Achievement of Metabolic Goals among Different Health Insurance Schemes in Thai Patients with Type 2 Diabetes Mellitus: a Nationwide Study

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ABSTRACT

Objective: Thailand has three healthcare insurance schemes, including: Universal Health Coverage (UHC), Social Health Insurance (SHI), and Civil Servant Medical Benefit (CSMB). UHC has the narrowest drug coverage, SHI uses its own list, and CSMB offers the greatest drug coverage. The aim of this study was to investigate metabolic goal achievement in patients with type 2 diabetes mellitus (T2DM) compared among the three healthcare schemes in Thailand.

Methods: Data were obtained from a nationwide survey administered by MedResNet during 2011 to 2012. A cross-sectional survey was conducted in patients with T2DM aged >35 years who were treated for at least 12 months. The data were retrospectively collected from medical records.

Results: Of 49,303 T2DM patients that were recruited, 69.8% were female. CSMB patients were the oldest and had the longest diabetes duration. Achievement of BP, HbA1c, and LDL goals was 32.8%, 33.3%, and 42.5%, respectively. UHC patients had the highest percentage of BP control achievement (<130/80 mmHg; 33.1%), while CSMB patients had the highest percentage of HbA_{1c} (<7%; 40.4%) and LDL (<100 mg/dL; 49%) achievement. CSMB patients had the highest prevalence of 2-goal (16.8% for T2DM without HT) and 3-goal achievement (8.2% for T2DM with HT). Multivariate analysis revealed the CSMB scheme to be significantly associated with 3-goal achievement compared to the UHC scheme (odds ratio: 1.48, 95% confidence interval: 1.30-1.67; $p<0.01$).

Conclusion: The prevalence of metabolic goal achievement in patients with T2DM in Thailand is low. CSMB patients have the highest prevalence of 2-goal and 3-goal achievement.

Keywords: Blood pressure; glycemic level; health insurance; lipid level; type 2 diabetes mellitus (Siriraj Med J 2020; 72: 1-9)

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a significant non-communicable disease. It can cause micro- and macro-vascular complications that lead to disability and mortality.[1] In addition to glycemic control, blood pressure and lipid control are also very important for reducing these vascular complications. Previous study demonstrated that intensified multifactorial intervention aimed at multiple risk factors reduced the risk of microvascular complications, cardiovascular events, and cardiovascular death.[2,3]

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Mortality and morbidity rates in patients with T2DM have fallen considerably over recent decades.[4-6] These improvements in diabetes care may be attributed to improvements in several factors, including level of patient (e.g., literacy, patient education, motivation), level of healthcare professional (e.g., knowledge, awareness), and level of healthcare system (e.g., broader list of drugs, increased budgets). For the healthcare professional, the Thai Clinical Practice Guideline for Diabetes was developed and it is revised approximately every 3 years. This guideline provides basic knowledge about diabetes, treatment goals, medication adjustment, and complication management. It is distributed to primary and secondary care physicians located in all regions of Thailand. Regarding the healthcare system, access to medical care and essential medicine are very important for optimizing outcomes. The cost of medicine consumed approximately 40% of the total direct medical cost in a developed country[7], and approximately 25-65% of total spending on health in developing countries.[8]

Thailand implemented universal health coverage in 2002. There are three main health insurance schemes, including: 1) the Civil Servant Medical Benefit (CSMB) scheme for government employees and their dependents, 2) the Social Health Insurance (SHI) scheme for private sector employees, and 3) the Universal Health Coverage (UHC) scheme for the rest of Thai population. In 2017, CSMB, SHI, and UHC covered approximately 4.4, 10.6, and 48.0 million Thai people, respectively.[9] The expansion of health insurance coverage increased access to medicines in primary care, especially for chronic diseases, such as diabetes and hypertension.[8] However, the drug lists, budgets, and payment methods all differ among the three health coverage schemes in Thailand. UHC has the narrowest drug coverage, as dictated by the Thailand National List of Essential Medicines (NLEM), with a closed-end budget system; SHI uses its own drug list with a closed-end budget system; and, CSMB offers the greatest drug coverage with an open-end budget system.[9] UHC and CSMB beneficiaries can receive medical service without any copayment while SHI beneficiaries have to pay a monthly deductible around 25 US dollars. Thus, the aim of this study was to investigate metabolic goal achievement in patients with T2DM compared among the three healthcare schemes in Thailand.

MATERIALS AND METHODS

Study design

The data evaluated in this study were obtained from a nationwide survey, entitled "An Assessment on Quality of Care among Patients Diagnosed with Type 2 Diabetes and Hypertension Visiting Ministry of Public Health and Bangkok Metropolitan Administration Hospitals in Thailand (Thailand DM/HT)". This survey was administered by the Medical Research Foundation Thailand (MedResNet). This survey was a cross-sectional study conducted in patients with T2DM and/or hypertension who were aged >35 years and treated for more than 12 months in hospitals across Thailand during 2011 to 2012. A two-stage stratified cluster proportional to the size sampling technique was used to select a representative sample of patients with T2DM and/or hypertension in Thailand. The first stage of sample collection was from the 77 provinces in Thailand that comprised 77 strata. The second stage of sample collection was from hospitals and clinics, which were stratified into five strata according to their size, in each province. University hospitals were excluded from this survey. At each hospital or clinic, health care personnel, usually a registered nurse would invite patients to participate into the study by signing a consent form for providing permission to review and abstract his or her medical records. The most recent data within 12 months, including general information, the status of diabetes complications, and laboratory results, were retrospectively collected from medical records by trained health care professionals. This national survey was approved by the Institutional Ethical Review Committee for Research in Human Subjects, Thailand Ministry of Public Health, and by the Royal Thai Army Medical Department Ethical Review Board. The authors of this study received approval to use the MedResNet database. The protocol for this study was approved by the Siriraj Institutional Review Board [SIRB] (Si 376/2014).

Study population

This study included patients with T2DM who were enrolled in the UHC, CSMB, and SHI public health insurance schemes in Thailand. Baseline characteristics and metabolic goal achievement were compared among health insurance schemes.

Goals of treatment

At the time of data collection, the targets of metabolic control were BP <130/80 mmHg, HbA_{1c} <7%, and LDL <100 mg/dL, as recommended by the American Diabetes Association (ADA) in 2011.[10] The BP and HbA_{1c} targets were the same targets as the current recommendations by the 2018 ESC/ESH Guidelines for the Management of Arterial Hypertension[11] and a consensus report by the ADA and the European Association for the Study of Diabetes.[12] However, the current recommendation for treatment of hypercholesterolemia recommends

using moderate- or high-intensity statin in people with diabetes.[13] There were 2 goals set for patients in the T2DM without HT group (HbA_{1c} and LDL), and there were 3 goals set for patients in the T2DM with HT group (BP, HbA_{1c}, and LDL).

Statistical analysis

Statistical analyses were performed using SPSS Statistics version 18.0 (SPSS, Inc., Chicago, IL, USA). Continuous data are reported as mean ± standard deviation (SD) or median and interquartile range (IQR), and categorical data are reported as number and percentage. One-way analysis of variance (ANOVA) or Kruskal-Wallis test was used to analyze continuous data, and chi-square test was used to evaluate categorical data. Univariate logistic regression analysis was used to identify factors significantly associated with 3-goal achievement. Multiple logistic regression analysis was employed to adjust factors associated with 3-goal achievement. A *p*-value less than 0.05 was considered statistically significant.

RESULTS

Baseline characteristics

Of the 49,303 T2DM patients recruited, 76.3% had UHC coverage, 19.5% had CSMB coverage, and 4.2% had SHI coverage. Around 69% (n=33,887) of patients had hypertension (DM with HT group). The mean ± standard deviation age of patients was 59±10.7 years, and 70% of patients were female. There were significant differences in baseline characteristics among the 3 healthcare schemes, as shown in Table 1. CSMB patients were the oldest and had the longest duration of diabetes, whereas SHI patients were the youngest and had the shortest duration of diabetes. The majority of UHC patients were followed-up at community hospitals. In contrast, CSMB and SHI patients were followed-up in relatively equal proportions at all 3 levels of hospitals. UHC patients had the lowest mean BP (131.5±16/75±10 mmHg), and CSMB patients had the lowest mean HbA_{1c} (7.7±1.8%) and LDL (106.0±37.0 mg/dL) levels.

Metabolic goal achievement

The overall achievement of BP, HbA_{1c}, and LDL goals was 32.8%, 33.3%, and 42.5%, respectively. Among the evaluated schemes, UHC patients had the highest percentage of overall BP control achievement (33.1%). CSMB patients had the highest percentage of overall glycemic (40.4%) and LDL control (49.0%) as shown in Fig 1. The achievement of HbA_{1c} and LDL goals was not different between UHC and SHI patients. CSMB patients had the highest prevalence of 2-goal and 3-goal achievement as shown in Fig 2A & B. Specific to 1-goal achievement, the percentage of LDL achievement was greater than that of HbA_{1c} and BP achievement. The overall percentage of 1-goal achievement was not different among the schemes. Regarding 2-goal achievement, the percentage of HbA_{1c} and LDL achievement was the greatest compared to other combinations. Metabolic goal achievement among DM with hypertension and without hypertension is shown in Table 2.

Univariate logistic regression analysis showed scheme, gender, age, duration of diabetes, and BMI to be associated with 3-goal achievement. Multiple logistic regression analysis revealed CSMB scheme (compared with UHC scheme), older age, shorter duration of diabetes, and lower BMI to be associated with 3-goal achievement (Table 3).

DISCUSSION

All Thai citizens have been covered by public universal health coverage since 2002. All three Thailand insurance schemes provide essential laboratory investigations and medications for blood pressure, glycemic, and lipid control. However, in the present study, the prevalence of each metabolic goal achievement in patients with T2DM was approximately 30-40% and 3-goal achievement was only 6.1%, which were close to the rates reported from developing countries[14,15] but lower than the rates reported from developed countries.[16,17] The 3-goal achievement percentage of study from India[14] and Ethiopia[15] was 9% and 8.5%, respectively. However, the BP goal of those studies was < 140/90 mmHg which was higher than BP goal of the present study. In the US during 2007-2010, the percentage of BP, HbA_{1c}, and LDL achievement was 51.3%, 52.2%, and 56.8%, respectively, while the rate of 3-goal achievement plus non-smoking status was 14.3%. The prevalence of metabolic goal achievement in the US increased markedly during 1999-2010.[16] In Thailand, the percentage of glycemic goal achievement increased from 26.3% in 2003 (data from Thailand Diabetes Registry (TDR) Project)[18] to 33.3% in the present study (2011-2012). However, the data in the TDR project came from university hospitals, which may treat cases of T2DM that are more complicated than those included in our study. In this study, the prevalence of LDL goal achievement was the highest, which is similar to the findings of a US study[16], followed by HbA_{1c} and BP goal achievement. However, there was no conclusion which risk factor had the greatest influence to morbidities and mortality in patients with T2DM. Lizheng Shi, *et al* suggested LDL level to be the strongest risk factor for diabetes complications and mortality in veterans with T2DM.[19] Soffia Gudbjörnsdottir,

TABLE 1. Baseline characteristics compared among different Thailand health schemes.

Characteristics	Total (N=49,303)	Universal Health Coverage Scheme (n=37,633)	Civil Servant Medical Benefit Scheme (n=9,641)	Social Health Insurance Scheme (n=2,029)	*P*-value
Hospital size, %					
Regional hospital (>500 beds)	15.6%	12.8%	23.0%	31.6%	
General hospital (200-500 beds)	22.9%	19.5%	33.7%	35.4%	***<0.01***
Community hospital (<120 beds)	61.5%	67.7%	43.4%	33.0%	
Female gender, %	69.8%	72.9%	61.4%	51.5%	***<0.01***
Age (years)	59±10.7	58.3±10.4	64.3±9.8*	49.4±8.8†‡	***<0.01***
<40 years, %	3.2%	3.3%	0.7%	13.8%	***<0.01***
40-49 years, %	14.9%	16.3%	5.4%	34.1%	
50-59 years, %	34.4%	36.2%	26.3%	40.2%	
60-69 years, %	29.7%	29.3%	35.4%	10.6%	
≥70 years, %	17.7%	14.9%	32.1%	1.4%	
BMI (kg/m^2), %	25.7±4.4	25.7±4.4	25.7±4.3	26.6±4.5†‡	***<0.01***
Duration of diabetes (years), median (IQR)	6 (3, 9)	6 (3, 9)	6 (4, 10)*	4 (3, 7)†‡	***<0.01***
<5 years, %	37.4%	38.3%	31.1%	51.0%	***<0.01***
5-9 years, %	41.4%	41.6%	41.6%	36.4%	
10-14 years, %	15.2%	14.6%	18.6%	9.9%	
≥15 years, %	6.0%	5.5%	8.7%	2.8%	
Blood pressure (mmHg)					
Hypertension group (n=33,887)					
Systolic	132.0±16	131.5±16.0	132.0±16.0*	133.0±16.0†‡	***<0.01***
Diastolic	75.0±11	75.0±10.0	74.0±11.0*	79.0±11.0†‡	***<0.01***
HbA_{1c}, %	8.1±2.0	8.2±2.0	7.7±1.8*	8.0±1.9‡	***<0.01***
LDL (mg/dL)	110±37	112±37	106±37*	111±37‡	***<0.01***
Triglyceride (mg/dL), median (IQR)	157 (113, 221)	155 (111, 128)	138 (100,192)*	143 (103, 199)†‡	***<0.01***
GFR (ml/min/1.73 m^2)	68±26	68±26	65±24*	84±24†‡	***<0.01***
Hypoglycemia, %	4.4%	4.6%	3.9%*	2.9%†‡	***<0.01***

Data presented as percentage (%) or mean ± standard deviation

* indicates $p<0.05$ between UHC and CSMB, † indicates $p<0.05$ between UHC and SHI, ‡ indicates $p<0.05$ between CSMB and SHI

Abbreviations: BMI = body mass index; IQR = interquartile range; HbA_{1c} = glycated hemoglobin; LDL = low-density lipoprotein cholesterol; GFR = glomerular filtration rate; UHC = Universal Health Coverage; CSMB = Civil Servant Medical Benefit; SHI = Social Health Insurance

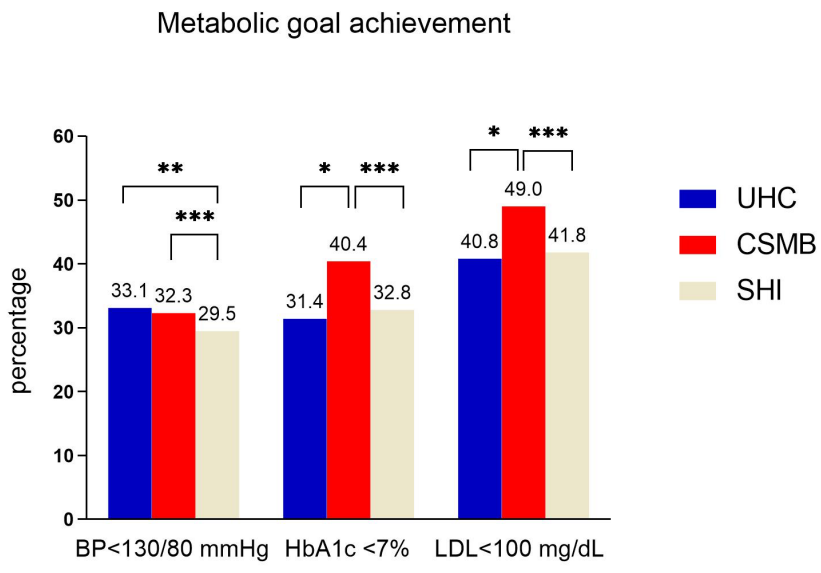

Fig 1. Metabolic goal achievement compared among different health schemes.
*indicates $p<0.05$ between UHC and CSMB ,
**indicates $p<0.05$ between UHC and SHI ,
***indicates $p<0.05$ between CSMB and SHI
Abbreviations: CSMB = Civil Servant Medical Benefit; SHI = Social Health Insurance; UHC = Universal Health Coverage

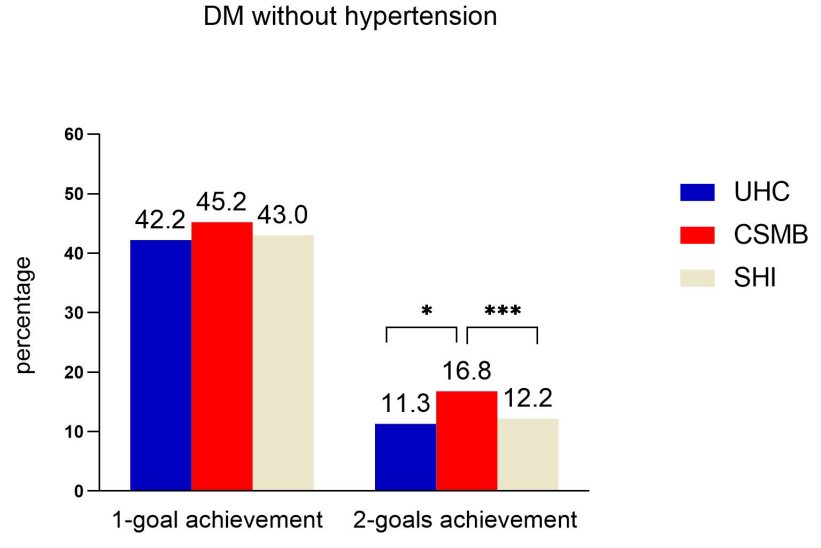

Fig 2A. Number of goal achievement of DM without hypertension group compared among different health schemes.
*indicates $p<0.05$ between UHC and CSMB ,
***indicates $p<0.05$ between CSMB and SHI
Abbreviations: CSMB = Civil Servant Medical Benefit; SHI = Social Health Insurance; UHC = Universal Health Coverage

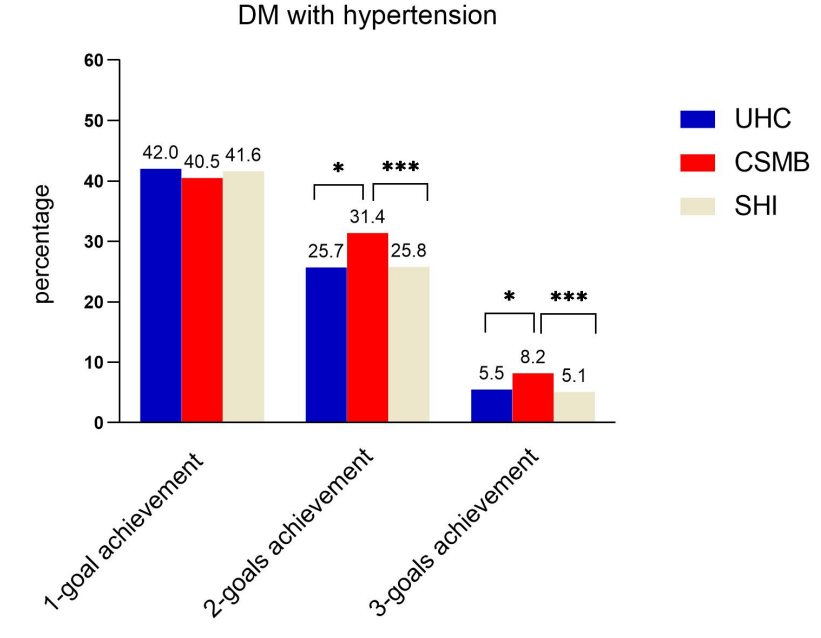

Fig 2B. Number of goal achievement of DM with hypertension group compared among different health schemes.
*indicates $p<0.05$ between UHC and CSMB ,
***indicates $p<0.05$ between CSMB and SHI
Abbreviations: CSMB = Civil Servant Medical Benefit; SHI = Social Health Insurance; UHC = Universal Health Coverage

TABLE 2. Metabolic goal achievement among DM with hypertension and without hypertension.

Metabolic goals	Total (n=49,303)	Universal Health Coverage Scheme (n=37,633)	Civil Servant Medical Benefit Scheme (n=9,641)	Social Health Insurance Scheme (n=2,029)	*P*-value
DM without hypertension	(n=15,416)	(n=12,383)	(n=2,319)	(n=714)	
1 goal achieved, %					
HbA_{1c} <7%	15.1%	14.6%	17.7%*	16.5%	***0.03***
LDL <100 mg/dL	27.6%	27.7%	27.5%	26.4%	0.84
2 goals achieved, %					
HbA_{1c} and LDL	12.3%	11.3%	16.8%*	12.2%‡	***<0.01***
DM with hypertension	(n=33,887)	(n=25,250)	(n=7,322)	(n=1,315)	
1 goal achieved, %					
HbA_{1c} <7%	12.3%	12.1%	13.1%	12.6%	0.12
LDL <100 mg/dL	17.4%	17.0%	18.5%	17.3%	0.06
BP <130/80 mmHg	11.9%	12.9%	8.9%*	11.7%‡	***<0.01***
2 goals achieved, %					
HbA_{1c} and LDL	11.5%	10.3%	15.0%*	12.7%†‡	***<0.01***
LDL and BP	9.7%	9.5%	10.3%	9.1%	0.19
HbA_{1c} and BP	5.8%	5.9%	6.0%	4.1%	0.052
3 goals achieved, %					
HbA_{1c} LDL and BP	6.1%	5.5%	8.2%*	5.1%‡	***<0.01***

*indicates $p<0.05$ between UHC and CSMB, †indicates $p<0.05$ between UHC and SHI, ‡indicates $p<0.05$ between CSMB and SHI
Abbreviations: BP = blood pressure; HT = hypertension; HbA_{1c} = glycated hemoglobin; LDL = low-density lipoprotein cholesterol; DM = diabetes mellitus; GFR = glomerular filtration rate; UHC = Universal Health Coverage; CSMB = Civil Servant Medical Benefit; SHI = Social Health Insurance

et al reported HbA_{1c} level to be the strongest predictor of stroke and acute myocardial infarction.[20] However, both of those studies confirmed that the higher the number of goals achieved to reduce cardiovascular risk factors, the lower the rate of morbidities and mortality.[19,20] This supports the importance of metabolic goal achievement in this patient population.

After adjusting for gender, age, duration of diabetes, and BMI, the CSMB scheme was still found to be associated with 3-goal achievement. This difference in metabolic control among schemes might be explained by one or more of the following factors: 1) differences in the lists of available medicine, 2) opportunity or not to consult a specialist, and/or 3) socioeconomic and/or geographic barrier.

First, UHC patients have to use the medicines listed in the Thailand NLEM (supplementary data), and most of these medicines are lower-cost alternatives. The drug list for SHI patients differs among hospitals, but it should be at least comparable to the NLEM. In contrast, the use of non-essential medicines is permitted for CSMB patients if physicians confirm them to be clinically indicated.[21]

TABLE 3. Multiple logistic regression analysis of 3-goal achievement.

Factors	Odds ratio	95% CI	*P*-value
UHC scheme	1.00		
CSMB scheme	1.48	1.30-1.69	***<0.01***
SHI scheme	0.99	0.71-1.41	0.99
Female	1.00		
Male	1.097	0.97-1.24	0.14
Age <40 years	1.00		
Age 40-49 years	2.55	1.11-5.88	***0.03***
Age 50-59 years	2.87	1.27-6.50	***0.01***
Age 60-69 years	3.34	3.34-1.48	***<0.01***
Age ≥70 years	4.29	4.29-1.89	***<0.01***
DM duration <5 years	1.00		
DM duration 5-9.9 years	0.95	0.83-1.08	0.44
DM duration 10-14.9 years	0.82	0.68-0.97	***0.02***
DM duration ≥15 years	0.64	0.49-0.83	***<0.01***
BMI ≥30 kg/m²	1.00		
BMI 25-29.9 kg/m²	1.21	0.99-1.48	0.55
BMI 23-24.9 kg/m²	1.43	1.15-1.77	***<0.01***
BMI <23 kg/m²	1.84	1.51-2.25	***<0.01***

A *p*-value<0.05 indicates statistical significance

Abbreviations: CI = confidence interval; UC = Universal Health Coverage; CSMB = Civil Servant Medical Benefit; SHI = Social Health Insurance; DM = diabetes mellitus; BMI = body mass index

For BP achievement, although only generic drugs are available in the NLEM, all antihypertensive drug classes are included. Contrarily, only moderate-intensity statin (NLEM 2008-2012) and low-cost anti-hyperglycemic agents are available in the NLEM for lipid and glycemic control. This might causes differences in lipid and glycemic control among schemes, but similar for BP control between UHC and CSMB. Second, UHC and SHI use a primary healthcare gatekeeping system. This means that patients can only access hospitals where they are registered, while CSMB allows patients to access specialists directly.[21] It should be mentioned that care given by specialists does not always ensure better metabolic control than care given by general practitioners.[22,23] Third, most CSMB patients live in urban settings and have higher socioeconomic status, whereas most UHC patients live in rural areas and have lower socioeconomic status.[21] Therefore, CSMB patients might have higher health awareness and health literacy. Although health centers and district hospitals are distributed across Thailand, geographic barriers remain a problem in some rural areas. However, data about the specialty of doctor, residency and socioeconomic status among health scheme were not collected in this study.

To reduce the disparities among health insurance schemes, the inclusion of some new anti-hyperglycemic agents and high potency statin with lowest acquisition cost to the NELM might improve glycemic and lipid control in UHC and SHI patients. There should also be strict indications and verification for the use of high-cost medicines to control the budget in all 3 schemes.

Otherwise, the expansion of the drug list will cause rapid cost escalation, as observed in the CSMB scheme. In 2014, expenditure per CSMB member was 4 times higher than that per UHC member.[21] Furthermore, appropriate referral to specialists might optimize metabolic goal achievement.

The strength of this study is a large number study population that represents all 5 regions of Thailand and different sized hospitals except university hospitals. Moreover, data were abstracted from medical records by trained healthcare professionals. Thus, the data used in this study should be considered more accurate than self-reported data. Although this study represents the context in 2011-2012, the trend of metabolic goal achievement among the 3 Thailand healthcare schemes may currently be the same. This hypothesis is based on the fact that the drug classes for BP, cholesterol and, glycemic control for type 2 diabetes in the NELM 2018 are similar to those listed in the NELM 2008-2012, except for the addition of a high-intensity statin for hypercholesterolemia treatment.

There are some limitations in this study. First, there might be some selection bias because of a nature of cross sectional study. Therefore, it can only demonstrate the association not cause and effect. Second, there were no data about other factors that might influence the metabolic goal achievements such as educational level, health literacy, income or residency. Therefore, we did not adjust those factors in the multiple logistic regression analysis. Finally, there were unequal sample sizes in each scheme since majority of Thai population use UHC scheme.

CONCLUSION

The prevalence of blood pressure, glycemic, and lipid control achievement in patients with T2DM in Thailand is low. CSMB patients have the highest prevalence of HbA_{1c}, LDL, 2-goal, and 3-goal achievement. Exploring the factors that contribute to differences among healthcare schemes may improve diabetes care in Thailand.

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REFERENCES

1. International Diabetes Federation. IDF Diabetes Atlas, 8th edn. Brussels, Belgium: International Diabetes Federation; 2017.
2. Gæde P, Vedel P, Larsen N, Jensen GV, Parving H-H, Pedersen O. Multifactorial intervention and cardiovascular disease in patients with type 2 diabetes. N Engl J Med 2003;348:383-93.
3. Gæde P, Lund-Andersen H, Parving H-H, Pedersen O. Effect of a multifactorial intervention on mortality in type 2 diabetes. N Engl J Med 2008;358:580-91.
4. Rawshani A, Rawshani A, Franzen S, Eliasson B, Svensson AM, Miftaraj M, et al. Mortality and Cardiovascular Disease in Type 1 and Type 2 Diabetes. N Engl J Med. 2017;376:1407-18.
5. Cheng YJ, Imperatore G, Geiss LS, Saydah SH, Albright AL, Ali MK, et al. Trends and Disparities in Cardiovascular Mortality Among U.S. Adults With and Without Self-Reported Diabetes, 1988-2015. Diabetes Care 2018;41:2306-15.
6. Gregg EW, Li Y, Wang J, Burrows NR, Ali MK, Rolka D, et al. Changes in diabetes-related complications in the United States, 1990-2010. N Engl J Med 2014;370:1514-23.
7. American Diabetes A. Economic Costs of Diabetes in the U.S. in 2017. Diabetes Care 2018;41:917-28.
8. Quick JD. Ensuring access to essential medicines in the developing countries: a framework for action. Clinical Pharmacology & Therapeutics. 2003;73(4):279-83.
9. Tangcharoensathien V, Witthayapipopsakul W, Panichkriangkrai W, Patcharanarumol W, Mills A. Health systems development in Thailand: a solid platform for successful implementation of universal health coverage. The Lancet. 2018.
10. Prevention I. Standards of medical care in diabetes—2011. Diabetes care. 2011;34:S11.
11. Williams B, Mancia G, Spiering W, Agabiti Rosei E, Azizi M, Burnier M, et al. 2018 ESC/ESH Guidelines for the management of arterial hypertension. Eur Heart J. 2018;39(33):3021-104.
12. Davies MJ, D'Alessio DA, Fradkin J, Kernan WN, Mathieu C, Mingrone G, et al. Management of hyperglycaemia in type 2 diabetes, 2018. A consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetologia. 2018;61(12):2461-98.
13. Grundy SM, Stone NJ, Bailey AL, Beam C, Birtcher KK, Blumenthal RS, et al. 2018 AHA/ACC/AACVPR/AAPA/ABC/ACPM/ADA/AGS/APhA/ASPC/NLA/PCNA Guideline on the Management of Blood Cholesterol: A Report of the

American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Journal of the American College of Cardiology. 2018:25709.
14. Kumar KH, Modi K. A1c, blood pressure and cholesterol goal achievement in patients of Type 2 diabetes. Medical Journal of Dr DY Patil University. 2016;9(2):195.
15. Belay E, Abera A, Mehari A, Gebremeskel G, Endrias A, Endris K. Achievements of Diabetes Goals and Their Determinants in Type 2 Diabetic Patients Attending Outpatient Diabetic Clinic in Northern Ethiopia. International journal of chronic diseases. 2017;2017.
16. Ali MK, Bullard KM, Saaddine JB, Cowie CC, Imperatore G, Gregg EW. Achievement of goals in U.S. diabetes care, 1999-2010. N Engl J Med. 2013;368(17):1613-24.
17. Yu SH, Kang JG, Hwang YC, Ahn KJ, Yoo HJ, Ahn HY, et al. Increasing achievement of the target goals for glycemic, blood pressure and lipid control for adults with diagnosed diabetes in Korea. J Diabetes Investig. 2013;4(5):460-5.
18. Kosachunhanun N, Benjasuratwong Y, Mongkolsomlit S, Rawdaree P, Plengvidhya N, Leelawatana R, et al. Thailand diabetes registry project: glycemic control in Thai type 2 diabetes and its relation to hypoglycemic agent usage. Journal of the Medical Association of Thailand = Chotmaihet thangphaet. 2006;89 Suppl 1:S66-71.
19. Shi Q, Liu S, Krousel-Wood M, Shao H, Fonseca V, Shi L. Long-term outcomes associated with triple-goal achievement in patients with type 2 diabetes mellitus (T2DM). Diabetes research and clinical practice. 2018;140:45-54.
20. Rawshani A, Rawshani A, Franzen S, Sattar N, Eliasson B, Svensson AM, et al. Risk Factors, Mortality, and Cardiovascular Outcomes in Patients with Type 2 Diabetes. N Engl J Med. 2018;379(7):633-44.
21. Patcharanarumol W, Panichkriangkrai W, Sommanuttaweechai A, Hanson K, Wanwong Y, Tangcharoensathien V. Strategic purchasing and health system efficiency: A comparison of two financing schemes in Thailand. PLoS One. 2018;13(4):e0195179.
22. De Berardis G, Pellegrini F, Franciosi M, Belfiglio M, Di Nardo B, Greenfield S, et al. Quality of care and outcomes in type 2 diabetic patients: a comparison between general practice and diabetes clinics. Diabetes Care. 2004;27(2):398-406.
23. Arai K, Hirao K, Matsuba I, Takai M, Matoba K, Takeda H, et al. The status of glycemic control by general practitioners and specialists for diabetes in Japan: a cross-sectional survey of 15,652 patients with diabetes mellitus. Diabetes research and clinical practice. 2009;83(3):397-401.