Barbosa et al., 2026).

From the payer's perspective, chronic diseases are a major driver of rising insurance expenditure, particularly when they are poorly managed and accompanied by complications. Reviews of cost management strategies in health insurance consistently show that

proactive chronic disease management including complication prevention, patient education, and regular monitoring is among the most effective ways to curb long-term claims escalation (Mosadeghrad et al., 2022). In Indonesia, strengthening strategic purchasing in primary care is considered a promising avenue for improving service quality while reducing long-term costs through earlier detection and prevention of complications (Lestari, 2025).

At the hospital level, cost-management research shows that service cost structures are shaped by material costs, labour costs, and indirect overhead, all of which require a strategic approach to ensure operational sustainability without compromising quality of care (Al-Salmawi, 2024). Techniques such as activity-based costing and cost-driver analysis can help hospitals identify inefficiencies and design improvement measures aligned with service quality objectives (Cost Accounting Standards Board, 2025). Research in Indonesia further confirms that organisational factors, governance arrangements, and variation in clinical practice play an important role in healthcare cost variation, suggesting that efficiency interventions must take local facility conditions into account (Sun et al., 2022).

From an equity perspective, national health financing analyses indicate that although JKN has improved financial protection overall, the burden of healthcare costs remains disproportionately distributed across certain socioeconomic groups, highlighting the need for policies that are more responsive to social vulnerability (Putri, Andayani, et al., 2019; Saeedi et al., 2019). The Global Burden of Disease analysis for Indonesia likewise shows that the expansion of JKN has improved access, yet disparities persist across provinces and socioeconomic groups, requiring more targeted policy responses (Zakir et al., 2023).

Previous Studies

The following table summarises relevant previous studies, particularly those examining the cost of T2DM services in Indonesia, and serves as the basis for identifying the research gap addressed by this study.

Table 1. Review of Previous Studies on the Cost of Type 2 Diabetes Mellitus Care in Indonesia

No	Author(s) (Year)	Research Focus	Methods and Data	Main Findings	Similarities	Limitations
1	(Hidayat et al., 2022)	Direct medical costs of T2DM and its complications in Indonesia	Prevalence-based COI; 2016 JKN claims data	Approximately 74% of total costs were attributable to patients with complications; the mean cost for patients with complications was nearly twice that of those	Analysed direct medical costs of T2DM using JKN claims data; distinguished between patients with and without complications	Used 2016 data; did not examine cost variation by ward class and province in detail

				without complications		
2	(Patty et al., 2021)	Economic burden of diabetes mellitus in Indonesia	Systematic review of COI studies conducted in Indonesia	Diabetes imposes a substantial economic burden; complications are the largest cost contributor; considerable methodological variation exists across studies	Examined the economic burden of diabetes and applied the COI framework	Review study rather than empirical claims-based research; did not analyse JKN data directly
3	(Qomariyah et al., 2023)	COI of T2DM as a basis for preventive policy advocacy	COI study; 144 patients in Bulungan Regency, North Kalimantan	Total cost per patient was approximately IDR 7.3 million per year; direct medical care accounted for the largest share	Assessed both direct and indirect costs of T2DM	Small sample size and limited to one regency; did not compare patients with and without complications
4	(Fadila, Purnamasari, et al., 2025)	Direct medical costs of diabetes with cardiovascular and renal complications	Cost analysis; inpatient data from a referral hospital	Cardiovascular and renal complications generated the highest direct medical costs; actual costs exceeded INA-CBGs tariffs	Assessed the effect of complications on direct medical costs in diabetes	Limited to two types of complications and one hospital; did not include patients without complications
5	(Negara et al., 2021)	Comparison of actual inpatient costs of T2DM with INA-CBGs tariffs	Cost analysis; inpatient data from Pandan Arang Regional Hospital, Boyolali	A discrepancy existed between actual costs and INA-CBGs tariffs; length of stay and disease severity influenced costs	Examined inpatient T2DM care and compared actual costs with INA-CBGs tariffs	Limited to one hospital; did not compare patients with and without complications; very narrow scope
6	(Tandah et al., 2024)	Direct medical costs and INA-CBGs tariffs for non-insulin-dependent T2DM	Cost analysis; inpatient data from Anutapura Regional Hospital, Palu	There was a gap between actual inpatient costs and INA-CBGs tariffs; complications and comorbiditie	Analysed direct medical costs of inpatient T2DM care and their relationship with INA-CBGs tariffs	Single-hospital study; limited to non-insulin-dependent T2DM; not national in scope

				s widened the gap		
7	(Putri, Darmawan, et al., 2019)	COI of outpatient T2DM among JKN patients	COI study; outpatient data from Condong Catur Hospital, Yogyakarta	Patients with complications incurred higher direct medical costs; medications were the largest cost component	Used a COI approach and distinguished between T2DM patients with and without complications	Limited to outpatient care in one hospital; not national in scope; did not include inpatient care
8	(Wahyudi, Andayani, et al., 2024)	Direct medical costs of oral antidiabetic therapy in outpatient care	Cost analysis; outpatient JKN patients	Physician fees and medications were the largest cost components; treatment regimen variation influenced costs	Analysed direct medical costs among T2DM patients covered by JKN	Focused only on outpatient oral antidiabetic therapy; did not consider complications or inpatient care
9	(Yuniarti et al., 2015)	Costs of diabetes treatment among JKN patients compared with INA-CBGs tariffs	Cost analysis; PKU Muhammadiyah Hospital, Yogyakarta	A discrepancy was found between actual costs and INA-CBGs tariffs; medications were the largest cost component; tariff gaps posed a risk to service quality	Analysed direct medical costs of diabetes using JKN-based data and compared them with INA-CBGs tariffs	Single-hospital study; included both type 1 and type 2 diabetes; used data from the early phase of JKN implementation and therefore may not reflect current conditions

Source: data proceed

A review of the nine previous studies presented in Table 4 reveals both consistent patterns and important gaps in the literature on the cost of type 2 diabetes mellitus (T2DM) in Indonesia. Four main themes emerge from these studies. First, the Cost of Illness (COI) approach and descriptive cost analysis are the most commonly used frameworks, with direct medical costs serving as the principal outcome of interest. Second, nearly all studies identify diabetes-related complications as the main driver of higher healthcare costs, although this evidence is largely derived from local data with limited sample sizes. Third, inpatient care and medications are consistently reported as the dominant cost components across both outpatient and inpatient settings. Fourth, discrepancies between INA-CBGs tariffs and actual treatment costs recur across hospital-based studies, pointing to persistent financial pressure on healthcare providers.

These studies also reveal substantial methodological limitations. Most were conducted in one or a few hospitals within a single city or district and therefore lack national representativeness. The most relevant national-level study remains that of Hidayat et al. (2022), which used

2016 claims data that no longer reflect current conditions, particularly in light of the major structural changes that have occurred within the JKN system over the past seven years. In addition, none of the previous studies simultaneously distinguished between outpatient and inpatient care, compared patients with and without complications, and examined cost variation by ward class and province, all of which are central analytical dimensions of the present study.

The contribution of this study can therefore be clearly situated within the existing literature. It is a prevalence-based Cost of Illness study using the largest and most recent JKN claims dataset currently available, covering 10,299 patients across Indonesia in 2023. It simultaneously analyses direct medical costs by complication status, type and class of service, sex, and province. With its national scope and updated dataset, this study is intended to address the gaps left by the nine earlier studies and to provide a more comprehensive and policy-relevant picture of the cost burden of T2DM for medium- and long-term JKN financing planning.

METHOD

This study employed a descriptive design using a prevalence-based Cost of Illness (COI) approach from the payer's perspective, specifically BPJS Kesehatan. A prevalence-based COI approach was selected because it is well suited to chronic diseases such as type 2 diabetes mellitus (T2DM), for which cost estimation must cover the entire population receiving care within a defined period, in this case, the year 2023. The payer perspective was adopted because the analysis focused on costs borne by BPJS Kesehatan as the principal healthcare financer within Indonesia's National Health Insurance system (*Jaminan Kesehatan Nasional*, JKN). This approach was intended to provide an up-to-date picture of the direct medical cost burden of T2DM and to compare cost patterns between patients with and without complications.

The study used secondary data obtained from the 2023 BPJS Kesehatan claims database. The study population included all patients who received healthcare services with a primary diagnosis of T2DM, identified by ICD-10 code E11.x, and recorded in the BPJS Kesehatan claims system during the study period. Because the objective was to describe the cost burden at the population level within the national financing system, total sampling was applied by including all cases that met the study criteria in the analysis. This approach allowed for a more comprehensive assessment of cost patterns based on patient characteristics, complication status, type of service, and regional variation.

The inclusion criteria were as follows: (1) patients aged 18 years or older; (2) a primary diagnosis of T2DM coded as ICD-10 E11.x; (3) receipt of either outpatient or inpatient care for at least one day during 2023; and (4) complete claims data, including INA-CBGs and/or non-CBGs cost components. Patients were excluded if their claims data were incomplete, if there were inconsistencies in administrative or clinical information, or

if T2DM was recorded only as a comorbid condition rather than the primary diagnosis. These criteria were applied to ensure consistency in case definition and to strengthen the validity of cost measurement.

The dependent variable in this study was total direct medical cost per patient per year. This was calculated as the sum of INA-CBGs costs, representing package-based reimbursement per episode of care according to case group, and non-CBGs costs, which included services outside the package, such as non-formulary medications, certain medical devices, and additional procedures reimbursed separately. The independent variables included complication status (with or without complications), type of complication (cardiovascular, neuropathy, nephropathy, cerebrovascular, retinopathy, and hypoglycaemia), complication category (macrovascular, microvascular, and metabolic), age, sex, province, type of care (outpatient or inpatient), ward class (Class I, II, or III), and length of hospital stay. These variables were selected on the basis of their relevance to variation in the cost of T2DM care within the JKN system.

Complication status was determined using ICD-10 diagnosis codes recorded in the claims data. Complications were identified according to the Diabetes Complications Severity Index (DCSI) framework for microvascular and macrovascular complications and were supplemented by hypoglycaemia codes to capture metabolic complications. Based on this classification, patients were grouped into two main categories: T2DM without complications and T2DM with complications. Complications were then further classified by type and category. This allowed the cost analysis to capture not only overall complication status but also more specific complication patterns.

Data processing was conducted in several stages. The first stage involved data cleaning, including the removal of duplicate records, verification of the consistency of the primary diagnosis, validation of the completeness of cost information, and exclusion of invalid records. The second stage involved variable coding according to the study's operational definitions, including classification of complication status, type of complication, complication category, type of service, ward class, and patient demographic characteristics. The final stage involved construction of the analytical dataset. All procedures were performed using anonymised data, with no personally identifiable patient information accessible during the analysis.

Descriptive analysis was used to examine patient characteristics and the distribution of direct medical costs in T2DM. The characteristics described included age, sex, province, complication status, type of complication, type of service, ward class, and length of hospital stay. Cost analysis was performed by comparing direct medical costs according to complication status, sex, province, type of service, and ward class. Numerical data were presented as means and standard deviations, while categorical data were reported as frequencies and percentages. This format was chosen to provide a general overview of cost variation and

patient profiles within the study population. All statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS).

RESULT AND DISCUSSION

Characteristics of Patients with Type 2 Diabetes Mellitus in the JKN System

A total of 10,299 patients with type 2 diabetes mellitus (T2DM) were included in the analysis, comprising 5,679 patients (55.1%) with complications and 4,620 patients (44.9%) without complications. The median age of the overall study population was 65 years (range 18–96 years), with a slightly higher median age among patients with complications (66 years) than among those without complications (63 years). This pattern reflects the natural course of T2DM as a progressive chronic disease: vascular damage and organ dysfunction develop gradually with prolonged hyperglycaemia, making complications more common among older patients (Khoe et al., 2020; Ong et al., 2023).

Before examining the magnitude of healthcare costs, it is important to understand the demographic and clinical profile of the study population, as patient characteristics directly influence patterns of healthcare utilisation and the resulting cost structure. Table 2 presents the distribution of study participants by age, sex, type of care, inpatient ward class, and length of stay, stratified by complication status. This profile provides the clinical and service context within which these costs arise.

Table 2. Characteristics of the Study Population

Variable	Total (n = 10,299)	With Complications (n = 5,679)	Without Complications (n = 4,620)
Age, median (range), years	65 (18–96)	66 (18–96)	63 (25–96)
Sex, n (%)			
— Male	4,092 (39.7)	2,158 (52.7)	1,934 (47.3)
— Female	6,207 (60.3)	3,521 (56.7)	2,686 (43.3)
Type of care, n (%)			
— Outpatient care	3,239 (31.4)	2,369 (73.1)	870 (26.9)
— Inpatient care	7,060 (68.6)	3,310 (46.9)	3,750 (53.1)
Inpatient ward class, n (%)			
— Class I	925 (13.1)	465 (50.3)	460 (49.7)
— Class II	2,366 (33.5)	954 (40.3)	1,412 (59.7)
— Class III	3,769 (53.4)	1,891 (50.2)	1,878 (49.8)
Length of stay, median (IQR), days	3 (2–7)	2 (2–5)	2 (2–7)

Source: data proceed

The data presented in Table 2 reveal several clinically and economically relevant patterns. The median age of the overall population was 65 years, with a three-year difference between patients with complications (66 years) and those without complications (63 years). This pattern reflects the nature of T2DM as a progressive chronic disease in which cumulative damage to blood vessels, kidneys, nerves, and the retina develops gradually over many years before appearing as clinically

recognised complications (Al-Salmawi, 2024; Patty et al., 2021). This finding is consistent with the literature identifying age and disease duration as the two strongest independent risk factors for the development of both microvascular and macrovascular complications in patients with T2DM.

The predominance of female patients (60.3%) in the overall population, which remained evident in the subgroup with complications (56.7%), should not be interpreted as evidence that women are biologically more susceptible to diabetic complications. A more plausible explanation is multifactorial. First, the prevalence of T2DM among women in Indonesia is closely associated with obesity and hypertension, both of which are more common among women across several age groups (Negara et al., 2021). Second, women in low- and middle-income countries tend to make greater use of formal healthcare services than men, making them more likely to be captured in claims databases (Butt et al., 2024). From a practical perspective, these findings suggest that T2DM management programmes at both the primary and secondary care levels should incorporate a gender-sensitive approach, given that women account for a larger share of the disease burden and healthcare utilisation within the JKN system.

The distribution of service type reveals a pattern that is not entirely intuitive. Inpatient care accounted for the majority of cases (68.6%). More notably, patients without complications were more frequently recorded in inpatient claims (53.1%), whereas patients with complications predominated in outpatient visits (73.1%). This pattern suggests that hospital-based episodes involving high-cost procedures are not always accompanied by adequate complication coding in claims diagnoses. It is likely that some patients underwent intensive interventions, such as cardiology procedures, urological treatment, or other invasive services, without explicit documentation of diabetes-related complications in the diagnostic coding, and were therefore classified administratively as having “no complications.” This phenomenon has direct implications for the distribution of costs between the two groups, as discussed further in the cost analysis section.

The distribution of ward class shows that most inpatients were treated in Class III wards (53.4%), followed by Class II (33.5%) and Class I (13.1%). This pattern is consistent with the structure of the JKN system, in which Class II and Class III services form the core of inpatient care for most beneficiaries, particularly contribution assistance recipients (*Penerima Bantuan Iuran*, PBI) and middle- to lower-income workers (Asante et al., 2023). The relatively similar distribution of ward class between patients with and without complications in Classes I and III suggests that ward class is shaped not only by clinical severity but also by insurance eligibility status and facility capacity. The median length of stay was three days for the overall population and two days in both subgroups, indicating that differences in cost between groups were driven less by length of stay than by differences in the intensity and complexity of care delivered during the treatment period.

Profile of Type 2 Diabetes Mellitus Complications

Understanding the distribution of complication types and categories is an essential step in analysing the cost burden of T2DM, as each complication carries distinct clinical and economic consequences. Among the 5,679 patients identified as having complications, further classification was undertaken based on the types of complications recorded in the claims diagnosis codes. These were then grouped into three broad categories according to their pathophysiological mechanisms: macrovascular, microvascular, and metabolic. Table 3 presents the frequency distribution of these complications.

Table 3. Profile of Complications Among Patients with Type 2 Diabetes Mellitus (n = 5,679)

Type of Complication	n (%)
Cardiovascular	2,032 (35.78)
Hypoglycaemia	1,989 (35.02)
Nephropathy	1,506 (26.51)
Cerebrovascular	134 (2.36)
Retinopathy	11 (0.19)
Neuropathy	7 (0.12)

Source: Data Proceed

Direct Medical Cost by Complication Status and Type of Service

Among the 5,679 patients with complications, the most frequently recorded complications were cardiovascular complications (35.78%) and hypoglycaemia (35.02%), followed by nephropathy (26.51%). Cerebrovascular complications, retinopathy, and neuropathy were reported far less often. The predominance of cardiovascular complications is consistent with international evidence showing that coronary heart disease, heart failure, and peripheral arterial disease are major causes of morbidity and mortality among patients with T2DM (Mansour et al., 2023; Oktora & Butar, 2022; Sandra et al., 2023).

The high proportion of hypoglycaemia (35.02%) as a metabolic complication reflects a major challenge in the pharmacological management of T2DM, particularly among older patients treated with insulin or combinations of glucose-lowering agents. Khunti et al. (2015) reported that 30–60% of patients with T2DM experience at least one hypoglycaemic episode each year. Among older adults with a long duration of disease, severe hypoglycaemia requiring emergency intervention or even hospitalisation is not uncommon (Farmaki, 2020). These findings underscore the need for stronger patient education on treatment management and hypoglycaemia prevention, particularly as an integral component of the Prolanis and Referral Back Programmes.

The very low proportions of neuropathy (0.12%) and retinopathy (0.19%) in these claims data warrant careful interpretation. This pattern most likely reflects limitations in the recording of secondary diagnoses within the claims system rather than the actual absence of these complications among patients. Underreporting of complications in claims

data is a methodological limitation that has been consistently noted in studies using administrative datasets (Patty et al., 2021).

This study primarily focuses on measuring and comparing direct medical costs between patients with T2DM with and without complications, while also examining how these costs vary by sex, type of service, and ward class. Total costs were calculated as the sum of INA-CBGs and non-CBGs components across all episodes of care received by each patient during the 2023 calendar year. Table 4 presents the mean annual direct medical cost, expressed in million Indonesian rupiah, together with standard deviations for each subgroup. These estimates reflect not only average expenditure but also the degree of cost variation within the study population.

Table 4. Direct Medical Cost by Complication Status and Type of Service (in million Indonesian rupiah)

Variable	Total (n = 10,299)	With Complications (n = 5,679)	Without Complications (n = 4,620)
Annual direct medical cost	685 ± 1,808	415 ± 1,457	1,016 ± 2,116
Sex			
Male	663 ± 1,665	469 ± 1,549	880 ± 1,767
Female	669 ± 1,896	381 ± 1,396	1,114 ± 2,334
Type of care			
Outpatient care	104 ± 186	58 ± 69	229 ± 308
Inpatient care	951 ± 2,127	670 ± 1,866	1,199 ± 1,306
Inpatient ward class			
Class I	245 ± 669	142 ± 801	349 ± 480
Class II	449 ± 1,309	352 ± 1,164	547 ± 1,436
Class III	2,273 ± 3,080	1,874 ± 2,847	2,542 ± 3,101

Source: Data Proceed

Table 4 presents findings that may appear paradoxical at first glance but, in fact, offer important diagnostic insight into how the JKN claims system operates. The mean annual direct medical cost for all patients was IDR 685 ± 1,808 million, indicating a highly right-skewed distribution. A standard deviation nearly three times the mean suggests that a small number of patients incurred extremely high-cost episodes, pulling the average sharply upward, while most patients incurred costs well below the mean. This pattern is common in healthcare cost distributions and helps explain why the median, which is less sensitive to outliers, is often more representative of the typical cost per patient, although the mean and standard deviation remain relevant for aggregate budget planning.

The most notable finding in this table is that the mean cost among patients without complications (IDR 1,016 ± 2,116 million) was higher than that of patients with complications (IDR 415 ± 1,457 million), reversing expectations based on previous studies. Using 2016 JKN data, (Hidayat et al., 2022) reported the opposite pattern, with complications generating nearly twice the cost, and similar findings have been consistently documented in systematic reviews of diabetes-related Cost

of Illness studies in Indonesia and in international literature (Butt et al., 2024; Patty et al., 2021). Several mechanisms may help explain this pattern in the 2023 data. First, patients undergoing very high-cost procedures, such as percutaneous coronary intervention, heart valve surgery, or intensive haemodialysis, may not always be coded explicitly as having diabetes-related complications in claims records, and may therefore be administratively classified as having no complications despite clinically significant disease. Second, stricter claims verification and reimbursement controls introduced by BPJS Kesehatan since 2023 may have affected complication-coded claims more strongly, particularly when additional justification was required, thereby shifting coding practices. Third, the case mix may have changed between 2016 and 2023, with more patients without documented complications being hospitalised for high-cost elective procedures not directly attributed to diabetes. These explanations are not mutually exclusive and should be considered together when interpreting the cost differences between the two groups.

Cost differences by sex also show a pattern that varies according to complication status. At the aggregate level, mean costs were nearly identical for men (IDR 663 ± 1,665 million) and women (IDR 669 ± 1,896 million). Once stratified by subgroup, however, men with complications had higher mean costs (IDR 469 ± 1,549 million) than women with complications (IDR 381 ± 1,396 million), whereas the pattern was reversed among patients without complications, where women had higher mean costs (IDR 1,114 ± 2,334 million) than men (IDR 880 ± 1,767 million). This interaction between sex, complication status, and service utilisation is complex and may reflect differences in comorbidity profiles, the types of procedures claimed, and healthcare-seeking behaviour within the JKN system.

By type of service, the nearly tenfold difference between inpatient care (IDR 951 ± 2,127 million) and outpatient care (IDR 104 ± 186 million) clearly identifies hospitalisation as the main cost driver in T2DM financing. This pattern was consistent across both subgroups. Among patients with complications, inpatient care (IDR 670 ± 1,866 million) was almost eleven times more expensive than outpatient care (IDR 58 ± 69 million). Among those without complications, the gap was even wider, with inpatient care costing IDR 1,199 ± 1,306 million compared with IDR 229 ± 308 million for outpatient care. These findings carry a clear strategic implication: any intervention that successfully prevents a single hospitalisation episode—whether through better glycaemic control, improved cardiovascular risk management, or optimisation of the Referral Back Programme—would likely yield substantially greater cost savings than efficiency gains achieved solely in outpatient care.

The cost pattern by inpatient ward class reveals another result that runs counter to tariff-based expectations. Class III, which has the lowest basic room tariff, recorded the highest mean cost (IDR 2,273 ± 3,080 million), well above Class II (IDR 449 ± 1,309 million) and Class I (IDR 245 ± 669 million). This pattern was consistent in both subgroups. Among patients with complications, Class III (IDR 1,874 ± 2,847 million)

remained more expensive than Class I (IDR 142 ± 801 million) and Class II (IDR 352 ± 1,164 million); the same pattern was observed among patients without complications. The most plausible explanation is that Class III serves patients who are generally more socioeconomically vulnerable, have poorer glycaemic and cardiovascular control, and face more limited access to preventive care before their condition deteriorates to the point of requiring hospital admission. As a result, once Class III patients are hospitalised, they often present in more severe condition, require more complex interventions, and need longer treatment, causing the total cost per episode to far exceed the basic ward tariff. Studies comparing actual costs with INA-CBGs tariffs in Indonesia have repeatedly reported similar patterns, in which complex cases in lower ward classes generate larger financing deficits for hospitals (Sri Astuti Marpaung et al., 2022; Sun et al., 2022; Wahyudi, Andayani, et al., 2024; Zakir et al., 2023). These findings reinforce the need not only to revise INA-CBGs tariffs for high-cost cases but also to strengthen upstream interventions that prevent Class III patients from reaching critical conditions requiring intensive and very costly care.

Most patients in this sample were older adults, with a median age of 65 years and a three-year difference between the groups with complications (66 years) and without complications (63 years). This pattern reflects the progressive nature of T2DM as a chronic disease in which cumulative vascular damage and organ dysfunction develop gradually over the course of prolonged hyperglycaemia. As a result, microvascular and macrovascular complications are more likely to occur in older patients with a longer disease history (Saeedi et al., 2019; Sandra et al., 2023).

The predominance of women (60.3%) in the overall sample, which remained evident in the subgroup with complications (56.7%), should not be interpreted solely as a reflection of greater biological susceptibility. Rather, it likely results from two overlapping mechanisms: the higher prevalence of key T2DM risk factors, particularly obesity and hypertension, among women in Indonesia (Mosadeghrad et al., 2022; Parker et al., 2024), and women's greater use of formal healthcare services, which increases the likelihood that their cases are captured in claims data (Lestari, 2025), this finding is relevant for the design of gender-sensitive chronic disease management programmes.

The geographic concentration of patients in West Java, Jakarta, and Yogyakarta reflects the unequal distribution of secondary and tertiary healthcare facilities that has been documented in previous analyses of JKN financing (Hu et al., 2021; Iwasaki et al., 2025). Provinces in eastern Indonesia contributed a much smaller share, which likely reflects limitations in access and service capacity rather than a lower clinical burden of disease. Variation in the proportion of complications across provinces also suggests differences in referral patterns and diagnostic coding practices, both of which should be considered when interpreting the data.

Inpatient care was the predominant type of service (68.6%), and most inpatients were treated in Class III wards (53.4%). This pattern is consistent with the structure of JKN, in which Class II and Class III services form the core of care for contribution assistance recipients (*Penerima Bantuan Iuran*, PBI) and middle- to lower-income workers (Galicia-Garcia et al., 2020; Gregg et al., 2019). Notably, patients without complications were more frequently recorded in inpatient claims (53.1%), whereas patients with complications were more common in outpatient visits (73.1%). This counterintuitive distribution suggests that costly hospital episodes are not always accompanied by adequate complication coding in claims records, a phenomenon with direct implications for the distribution of costs between the two groups.

Among the 5,679 patients with complications, the most frequently recorded types were cardiovascular complications (35.78%) and hypoglycaemia (35.02%), followed by nephropathy (26.51%). Cerebrovascular complications, retinopathy, and neuropathy accounted for only a very small proportion. The predominance of cardiovascular complications is consistent with the global literature, which identifies coronary heart disease, heart failure, and stroke as major causes of morbidity and mortality in patients with T2DM (Dunn et al., 2025; Fadila, Andayani, et al., 2025). These complications are closely associated with recurrent hospitalisation and longer treatment duration, thereby contributing substantially to total healthcare costs.

The high proportion of hypoglycaemia reflects a major challenge in pharmacological management, particularly among older patients treated with insulin or sulfonylureas. Severe hypoglycaemia requiring emergency intervention or hospitalisation occurs more frequently in patients with a long duration of T2DM (Farmaki et al., 2020), and in claims data this type of acute complication is more likely to be recorded accurately than chronic complications that develop gradually.

The very low proportions of neuropathy (0.12%) and retinopathy (0.19%) almost certainly do not reflect their true clinical prevalence. Globally, neuropathy is found in 30–50% of patients with T2DM, while retinopathy affects around 35% of those with a disease duration of more than 10 years (Sun et al., 2022; Wahyudi, Andayani, et al., 2024). This discrepancy suggests systematic undercoding of chronic complications within the JKN claims system, an inherent limitation of studies based on administrative data and a strong indication of the need to improve diagnostic recording practices across healthcare facilities.

By category, macrovascular complications were the most common (38.1%), followed by metabolic complications (35.0%) and microvascular complications (26.8%). Although microvascular complications appeared less frequently in the claims data, they carry substantial long-term cost implications, particularly through the need for renal replacement therapy in advanced nephropathy, they also often coexist with macrovascular complications, increasing the overall complexity of care (Saeedi et al., 2019; Sandra et al., 2023). The pathophysiological progression from microvascular to macrovascular damage underscores the importance of

early control of cardiometabolic risk factors as a means of reducing both clinical burden and long-term costs (Zakir et al., 2023).

The mean annual direct medical cost for all patients was IDR 685 ± 1,808 million, indicating a highly asymmetric distribution. A standard deviation nearly three times the mean suggests that a small number of patients experienced extremely costly episodes, sharply increasing the average, while most patients incurred much lower costs.

The most substantial finding was that the mean cost in the group without complications (IDR 1,016 ± 2,116 million) was higher than that in the group with complications (IDR 415 ± 1,457 million), reversing the pattern reported by Hidayat et al. (2022) using 2016 JKN data, in which the cost for the complication group was nearly twice as high. At least three mechanisms may explain this pattern. First, very high-cost procedures such as percutaneous coronary intervention or haemodialysis are not always explicitly coded as diabetes-related complications, causing such patients to be classified administratively as having no complications. Second, the intensified claims verification process introduced by BPJS Kesehatan since 2023 may have had a greater effect on claims coded with complications, particularly those requiring additional justification, thereby shifting coding practices. Third, changes in the case mix and in the dominant types of procedures between 2016 and 2023 may have produced a different cost profile. These mechanisms are not mutually exclusive and together form the context necessary for interpreting cost differences between the two groups. This finding shows that COI results cannot be interpreted independently of the financing system, claims policy, and coding practices in place during the observation period.

The nearly tenfold gap between inpatient costs (IDR 951 ± 2,127 million) and outpatient costs (IDR 104 ± 186 million) confirms quantitatively that hospitalisation is the primary cost driver in the financing of T2DM, consistent with (Hidayat et al., 2022) and several international studies. The implication is clear: any intervention that prevents a single hospital admission for T2DM, whether through better glycaemic control, improved risk-factor management, or optimisation of the Referral Back Programme, is likely to generate far greater savings than efficiency improvements confined to outpatient care.

The most striking finding in the ward-class analysis was that Class III, despite having the lowest basic room tariff, recorded the highest mean cost (IDR 2,273 ± 3,080 million), substantially exceeding Class II (IDR 449 ± 1,309 million) and Class I (IDR 245 ± 669 million). This pattern was consistent across both subgroups and aligns with findings from several Indonesian studies comparing actual costs with INA-CBGs tariffs (Rahayuningrum et al., 2016; Sri Astuti Marpaung et al., 2022; Tandah et al., 2024). The most plausible explanation lies in the profile of Class III patients, who generally have poorer glycaemic and cardiovascular control, more limited access to preventive care, and more severe clinical conditions at the time of admission. This combination requires more complex interventions and longer treatment duration, causing total

episode costs to exceed what would be expected based on ward tariff alone. (Fadila, Andayani, et al., 2025) similarly found that among patients with T2DM and cardiovascular or renal complications, actual treatment costs consistently exceeded INA-CBGs tariffs, reflecting a financing deficit that may threaten provider financial sustainability.

An understanding of these cost drivers provides an empirical basis for three interrelated policy implications from a strategic cost management perspective. For policymakers, the findings reinforce the urgency of strengthening primary care through Prolanis and the Referral Back Programme, both of which have been shown to improve treatment adherence and may reduce the use of high-cost services (Khoe et al., 2020). Regular evaluation of INA-CBGs tariffs and the development of more evidence-based strategic purchasing are also needed to align financial incentives with the prevention of complications (Putri, Andayani, et al., 2019; Saeedi et al., 2019). For hospital management, the implementation of standardised clinical pathways for T2DM, the establishment of clear cost centres, and analysis of key cost drivers such as length of stay, high-cost medications, and invasive procedures are concrete steps toward improving efficiency without compromising quality of care (Al-Salmawi, 2024; Satibi et al., 2019). For the JKN system as a whole, improving the consistency and quality of diagnostic recording and coding across all regions of Indonesia is essential if claims data are to reflect the true clinical burden accurately and serve as a reliable basis for budget planning.

It should also be noted that the economic burden of T2DM is borne not only by BPJS Kesehatan but also by households through indirect costs and productivity loss, especially when viewed from the perspective of financing equity. COI studies in low- and middle-income countries have shown that lower-income groups are particularly vulnerable to catastrophic health expenditure related to diabetes (Butt et al., 2024), and analyses of health financing in Indonesia confirm that although JKN has improved financial protection overall, cost burdens remain disproportionately concentrated among certain vulnerable groups (Asante et al., 2023). This strengthens the argument that investment in better prevention and management of T2DM is not merely an efficiency strategy, but also an equity imperative within the social insurance system, as mandated by Law No. 24 of 2011 on the National Social Security System.

CONCLUSION

This study concludes that type 2 diabetes mellitus imposes a substantial direct medical cost burden on Indonesia's National Health Insurance system and remains a major challenge for the long-term sustainability of health financing. The findings show that cost patterns are shaped not only by the presence of complications, but also by differences in service utilisation, inpatient care, ward class, claims governance, and diagnostic coding practices. These results highlight the importance of strengthening primary care, improving chronic disease

management, and enhancing the accuracy of claims and diagnostic recording to support a more efficient, equitable, and sustainable financing system.

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