ความชุกของภาวะความดันในเลือดสูง ไขมันในเลือดสูง และไตวาย ในผู้ป่วยเบาหวานชนิดที่ 2

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บทคัดย่อ

ประเทศไทยอยู่ในช่วงการเปลี่ยนสภาพทางประชากรที่มีแนวโน้มว่า ผู้ที่มีอายุมากขึ้นจะเป็นโรคไม่ติดต่อเรื้อรังรวมถึงโรคเบาหวาน งานวิจัยนี้ได้ศึกษาความชุกของภาวะความดันในเลือดสูง ไขมันในเลือดสูง และไตวาย ในผู้ป่วยเบาหวานชนิดที่ 2 จำนวน 234 ราย ที่เข้ารับการรักษาในโรงพยาบาลส่งเสริมสุขภาพ 6 แห่ง และโรงพยาบาลอำเภอหนองวัวซอ จังหวัดอุดรธานี ในปี พ.ศ. 2558-2559 โดยผู้วิจัย ได้วิเคราะห์ความสัมพันธ์ของผู้ป่วยโรคเบาหวานชนิดที่ 2 กับภาวะความดันในเลือดสูง ระดับ HbA1c ค่ายูเรียไนโตรเจน (blood urea nitrogen; BUN) ครีอะตินีน (creatinine; Cr) ระดับไขมันในเลือด ไมโครอัลบูมิน และการประมาณค่าอัตราการกรองของไต (estimated glomerular filtration rate; eGFR) ผลการศึกษาพบว่า ผู้ป่วยเบาหวานชนิดที่ 2 ร้อยละ 41 มีภาวะความดันในเลือดสูง ร้อยละ 34 มีระดับไขมันชนิด LDL-C มากกว่า 130 mg/dL และผู้ป่วยร้อยละ 48 มีค่า eGFR น้อยกว่า 90 mL/min/1.73m^2 และยังพบว่า อายุ ค่ายูเรียไนโตรเจน ครีอะตินีน และ eGFR ของผู้ป่วยสัมพันธ์กับภาวะความดันในเลือดสูง นอกจากนี้ อายุ ค่ายูเรียไนโตรเจน ครีอะตินีน และ HbA1c ของผู้ป่วยยังสัมพันธ์กับค่า eGFR stage ผลการวิเคราะห์แบบ univariate analysis ของผู้ป่วยซึ่งมีภาวะความดันในเลือดสูงกับอายุและเพศ แสดงให้เห็นว่า ภาวะความดันในเลือดสูงมีความสัมพันธ์กับค่า eGFR stage ของผู้ป่วยเบาหวานชนิดที่ 2 การศึกษานี้แสดงให้เห็นว่า ผู้ป่วยเบาหวานชนิดที่ 2 มีแนวโน้มที่จะมีภาวะความดันในเลือดสูง ไขมันในเลือดสูง และไตวายได้มาก ข้อมูลจากงานวิจัยนี้เป็นข้อมูลเบื้องต้น ซึ่งจะนำไปสู่การศึกษาปัจจัยที่ทำให้เกิดภาวะความดันในเลือดสูง ไขมันในเลือดสูง และไตวาย ในผู้ป่วยเบาหวานชนิดที่ 2 เพื่อเป็นแนวทางในการรักษาผู้ป่วยเบาหวานชนิดที่ 2 ต่อไป

คำสำคัญ: เบาหวาน ความดันในเลือดสูง eGFR ไตวาย

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Prevalence of Hypertension, Dyslipidemia and Renal Insufficiency in Type 2 Diabetic Patients

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Abstract

Thailand is amidst a demographic transition showing an aging trend with increasing non-communicable diseases including diabetes. The aim of this work was to study the prevalence of hypertension, dyslipidemia, and renal insufficiency in type 2 diabetic patients. Data were extracted from medical records of 6 health promoting hospitals and 1 general hospital in Nong Wua Saw District, Udon Thani Province, Thailand. Two hundred and thirty four records of Type 2 diabetic patients were retrieved and reviewed for hypertension, HbA1c level, blood urea nitrogen (BUN), creatinine level, blood lipid profile, microalbuminuria and eGFR during 2015-2016. Forty-one percent of the diabetic patients presented hypertension, thirty four percent LDL-C more than 130 mg/dL and forty eight percent eGFR less than 90 mL/min/1.73m^2. Age, BUN, creatinine, and eGFR of diabetic patients were associated with hypertension. Moreover, age, BUN, creatinine, and HbA1c of diabetic patients were associated with eGFR stage. Univariate analysis of diabetic patients with hypertension and parameters adjusted by age and gender has confirmed association of hypertension and eGFR stage of the patients. In conclusion, this study indicated that persons with T2DM tend to have hypertension, dyslipidemia, and kidney problem. Moreover, results of this study will serve as primary epidemiological data leading to further studies on factors associated with hypertension, dyslipidemia, and renal insufficiency in type 2 diabetic patients which will help therapeutic regimen of T2DM.

Keywords: Diabetes, Hypertension, eGFR, Renal insufficiency

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Introduction

Diabetes mellitus (DM) is one of the leading health problems in Thailand, contributing significantly to morbidity and mortality and adversely affecting both the quality and length of life. Prevalence of 670,664 diabetic patients was found in Thailand during 2014 (prevalence rate 1,032.5:1).[1] DM frequently co-exists with renal insufficiency, dyslipidemia, and hypertension. Hypertension is a major risk factor for cardiovascular and renal disease. In addition, chronic kidney disease (CKD) is the most common form of secondary hypertension and it is an independent risk factor for cardiovascular morbidity and mortality.[2-4] Dyslipidemia is also common in DM, as both insulin deficiency and resistance affect enzymes and pathways of lipid metabolism.[5] Characteristic abnormalities of lipids in type 2 DM (T2DM) include elevated triglyceride (TG) levels, decreased high density lipoprotein-cholesterol (HDL-C) levels and increased levels of small dense low density lipoprotein-cholesterol (LDL-C).[6] Renal insufficiency in type 2 diabetic patients is commonly found with the development of microalbuminuria.[7] Patients with low estimated glomerular filtration rate (eGFR) (<60 mL/min/1.73 m^2) and normoalbuminuria presented an increased rate of cardiovascular disease due to unknown reasons.[8, 9]

To control diabetes and reduce the risk of developing complications, it is essential to optimize physiological values such as glycemic levels, blood pressure, and perform regular examinations for nephropathy (albumin excretion, serum creatinine). The aim of this work was to study the prevalence of hypertension, dyslipidemia, and renal insufficiency in type 2 diabetic patients. This information will help planning to decrease the prevalence, complications, disability, mortality and cost of illness of diabetes in Thailand.

Materials and methods

Samples

This cross-sectional study was conducted during 2015-2016, with patients followed up in 7 primary care units (PCU) in Nong Wua Saw District, Udon Thani Province, Thailand namely Nong Wua Saw Hospital, Kut Mak Fai Tambon Health Promoting Hospital, Ban Khok Phak Hom Tambon Health Promoting Hospital, Ban Nam Phon Tambon Health Promoting Hospital, Ban Non Wai Tai Tambon Health Promoting Hospital, Ban Nong Mek Health Promoting Hospital, Ban Aup Mung Tambon Health Promoting Hospital. Total 234 new cases of diabetic patients (120 cases in 2015 and 114 cases in 2016) were used in this study. Cut-off at 140/90 mmHg (Thai hypertension society) was used for patients with hypertension and cut-off at fasting plasma glucose ⩾126 mg/dL (Diabetes association of Thailand) was used for diabetic patients.

Data collection

The medical records of 234 diabetic patients were retrieved and reviewed. These

data consisted of age of patients, gender, year of visit, hypertension, blood urea nitrogen (BUN), creatinine, low-density lipoprotein cholesterol (LDL-C), triglyceride, microalbumin, eGFR, and hemoglobin A1c (HbA1c) level. All data were collected from the last visit records. Age of patients were categorized into 6 groups; <40, 40-49, 50-59, 60-69, 70-79, and > 80 years. BUN levels were categorized into 2 groups; >20 mg/dL and ⩽20 mg/dL. Creatinine levels were categorized into 2 groups; >1.2 mg/dL and ⩽2 mg/dL. LDL levels were categorized into 5 groups; <10, 100-129, 130-159, 160-189, and ⩾190 mg/dL. HbA1c levels were categorized into 2 groups; <7% and ⩾7%. Triglyceride levels were categorized into 5 groups; ⩽100, 101-150, 151-199, 200-499, and ⩾500 mg/dL. Microalbumin levels were categorized into 3 groups; <30, 30-300, and >300 μg/creatinine. eGFR levels were categorized into 5 groups; stage I (⩾90 mL/min/1.73 m^2), stage II (60-89 mL/min/1.73 m^2), stage III (30-59 mL/min/1.73 m^2), stage IV (15-29 mL/min/1.73 m^2), and stage V (<15 mL/min/1.73 m^2).

Principle of method

BUN and creatinine levels were determined by enzymatic method. HbA1c was determined by immunoblot method. LDL and triglyceride levels were determined by colorimetric method. Microalbumin level was determined by end point method. eGFR was calculated by CKD-EPI formula described by Nephrology Society of Thailand.

Statistical analysis

The research protocol of this study was approved by the Nong Wua Saw Hospital and the Ethical Clearance Committee on Human Rights Related to Researches Involving Human Subjects of Walailak University with no necessity of a consent form. The normality of data was evaluated by Kolmogorov—Smirnov test. Data were described and analyzed with a parametric test, and with a non-parametric test for non-normally distributed parameters. The level of type I error was $\alpha = 5\%$, and p-value < 0.05 was considered significant. Data analysis was performed using SPSS ver. 11.5 (SPSS Inc., Chicago, IL, USA).

Results

General characteristics

Demographic data and laboratory data of diabetic patients are shown in Table 1. Most of diabetic patients (34.2%) were registered at Kut Mak Fai Tambon Health Promoting Hospital, followed by Ban Non Wai Tai Tambon Health Promoting Hospital (28.6%), Ban Aup Mung Tambon Health Promoting Hospital (13.7%), and Ban Nong Mek Health Promoting Hospital (13.2%), respectively. The age range of most diabetic patients were between 60-69 years (40.6%), followed by 50-59 years (26.9%) and 70-79 years (19.7%), respectively. Most of diabetic patients were female (76.5%).

Table 1 Demographic and laboratory data

Variable		Frequency (%) (N=234)
Primary care unit (PCU)	Nong Wua Saw Hospital	1 (0.4)
	Kut Mak Fai Tambon Health Promoting Hospital	80 (34.2)
	Ban Khok Phak Hom Tambon Health Promoting Hospital	15 (6.4)
	Ban Nam Phon Tambon Health Promoting Hospital	8 (3.4)
	Ban Non Wai Tai Tambon Health Promoting Hospital	67 (28.6)
	Ban Nong Mek Health Promoting Hospital	31 (13.2)
	Ban Aup Mung Tambon Health Promoting Hospital	32 (13.7)
Age groups	<40	1 (0.4)
	40-49	18 (7.7)
	50-59	63 (26.9)
	60-69	95 (40.6)
	70-79	46 (19.7)
	≥80	11 (4.7)
Gender	Male	55 (23.5)
	Female	179 (76.5)
Hypertension	Yes	98 (41.9)
	No	136 (58.1)
BUN (mg/dL)	> 20	31 (13.2)
	≤20	203 (86.8)
Creatinine (mg/dL)	> 1.2	17 (7.3)
	≤1.2	217 (92.7)
HbA1c (%)	<7	40 (17.1)
	≥7	194 (82.9)
LDL (mg/dL)	<100	75 (32.1)
	100-129	65 (27.8)
	130-159	55 (23.5)
	160-189	24 (10.3)
	≥190	15 (6.4)
Triglyceride (mg/dL)	≤100	28 (12)
	101-150	73 (31.2)
	151-199	50 (21.4)
	200-499	81 (34.6)
	≥500	2 (0.9)
Microalbumin (µg/creatinine)	<30	202 (86.3)
	30-300	31 (13.2)
	>300	1 (0.4)
eGFR (mL/min/1.73 m^2)	≥90	122 (52.1)
	60-89	80 (34.2)
	30-59	32 (13.7)

Clinical, laboratory data and hypertension

Forty-one percent of patients had hypertension. For laboratory data, most of diabetic patients (86.8%) had ⩽20 mg/dL of BUN, 92.7% had ⩽1.2 mg/dL of creatinine, 82.9% had ⩾7% of HbA1c, 32.1% had less than 100 mg/dL of LDL, 34.6% had 200-499 mg/dL of triglyceride, 86.3% had less than 30 μg/creatinine of microalbumin, and 52.1% had more than 90 mL/min/1.73 m^2 of eGFR (Table 2). Mean age of diabetic patients with hypertension (65.14 years) was significantly higher than that of patients with non-hypertension (61.28 years) (*p*-value =0.002). Mean BUN of diabetic patients with hypertension (16.26 mg/dL) was significantly higher than that of patients with non-hypertension (14.54 mg/dL) (*p*-value=0.028). Mean creatinine of diabetic patients with hypertension (0.86 mg/dL) was significantly higher than that of patients with non-hypertension (0.76 mg/dL) (*p*-value = 0.002). Mean eGFR of diabetic patients with hypertension (80.88 mL/min/1.73 m^2) was significantly lower than that of patients with non-hypertension (90.57 mL/min/1.73 m^2) (*p*-value=0.001). However, no significant differences in HbA1c, LDL, triglyceride, and microalbumin levels were found (*p* value>0.05).

Table 2 Demographic data, laboratory data and hypertension status

Parameter	Hypertension (Mean±SD)		*p*-value
	Yes	No	
Age (years)	65.14 ± 9.23	61.28 ± 9.58	0.002*
BUN (mg/dL)	16.26 ± 5.64	14.54 ± 4.55	0.028*
Creatinine (mg/dL)	0.86 ± 0.25	0.76 ± 0.24	0.002*
HbA1c (%)	8.77 ± 2.06	9.22 ± 2.39	0.176
LDL (mg/dL)	120.58 ± 40.51	123.91 ± 38.96	0.374
Triglyceride (mg/dL)	188.29 ± 98.44	184.04 ± 88.46	0.760
Microalbumin (μg/creatinine)	18.35 ± 33.49	15.89 ± 39.32	0.545
eGFR (mL/min/1.73 m^2)	80.88 ± 20.93	90.57 ± 19.76	0.001*

* *p*-value by The Mann-Whitney U

Laboratory data and eGFR stage

Comparing between eGFR stage I, eGFR stage II, eGFR stage III and laboratory data, the results showed that mean age of patients, BUN and creatinine levels were significantly different among 3 eGFR stages (*p*-value <0.0001). Mean age of diabetic patients with eGFR stage III (72.7 years) was higher than those with stage I (58.19 years) and stage II (66.14 years). Mean BUN of diabetic patients with eGFR stage III (21.13 mg/dL)

was higher than those with stage I (13.29 mg/dL) and stage II (15.91 mg/dL). Mean creatinine of diabetic patients with eGFR stage III (1.21 mg/dL) was higher than those with stage I (0.64 mg/dL) and stage II (0.87 mg/dL). Mean HbA1c of diabetic patients with eGFR stage I (9.39 %) was higher than those with stage II (8.72%) and stage III (8.40%) (p-value =0.036). However, no significant differences in mean LDL, triglyceride, and microalbumin were found (p-value >0.05) (Table 3).

Table 3 Demographic data, laboratory data and eGFR stage

Parameter	eGFR stage (Mean±SD)			p-value
	Stage I	Stage II	Stage III	
Age (years)	58.19 ± 7.93	66.14 ± 7.98	72.75 ± 8.41	<0.0001*
BUN (mg/dL)	13.29 ± 3.61	15.91 ± 4.58	21.13 ± 6.22	<0.0001*
Creatinine (mg/dl)	0.64 ± 0.14	0.87 ± 0.14	1.21 ± 0.22	<0.0001*
HbA1c (%)	9.39 ± 2.36	8.72 ± 2.11	8.40 ± 2.06	0.036*
LDL (mg/dL)	125.20 ± 39.01	121.24 ± 37.84	115.47 ± 45.69	0.244
Triglyceride (mg/dL)	176.04 ± 67.46	200.90 ± 120.35	185.44 ± 93.8	0.613
Microalbumin (µg/creatinine)	12.53 ± 23.20	20.56 ± 51.49	24.57 ± 35.00	0.095

*p-value by The Kruskal Wallis Test

Univariate and multivariate analyses of diabetic patients with hypertension and parameters adjusted by age and gender were also performed (Table 4). The univariate showed that age and gender did not confound the association between creatinine level and hypertension (p-value=0.047). In addition, age and gender did not confound the association between eGFR level and hypertension (p-value=0.04). In contrast, the multivariate analyses showed that age and gender confounded the association between creatinine level and hypertension (p-value >0.05).

Discussion

Type 2 Diabetes (T2DM) is a disease characterized by hyperglycemia caused by either a lack of insulin or the body's inability to use insulin efficiently. T2DM develops most often in middle-aged and older adults but can appear in children, teens and young people.[10] In this study, the age of most diabetic patients were between 60-69 years. Previous studies have shown that the incidence and prevalence of T2DM increase with age.[11, 12] In Thailand, the number of older persons (age 60 and over) has grown rapidly and future population aging

Table 4 Univariate and multivariate analyses of diabetic patients with hypertension and parameters adjusted by age and gender

Analysis type	Variable	Hypertension	
		B*	*p*-value
Univariate	BUN	-0.048	0.090
	Creatinine	-1.273	0.047
	HbA1c	0.062	0.386
	LDL	0.000	0.978
	Triglyceride	0.000	0.906
	Microalbumin	0.000	0.967
	eGFR	0.017	0.040

*unstandardized variables

will occur even more rapidly with the number of older persons projected to increase to over 20 million by 2035, at which point they will constitute over 30% of the population.[13] Data from the Thai National Health Examination Survey IV (NHES IV) in 2009 indicated that prevalence of diabetes in individuals age 15 years and over has increased over time from 2.3% in 1991 to 6.9%.[14] The underlying mechanism behind why prevalence of diabetes is increasing in the elderly is still not clearly understood. However, an evidence showed that beta cell function declined with age at a rate of about 1% per year and the age-related decline in glucose tolerance is primarily related to the loss of beta-cell function.[15] In addition, a previous study showed aberrations in glucose-stimulated insulin responses appeared in older.[16] Additional study also found that the decreased insulin secretory response to glucose during old age is due to inadequate inhibition of K+ efflux and diminished net uptake of Ca^{2+}.[17]

This study demonstrated that T2DM frequently occurred in female patients (76%). This was correlated with reports from NHES indicating women experienced a higher prevalence than men.[18, 19] The mechanism of this evidence is inconclusive. However, as obesity is the major risk factor of T2DM in both sexes, a systematic analysis showed females tend to be more obese than men[20] which mean T2DM tend to occur more in female. Furthermore, ration behind sex difference in incidence of obesity might be due to income inequality which was related to the rates of obesity and of diabetes mortality in both sexes, with stronger effects in women.[21] The dimension of female obesity was found to be greater in countries characterized by gender

inequality, derived by social or economic data.[22] However, the International Collaborative Study of Cardiovascular Disease in Asia (InterASIA) reported no difference in diabetes prevalence between men and women age 35 and over.[23]

This study also demonstrated that 41% of diabetic patients presented hypertension. Hypertension and T2DM are two of the leading risk factors for atherosclerosis and its complications, including heart attacks and strokes. There is substantial overlap between T2DM and hypertension in etiology and disease mechanisms. Obesity, inflammation, oxidative stress and insulin resistance are thought to be the common pathways.[24] In the US population, hypertension occurs in approximately 30% of patients with type 1 diabetes and in 50% to 80% of patients with type 2 diabetes[25] which is similar to this study.

In this study, hypertension was significantly associated with eGFR of diabetic patients. It is known that hypertension is common in patients with T2DM when compared with the general population and may occur in 75% of patients with T2DM. [26] Hypertension can accelerate the course of microvascular and macrovascular complications of diabetic patients. A previous study found that early detection of nocturnal hypertension and early intervention with angiotensin blockade may delay progression of diabetic nephropathy in T2DM.[26]

This study demonstrated that diabetic patients with hypertension had significantly higher age than those with non-hypertension. A previous study showed that systolic hypertension is the most prevalent type of hypertension in diabetic patients age 50 years or over[27] and increased age is associated with a significant increase in the prevalence of hypertension after the age of 60 years.[28] The increase in blood pressure with age is mostly associated with structural changes in the arteries and especially with large artery stiffness. In the elderly, the most powerful predictor of risk is increased pulse pressure due to decreased diastolic and increased systolic blood pressure.[27]

In this study, about 14% of diabetic patients was defined as chronic kidney disease. This was lower than data from the Thailand Diabetes Registry which indicated diabetic nephropathy accounting for 43.9% of all complications.[29] Diabetes affects the kidney in stages. At the onset of diabetes, the kidney grows larger and the glomerular filtration rate (GFR) becomes disturbed. Progressive microvascular alterations in diabetic patients lead to diabetic kidney disease (DKD) resulting in urinary protein loss and then eventual renal function decline with estimated glomerular filtration rate (eGFR) less than 60 mL/min/1.73 m^2.[30] This study showed that some of diabetic patients (13.2%) had >20 mg/dL of BUN and some of diabetic patients (7.3%) had >1.2 mg/dL of creatinine. BUN is a major

nitrogenous end product of protein and amino acid catabolism and creatinine is a breakdown product of creatinine phosphate in muscle excreted by kidneys.[31] BUN and creatinine are widely accepted as most commonest parameters to assess renal functions.[32] Increased serum level of BUN and creatinine are indications of kidney dysfunction. The result of this study revealed the progressive renal insufficiency of these diabetic patients and also showed that diabetic patients with hypertension had significantly higher BUN and creatinine than those with non-hypertension. The association of T2DM and hypertension may be explained as the kidney has a pivotal role in setting the blood pressure and hypertension commonly exists in T2DM prior to kidney disease.[33] Previous study found that diabetes duration does not increase the incidence of hypertension, although the presence of impaired kidney function does.[34] In another study, 58% of patients with newly diagnosed DM2 (without proteinuria) already had hypertension prior to being diagnosed as DM2[35], with another study showing as high as 70%.[36]

In this study, most of diabetic patients (82.9%) had ⩾7% of HbA1c level. This is in concordance with the evidence from a previous study that showed a very high proportion of diabetic patients with poor glycemic control (more than 70% of diabetic patients with HbA1c >7%).[37] Glycated hemoglobin concentrations or HbA1c reflect time-averaged blood glucose during the previous 2-3 months and are used as the gold standard for long-term follow-up of glycemic control.[38] It enables clinicians to make treatment decisions to achieve favorable diabetes control with the aim of reducing or avoiding complications associated with hyperglycemia. Elevated HbA1c levels (>7%) are associated with a higher incidence of microvascular and macrovascular complications in patients with T2DM. It has been shown conclusively that a reduction in plasma HbA1c levels below 7%, leads to a lower incidence of microvascular complications in T2DM.[39, 40] This conferred that diabetic patients in this study had unfavorable diabetes control.

A previous study showed T2DM frequently co-exists with dyslipidemia as both insulin deficiency and resistance affect enzymes and pathways of lipid metabolism.[5] Characteristic abnormalities in lipids in T2DM included elevated triglyceride levels, decreased HDL-C levels, and increased levels of LDL-C.[6] This study found that 32.1% of diabetic patients had less than 100 mg/dL of LDL-C. This conferred that these diabetic patients had favorable practices of lipid control. However, the rest of them (68%) had more than 100 mg/dL of LDL. These diabetic patients may be considered at higher risk of a coronary heart disease (CHD). These patients may necessitate more stringent lipid control for primary prevention of CHD.[41] Moreover, this study found that more than 50% of diabetic patients had triglyceride levels ⩾150 mg/dL (⩾1.70 mmol/L) which is one of five accepted criteria

for defining individuals at high risk for cardiovascular disease and T2DM, arguably termed the "metabolic syndrome".[42] In addition, elevated triglyceride levels are common dyslipidemic feature accompanying pre-diabetic states and T2DM.[43]

Our study still has some limitations. Firstly, this is a cross-sectional design reflecting only associations between laboratory profiles in T2DM. Other variables such as body mass index (BMI) and waist circumference had not been investigated. Secondly, a limited sample size of 234 was retrieved. Despite these limitations, the results of this study give the association between laboratory profiles of T2DM and complication in the Thai population.

Conclusion

This study can be concluded that there was a high prevalence of hypertension, dyslipidemia, and renal insufficiency in diabetic patients. Higher age, BUN, creatinine, and lower eGFR of diabetic patients were associated with hypertension. Moreover, higher age, BUN, and creatinine were significantly associated with low eGFR. Therefore, all persons with T2DM who presented hypertension, dyslipidemia, and kidney problem must be started on primary prevention by encouraging healthy lifestyle factors. Further studies should be undertaken to establish the factors that may lead to hypertension, dyslipidemia, and renal insufficiency. A holistic and multidisciplinary approach for management of T2DM is rapidly needed.

Acknowledgement

We would like to thanks Nong Wua Saw Hospital for providing the information of the patients.

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