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Economic Evaluation

Direct Medical Cost of Type 2 Diabetes Mellitus and Its Associated Complications in Indonesia

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ABSTRACT

Objectives: To estimate the direct medical cost of type 2 diabetes mellitus (T2DM) and its complications in the Indonesian population from a payer perspective using a prevalence-based approach.

Methods: The direct medical costs in 2016 were estimated using the database of Indonesia's National Health Insurance, known as Jaminan Kesehatan Nasional, which included diagnosis-related group costs and unbundled costs for patients accessing advanced care. The study population included people aged 30 years or older having a diagnosis of T2DM. T2DM and its related complications were identified using the International Classification of Diseases, 10th Revision, code. Hypoglycemia and all complications listed in the Diabetes Severity Complications Index were included. Descriptive analysis was conducted. Costs were converted to 2016 US dollar equivalent.

Results: Of the 18.9 million Jaminan Kesehatan Nasional members who accessed secondary and tertiary care, 812 204 (4%) were identified with T2DM, of which 57% had complications. The most common complication was cardiovascular diseases (24%). The total direct medical cost was US $576 million, with 56% spent on hospitalization, 38% on specialist visits, 4% on unbundled non–diabetes-related medication, and 2% on unbundled anti-hyperglycemic medications. Approximately 74% of the total costs was used for the management of people with complications. People with complications (US $930/person/year ± US $1480/person/year) incurred twice the cost of those without complications (US $421/person/year ± US $745/person/year).

Conclusion: The direct medical cost for management of people with T2DM in Indonesia was high. Early diagnosis and optimal management of T2DM to prevent complications may reduce the costly sequelae and have a possibility of cost savings.

Keywords: claims database, diabetes mellitus, Indonesia, medical care costs, type II.

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Introduction

Diabetes in Indonesia

In 2019, Indonesia has 10.7 million people with diabetes, one of the highest absolute prevalence worldwide.[1] This is projected to increase to 16.6 million in 2045.[1,2] Diabetes was one of the top 3 causes of death in Indonesia in 2017.[3] The burden is further compounded by uncontrolled diabetes, which adversely affects nearly every system of the human body.[4] The global DISCOVER study reported that, on average, people with type 2 diabetes mellitus (T2DM) receiving second-line glucose-lowering therapy in Indonesia were found to have the second-highest hemoglobin A1C (HbA1c) level at 8.7% among studied countries, after Oman at 8.8%.[5] The DiabCare project, which was conducted in primary, secondary, and tertiary care centers across Indonesia, also reported inadequate diabetes control among patients with T2DM.[6,7] It was conducted at 2 time points. The first survey recruited 1785 patients between 2008 and 2009, and the second survey enrolled 1967 patients between 2013 and 2014. Both surveys revealed that around two-thirds of patients did not achieve the recommended HbA1c target of less than 7%.

The Indonesian Healthcare System

In 2016, 65% of the Indonesian population was covered by National Health Insurance, otherwise known as Jaminan Kesehatan Nasional (JKN).[8] Indonesia employs a mixed payment system. The primary care operates on a capitated and noncapitated payment system. Secondary and tertiary care involve a bundled payment model or diagnostic-related group, known as Indonesia case-based groups (INA-CBGs), and unbundled fee-for-service model, also known as noncase-based groups (non-CBGs).[9] INA-CBGs, which provide a set price for a specific disease classification episode of care, covers professional fees, bed and board, diagnostics and laboratories, medicines and supplies, and operating room fees. The tariff differs by the class of facilities, hospital ownership, class of care, and region. The class of facilities ranges from A to D, with class

A being the highest and class D the lowest. Private hospitals have a slightly higher tariff (approximately 3%) than public hospitals.[10] High-cost drugs, such as chemotherapy and medicine for certain chronic diseases and special services for patients with cancer, are unbundled and itemized for reimbursement under the non-CBG system. The drugs provided for selected chronic diseases, including diabetes, are administered under the "Program Rujuk Balik," also known as the back-referral program. INA-CBGs cover the cost of a 7-day supply for glucose-lowering drugs such as metformin, glibenclamide, glimepiride, thiazolidinediones, and insulins listed in the national formulary. Non-CBGs reimburse the remaining 23 days of medication for patients under specialist care (as shown in Appendix Figure 1A in Supplemental Materials found at https://doi.org/10.1016/j.vhri.2021.04.006). This 23-day supply could be obtained from the hospital or accredited retail pharmacies. Those who could keep T2DM under control were stepped down to primary care and would receive the 30-day supply of medications from accredited pharmacies. They would be referred to the specialist again after 3 months.[11] In 2016, 80.5% and 0.3% of the expenditure of Badan Penyelenggara Jaminan Sosial (BPJS) Kesehatan, or Social Insurance Administration Organization, went to the payment of INA-CBGs and non-CBGs, respectively.[8] The rest was spent on capitation (17.7%) and noncapitation (1.5%) at primary care health facilities, including medicines, prevention programs, consultation, procedures, and examination services.

Cost of Diabetes in Indonesia

Several studies have examined the cost of T2DM in Indonesia. A study conducted in Dr. Sardjito Hospital investigated the costs incurred by 29 inpatients. The authors estimated that the episodic cost of treating patients with major complications of T2DM and comorbidities was Indonesian rupiah (IDR) 105 million (US $7892), which was approximately 20 times more than that of those with no complications and comorbidities (IDR4.5 million [approximately US $338]).[12] Other studies have also estimated the costs of diabetes mellitus-related complications, mainly on renal complications,[13,14] neuropathy, and foot ulcers.[15] In 2006, hemodialysis and peritoneal dialysis cost people with T2DM an additional US $4800 to US $6500/year,[14] and those with a renal transplant another additional US $720 000/year.[13] People who were noncompliant with medications for diabetes bore extra costs related to subsequent complications like neuropathy (US $800/year) and foot ulcers (US $1040/year).[15] Nevertheless, these studies were conducted within a facility with small sample sizes, most of which were conducted before the roll-out of JKN in 2014. There has not been a comprehensive study examining the direct medical costs of T2DM and its related complications across Indonesia. Furthermore, the costs of cardiovascular, ophthalmic, other peripheral vascular, and neurological complications remain unknown. Most importantly, data extraction methods, such as identifying complications and comorbidities using unified coding, have not been detailed in previous cost studies in T2DM. The objective of this study was to estimate the direct medical cost of T2DM and its associated complications in Indonesia.

Methodology

This was a retrospective cohort study using the JKN database. A payer perspective was adopted to estimate the direct medical costs of T2DM in Indonesia and its associated complications. The following 7 categories of complications specified by the Diabetes Complications Severity Index (DSCI) were included: cardiovascular disease, nephropathy, ophthalmic conditions, peripheral vascular disease, neuropathy, cerebrovascular conditions, and metabolic conditions.[4] Iatrogenic hypoglycemia, another well-recognized complication of T2DM, was also investigated.[16] This study used a prevalence-based approach to estimate costs related to diabetes; its comorbidities, namely, dyslipidemia and hypertension; and its complications in 1 year. The research was approved by the ethics committee of the Faculty of Public Health at the University of Indonesia.

Data Source

The JKN database contains the INA-CBGs that hold reimbursement records for hospitalized and specialist outpatient care in all public and BPJS-contracted private facilities. In 2016, 18.9 million of the 170 million people (11%) insured by JKN used its referral healthcare in secondary and tertiary hospitals. Information stored in the database was closely related to the reimbursement system. In early 2018, we extracted diabetes cases that emerged from January to December 2016 from the JKN database which ensured that all incurred cases were reported. The hospitalization records captured total bundled cost; details of costs by a list of services provided to the patient during the inpatient stay and specialist outpatient visits were unavailable. The database also captured non-CBGs costs.[17] Although primary care visits were also captured in the JKN database, no costs were recorded owing to the capitation system. Therefore, we did not include the costs of primary care in this study. A diagrammatic representation of what is included in this data source is summarized in Appendix Figure 1B in Supplemental Materials found at https://doi.org/10.1016/j.vhri.2021.04.006. All data were anonymized.

Study Population and Medical Conditions

From the extraction, we only included the study population of people above 30 years of age and had T2DM-related claims between January 1, 2016, and December 31, 2016. We excluded those younger than 30 years to minimize the inclusion of persons with type 1 diabetes. People with T2DM were identified as those indicated with the International Classification of Diseases, Tenth Revision (ICD-10) code E11 in either the primary or secondary diagnosis. ICD-10 codes listed in the DSCI were used to identify individuals with T2DM-related complications. Comorbid conditions included dyslipidemia, as coded by ICD-10 E78.5, and hypertension, as coded by ICD-10 I10 to I16. Iatrogenic hypoglycemia was identified by ICD-10 E16 (drug-induced hypoglycemia), ICD-10 T38.3X (poisoning by insulin and oral hypoglycemic drugs), ICD-10 E11.649 (T2DM with hypoglycemia, but without coma), and E11.641 (T2DM without hypoglycemic coma).

Cost Analyses

The annual total direct medical cost of T2DM comprised the total inpatient costs, the total specialist outpatient costs, and the total cost of drugs included in the non-CBGs. All costs were standardized to the 2016 US dollar equivalent of IDR (US $1 approximately IDR13 305). Data were summarized using frequencies, percentages, mean (± standard deviation), and median (interquartile range). Descriptive statistical analyses were conducted using Stata version 15 (StataCorp LLC, College Station, TX).

Results

Description of the Study Population

The prevalence of T2DM and its associated complications is presented in Table 1. Of the 18.9 million insured people who

Table 1. Characteristics of people with type 2 diabetes mellitus captured in the National Health Insurance Database (Jaminan Kesehatan Nasional) in Indonesia in the year 2016.

Characteristics	All (N = 812 204)	Without complications (n = 351 706)		With complications (n = 460 498)	
	n	n	%	n	%
Gender					
Male	349 232	144 345	41.3	204 887	58.7
Female	462 972	207 361	44.8	255 611	55.2
Age, y					
31-40	39 101	23 202	59.3	15 899	40.7
41-50	150 421	75 128	49.9	75 293	50.1
51-60	305 312	132 422	43.4	172 890	56.6
61-70	225 899	87 000	38.5	138 899	61.5
71 and above	91 471	33 954	37.1	57 517	62.9
Province					
Java	522 571	208 010	39.8	314 561	60.2
Sumatra	161 216	76 870	47.7	84 346	52.3
Bali	9914	4632	46.7	5282	53.3
Nusa Tenggara	15 370	8512	55.4	6858	44.6
Kalimantan	43 142	20 942	48.5	22 200	51.5
Sulawesi	50 005	27 089	54.2	22 916	45.8
Maluku	3927	2266	57.7	1661	42.3
Papua	6059	3385	55.9	2674	44.1
Type of hospital					
Private	473 110	194 925	41.2	278 185	58.8
Public	296 404	111 430	37.6	184 974	62.4
Type of drugs received as part of the unbundled package (non-CBG)					
Had ever received medications for diabetes	263 192	87 108	33.1	176 084	66.9
Oral hypoglycemic agents only	147 052	51 027	34.7	96 025	65.3
Insulin only	73 557	24 291	33.0	49 266	67.0
Insulin and oral hypoglycemic agents	42 583	11 790	27.7	30 793	72.3
Had never received medications for diabetes	549 012	264 598	48.2	284 414	51.8
Received non–diabetes-related medications	506 151	248 546	49.1	257 605	50.9
Did not receive any medication at all	42 861	16 052	37.5	26 809	62.5
Comorbid conditions					
No dyslipidemia and no hypertension	350 973	194 728	55.5	156 245	44.5
Only dyslipidemia	16 540	7418	44.8	9122	55.2
Only hypertension	397 077	136 837	34.5	260 240	65.5
Dyslipidemia and hypertension	47 614	12 723	26.7	34 891	73.3

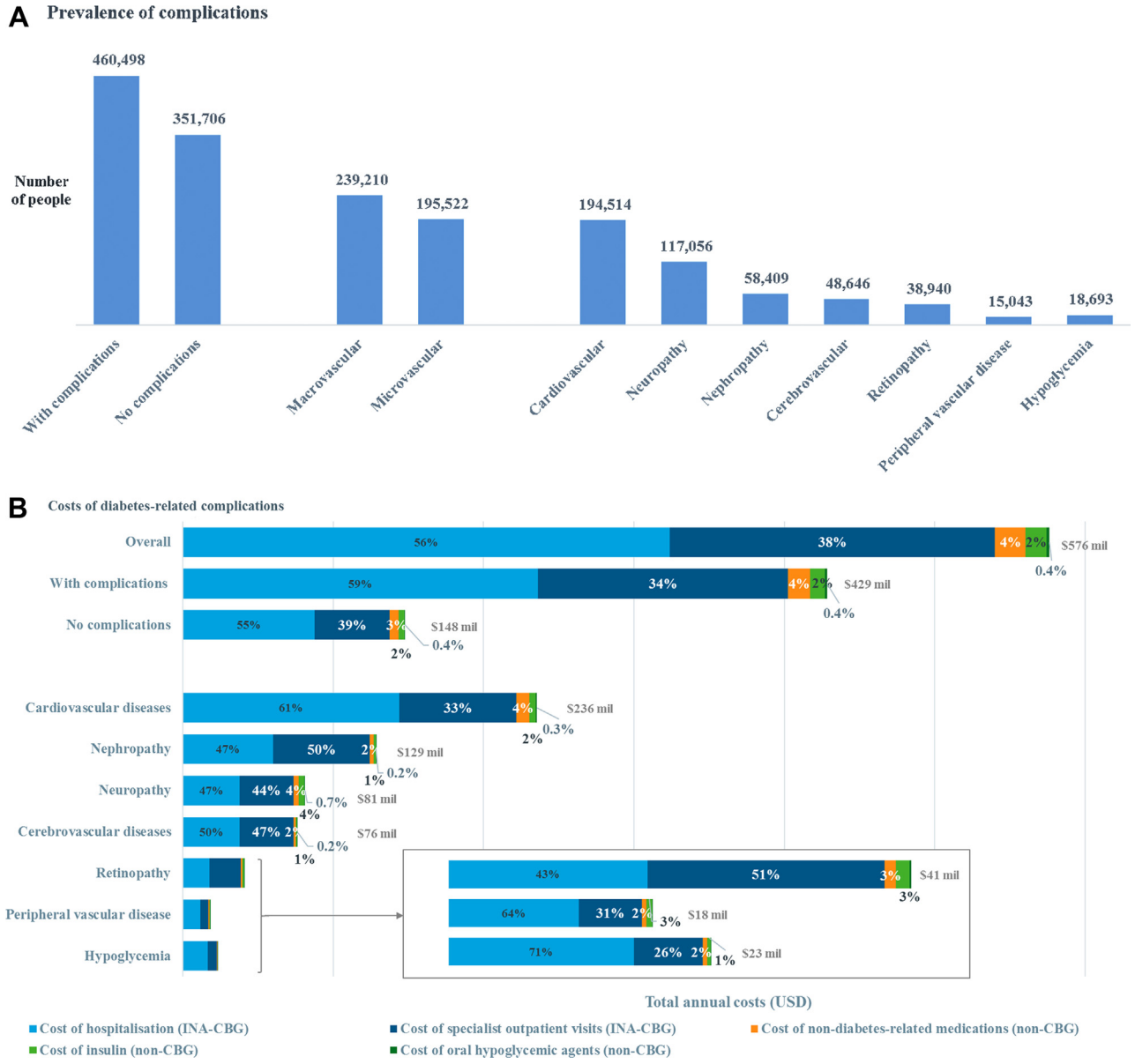
CBG indicates case-based group.

used the INA-CBGs and non-CBGs services of the JKN, 812 204 people (4%) were identified with T2DM diagnosis. In this study population, 57% had diabetes-related complications. Approximately 57% (n = 462 972) were females. Two-thirds of the study population were aged between 51 and 70 years and living in Java. More people were receiving treatment in private facilities (n = 473 110; 58%) than public facilities (n = 296 404; 42%). Approximately 57% had at least 1 comorbidity. Only 32% of the cohort received medications for T2DM as part of the unbundled payment model. Among them, 56% were treated with only oral hypoglycemic agents, 28% were treated with only insulin, and the rest (16%) were treated with both oral hypoglycemic agents and insulin.

Prevalence of T2DM Complications

The most common complication among all the patients was cardiovascular diseases (24%) (Fig. 1A). This was followed by neuropathy (14%), nephropathy (7%), cerebrovascular diseases (6%), retinopathy (5%), and peripheral vascular diseases (2%). Although no metabolic complications were found, 2% of the people with T2DM were found to have iatrogenic hypoglycemia. A higher prevalence of complications was seen in males than females (59% vs 55%). The prevalence of complications increased with age, with the lowest (41%) in those aged between 31 and 40 years and highest (63%) in those aged 71 years or above. In Java, Bali, Sumatera, and Kalimantan, more than half of the people with

Figure 1. (A) Prevalence of complications and (B) breakdown of the total direct medical cost of US $576 million in the management of diabetes mellitus and its associated complications among people who received a diagnosis of type 2 diabetes mellitus registered in the National Health Insurance, estimated for the year 2016. The INA-CBG is the local equivalent of the diagnosis-related group (DRG). A standard tariff is applied to each hospitalization or specialist outpatient visit based on the INA-CBG code. These standard tariffs include consultation, medical and related procedures, nursing care, treatments (7-day of the supply), and accommodation. Non-CBG covers a 23-day supply or a 30-supply of the unbundled medications from secondary or tertiary care and primary care, respectively.



CBG indicates case-based group; INA-CBG, Indonesia case-based group.

diabetes had complications. In comparison, the rest of Indonesia, namely, Nusa Tenggara, Sulawesi, Maluku, and Papua, had a prevalence of less than 50%. The presence of complications was similar between people receiving public care (62%) and private care (59%). People with both dyslipidemia and hypertension were seen to have the highest percentage of complications (73%), whereas those without any comorbid conditions had the lowest percentage (45%).

Mean Annual Direct Medical Cost

The mean annual direct medical cost was US $708/person (± US $1247/person). People with complications (US $930/person/year ± US $1480/person/year) incurred higher costs than those without complications (US $421/person/year ± US $745/person/year), and this trend remains unchanged regardless of the demographic differences (Table 2). The main cost driver for people with T2DM-related complications was inpatient hospitalization, with a mean cost of US $513 (± US $1067), accounting for 55% of the total mean costs (Fig. 2). Similarly, inpatient hospitalization was also the key cost driver for patients without complications at 59%. Table 3 shows that patients with complications had a higher healthcare resource use (inpatient visits and days and number of specialist outpatient visits).

Table 2. Annual mean cost (US dollars) of people with type 2 diabetes mellitus in the National Health Insurance Database (Jaminan Kesehatan Nasional) in Indonesia in the year 2016, by demographics and comorbid conditions.

Characteristics	Annual mean cost per person (US dollars), mean (SD)		
	All (N = 812 204)	With complications (n = 460 498)	Without complications (n = 351 706)
Gender			
Male	789 (1045)	1047 (1661)	431 (797)
Female	647 (1105)	837 (1315)	413 (710)
Age, y			
31-40	594 (1273)	865 (1555)	409 (993)
41-50	647 (1227)	903 (1530)	391 (733)
51-60	709 (1271)	936 (1522)	412 (737)
61-70	753 (1262)	951 (1476)	438 (703)
71 and above	757 (1120)	921 (1275)	478 (707)
Province			
Java	756 (1324)	965 (1540)	440 (809)
Sumatra	623 (1041)	830 (1265)	396 (649)
Bali	863 (1596)	1215 (1986)	462 (808)
Nusa Tenggara	480 (860)	692 (1113)	309 (523)
Kalimantan	620 (1054)	855 (1303)	371 (608)
Sulawesi	678 (1214)	976 (1580)	427 (685)
Maluku	506 (794)	718 (1079)	350 (427)
Papua	389 (643)	533 (857)	275 (364)
Type of hospital			
Private	782 (1330)	1022 (1578)	438 (741)
Public	1045 (1676)	1308 (1902)	604 (1097)
Comorbid conditions			
No dyslipidemia and no hypertension	510 (911)	656 (1075)	392 (734)
Only dyslipidemia	475 (757)	595 (886)	328 (524)
Only hypertension	880 (1469)	1101 (1682)	462 (784)
Dyslipidemia and hypertension	840 (1248)	981 (1394)	452 (543)

SD indicates standard deviation.

Total Direct Medical Cost

The total cost of the treatment of T2DM and its complications amounted to US $576 million in 2016, with 74% of the cost going for management of people with diabetes-related complications (Fig. 1B). The costs of hospitalization and specialist visits represented 56% and 38% of the total cost, respectively. Oral hypoglycemic agents and insulin were reimbursed under the non-CBGs payment model, accounting for 2% and 0.4% of the total cost, respectively. Overall, the total direct medical cost was the highest for people with cardiovascular diseases (US $236 million), followed by nephropathy (US $129 million), neuropathy (US $81 million), cerebrovascular diseases (US $76 million), retinopathy (US $41 million), and peripheral vascular diseases (US $18 million).

Figure 2. Annual mean direct medical cost among people who received a diagnosis of type 2 diabetes mellitus in the National Health Insurance, with (mean cost US $930) and without complications (mean cost US $420), estimated for the year 2016.

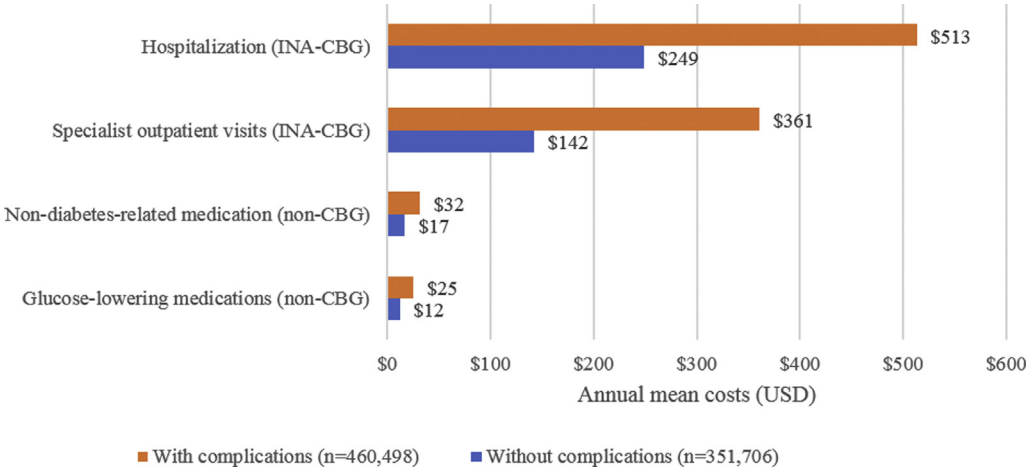


Table 3. Health care resource use among people with type 2 diabetes mellitus in the National Health Insurance Database (Jaminan Kesehatan Nasional) in Indonesia in the year 2016.

Type of health care resources	All (N = 812 204)	With complications (n = 460 498)	Without complications (n = 351 706)
Number of inpatient visits			
Mean (SD)	0.9 (1.4)	1.05 (1.5)	0.71 (1.2)
Median (IQR)	1 (0-1)	0 (0-1)	0 (0-1)
Inpatient days			
Mean (SD)	19.58 (19.12)	24.32 (21.61)	13.37 (12.82)
Median (IQR)	15 (7-25)	19 (10-31)	10 (5-18)
Number of specialist outpatient visits			
Mean (SD)	14.08 (16.51)	17.8 (18.83)	9.1 (11.1)
Median (IQR)	9 (3-20)	13 (5-24)	5 (2-13)

IQR indicates interquartile range; SD, standard deviation.

The total cost for managing people with hypoglycemia was US $ 23 million in 2016.

Discussion

Indonesia has one of the highest prevalence of adults having a diagnosis of diabetes worldwide.[1] This is the first study that analyzed data derived from the largest single-payer scheme worldwide[18] to provide a granular understanding of the cost of T2DM. The unremitting nature of this disease was estimated to cost the BPJS Kesehatan US $567 million in 2016, amounting to 10% of its total medical spending.[19] The management of persons with T2DM-related complications accounted for three-quarters of the total cost of T2DM. Despite the sheer cost of diabetes presented in this study, this estimate is conservative. Apart from excluding direct nonmedical costs and indirect costs, this study did not include the cost incurred at primary care, which is disbursed through capitation. Although the study investigated diabetes-related complications considered in the DSCI, it did not include other common diabetes complications, such as erectile dysfunction. The latter was found to affect one-third of the male patients in the latest DiabCare survey.[6] Our study also did not include any metabolic complications other than hypoglycemia. This could be explained by the unreported ICD-10 codes, which correspond to the INA-CBG codes. Nonetheless, our study findings corroborate those from previous studies in the Asia region[20–22] and locally[15,23] showing higher direct medical costs associated with T2DM-related complications and that the total annual healthcare cost were the highest for patients with cardiovascular complications.[21,22]

Our findings and other evidence highlighted room to improve healthcare access, although this was not directly investigated in this study. We found that less populous regions had a lower proportion of complications. In these regions, the true phenomenon could be masked by lower access to healthcare facilities or use of services or lack of skilled healthcare workers, which warrants further research. Another poor marker of access to care is the fact that there remains 7.9 million people with undiagnosed diabetes in Indonesia.[1] Furthermore, we estimated that approximately 1.5 million individuals should be receiving advanced care, based on the International Diabetes Federation estimate of 2.7 million people having a diagnosis of T2DM and assuming a 55% complication rate from a population-based study in Vietnam.[1,21] The discrepancy between this estimate and the number of individuals captured in this study could signify a significant proportion of the people with diagnosed diabetes still did not receive any form of treatment, were not aware of their complications, or were not covered by the insurance.

The total cost is likely to increase in the coming years owing to several factors. First, a rapidly expanding population in Indonesia will result in more people with diabetes, even if the prevalence of diabetes remains constant. Indonesia's population, as of 2019, stands at approximately 271 million. This would increase to more than 300 million by 2045.[24] Second, the percentage of people with diabetes has been steadily increasing from 4.6% in 2009 to 6.2% in 2019.[1,25] Next, alongside the increasing coverage of health insurance and widening array of reimbursed treatments, the use of healthcare services has risen since the introduction of universal healthcare coverage.[26] Finally, undiagnosed and diagnosed diabetes, when unrecognized and untreated for a long time, respectively, portends poorer health outcomes and higher costs in the long-term. Several studies in Indonesia have also reported suboptimal glycemic control, a well-established precursor of complications, even among people receiving care.[5–7] As evident in this study, T2DM-related complications require more costly management and increase the burden on the healthcare system.

Limitations

Studies outside Indonesia have shown that healthcare costs of those with and without complications may differ for reasons other than the variables captured in this study, such as the duration of diabetes, differences in access to healthcare, income, or other dimensions of health.[27,28] Future studies intending to measure the causal effect of diabetes on medical care costs should collect these variables. The costs captured in the JKN database did not include the excess or deficit costs incurred by the healthcare provider or patient. It remains unknown whether the costs borne by the healthcare provider and patient are significant, although an empirical study before the JKN was fully implemented showed that the limit for more severe conditions imposed by the INA-CBGs was lower than the actual healthcare bill.[12] The generalizability of our study findings was also limited to JKN members who used services in secondary and tertiary care and were more likely to have severe conditions or uncontrolled T2DM. Owing to the nature of the reimbursement model, we could not break down costs by the type of resources such as laboratory tests and drugs, which could help us understand the varying resources needed to manage the conditions. We also did not separate the costs of the procedures from the bundled costs. Future studies capturing these parameters, as well as direct costs from a provider perspective, could be initiated through a direct survey to the healthcare service providers.

Implications

Because the costs captured in this study are entirely borne by public health insurance, the high costs represent an economic rationale for government intervention to prevent and reduce diabetes complications. The more relevant comparison is not the complications to the noncomplications, but controlled diabetes to uncontrolled diabetes. The DiabCare project and the DISCOVER study have consistently shown that poorly controlled diabetes still prevails among those receiving glucose-lowering therapy.[5–7] These patients were managed mainly in secondary or tertiary care. Nevertheless, our findings showed that only 33% of the patients receiving advanced care were prescribed a 23-day supply of antiglycemic medications, whereas the rest did not receive antiglycemic medications as part of the non-CBGs. The reasons for this phenomenon remain to be elucidated although a few possibilities exist. First, the nature of the bundled payment model could lead to a change in provider practice, including the reduction of unnecessary and necessary services.[29–31] Individuals attending specialist care might not be receiving the treatment aligned with the standard management of treating people with diabetes. This inconsistent management treatment could worsen the course of the disease and lead to costly complications. Second, instead of monthly specialist visits, persons with T2DM could also return to the specialist more frequently than required to receive their medications.[31] If this is true, this would significantly strain the healthcare system owing to increased and probably non-essential visits. Hence, reform on the existing bundled payment model should be made by taking into account the unintended effects of the bundled payment model and institutionalizing a utilization review program. Finally, patients could also be receiving glucose-lowering therapy in non-BPJS facilities, which is unlikely because of the chronicity of this condition and its associated costs. When all perspectives are taken into considerations, there should be clearer requirements for providers of advanced care to give individuals sufficient medications until the next healthcare visit or as clinically appropriate. With more than 80% of the BPJS Kesehatan's expenditure spent on secondary care in 2016, there is also a strong case to strengthen primary care. Today, primary healthcare physicians are only allowed to prescribe metformin, glibenclamide, and glimepiride or continue the prescriptions (including insulin) previously issued by specialists for people with well-controlled T2DM, that is, the *Program Rujuk Balik* patients. Step-up therapy, such as initiation of insulin, is only recommended when the HbA1c level is more than 9% and is only available at higher facilities. The cumulative delays in care seeking and referral to specialized care may further worsen glycemic control. As recommended by the International Diabetes Federation, empowering primary care physicians on prescribing insulin could be a cost-effective way to keep blood glucose under control, preventing long-term complications.[32]

Conclusion

This article adds to a growing literature noting associations between T2DM complications and health services use and costs. It showed the burden that T2DM imposes on individual health and the financial consequences borne by public health insurance. Timely and optimal management of T2DM can be achieved through continuous monitoring and treatment at all levels of care. With early diagnosis, these will have potential savings capacity by avoiding its complications, such as cardiovascular diseases and nephropathy. Because primary care is the cornerstone of population health management, improving access and empowering primary care physicians are also effective ways to encourage early diagnosis and maintain glycemic control, improve health outcomes, and decrease the use of more costly services.

Supplemental Materials

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.vhri.2021.04.006.

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REFERENCES

1. International Diabetes Federation. *IDF Diabetes Atlas. 9th ed*. International Diabetes Federation: Brussels, Belgium; 2019. https://www.diabetesatlas.org/en/. Accessed June 23, 2021.

2. International Diabetes Federation. *IDF Diabetes Atlas. 7th ed*. Brussels, Belgium; 2019. https://www.idf.org/e-library/epidemiology-research/diabetes-atlas/13-diabetes-atlas-seventh-edition.html. Accessed June 23, 2021.
3. Indonesia profile. Institute for Health Metrics and Evaluation. http://www.healthdata.org/indonesia. Accessed March 11, 2020.
4. Glasheen WP, Renda A, Dong Y. Diabetes Complications Severity Index (DCSI)-update and ICD-10 translation. *J Diabetes Complications*. 2017;31(6):1007–1013.
5. Gomes MB, Rathmann W, Charbonnel B, et al. Treatment of type 2 diabetes mellitus worldwide: baseline patient characteristics in the global DISCover study. *Diabetes Res Clin Pract*. 2019;151:20–32.
6. Cholil AR, Lindarto D, Pemayun TGD, Wisnu W, Kumala P, Puteri HHS. DiabCare Asia 2012: diabetes management, control, and complications in patients with type 2 diabetes in Indonesia. *Med J Indones*. 2019;28(1):47–56.
7. Soewondo P, Soegondo S, Suastika K, Pranoto A, Soeatmadji DW, Tjokroprawiro AJM. The DiabCare Asia: 2008 study–outcomes on control and complications of type 2 diabetic patients in Indonesia. *Med J Indones*. 2010;19(4):235–244.
8. Kesehatan BPJS, RE Laporan. Pengelolaan Program dan Laporan Keuangan Jaminan Sosial Kesehatan. https://bpjs-kesehatan.go.id/bpjs/dmdocuments/b39df9ae7a30a5c7d4bd0f54d763b447.pdf. Accessed February 10, 2020.
9. Ministry of Law and Human Rights Republic Indonesia. Peraturan Presiden Republik Indonesia No 28 tahun. 2016 Tentang Jaminan Kesehatan. Precidential Regulation No 28 2016 about National Health Insurance; 2016.
10. Ministry of Health Republic Indonesia. *Peraturan Menteri Kesehatan Republik Indonesia No 64 tahun. 2016 Tentang Standar Tarif Pelayanan Kesehatan dalam Penyelenggaraaan Program Jaminan Kesehatan. Ministry of Health Decree No 64 2016 about Standard of Tariff for*. National Health Insurance Program; 2016.
11. Ministry of Health republic Indonesia. *Surat Edaran Nomor HK/Menkes*/32/I/2014 Tentang Pelaksanaan Pelayanan Kesehatan Bagi Peserta BPJS Kesehatan Pada Fasilitas Kesehatan Tingkat Pertama dan Fasilitas Kesehatan Tingkat Lanjutan dalam Penyelenggaraan Program Jaminan Kesehatan. Circular Letter Number HK / Menkes / I/2014 Regarding the Implementation of Health Services for Health BPJS Participants in First Level Health Facilities and Advanced Health Facilities in Implementing Health Insurance Programs. 2014.
12. Sari RP. Perbandingan biaya riil dengan tarif paket ina-cbg's dan analisis faktor yang mempengaruhi biaya riil pada pasien diabetes melitus Rawat inap jamkesmas di rsup dr. Sardjito Yogyakarta. *J Ilmiah Bisnis Keuangan*. 2016;4(1).
13. Markum HM. Renal transplantation problem in Indonesia. *Acta med Indones*. 2004;36(3):184–186.
14. Prodjosudjadi W. Incidence, prevalence, treatment and cost of end-stage renal disease in Indonesia. *Ethn Dis*. 2006;16(2 Suppl 2):S2–S16.
15. Andayani T, Ibrahim M, Asdie A. Assessing the impact of complications on the direct medical costs of type 2 diabetes mellitus outpatients. *Int J Cur Pharm Res*. 2010;2(2):32–35.
16. Shafiee G, Mohajeri-Tehrani M, Pajouhi M, Larijani B. The importance of hypoglycemia in diabetic patients. *J Diabetes Metab Disord*. 2012;11(1):17.
17. Ng JYS, Ramadani RV, Hendrawan D, Duc DT. Kiet PHT. National health insurance databases in Indonesia, Vietnam and the Philippines. *Pharmacoecon Open*. 2019;3(4):517–526.
18. Agustina R, Dartanto T, Sitompul R, et al. Universal health coverage in Indonesia: concept, progress, and challenges. *Lancet*. 2019;393(10166):75–102.
19. Kesehatan BPJS, Laporan Pengelolaan Program. Tahun 2016 dan Laporan Keuangan Tahun. *(Auditan)*. https://bpjs-kesehatan.go.id/bpjs/unduh/index/900. Accessed February 10, 2020.
20. Cheng SW, Wang CY, Chen JH, Ko Y. Healthcare costs and utilization of diabetes-related complications in Taiwan: a claims database analysis. *Med (Baltim)*. 2018;97(31):e11602.
21. Tuan Kiet Pham H, T Tuyet Mai Kieu, T Duc Duong, et al. Direct medical costs of diabetes and its complications in Vietnam: a national health insurance database study. *Diabetes Res Clin Pract*. 2020;162:108051.
22. Wang W, Fu CW, Pan CY, et al. How do type 2 diabetes mellitus-related chronic complications impact direct medical cost in four major cities of urban China? *Value Health*. 2009;12(6):923–929.
23. *RPJJIBdK. Perbandingan biaya riil dengan tarif paket ina-cbg's dan analisis faktor yang mempengaruhi biaya riil pada pasien diabetes melitus rawat inap jamkesmas di rsup dr. sardjito yogyakarta*-Sar i;Vol. 4(1); 2016.
24. Bappenas BPS, UNFPA. Indonesia Population Projection 2015-2045. https://indonesia.unfpa.org/en/publications/indonesia-population-projection-2015-2045-0. Accessed June 25, 2021.
25. Unwin N, Whiting D, Gan D, Jacqmain O, Ghyoot G. *International Diabetes Federation (IDF) Diabetes Atlas*. 4th ed. Brussels, Belgium: International Diabetes Federation (IDF); 2009.
26. Erlangga D, Ali S, Bloor K. The impact of public health insurance on healthcare utilisation in Indonesia: evidence from panel data. *Int J Public Health*. 2019;64(4):603–613.
27. Gutierrez JP, Garcia-Saiso S, Aracena BM. Mexico's household health expenditure on diabetes and hypertension: what is the additional financial burden? *PLoS One*. 2018;13(7):e0201333.
28. Sortsø C, Lauridsen J, Emneus M, Green A, Jensen PB. Socioeconomic inequality of diabetes patients' health care utilization in Denmark. *Health Econ Rev*. 2017;7(1):21.
29. Ellis RP. Creaming, skimping and dumping: provider competition on the intensive and extensive margins. *J Health Econ*. 1998;17(5):537–555.
30. Newhouse JP. Do unprofitable patients face access problems? *Health Care Financ Rev*. 1989;11(2):33–42.
31. Nurwahyuni A, Ramadani RV, Hidayat B. *Unintended Consequences of DRGS Payment in Indonesia*. 2019.
32. International Diabetes Federation. IDF clinical practice recommendations for managing type 2 diabetes in primary care. www.idf.org/managing-type2-diabetes.