Assessment of Stroke Risk and Related Complications in Type 2 Diabetes Mellitus Patients in Samut Songkhram Province, Thailand

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Abstract

Background: Stroke is a leading cause of death and disability worldwide, particularly among patients with type 2 diabetes mellitus (T2DM). Diabetes is associated with a range of acute and chronic complications, including an elevated risk of stroke. Early identification of stroke risk factors in diabetic patients is critical to reducing complications and improving health outcomes.

Objectives: This study aimed to assess the stroke risk levels among patients with T2DM, identify associated factors, and provide insights for targeted interventions.

Methods: A cross-sectional descriptive study was conducted on 40 patients with T2DM at Khlongkhoen Subdistrict Health Promoting Hospital in Samut Songkhram Province, Thailand. Data were collected using structured interviews, including demographic characteristics, comorbidities, and complications. Stroke risk levels were classified into low risk and moderate-to-high risk. Statistical analyses included descriptive statistics, Chi-square tests, and logistic regression.

Results: Among the patients, 35% were classified as low risk, while 65% were in the moderate-to-high risk category. Significant factors associated with stroke risk included earlier age at diabetes diagnosis (<60 years; p=0.02) and the presence of two or more comorbidities (p=0.04). Symptoms of hypoglycemia or hyperglycemia were also significantly associated with stroke risk (p=0.043). However, exercise frequency showed no significant relationship with stroke risk (p=0.533).

Conclusion: The findings highlight the need for early screening and comprehensive management of stroke risk factors in diabetic patients, particularly those with early-onset diabetes and multiple comorbidities. Integrating community-based interventions and patient education may improve self-care and reduce stroke-related complications.

Keywords: Stroke risk, type 2 diabetes mellitus, comorbidities, complications

1. Introduction

Diabetes is a critical global public health issue, particularly type 2 diabetes mellitus (T2DM), which is associated with various complications, including stroke. According to the International Diabetes Federation, the global prevalence of diabetes is projected to increase from 425 million

in 2017 to 629 million by 2045 (IDF, 2017). Stroke is the second leading cause of death and the third leading cause of disability worldwide (WHO, 2012). In Thailand, diabetes-related deaths are as high as 180 per day. Mortality rates have shown an increasing trend over the past three years (2021–2023), with rates of 21.25, 22.68, and 24.43 per 100,000 population, respectively. Similarly, hospitalization rates for diabetes complications have risen, with admission rates of 1,392.98, 1,563.02, and 1,692.43 per 100,000 population in 2021, 2022, and 2023, respectively (Ministry of Public Health, 2021).

Complications from diabetes can be categorized as acute or chronic. Acute complications, such as hyperglycemia or ketoacidosis, can lead to unconsciousness or death if untreated promptly (Negera et al., 2020; Nomura et al., 2021). Chronic complications, including cardiovascular disease, chronic kidney disease, retinopathy, and stroke, arise from poorly controlled blood glucose levels (Lee et al., 2019; Leeprakobboon, 2024). Stroke results from arterial occlusion, narrowing, or rupture, causing a lack of blood and oxygen supply to the brain. This can lead to paralysis, permanent disability, or even death (Krugman & Hoffman, 2014).

In Samut Songkhram Province, the incidence of diabetes and stroke has been increasing, especially in Mueang Samut Songkhram District and Khlongkhoen Subdistrict. Data from 2020–2022 revealed a continuous rise in T2DM cases in Khlongkhoen Subdistrict. Similarly, the incidence and mortality rates of stroke also showed an upward trend (Somboon and Sangkharat, 2020). Most diabetes patients face challenges in self-care. Despite receiving medical treatment, many lack awareness and understanding of the potential complications of diabetes. This often leads to the inability to control complications effectively, whether chronic—such as complications affecting the eyes, kidneys, nervous system, or feet—or acute, such as hypoglycemia, diabetic ketoacidosis, or hyperosmolar hyperglycemic state (Kai Wang et al., 2022). Additionally, diabetes patients are at an elevated risk of stroke (Shi, 2020).

Past studies have indicated a significant association between stroke mechanisms and diabetes patients' lifestyle behaviors, genetics, and socio-demographic factors (Kai Wang et al., 2022). Stroke awareness and social support have been shown to predict preventive behaviors by 25.8% (Somboon and Sangkharat, 2020). Moreover, Shi (2020) identified 11 key risk factors for stroke, including age, duration of T2DM, estimated glomerular filtration rate, systolic blood pressure, diastolic blood pressure, low-density lipoprotein, high-density lipoprotein, triglycerides, body mass index, uric acid, and glycated hemoglobin A1c. These factors contribute to an increased risk of ischemic stroke among diabetes patients. While stroke is preventable through risk factor management and early recognition of warning signs, a review of related research indicates gaps in patient knowledge. Jittanoon et al. (2021) found that stroke knowledge scores among patients were generally low. Similarly, Nguyen and Tran, (2013) reported that while most participants had high levels of knowledge, some exhibited misconceptions about stroke warning signs, recognizing only partial symptoms. This highlights a lack of comprehensive awareness among patients, which could exacerbate stroke severity and lead to fatalities.

Moreover, there is limited research on the stroke risk levels of diabetes patients in primary care settings, particularly in community-specific contexts. This lack of data hinders the effectiveness of surveillance and prevention strategies at the community level, especially for diabetes patients, who are a high-risk group. Recognizing the importance of early risk screening for stroke in high-risk groups, as emphasized by Thailand's Ministry of Public Health, this study aims to assess the stroke risk levels of diabetes patients in the study area. The findings will

provide insights into self-care practices to reduce risks and prevent complications related to stroke and other diabetes-related conditions.

Research Objective

1.To assess the risk level of stroke among patients with T2DM.

2.To investigate the risks of chronic and acute complications contributing to stroke in patients with T2DM.

2. MATERIALS AND METHODS

2.1 Ethical approval

This research proposal was approved by the Human Research Ethics Committee at Suan Sunandha Rajabhat University (Reference number: COA.1-046/2023).

2.2 Study Design and Participants

This study a descriptive research design focusing on patients with diabetes who received care at the Khlongkhoen Sub-district Health Promoting Hospital, Mueang District, Samut Songkhram Province. The inclusion criteria were as follows: (1) patients aged over 18 years; (2) patients who had been diagnosed with T2DM by a physician for at least one year; (3) patients who had consistently received treatment at the diabetes clinic of Khlongkhoen Sub-district Health Promoting Hospital, Mueang District, Samut Songkhram for at least one year; (4) patients who could communicate in Thai; and (5) patients who voluntarily participated in the study and signed the informed consent document. The exclusion criteria were: (1) patients or family members who failed to provide consent; and (2) patients with mental health problems. The sample size was calculated to include a total of 40 patients. Simple random sampling was used to select the participants. The research instruments consisted of structured questionnaires divided into three sections:

1. Demographic characteristics, including age at study baseline, sex, education level, comorbidities, Duration of diabetes was classified into two ordinal groups ($\leq$ 5 years , $\geq$ 6 years). For age at diagnosis was classified into two groups: less than age 60 and aged from 60 and above, comorbidities are categorized into two types: single comorbidity and two or more comorbidities. and exercise habits.

2. A stroke risk screening questionnaire.
3. A survey assessing acute and chronic complications and risk factors associated with stroke.

Estimation of sample size

The sample size calculation was estimated by using a formula for cross-sectional studies as outlined by Ngamjarus (2021) following formula.

$$n = \frac{Nz_{\alpha}^{2}/2p(1-p)}{e^{2}(N-1) + z_{\alpha}^{2}/2p(1-p)}$$

N = 200, patient who live in Khlongkhoen Subdistrict ware diagnosed diabetes mellitus

z = z value at α = 0.05, the prevalence of primary outcome in previous study was 56.7% (p), the desired level of relative precision was 0.15 (e) . Then, considering drop-out rate of 10% total sample size, hence the minimum sample required for conducting this study was found to be 38

2.3 Statistical analyses

All statistical analyses were performed using R software (version 4.3.2). Demographic characteristics of the patients were analyzed using descriptive statistics, including frequencies, percentages, means, and standard deviations. The level of risk for stroke was assessed using descriptive statistics, specifically frequencies and percentages. Chronic and acute complications, along with risk factors associated with stroke, were analyzed and presented in terms of their frequencies and percentages of occurrence. The relationships between various factors and the level of risk for stroke were analyzed using Chi-square and Fisher's Exact tests for categorical outcomes. Factors influencing the occurrence of complications in diabetic patients were analyzed using logistic regression analysis. A significance level of α = 0.05 was employed, with p-values < 0.05 considered indicative of statistically significant relationships.

2.4 Results

The study included 40 patients with type 2 diabetes mellitus (T2DM) classified by stroke risk levels: 14 (35.0%) in the low-risk group and 26 (65.0%) in the moderate-to-high risk group (Figure 1). Most patients were female (70.0%), and the mean age was 64 ± 11.3 years old. Patients in the low-risk group had a higher mean age (68.2 ± 11.5 years old) compared to those in the moderate-to-high risk group (61.7 ± 10.8 years old). Regarding comorbidities, 42.5% of the patients had a single comorbidity, while 57.5% had two or more comorbidities (Table 1). The identified comorbidities included hypertension, hyperlipidemia, kidney disease, heart disease, lung cancer, anemia, fatty liver disease, peripheral neuropathy, and asthma.

The prevalence of chronic and acute complications varied between the risk groups. Symptoms of hypoglycemia or hyperglycemia were significantly more common in the moderate-to-high risk group (67.6%) than in the low-risk group (32.4%) (p=0.043). Other complications, such as hemiparesis and sudden vision loss, were more frequent in the moderate-to-high risk group but did not reach statistical significance (Table 2). Significant associations were observed between stroke risk and age at diagnosis (p=0.02) and the presence of two or more comorbidities (p=0.04). No significant relationships were found for other factors, such as sex, duration of diabetes, education level, or exercise frequency (Table 3).

Logistic regression analysis was performed to identify factors influencing stroke complications in patients with T2DM. The crude odds ratio (cOR) analysis revealed that patients diagnosed with T2DM before the age of 60 had a significantly higher risk of stroke complications (cOR = 5.87**,** 95%CI*:* 1.31–26.33*)*, which remained significant after adjustment for confounding variables (aOR = 21.76**,** 95%CI: 2.41–196.56, p = 0.006). Similarly, having two or more comorbidities was associated with an increased risk of stroke complications (cOR = 4.05**,** 95%CI: 1.03–16.01), with the association persisting in the adjusted model (aOR = 9.69**,** 95%CI: 1.24–75.67, p = 0.030). Other factors, such as the duration of diabetes (≤ 5 years vs. ≥ 6 years), showed a crude odds ratio of 1.02 (95% CI: 0.28–3.80) and an adjusted odds ratio of 3.00 (95%CI: 0.47–19.01, p = 0.243)**,** which were not statistically significant. Hemiparesis demonstrated a higher crude odds ratio of 5.78 (95% CI: 0.64–52.03) and an adjusted odds ratio of 9.33 (95%CI*:* 0.76–114.65, p = 0.081); although not statistically significant, it showed a trend toward moderate-to-high stroke risk. These findings are summarized in Table 4.

Figure 2 clearly illustrates the key factors contributing to moderate-to-high stroke risk in patients with T2 DM. These factors include being under 6 0 years of age, the presence of comorbidities, and other clinical conditions such as the duration of diabetes and hemiparesis. This comprehensive analysis underscores the critical need for early diagnosis and proactive management of comorbidities to effectively reduce complications and mitigate the risk of stroke in patients with T2DM

Figure 1: Distribution of Stroke risk level among patients

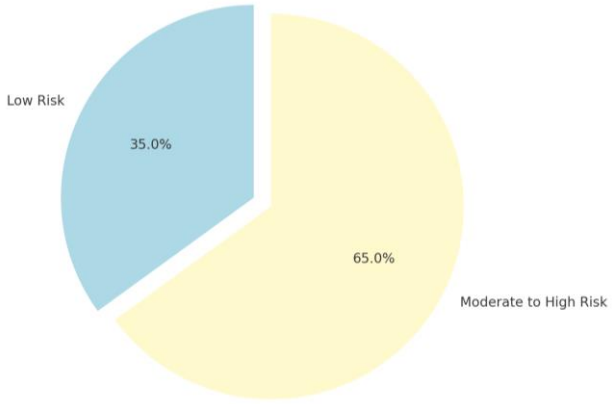


Table 1: Demographic characteristics of patients with T2DM classified by stroke risk levels

Variables	Total n (%)	Risk level of stroke	
		low risk n (%)	Moderate-high risk n (%)
Sex			
Male	12 (30.0)	4 (10.0)	8 (20.0)
Female	28 (70.0)	10 (25.0)	18 (45.0)
Age (years) Mean ± SD	64±11.3	68.2±11.5	61.7±10.8
Age group			
<65 years old	22 (55.0)	6 (15.0)	16 (40.0)
≥ 65 years old	18 (45.0)	8 (20.0)	10 (25.0)
Age at diagnosis			
<60 years old	19 (47.5)	3 (7.5)	16 (40.0)
≥ 60 years old	21 (52.5)	11 (27.5)	10 (25.0)
Duration of Diabetes (years)	6.1±5.7	5.1±3.7	6.6±6.6
Duration of Diabetes (group)			
$\leq 5\ years$	23 (57.5)	8 (20.0)	15 (37.5)
$\geq 6\ years$	17 (42.5)	6 (15.0)	11 (27.5)
Education level			
Primary education	28 (70.0)	10 (25.0)	18 (45.0)
Secondary education or higher	12 (30.0)	4 (10.0)	8 (20.0)
Comorbidities			
Single comorbidity	17 (42.5)	9 (22.5)	8 (20.0)
2 or more comorbidities	23 (57.5)	5 (12.5)	18 (45.0)
Exercise Frequency			
No exercise	15 (37.5)	6 (15.0)	9 (22.5)
Exercise for 30 minutes	25 (62.5)	8 (20.0)	17 (42.5)

Table 2: Frequency and Percentage of Patients with Chronic and Acute Complications Classified by Stroke Risk

Complications	Number of patients with symptoms	Risk level of stroke		p-value
		low risk n (%)	Moderate-high n (%)	
1. Symptoms of hypoglycemia or hyperglycemia	34	11 (32.4)	23 (67.6)	0.043[a]
2. Complications affecting the eyes, kidneys, or feet in the past	18	6 (33.3)	12 (66.7)	0.842[a]
3. Hemiparesis (numbness on one side of the body)	9	1 (11.1)	8 (88.9)	0.124[b]
4. Weakness, facial drooping, or arm and leg weakness combined with difficulty speaking	1	0	1 (100.0)	1.000[b]
5. Dizziness, imbalance, unsteady gait, difficulty swallowing, or headache	19	8 (42.1)	11 (57.9)	0.370[a]
6. Sudden inability to speak, difficulty understanding, or slurred speech	1	0	1 (100.0)	1.000[b]
7. Sudden loss of vision in one eye, double vision, or a curtain-like vision loss	14	3 (21.4)	11 (78.6)	0.187[a]
8. Sudden severe headache unlike any experienced before	11	5 (45.5)	6 (54.5)	0.393[a]
9. Confusion, dizziness, or loss of balance	16	8 (50.0)	8 (50.0)	0.104[a]
10. Mood swings or depression	11	5 (45.5)	6 (54.5)	0.393[a]

Note: [a] chi-square test, [b] fisher's exact test

Table 3: Relationship Between Factors and Stroke Risk

Factors	p-value
Sex	0.885[a]
Age group	0.257[a]
Age at diagnosis	0.02[b]*
Duration of Diabetes	0.973[a]
Education level	0.885[a]
Comorbidities	0.04[a]*
Exercise	0.533[b]

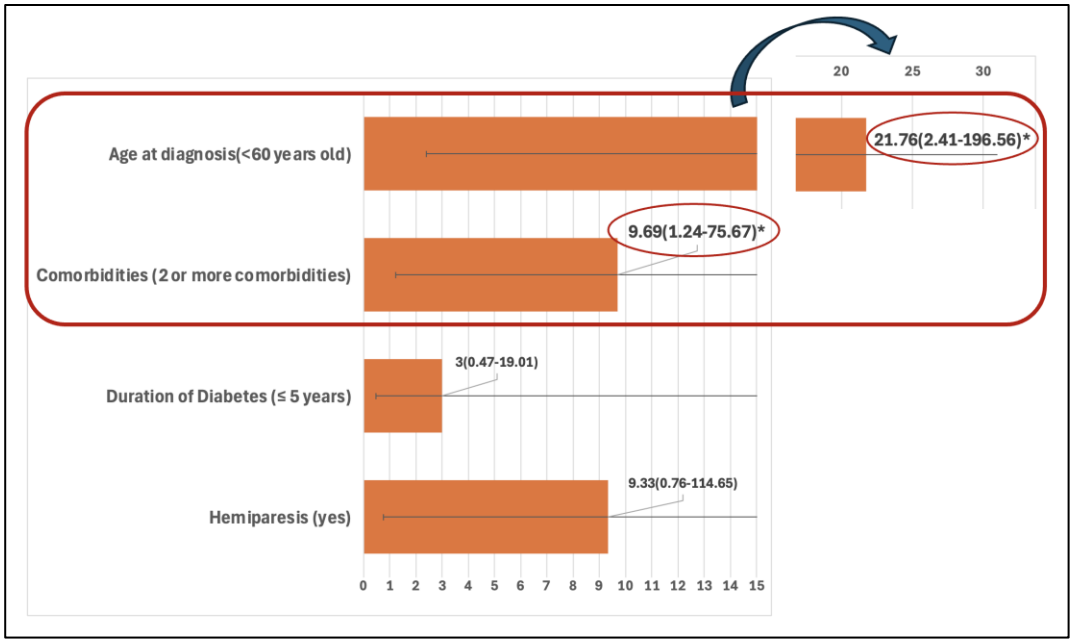
*Note: [a] chi-square test, [b] fisher's exact test, *p-value<0.05*

Table 4: Logistic Regression for Factors Influencing Complications

Predictor Variable	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)	p-value
Age at diagnosis			0.006*
≥ 60	*Ref.*	*Ref.*	
<60	5.87 (1.31-26.33)	21.76 (2.41-196.56)	
Comorbidities			0.030*
Single comorbidity	*Ref.*	*Ref.*	
2 or more comorbidities	4.05 (1.03-16.01)	9.69 (1.24-75.67)	
Duration of Diabetes			0.243
$\geq 6\ years$	*Ref.*	*Ref.*	
$\leq 5\ years$	1.02 (0.28-3.80)	3.00 (0.47-19.01)	
Hemiparesis			0.081
None	*Ref.*	*Ref.*	
Yes	5.78 (0.64-52.03)	9.33 (0.76-114.64)	

*Note: *p-value<0.05, Ref.: Reference Group*

Figure 2: Key Factors Associated with Moderate-High Stroke Risk in Type 2 Diabetes Mellitus Patients



2.5 Discussion

This study evaluated the demographic characteristics, complications, and risk factors associated with stroke in patients with type 2 diabetes mellitus (T2DM), classifying them into low-risk and moderate-to-high risk categories. The findings highlight critical associations between stroke risk and key factors, such as age at diabetes diagnosis and the presence of comorbidities, which are consistent with existing literature.

The study revealed that the majority of patients in the moderate-to-high risk group had earlier diabetes onset (<60 years) and a higher prevalence of comorbidities (57.5%) compared to the low-risk group. These findings align with Shi et al. (2020); Morton et al. (2022), who identified earlier onset of diabetes and the presence of multiple comorbidities as significant predictors of stroke risk in diabetic populations. Yao et al. (2023) similarly noted that patients diagnosed at a younger age and with a longer diabetes duration faced higher cardiovascular and cerebrovascular risks. This underscores the importance of managing comorbid conditions, such as hypertension and dyslipidemia, to mitigate stroke risk in diabetic patients. Furthermore, patients with two or more comorbidities were significantly more likely to fall into the moderate-to-high risk category ($p=0.04$).

Chronic and acute complications, such as hypoglycemia, hyperglycemia, and organ damage (eyes, kidneys, and feet), were more prevalent in the moderate-to-high risk group. For instance, symptoms of hypoglycemia or hyperglycemia were significantly associated with stroke risk ($p=0.043$). These findings are supported by Wang et al. (2022); Li et al. (2024), who noted that glycemic variability contributes to vascular complications and increases stroke susceptibility in diabetic patients. The lack of significant differences in other complications, such as hemiparesis and vision loss, may reflect the need for larger sample sizes or additional longitudinal data to capture their impact.

Patients diagnosed with diabetes at a younger age (<60 years) had a significantly higher likelihood of stroke risk ($p=0.02$). This finding resonates with prior studies, such as those by Nomura et al. (2021), which suggested that prolonged exposure to hyperglycemia and vascular stress in younger-onset diabetes exacerbates the risk of cardiovascular and cerebrovascular

diseases. Yao et al. (2023) further emphasized the compounding effect of longer diabetes duration on cardiovascular risks. Early diagnosis and intervention are thus critical for mitigating long-term risks.

Although exercise frequency did not significantly correlate with stroke risk in this study (p=0.533), prior research underscores the protective role of regular physical activity. Lee et al. (2019) found that moderate-intensity exercise reduces ischemic stroke risk in diabetic patients. Prabsangob K. (2016) highlighted the influence of education, income, diabetes knowledge, social support, doctor communication, health information, and literacy on self-care behavior. Similarly, Suksatan, W. et al. (2021) reported that enhanced health literacy improves self-care and blood sugar control. These findings emphasize the need for nurses and multidisciplinary teams in developing effective health promotion programs.

This study emphasizes the importance of early screening for stroke risk in diabetic patients, particularly those with multiple comorbidities or early-onset diabetes. Effective management of risk factors, including glycemic control, comorbid conditions, and lifestyle interventions, is crucial. The findings support initiatives by the Ministry of Public Health to implement targeted screening and preventive measures for high-risk populations.

This study has certain limitations, including a relatively small sample size and the cross-sectional nature of the data, which precludes causal inferences. Future research should focus on larger cohorts and longitudinal designs to better understand the temporal relationships between risk factors and stroke outcomes. Additionally, integrating biomarkers such as HbA1c and inflammatory markers may provide deeper insights into the pathophysiology of stroke in diabetic patients.

3. Conclusion

The findings of this study contribute to the growing understanding of the complex relationship between diabetes-related factors and stroke risk. Specifically, being under 60 years old and having comorbidities are identified as key factors that increase stroke risk. These insights deepen our understanding of patient profiles that necessitate targeted interventions, emphasizing the importance of early action and effective management of both comorbidities and lifestyle factors to reduce the stroke burden and improve health outcomes for individuals with type 2 diabetes mellitus.

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