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Factors Associated with Chronic Kidney Disease among Patients with Type 2 Diabetes in Narathiwat Province

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ABSTRACT

A Cross-sectional study focused on factors associated with chronic kidney disease in patients with type 2 diabetes in Narathiwat Province. The content is derived from information received from the Narathiwat Provincial Public Health Office in 2012 – 2022. To determine the factors associated with chronic kidney disease among patients with type 2 diabetes in Narathiwat Province. Researchers examined 43 folders containing data on 16,021 patients with 21 different variables. The multivariate variables were then analyzed using multiple logistic regression analysis, and the adjusted odds ratios were presented with a 95% confidence interval. Between 2012 and 2021, 4,484 patients with type 2 diabetes under continuous care at Narathiwat Province's district were studied. Of these, 618 (13.7%) had chronic kidney disease (CKD), Males had a higher risk of CKD compared to females (ORadj=1.59, 95%CI=1.32-1.93). Each year of increase in age correlated with a 1.09 times higher odds of developing CKD (ORadj=1.09, 95%CI=1.08-1.11).Years after first diabetes diagnosis: Each additional year since diagnosis was associated with a slight increase in the odds of CKD (ORadj=1.05, 95%CI=1.02-1.09). Individuals with HbA1c levels ≥ 7% had lower odds of CKD compared to those with levels <7% (ORadj=0.75, 95%CI=0.62-0.91). lipid levels ≥200 mg/dL had higher odds of CKD (ORadj=1.23, 95%CI=1.02-1.48). Specific levels of retinal abnormalities, especially level 4, were associated with higher odds of CKD (ORadj=2.39, 95%CI=1.33-4.27). BMI was associated with a slight increase in the odds of CKD (ORadj=1.05, 95%CI=1.03-1.07). These findings suggest that gender, age, duration of diabetes, HbA1c levels, lipid levels, retinal abnormalities, and BMI are independently associated with the likelihood of CKD. Therefore, the screening is fast. Watch out for risk factors Follow up on the severity of chronic kidney failure. Continuously has a good patient referral system. It can delay chronic kidney failure in diabetic patients.

Keywords: type 2 diabetes, chronic kidney disease, factors associated

Introduction

Chronic diabetic kidney disease is a severe autoimmune condition stemming from prolonged high blood sugar levels, damaging kidneys' blood vessels and filtering units. It leads to protein leakage into urine and reduced kidney function, potentially progressing to end-stage renal disease (ESRD) (Diajas Institute of Diabetes and Gastroenterology, 2021). If untreated. Notably, it significantly impacts morbidity, mortality, and imposes economic burdens (Talerngsak & Kullaya, 2020).

Globally, Chronic Kidney Disease (CKD) affects millions, with diabetes as a primary cause. Early detection and management are crucial to mitigate risks and improve patients' quality of life (Saeng Arun Suiyayanyongsiri, 2023). In Thailand, CKD prevalence, particularly in severe stages, highlights the urgency of addressing this issue. Diabetes significantly raises the risk of CKD, emphasizing the need for comprehensive management beyond blood sugar control (Talerngsak & Kullaya, 2020).

Research identifies various factors contributing to CKD, including prolonged diabetes duration, high blood pressure, lipid levels, and diabetic eye disease. Local dietary habits, featuring intensely flavored and rich foods, may exacerbate CKD risk (Bancha Satirapojon, 2011). Additionally, diabetic kidney disease prevails as a primary cause of CKD, emphasizing the importance of understanding its pathological progression.

Studies in Thailand's southern region highlight dietary patterns potentially exacerbating CKD risk. Narathiwat Province, known for its high-risk demographics and lifestyles, warrants focused research on CKD

factors among diabetic patients. Understanding these factors is essential for targeted interventions and improved patient outcomes (Penapa, 2016).

Purposes

To determine the factors associated with chronic kidney disease among patients with type 2 diabetes in Narathiwat Province.

Research Methodology

1. Data source and management

This study describes the research method used in a study on chronic kidney disease (CKD) in type 2 diabetes patients. It was a cross-sectional study (looking at a snapshot in time) that analyzed existing medical records from 2012 to 2021. Researchers examined 43 folders containing data on 16,021 patients with 21 different variables

2. Data cleaning and variable conversion

In this study, the level of estimated glomerular filtration rate (eGFR) was used as the dependent variable to classify chronic kidney disease (CKD) into binary values. CKD was defined as eGFR < 60 ml/min/1.73 m2, with the "case" group comprising type 2 diabetes patients meeting this criterion, and the "control" group comprising those with eGFR > 60 ml/min/1.73 m2 who received treatment.

Data cleaning involved several steps:

- Patients diagnosed with type 2 diabetes mellitus (DM type 2) according to ICD-10 classification under group E11 and receiving treatment for at least one year were included. Cases with other renal complications such as concurrent kidney diseases were excluded.
- Unusual BMI values, including weights less than 10 kg and heights exceeding 400 cm, were removed due to potential recording errors.
- Variables with more than 60% missing values compared to the total records were dropped, including smoke, urinary protein-to-creatinine ratio (UPCR), and albumin-to-creatinine ratio (ACR). Records with missing values for remaining variables were also removed, resulting in 4484 records for further analysis.

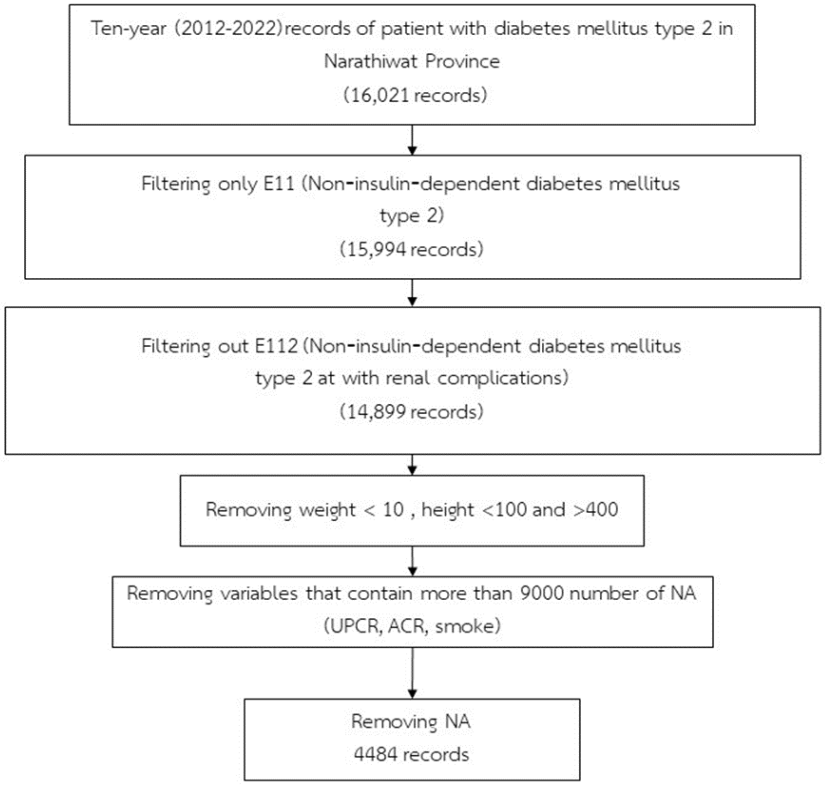

Figure 1.1 the flow step of data cleaning in this study

The control group for this study comprised type 2 diabetes patients without chronic kidney disease (17%) and those with chronic kidney disease (82%). With an Odds Ratio of 1.26, a power level of 80%, and a 95% confidence interval, the sample size was determined using multiple logistic regression, resulting in a study group of 623 individuals. Originally, a 1:1 Case:Control ratio was planned, requiring 1246 individuals. However, due to rare cases, the ratio was adjusted to 1:5, yielding a study group of 352
individuals and a control group of 2112 individuals. Following Grimes and Schulz (2005), the control group was increased above the cases, resulting in 618 cases and 3386 controls, sufficient for detecting significance with an odds ratio of 0.6 and a power of 80%. The sample size calculation was conducted using the epi.sscc() function in the epiR package.

Table 1.1 Number of missing values in each variable

Variables	Number of missing records	percentage
FPG	2,460	16.51
eGFR	2,468	16.56
creatinine	3,599	24.15
BMI	3,696	24.80
lipid	4,507	30.25
hba1c	5,131	34.43
Foot	6,811	45.71
Retina	7,291	48.93
Smoke	9,318	62.54
UPCR	12,274	82.38
ACR	14,483	97.20

3. Data analysis

3.1 Descriptive analysis

In the data analysis phase, descriptive statistics including mean, standard deviation, frequency, and percentages were utilized for data exploration. Categorical variables were examined by reporting the percentages of each category, while continuous variables were analyzed by determining the mean and standard deviation of the sample.

3.2 Analysis of factor explaining CKD patients from

The relationships between various factors and chronic kidney disease were analyzed using univariate logistic regression analysis, with a 95% confidence interval for the odds ratio. The multivariate variables were then analyzed using multiple logistic regression analysis, and the adjusted odds ratios were presented with a 95% confidence interval using the finalfit() function in the finalfit package (Harrison, 2023). Variables with a univariate analysis p-value < 0.20 were included. Finally, the best model was identified using the backward elimination method, with one variable being eliminated at a time, using the stepAIC() function in the MASS package (Ripley et al., 2023). Subsequently, the best model was used to calculate the predicted probability of chronic kidney disease in type 2 diabetes patients, and the prediction line with a 95% prediction interval was plotted using the plot_model() function in the sjPlot package (Lüdecke, 2023). All data analyses were performed using R software version 4.3.3 (R Core Team, 2024).

Results

1. Descriptive statistics of the patients

Between 2012 and 2021, 4,484 patients with type 2 diabetes under continuous care at Narathiwat Province's district ophthalmic promotion hospital were studied. Of these, 618 (13.7%) had chronic kidney disease (CKD), while 3866 (86.2%) did not. Females constituted a larger proportion of CKD cases (58.3%) compared to males (41.7%). Non-CKD patients had a lower average age (57.8 years) compared to CKD patients (67.5 years). Both CKD and non-CKD patients had a mean BMI over 25 kg/m2, with no significant difference. Most patients were obese, approximately 68% for CKD and 71% for non-CKD. The average duration since initial diabetes diagnosis was 5.1 years for non-CKD patients and slightly longer for CKD patients, at 5.8 years. Non-CKD patients exhibited higher mean fasting plasma glucose levels (159.8 ± 63.5) compared to CKD patients (146.1 ± 70.0). For HbA1c, 61% of non-CKD patients had values above 7, while proportions did not differ significantly for CKD patients. Lipid levels and waist circumference did not vary significantly between CKD and non-CKD patients. Diabetic retinopathy was predominantly classified as stage two for both groups (91% for non-CKD, 88.7% for

CKD). A majority of patients exhibited poor diabetes control (78.0% for non-CKD, 70.2% for CKD), while controlled hypertension was similar between groups. The prevalence of diabetic foot symptoms was consistent across both CKD and non-CKD groups.

Table 1.2 General information of chronic kidney disease patients compared to normal kidney function patients in type 2 diabetes patients (n=4484).

Variables	**levels**	**No CKD (n=3866)**	**CKD (n=618)**
Gender	Male	1135 (29.4)	258 (41.7)
	Female	2731 (70.6)	360 (58.3)
Age	Mean (SD)	57.8 (10.3)	67.5 (10.4)
Years after first diagnostic as E11	Mean (SD)	5.1 (2.9)	5.8 (2.9)
HbA1c	<7 mg/dL	1491 (38.6)	331 (53.6)
	≥7 mg/dL	2375 (61.4)	287 (46.4)
FPG	Mean (SD)	159.8 (63.5)	146.1 (70.0)
Creatinine	Mean (SD)	34.6 (76.5)	33.5 (71.3)
Lipid	< 200 mg/dL	1991 (51.5)	346 (56.0)
	≥ 200 mg/dL	1875 (48.5)	272 (44.0)
Diabetic Retinopathy	1	252 (6.5)	40 (6.5)
	2	3518 (91.0)	548 (88.7)
	3	9 (0.2)	1 (0.2)
	4	87 (2.3)	29 (4.7)
Control DM	No	3014 (78.0)	434 (70.2)
	Yes	852 (22.0)	184 (29.8)
Control HT	No	2165 (56.0)	316 (51.1)
	Yes	1701 (44.0)	302 (48.9)
BMI	Mean (SD)	26.5 (5.0)	26.1 (5.2)
obesity	No	1117 (28.9)	195 (31.6)
	Yes	2749 (71.1)	423 (68.4)
Waist	Mean (SD)	84.5 (21.4)	85.0 (18.6)
Diabetic Foot	No	3807 (98.5)	603 (97.6)
	Yes	59 (1.5)	15 (2.4)

The control group consisted of type 2 diabetes patients receiving continuous care in Narathiwat province over ten years. Among them, 3866 individuals (86.3%) had an estimated glomerular filtration rate (eGFR) > 60 ml/min/1.73 m2. The patient group with chronic kidney disease (CKD) comprised 618 individuals (13.7%), with 383 (8.54%) classified as CKD stage 3a, 169 (3.77%) as CKD stage 3b, 43 (0.95%) as CKD stage 4, and 23 (9.51%) as CKD stage 5, as detailed in Table 1.3.

Table 1.3 Data of type 2 diabetes patients categorized by estimated glomerular filtration rate (eGFR) (n=4484).

Stages	**estimated glomerular filtration rate (ml/min/1.73 m^2)**	**number**	**%**
1	≥ 90	2,334	52.10
2	60 - 89	1,532	34.20
3a	45 - 59	383	8.54
3b	30 - 44	169	3.77
4	15 - 29	43	0.95
5	< 14	23	0.51

Note: stage 1-2 = no CKD patients
stage 3a-5 = CKD patients

2. Analysis of factors influencing incidence of CKD in patients with diabetic type 2
From the analysis of single-variable relationships, significant factors associated with the development of chronic kidney disease in patients with type 2 diabetes who received continuous care in Narathiwat province from 2012 to 2021 at a statistically significant level of 0.05 include gender (OR= 1.72, 95%CI=1.45-2.05), age (OR=1.09 ,

95%CI= 1.08-1.10), years after diagnostic as E11 (OR= 1.09 , 95%CI= 1.06-1.12), HbA1c (OR= 0.54, 95%CI= 0.46-0.65), FPG (OR= , 95%CI=), lipid (OR= 0.83, 95%CI= 0.70-0.99), retina (OR=2.1 , 95%CI=1.22-3.58), and control DM (OR=1.5 , 95%CI=1.24-1.81), and control HT (OR= 1.22 , 95%CI=1.03-1.44) as shown in Table 1.4 These eight variables with BMI, obesity and diabetic foot were then analyzed further for multiple logistic regression.

Table 1.4 Factors influencing the development of chronic kidney disease in type 2 diabetes patients by analyzing the relationship of single variables (n=4484).

Variables	**level**	**No CKD (n=3866)**	**CKD (n=618)**	**OR**	**95%CI**	**p-value**
Gender	Male	1135 (81.5)	258 (18.5)	-		
	Female	2731 (88.4)	360 (11.6)	1.72	1.45-2.05	<0.001
Age	Mean (SD)	57.8 (10.3)	67.5 (10.4)	1.09	1.08-1.10	<0.001
Years after first diagnostic as E11	Mean (SD)	5.1 (2.9)	5.8 (2.9)	1.09	1.06-1.12	<0.001
HbA1c	<7 mg/dL	1491 (81.8)	331 (18.2)	-		
	≥7 mg/dL	2375 (89.2)	287 (10.8)	0.54	0.46-0.65	<0.001
FPG	Mean (SD)	159.8 (63.5)	146.1 (70.0)	1	0.99-1.00	<0.001
creatinine	Mean (SD)	34.6 (76.5)	33.5 (71.3)	1	1.00-1.00	0.736
lipid	< 200 mg/dL	1991 (85.2)	346 (14.8)	-		
	≥ 200 mg/dL	1875 (87.3)	272 (12.7)	0.83	0.70-0.99	0.038
Diabetic Retinopathy	1	252 (86.3)	40 (13.7)	-		
	2	3518 (86.5)	548 (13.5)	0.98	0.70-1.41	0.915
	3	9 (90.0)	1 (10.0)	0.7	0.04-3.87	0.738
	4	87 (75.0)	29 (25.0)	2.1	1.22-3.58	0.007
Control DM	No	3014 (87.4)	434 (12.6)	-		
	Yes	852 (82.2)	184 (17.8)	1.5	1.24-1.81	<0.001
Control HT	No	2165 (87.3)	316 (12.7)	-		
	Yes	1701 (84.9)	302 (15.1)	1.22	1.03-1.44	0.024
BMI	Mean (SD)	26.5 (5.0)	26.1 (5.2)	0.99	0.97-1.00	0.128
Obesity	No	1117 (85.1)	195 (14.9)	-		
	Yes	2749 (86.7)	423 (13.3)	0.88	0.73-1.06	0.177
Waist	Mean (SD)	84.5 (21.4)	85.0 (18.6)	1	1.00-1.00	0.56
Diabetic Foot	No	3807 (86.3)	603 (13.7)	-		
	Yes	59 (79.7)	15 (20.3)	1.61	0.87-2.77	0.106

The full model of multiple logistic regression consisted of twelve variables. Then the selected feature was selected by the backward method. After that, four variables were removed as shown in table 1.5.

Table 1.45 Steps of backward elimination of variables from the full model.

step	Model	AIC
1	y ~ gender + age + years_diabatic + hba1c + fpg + lipid + retina + control_dm + control_ht + bmi + obesity + foot	3120.7
2	y ~ gender + age + years_diabatic + hba1c + fpg + lipid + retina + control_dm + control_ht + bmi + obesity	3118.87
3	y ~ gender + age + years_diabatic + hba1c + fpg + lipid + retina + control_ht + bmi + obesity	3117.07
4	y ~ gender + age + years_diabatic + hba1c + lipid + retina + control_ht + bmi + obesity	3115.34
5	y ~ gender + age + years_diabatic + hba1c + lipid + retina + control_ht + bmi	3113.89
6	y ~ gender + age + years_diabatic + hba1c + lipid + retina + bmi	3113.47

In the final multiple logistic regression analysis, several factors were found to be significantly associated with the development of chronic kidney disease (CKD) in type 2 diabetes patients, even when controlling for confounding variables:

● Gender: Males had a higher risk of CKD compared to females (ORadj=1.59, 95%CI=1.32-1.93).
● Age: Each year of increase in age correlated with a 1.09 times higher odds of developing CKD (ORadj=1.09, 95%CI=1.08-1.11).
● Years after first diabetes diagnosis: Each additional year since diagnosis was associated with a slight increase in the odds of CKD (ORadj=1.05, 95%CI=1.02-1.09).
● HbA1c: Individuals with HbA1c levels ≥ 7% had lower odds of CKD compared to those with levels <7% (ORadj=0.75, 95%CI=0.62-0.91).
● Lipid levels: Individuals with lipid levels ≥200 mg/dL had higher odds of CKD (ORadj=1.23, 95%CI=1.02-1.48).
● Retinal abnormalities: Specific levels of retinal abnormalities, especially level 4, were associated with higher odds of CKD (ORadj=2.39, 95%CI=1.33-4.27)
● BMI: Each unit increase in BMI was associated with a slight increase in the odds of CKD (ORadj=1.05, 95%CI=1.03-1.07).

These findings suggest that gender, age, duration of diabetes, HbA1c levels, lipid levels, retinal abnormalities, and BMI are independently associated with the likelihood of CKD in individuals with type 2 diabetes. Adjusting for other variables in the model helps to provide more accurate estimates of these associations, accounting for potential confounding factors.

Table 1.6 Factors influencing the occurrence of chronic kidney disease in type 2 diabetes patients by analyzing the relationship of multiple logistic regression variables.

Variables	**Levels**	**OR**	**95%CI**	**p-value**	**OR_{adj}**	**95%CI**	**p-value**
Gender	female	-			-		
	male	1.72	1.45-2.05	<0.001	1.59	1.32-1.93	<0.001
Age		1.09	1.08-1.10	<0.001	1.09	1.08-1.11	<0.001
Years after first diagnosis as E11 (diabetes)		1.09	1.06-1.12	<0.001	1.05	1.02-1.09	0.001
HbA1c	< 7 mg/dL	-			-		
	> 7 mg/dL	0.54	0.46-0.65	<0.001	0.75	0.62-0.91	0.003
Lipid	< 200 mg/dL	-			-		
	> 200 mg/dL	0.83	0.70-0.99	0.038	1.23	1.02-1.48	0.033
Retina	Retina1	-			-		
	Retina2	0.98	0.70-1.41	0.915	1.03	0.72-1.51	0.882
	Retina3	0.7	0.04-3.87	0.738	0.46	0.02-3.49	0.522
	Retina4	2.1	1.22-3.58	0.007	2.39	1.33-4.27	0.003
BMI		0.99	0.97-1.00	0.128	1.05	1.03-1.07	<0.001

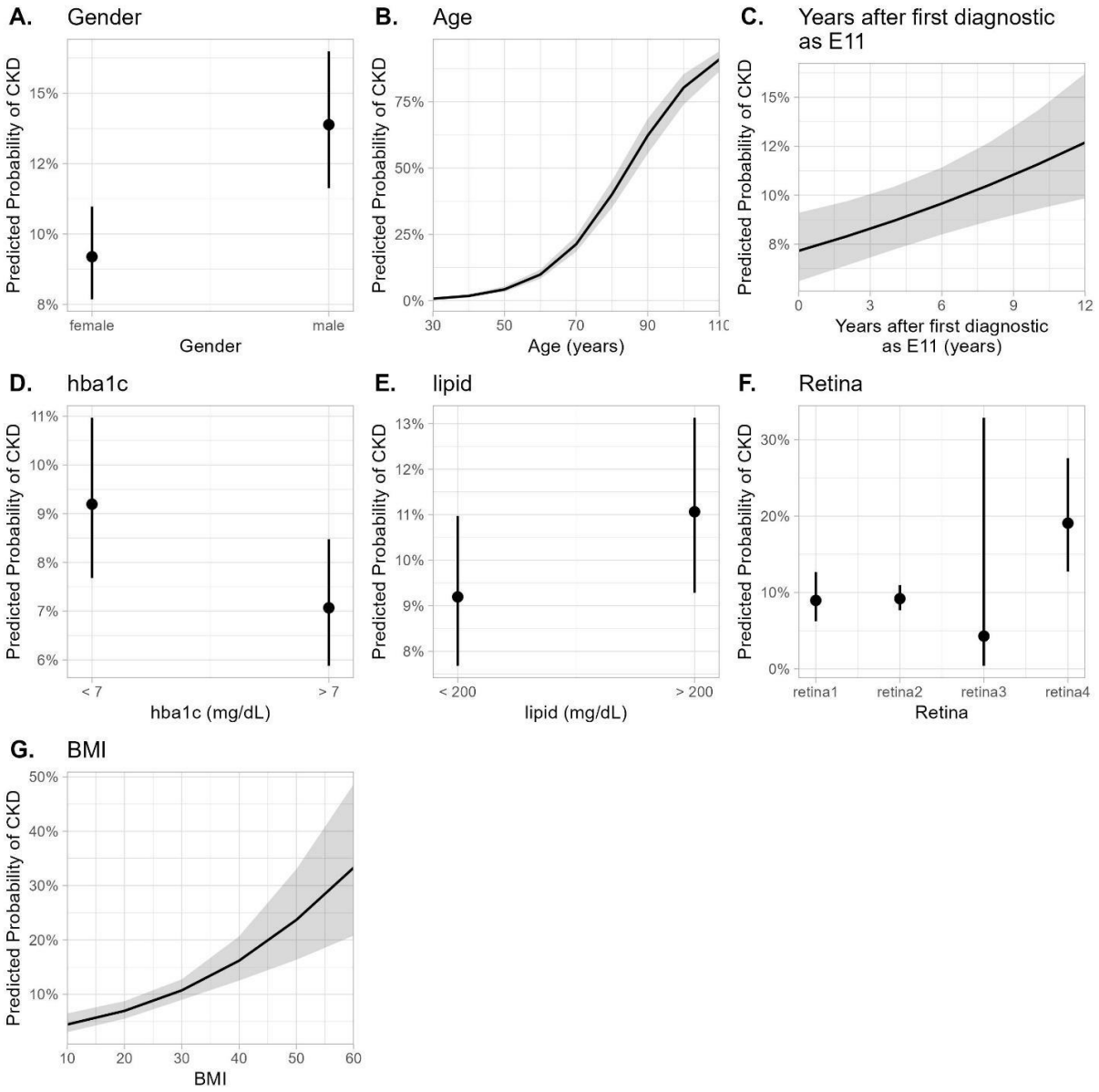

Figure 1.2 Plots of prediction probability of seven variables from the best model, black line represented prediction probability, grey color represented prediction interval at 95%

Discussion

1. Incidence of diabetic nephropathy in type 2 diabetes patients

The study revealed a 13.70% incidence of nephropathy in type 2 diabetes patients, predominantly at severe stages: 8.54% at stage 3a, 3.77% at stage 3b, 0.95% at stage 4, and 0.51% at stage 5. Compared to national averages (around 70 million), with diabetic patients constituting approximately 40% of all cases (Kongprasert et al., 2015). This incidence is lower, with previous studies in the region reporting higher rates: 29.4% in the southern region (Charenpiriya et al., 2017), 46.0%-48.0% in the central region and Suphan Buri (Janprempree, 2021), 16.13% in the northeastern region (Yodklaew and Suggaravetsir 2019), and 30.0% in the northern region (Situe, 2019). Alarmingly, only 1.9% of diabetic patients in Thailand are aware of their condition (Kongprasert et al, 2015). Late diagnosis may delay proper management, leading to progression to severe stages and increased healthcare costs. Preventing or delaying end-stage renal disease is crucial in diabetes management. Without lifestyle adjustments and proper self-care, severity may progress to stages 4 and 5, potentially leading to death if that patient were untreated properly (The Nephrology Society of Thailand, 2020). Moreover, diabetes and its complications impose

a significant burden on healthcare costs of people. Therefore, a crucial goal in diabetes management is preventing or delaying the progression to end-stage renal disease should be carefully considered.

2. Factors influencing the occurrence of diabetic nephropathy in type 2 diabetes patients.

This study identified key factors contributing to the development of chronic kidney disease (CKD) in type 2 diabetes patients, categorized into demographic and physiological factors:

2.1 Demographic factors

2.1.1 Gender: Males had a 1.55 times higher risk of complications compared to females (95%CI=1.30-1.85) (Al-Rubeaan et al., 2014). This aligns with previous findings attributing male susceptibility to abnormal albuminuria excretion.

2.1.2 Age: Each year increase in age correlated with a 1.09 times higher odds of CKD (95% CI=1.08-1.11) (Fordsungnoen, 2017), consistent with other studies indicating age-related decline in kidney function.

2.1.3 Duration of diabetes, years after diagnostic as diabetes. Each year of diabetes duration increased CKD risk by 1.09 times (95% CI=1.06-1.12) (Situe, 2019), reflecting the progressive nature of diabetic nephropathy.

2.2 Physiological factors

2.2.1 HbA1c: Contrary to expectations, HbA1c levels ≥ 7 mg/dL had lower odds of CKD (ORadj=0.75, 95%CI=0.63-0.89) (Little et al., 2013), possibly due to inaccuracies in HbA1c measurement in kidney failure.

2.2.2 Lipid: High lipid levels (> 200 mg/dL) increased CKD risk (ORadj=1.22, 95% CI=1.02-1.48) (Phaosawasdi et al., 2013), implicating triglyceride elevation in renal complications.

2.2.3 Diabetic Retinopathy: Severe proliferative diabetic retinopathy correlated with higher CKD risk (ORadj=1.22, 95% CI=1.40-4.18), suggesting a potential link between retinal and renal complications (Liu et al., 2023).

2.2.4 BMI: Each unit increase in BMI raised CKD risk by 1.05 times (95% CI=1.03-1.07), indicating obesity as a metabolic disorder risk factor (Bae et al., 2016).

2.3 Risk factors that were not included in this study

The study did not address several risk factors due to missing data, including urinary albumin levels, obesity, and smoking history. Elevated urinary albumin excretion, known as microalbuminuria, is a key marker for diabetic nephropathy. However, some type 2 diabetes patients experience declining kidney function despite normal albumin levels, highlighting the importance of assessing glomerular filtration rate alongside albuminuria (Kramer et al., 2003; MacIsaac et al., 2004). Obesity is linked to an increased risk of diabetic nephropathy (Tapp et al., 2004), with abdominal obesity correlating with higher albuminuria rates. Weight loss has been shown to reduce albumin excretion and prevent kidney function decline. Smoking is associated with increased albuminuria and declining kidney function in type 2 diabetes patients, underscoring its detrimental effects on renal health (Gambaro et al., 2001).

Conclusions

This study investigated the incidence of diabetic nephropathy in type 2 diabetes patients and identified factors influencing its occurrence. The incidence of nephropathy was found to be 13.70%, with higher stages of severity observed in older individuals. Despite being lower than in previous studies, diabetic patients still face a considerable risk of developing nephropathy, with late diagnosis potentially leading to severe complications and increased healthcare costs. Demographic factors such as gender, age, and duration of diabetes were found to influence the occurrence of nephropathy. Males had a higher risk, and older age and longer duration of diabetes were associated with increased odds of developing nephropathy. Physiological factors including HbA1c, lipid levels, diabetic retinopathy, and BMI were also identified as influencing nephropathy occurrence. Higher HbA1c levels were associated with a lower risk, while elevated lipid levels and severe diabetic retinopathy were linked to higher odds of nephropathy. Additionally, higher BMI was associated with increased risk, although it was not significant in the final model. The study did not include factors like urinary albumin levels, obesity, and smoking due to missing data, despite their known associations with diabetic nephropathy. Increased urinary albumin excretion, obesity, and smoking are important risk factors to consider in understanding and managing diabetic nephropathy.

Recommendations

1. The results of this study serve as important basic information for Public health personnel both in service locations and networks Services in developing service systems for those who receive Diagnosed with type

2 diabetes at an early stage. To prevent and delay the occurrence of complications. Small arteries by preliminary screening in those at high risk

2. Should study the consumption behavior patterns of patients with type 2 diabetes by interview or observation

Consumption behavior to provide information for health education correct for the patient or design communication channels to create health knowledge in taking care of one's health patients and relatives.

3. From studies abroad, it was found that the level increased uric acid in the blood will be another factor that results in abnormal kidney function in diabetic patients. The uric acid level will be higher when kidney complications occur. Therefore, further research may Further studies will be conducted. The relationship between uric acid with kidney complications

References

เกตุแก้ว จันทร์จารัส. (2558). การสารวจความชุกและปัจจัยเสี่ยงของโรคเบาหวานชนิดที่ 2 ที่มีภาวะแทรกซ้อนที่ไตใน โรงพยาบาลสมเด็จพระปิ่นเกล้า. วิทยานิพนธ์ปริญญาเทคนิคการแพทยมหาบัณฑิต. สาขาวิชาเทคนิคการแพทย์ คณะสหเวชศาสตร์ ปทุมธานี: มหาวิทยาลัยธรรมศาสตร์.

กรอง จันทร์เปรมปรี. (2564). ความชุกและปัจจัยสัมพันธ์กับโรคไตจากเบาหวานในผู้ป่วยเบาหวานชนิดที่ 2ของโรงพยาบาล ด่านช้าง สุพรรณบุรี. วารสารวิชาการแพทย์และสาธารณสุข เขตสุขภาพที่ 3, 18(3), 225-237.

วิจิตรา สุวรรณอำไพ และ กาญจนา มีชำนาญ. (2555). ความชุกของภาวะ microalbuminuria ในผู้ป่วยเบาหวานใน โรงพยาบาลศรีสัชนาลัย.ขอนแก่น: สาขาวิชาเทคนิคการแพทย์ คณะเทคนิคการแพทย์ มหาวิทยาลัยขอนแก่น.

สมศรี เผ่าสวัสดิ์, ศัลยเวทย์ เลขะกุล, ธีระชัย ฉันท์โรจน์ศิริ, ธัญญารัตน์ ธีรพรเลิศรัฐ, สุนันทา วิจิตรจิตเลิศ, ธีรยุทธ เจียมจริยา ภรณ์,และคณะ. (2556). ความรู้เรื่องโรคไตสำหรับประชาชน.นนทบุรี: เฮลธ์ เวิร์ค

วิวัฒน์ จรุง เกียรติ กุล, มงคล เจริญ พิทักษ์ ชัย, รัตนา วรรณ ดิ ษ ฐ ป้าน, อุปถัมภ์ ศุภ สิน ธุ์, & บัญชา ส ถิ ระ พจน์. (2014). การ ย้อม periostin เป็น ดัชนี ชี้ การ เกิด พยาธิ สภาพ ไต ใน โรค ไต อักเสบ เรื้อรัง. Royal Thai Army Medical Journal, 67(4), 139-148.

จิรวัฒน์ สีตื้อ. (2562). ความชุกของโรคไตวายเรื้อรังและปัจจัยเสี่ยงที่สัมพันธ์กับการทางานของไตลดลง ของผู้ป่วยเบาหวาน ชนิดที่ 2 ในศูนย์สุขภาพชุมชนเขตเมืองร่องซ้อ จังหวัดแพร่. วารสารโรงพยาบาลแพร่, 27(2), 1-15.

จุรีพร คงประเสริฐ, สุมนี วัชรสินธุ์, วิวัฒน์ จันเจริญฐานะ และธิดารัตน์ อภิญญา. (2558). แนวทางการตรวจคัดกรองและดูแล รักษาภาวะแทรกซ้อนทางไต ในผู้เป็นเบาหวานและความดันโลหิตสูง. ครั้งที่ 1. กรุงเทพมหานคร: โรงพิมพ์ชุมนุม สหกรณ์การเกษตรแห่งประเทศไทย จากัด.

ณิชชาภัทร ยอดแคล้ว และพรนภา ศุกรเวทย์ศิริ. (2562). ความชุกและปัจจัยที่มีความสัมพันธ์กับการเกิดโรคไตเรื้อรังในผู้ป่วย เบาหวานชนิดที่ 2 ที่เข้ารับการรักษาที่ศูนย์สุขภาพชุมชนเมือง จังหวัดขอนแก่น. วารสารสานักงานป้องกันควบคุม โรคที่ 7 ขอนแก่น, 26(2), 24-35.

ทักษพร ฝอดสูงเนิน. (2560). ความชุกและปัจจัยที่มีความสัมพันธ์กับการเกิดโรคไตเรื้อรังในผู้ป่วยเบาหวานชนิดที่ 2 โรงพยาบาลหนองบัวแดง จังหวัดชัยภูมิ. วิทยานิพนธ์ปริญญาสาธารณสุขศาสตรมหาบัณฑิต. สาขาวิชาวิทยาการระบาด ขอนแก่น: มหาวิทยาลัยขอนแก่น.

สายฝน ม่วงคุ้ม, สุภาภรณ์ ด้วงแพง, วัลภา คุณทรงเกียรติ และพรพรรณ ศรีโสภา. (2560). ปัจจัยที่มีอิทธิพลต่อภาวะแทรกซ้อนของหลอดเลือดแดงขนาดใหญ่ ของผู้ที่เป็นเบาหวานชนิดที่ 2. วารสารคณะพยาบาลศาสตร์ มหาวิทยาลัยบูรพา, 25(2), 82-93.

แสงอรุณ สื่อ ยรรยง ศิริ. (2023). ปัจจัย ที่ มี ความ สัมพันธ์ ต่อ การ เกิด ไต วาย ใน ระยะ ที่ สาม ใน ผู้ ป่วย เบาหวาน โรง พยาบาล สุรินทร์. วารสาร การ แพทย์ โรง พยาบาล ศรีสะเกษ สุรินทร์ บุรีรัมย์, 38(1), 105-112.

เพ็ญ นภา พง ษ์ ศรี. (2023). การ พยาบาล ผู้ ป่วย เด็ก ที่ มี ภาวะ MIS-C: กรณี ศึกษา. Region 3 Medical and Public Health Journal-วารสาร วิชาการ แพทย์ และ สาธารณสุข เขต สุขภาพ ที่ 3, 44-50.

Abera, R.G., Demesse, E.S. & Boko, W.D. (2022) Evaluation of glycemic control and related factors among outpatients with type 2 diabetes at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia: a cross-sectional study. *BMC Endocr Disord* **22**, 54

Agarwal R, Light RP .(2011). Relationship between glycosylated hemoglobin and blood glucose during progression of chronic kidney disease. Am J Nephrol 34:32-41.

Al-Rubeaan,K., Youssef,A. M., Subhani,S. N., Ahmad,N. A., Al-Sharqawi,A. H., Al-Mutlaq,H. M., et al. (2014). Diabetic nephropathy and its risk factors in a society with a type 2 diabetes epidemic: ASaudi National Diabetes Registry-based study.PloSOne, 9(2), e88956

Ali, B., & Gray-Vickrey, P. (2011). Limiting the damage from acute kidney injury. Nursing2022, 41(3), 22-31.

Bae JP, Lage MJ, Mo D, Nelson DR, Hoogwerf BJ. (2016). Obesity and glycemic control in patients with diabetes mellitus: analysis of physician electronic health records in the US from 2009-2011. J Diabetes Complications 30:212-220.

de Boer IH, Sibley SD, Kestenbaum B, Sampson JN, Young B, Cleary PA, Steffes MW, Weiss NS, Brunzell JD. (2007). Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications Study Research Group. Central obesity, incident microalbuminuria, and change in creatinine clearance in the epidemiology of diabetes interventions and complications study. J Am Soc Nephrol. 18:235–243.

Gall MA, Hougaard P, Borch-Johnsen K, Parving HH. (1997) Risk factors for development of incipient and overt diabetic nephropathy in patients with non-insulin dependent diabetes mellitus: prospective, observational study. BMJ. 314(7083):783–788.

Gambaro G, Bax G, Fusaro M, Normanno M, Manani SM, Zanella M, Dangelo A, Fedele D, Favaro S. (2001) Cigarette smoking is a risk factor for nephropathy and its progression in type 2 diabetes mellitus. Diabetes Nutr Metab. 14:337–342.

He F, Xia X, Wu XF, Yu XQ, Huang FX. (2013). Diabetic retinopathy in predicting diabetic nephropathy in patients with type 2 diabetes and renal disease: A meta-analysis. *Diabetologia.* 56(3):457–66.

Hernandez D, Espejo-Gil A, Bernal-Lopez MR, Mancera-Romero J, Baca-Osorio AJ, Tinahones FJ, Armas-Padron AM, Ruiz-Esteban P, Torres A, Gomez-Huelgas R. (2013). Association of HbA1c and cardiovascular and renal disease in an adult Mediterranean population. BMC Nephrol. ;14:151.

Kanjanabuch, T., & Takkavatakarn, K. (2020). Global dialysis perspective: Thailand. Kidney360, 1(7), 671-675.

Kidney Disease: Improving Global Outcomes (KDIGO). (2013). CKD Work Group. KDIGO clinical practice guideline for the evaluation and management of chronic kidney disease. Kidney Int Suppl 113:S1–S150.

Kramer HJ, Nguyen QD, Curhan G, Hsu CY. (2003). Renal insufficiency in the absence of albuminuria and retinopathy among adults with type 2 diabetes mellitus. JAMA. 289:3273–3277.

Little RR, Rohlfing CL, Tennill, AL. (2013) Measurement of Hba(1C) in patients with chronic renal failure. Clin Chim Acta.418:73–76.

Liu Z, Li X, Wang Y, Song Y, Liu Q, Gong J, Fan W, Lv C, Cao C, Zhao W, Xiao J. (2023) The concordance and discordance of diabetic kidney disease and retinopathy in patients with type 2 diabetes mellitus: A cross-sectional study of 26,809 patients from 5 primary hospitals in China. Front Endocrinol (Lausanne). ;14:1133290.

Low,S. K., Sum,C. F., Yeoh,L. Y., Tavintharan,S., Ng,X. W., Lee,S. B., et al. (2015). Prevalence of chronic kidney disease in adults with type 2diabetes mellitus. ANNALS Academy of Medicine Singapore, 44(5), 164–171

MacIsaac RJ, Jerums G, Ekinci EI. (2017). Effects of glycaemic management on diabetic kidney disease. World J Diabetes. 15;8(5):172-186

MacIsaac RJ, Tsalamandris C, Panagiotopoulos S, Smith TJ, McNeil KJ, Jerums G. (2004). Nonalbuminuric renal insufficiency in type 2 diabetes. Diabetes Care.27:195–200.

Molitch ME, Steffes M, Sun W, Rutledge B, Cleary P, de Boer IH, Zinman B, Lachin J. (2010). Epidemiology of Diabetes Interventions and Complications Study Group. Development and progression of renal insufficiency with and without albuminuria in adults with type 1 diabetes in the diabetes control and complications trial and the epidemiology of diabetes interventions and complications study. Diabetes Care.33:1536–1543.

Morales E, Valero MA, Leon M, Hernandez E, Praga M. (2003). Beneficial effects of weight loss in overweight patients with chronic proteinuric nephropathies. Am J Kidney Dis. 41:319–327.

Shankar A, Klein R, and Klein BE. (2006). The Association Among Smoking, Heavy Drinking, and Chronic Kidney Disease,. American Journal of Epidemiology 164 : 263 – 271

Tapp RJ, Shaw JE, Zimmet PZ, Balkau B, Chadban SJ, Tonkin AM, Welborn TA, Atkins RC. (.2004). Albuminuria is evident in the early stages of diabetes onset: results from the Australian Diabetes, Obesity, and Lifestyle Study (AusDiab) Am J Kidney Dis. 44:792–798. [PubMed] [Google Scholar]

Yang CW, Park JT, Kim YS, (2011). Prevalence of diabetic nephropathy in primary care type 2 diabetic patients with hypertension: data from the Korean Epidemiology Study on Hypertension III (KEY III study). Nephrol Dial Transplant 26:3249-55

Zhang, Q. L., & Rothenbacher, D. (2008). Prevalence of chronic kidney disease in population-based studies: systematic review. BMC public health, 8(117), 1-13.