

The prevalence of and risk factors for stroke among type 2 diabetes mellitus patients in Qatar: A hospital-based study

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ABSTRACT

Background and Objectives: The complications of type 2 diabetes mellitus (T2DM) can occur in some organs, such as the heart, blood vessels, eyes, kidneys, and nerves. Stroke, one of such complications, is increasing every year. This study aims to investigate the prevalence of and risk factors for stroke among T2DM patients in Qatar. **Methods:** This was a secondary *post hoc* analysis of collected data from our previous study titled “Association of Vitamin D deficiency with dyslipidemia, glycemic control, and microalbuminuria in patients with T2DM in Qatar.” **Results:** The prevalence of stroke among our patients was 3.8%. A comparison between stroke and no-stroke groups showed a significant association between stroke and other diseases, namely, chronic kidney diseases (CKD) ($p=0.007$), coronary artery disease (CAD) ($p=0.010$), peripheral vascular disease (PVD) ($p<0.001$), retinopathy ($p=0.044$), prolonged duration of diabetes mellitus (DM) ($p=0.041$), glycated hemoglobin (HbA1c) ($p=0.006$), and a high serum creatinine level ($p=0.003$). In the multivariate analysis, we identified the following variables as independent risk factors for stroke in patients with T2DM: male gender, CKD, CAD, PVD, high HbA1c, a high creatinine level, and prolonged duration of DM. **Conclusion:** The prevalence of stroke among T2DM patients in Qatar was around 3.8%. The main risk factors were male gender, CKD, CAD, PVD, high HbA1c, prolonged duration of DM, and a high level of creatinine.

Key words: Logistic regression, Qatar, Risk factors, Stroke, Type 2 diabetes mellitus

Diabetes is one of the most common non-communicable diseases and a growing global public health problem with a significant economic burden. Type 2 diabetes mellitus (T2DM) accounts for 90% of diabetes worldwide [1]. In chronic complications, such as chronic kidney diseases (CKD) and cardiovascular diseases, strokes are well-known outcomes of T2DM progression that reduces patients’ quality of life and increases the burden on the health-care system. Individuals with diabetes have a risk of experiencing a stroke 2 times higher than those that do not have this condition [2]. Some researchers estimated that the prevalence of stroke among T2DM patients was between 2.5% and 20% [2-4], while a recent meta-analysis estimated that the prevalence of diabetes in all stroke inpatients was 28% [5].

With a prevalence of approximately 19.8%, Qatar is among the top 10 nations in the world for diabetes. As Qatar continues to develop, the risk of diabetes is increasing due to ongoing urbanization and changing lifestyles in the country [1]. A recent study [6] shows that about 71.8% of stroke patients in Qatar have diabetes mellitus (DM). The prevalence of stroke among

T2DM patients in Qatar is not well-studied. This study aimed to investigate the prevalence of and risk factors for stroke among T2DM patients in Qatar.

MATERIALS AND METHODS

Study Design, Setting, and Population

This was a secondary *post hoc* analysis of collected data from our previous study titled “Association of Vitamin D deficiency with dyslipidemia, glycemic control, and microalbuminuria in patients with T2DM in Qatar” [7], which was conducted from January 1, to July 31, 2018. The collected data were used to conduct a new study with modified objectives, without using patients’ medical records.

Definitions, Inclusion and Exclusion Criteria

Stroke status was determined on the basis of the information gathered initially from the electronic medical records of the involved patients. According to these records, strokes had been diagnosed by the stroke team in the hospital. However, the primary study did not gather information on types of strokes (ischemic or hemorrhagic).

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Therefore, no distinction was made regarding the types of stroke in this study. The primary outcome of this study was the prevalence of stroke among T2DM, while the secondary outcomes were independent risk factors for stroke among T2DM patients.

Data Analysis

The data analysis was performed using the Statistical Package for the Social Sciences software V23 (IBM Corp., Armonk, NY, USA). To report data, mean and standard deviation were calculated for quantitative variables, whereas numbers and percentages were used for qualitative variables. The Fisher exact test and analysis of variance test were used for cross tabulation at 0.05 margins of error. Variables with $p < 0.05$ values were entered into the multiple logistic regression model to identify the risk factors for stroke among our patients. All significance tests were two-sided with $p < 0.05$ as the level of significance.

Ethical Consideration

Since this was a secondary *post hoc* analysis of collected data from our previous study, ethics committee approval or informed consent was not required. The original study was approved by the medical research ethical committee at Hamad medical corporation, Qatar.

RESULTS

Demographic and Clinical Data

The primary study recruited 400 subjects with T2DM. Their mean age was 58.97 ± 10.32 years (the range of 28–86 years), and the majority were women (52.0%) and Arabs (69.5%). The mean duration of type 2 diabetes diagnosis was 14.94 ± 8.99 years (the range of 1–50 years), and mean BMI was 31.48 ± 6.21 kg/m² (the range of 19.8–64.3 kg/m²). Table 1 describes the demographic and clinical characteristics of the study population. The prevalence of stroke among this cohort was 3.8%.

Comparison between Stroke and No-stroke Groups

A comparison between stroke and no-stroke groups showed a significant association between stroke and other diseases, namely, chronic kidney CKD ($p = 0.007$), coronary artery disease (CAD) ($p = 0.010$), peripheral vascular disease (PVD) ($p < 0.001$), retinopathy ($p = 0.044$), prolonged duration of DM ($p = 0.041$), glycated hemoglobin (HbA1c) ($p = 0.006$), and a high serum creatinine level ($p = 0.003$) (Table 2).

Multiple Regression Test to Identify the Risk Factors for Stroke

Table 3 demonstrates the association of various risk factors with stroke. In the multivariate analysis – after adjusting for various confounders, such as gender, CKD, CAD, PVD, retinopathy,

Table 1: Demographic and clinical characteristics of the patients involved in this study

Variable	n (%) / Mean \pm SD (Range)
Age	58.97 \pm 10.32 (28–86)
Sex	
Male	192 (48.0%)
Female	208 (52.0%)
Nationality	
Arabs	278 (69.5%)
Non-Arabs	122 (30.5%)
Clinical characteristics	
Hypertension	301 (75.25%)
Dyslipidemia	340 (85%)
CKD	89 (22.25%)
Liver disease	11 (2.75%)
CAD	94 (23.5%)
PVD	17 (4.25%)
Retinopathy	119 (29.75%)
Neuropathy	66 (16.5%)
Vitamin D deficiency	118 (29.5%)
BMI	31.48 \pm 6.21 (19.8–64.3)
Duration of DM	14.94 \pm 8.99 (1–50 years)
Investigations	
Fasting Blood Sugar	7.41 \pm 1.88 (3.8–21 mmol/l)
Random Blood Sugar	10.64 \pm 3.36 (1.8–22 mmol/l)
HbA1c	8.07 \pm 1.48 (5–12.7)
Total cholesterol	4.07 \pm 1.19 (1.1–11.9 mmol/l)
LDL (c)	2.15 \pm 0.99 (0.40–9.40 mmol/l)
HDL (c)	1.16 \pm 0.31 (0.4–2.5 mmol/l)
Triglycerides	1.62 \pm 0.92 (0.4–8.5 mmol/l)
Creatinine	105.80 \pm 123.29 (15–909 μ mol/l)
eGFR	77.09 \pm 24.53 (3.40–160 mL/min/1.73m ²)
Vit D level	29.89 \pm 14.46 (4–81 ng/ml)
Calcium	2.39 \pm 0.10 (1.87–2.80 mmol/l)
Phosphorous	1.32 \pm 0.36 (0.72–2.44 mmol/l)
UACR	21.34 \pm 90.16 (0.3–999.9 μ g albumin/mg creatinine)
Primary outcome	
Stroke	15 (3.8)

CKD: Chronic kidney disease, CAD: Coronary artery disease, PVD: Peripheral vascular disease, BMI: Body mass index, LDL (C): Low-density lipoprotein cholesterol, HDL (C): High-density lipoprotein cholesterol; eGFR: Estimated glomerular filtration rate, UACR: Urinary Albumin Excretion Rate, DM: Diabetes mellitus, HbA1c: Glycated hemoglobin

and a high serum creatinine level – we identified the following variables as independent risk factors for stroke in patients with T2DM: male gender, CKD, CAD, PVD, HbA1c, a high creatinine level, and prolonged duration of DM.

DISCUSSION

To the best of our knowledge, this is the first study conducted to investigate prevalence of stroke among T2DM patients in Qatar.

Table 2: A comparison between Vitamin D deficiency and vitamin D sufficiency groups crosschecked with demographic and clinical aspects

Variables	Total	Stroke (%)	No-stroke (%)	P-value
Gender (M/F)	192/208	12/13	180/205	0.016
Nationality				
Arab	278	3 (28.1)	275 (71.9)	0.056
Asian	105	12 (36.2)	93 (63.8)	
Others	17	0 (0)	17 (100)	
Clinical aspects				
Hypertension	301	13 (86.7)	288 (73.4)	0.238
Dyslipidemia	340	12 (80.0)	228 (74.8)	0.480
CKD	89	8 (53.3)	81 (21.0)	0.007
CAD	94	8 (53.3)	86 (22.3)	0.010
PVD	17	5 (33.3)	12 (3.1)	<0.001
Retinopathy	119	8 (53.3)	111 (28.8)	0.044
Neuropathy	66	1 (6.7)	65 (16.8)	0.482
Vitamin D deficiency	118	4 (26.6)	114 (29.6)	1.00
Age	58.97±10.32 (28–86)	61.80±8.27	58.86±10.39	0.281
BMI	31.48±6.21 (19.8–64.3)	32.07±6.41	31.45±6.21	0.705
Duration of DM	14.94±8.99 (1–50)	19.46±14.52	14.76±8.69	0.041
FBS	7.41±1.88 (3.8–21)	7.30±2.03	7.42±1.88	0.818
RB sugar	10.64±3.36 (1.8–22)	11.01±4.15	10.63±3.33	0.671
HBA1c	8.07±1.48 (5–12.7)	8.05±1.57	7.07±1.48	0.006
Total cholesterol	4.07±1.19 (1.1–11.9)	3.59±0.95	4.09±1.20	0.118
LDL (c)	2.15±0.99 (0.40–9.40)	1.95±1.00	2.16±0.99	0.433
HDL (c)	1.16±0.31 (0.4–2.5)	1.06±0.29	1.17±0.31	0.128
Triglyceride	1.62±0.92 (0.4–8.5)	1.28±0.46	1.63±0.93	0.154
Creatinine	105.80±123.29 (15–909)	196.70±216.48	102.26±117.26	0.003
UACR	21.34±90.16 (0.3–999.9)	33.03±95.35	20.89±90.08	0.635

CKD: Chronic kidney disease, CAD: Coronary artery disease, PVD: Peripheral vascular disease, BMI: Body mass index, LDL (c): Low-density lipoprotein cholesterol, HDL (c): High-density lipoprotein cholesterol, UACR: Urinary Albumin Excretion Rate, FB: Fasting blood, RB: Random blood, DM: Diabetes mellitus, HBA1c: Glycated hemoglobin

Table 3: Multivariate analysis of predictors of in-hospital mortality

Variables	Adjusted odds ratio (95% confidence interval)	P-value
Male gender	3.56 (1.57–3.95)	0.032
CKD	3.64 (2.16–7.22)	<0.001
CAD	2.37 (1.55–2.49)	0.024
PVD	8.34 (4.33–11.23)	<0.001
Retinopathy	1.23 (0.62–2.43)	0.146
HBA1c	2.16 (1.11–3.51)	0.021
Creatinine	4.92 (1.49–6.72)	0.007
Duration of DM	2.11 (0.98–2.15)	0.043

HBA1c: Glycated hemoglobin

The prevalence of stroke among T2DM patients varies from country to country. Tseng *et al.* found the prevalence of 7.5% in Taiwan [8], while Almobarak *et al.* found the prevalence of 2.8% in Sudan [3]. Khan *et al.* found the prevalence of 11.2% in the United States [4], while Asfandiyarova *et al.* found the prevalence of 2.9% in Russia [9]. In Indonesia, Amelia *et al.* found that the prevalence was 20% [2], while, in Qatar, we found that the prevalence of stroke among T2DM patients was

3.8%. This variation can be attributed to the variation in the coexisting medical conditions, such as hypertension, CKD, and cardiovascular diseases [10].

Risk factors for stroke in T2DM patients have been identified in many studies. The identification of the risk factors proved invaluable as it could help prevent late complications of diabetes and reduce the mortality rate from stroke. In Qatar, no previous studies had investigated predictors of stroke among adults with T2DM; our study was the first to do that. Khan *et al.* and Tseng *et al.* identified hypertension as an independent risk factor for stroke among diabetic patients [4, 8]. According to a report by the American Heart Association (AHA), hypertension increased the risk of stroke by weakening arteries, and weakened arteries were more likely to burst or clog, resulting in hemorrhagic or ischemic stroke, respectively [11]. In contrast, we could not find hypertension as a predictor of stroke in our study. A study by Bushnell *et al.* reported that the risk of stroke doubled every 10 years after the age of 55 [12]. The possible mechanism underlying the effect of age was that arteries naturally became narrower and harder with increasing age due to the change mediated by endothelial dysfunction and impaired cerebral autoregulation [13]. In contrast, our study did not show a

significant association between age and stroke. However, among our patients, male sex was found to be a risk factor for stroke. A study by Tseng *et al.* had similar findings [8].

DM is a major risk factor for stroke. Individuals with diabetes have a risk of experiencing a stroke 2 times higher than those that do not have this condition [4]. DM is strongly associated with both microvascular and macrovascular complications. Microvascular complications include retinopathy, nephropathy, and neuropathy, while macrovascular complications include ischemic heart disease, PVD, and cerebrovascular disease. They result in organ and tissue damage in approximately one-third to half of people with diabetes [14]. Given that these complications are correlated with a history of poor blood glucose control, they may also be an indication of the effect of diabetes on the occurrence of stroke. The harmful effects can be explained not only by endothelial damage but also by factors such as hypertension which is often triggered by kidney damage. Similarly, the bivariate analysis in our study has shown a significant association between CKD, CAD, PVD, retinopathy, a high level of HbA1c, long duration of DM, and a high level of creatinine.

Almobarak *et al.* found that HbA1c and the duration of diabetes were significantly associated with stroke. In multivariate analysis, we found CKD, CAD, PVD, a high level of HbA1c, duration of DM, and a high level of creatinine as independent risk factors for stroke.

This study has some limitations. It is a *post hoc* analysis of a retrospective cohort study that was conducted at a single hospital. A more comprehensive prospective study should be conducted for a more accurate estimation of prevalence and risk factors. This study is novel as it is the first that is conducted in Qatar. Our findings will be useful in guiding health equity programs that are geared toward reducing strokes among populations with diabetes in Qatar.

CONCLUSION

The prevalence of stroke among T2DM patients in Qatar was around 3.8%. The main risk factors were male gender, CKD, CAD, PVD, a high level of HbA1c, long duration of DM, and a high level of creatinine. Strict blood sugar control and regular screening for proteinuria could help reduce stroke risks in T2DM patients.

AUTHORS' CONTRIBUTIONS

Karuppasamy G analyzed the data and wrote the final manuscript. Al Shokri S proposed the idea, reviewed the literature, and aided

in the data analysis. Sukik A reviewed the literature and aided in writing the manuscript. Bacha KA aided in the data analysis, literature review, and the revision of the final manuscript. All authors read the manuscript and agree to its publication.

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