The prevalence and risk factors of stroke among Sudanese individuals with diabetes: Cross-sectional survey

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Abstract:

INTRODUCTION: Diabetes complications in Sudan were increasing at an alarming rate. The aim of this study was to assess the prevalence of stroke among Sudanese individuals with diabetes.

METHODOLOGY: This cross-sectional study recruited 283 individuals with diabetes from three diabetes centers in Sudan. Data were collected using a standardized pretested questionnaire, and data were analyzed using Chi-square and logistic regression analysis.

RESULTS: The average age of participants was 51 (±12 standard deviation) and 35% were aged between 51 and 60 years. Females were 66.8%, and most of the participants (73.9%) were from urban areas and 66.1% received formal education between primary school and university. Body mass index (BMI) classification showed that 34.3% were obese, 31.8% overweight, and 30.4% normal BMI. Diabetes for 1-5 years were observed in 71.7% and for more than 10 years (12%). The majority, i.e., 94.3% had type 2 diabetes mellitus while only 5.7% had type 1. Only one-third of the participants were able to achieve glycosylated hemoglobin (HbA1c) target for diabetes control. The prevalence of cerebrovascular accident (CVA) was 2.5%, hypertension (HTN) was 20%, ischemic heart disease 3.2%, and neuropathy was 45.6%. Chi-square test showed significant association between HbA1c, serum creatinine, total cholesterol, triglyceride, low density lipoprotein, high density lipoprotein level, and the presence of CVA. Logistic regression analysis showed HbA1c, and the duration of diabetes are significantly associated with the presence of CVA (P = 0.010, 0.014).

CONCLUSION: The prevalence of stroke among Sudanese individuals with diabetes was around 2.5%. The main risk factors were HbA1c, HTN, and duration of diabetes.

Keywords:
Diabetes, hypertension, stroke, Sudan

Introduction

Diabetes control and associated complications will remain serious challenges for health authorities in Sudan. The estimated prevalence of diabetes in urban areas is 19% and rural areas is around 2.6%.[1,2] Factors identified to be associated with high prevalence of diabetes in Sudan are increasing age, family history of diabetes, central obesity, abnormal body mass index (BMI), and hypertension (HTN).[1] The increase in prevalence of obesity among Sudanese individuals with diabetes was estimated to be around 24.5% and overweight was 39.9% and more among women than men.[3] Obesity and central obesity were significantly associated with female sex and HTN.[3] Furthermore, the prevalence of fatty liver among individuals with type 2 diabetes was thought to be 50.3%. The possible predictors of fatty liver in Sudanese individuals with diabetes were overweight, increase in features of metabolic syndrome, obesity, central obesity, high

triglyceride (TG) level, and low high-density lipoprotein cholesterol (HDL-c) level.[4] Satisfactory diabetes control is greatest challenge for health authorities in Sudan. For instance, the number of Sudanese individuals with type 1 and type 2 diabetes who achieved adequate glycosylated hemoglobin (HbA1c) was estimated to be 16.2% and 15% respectively.[5,6] Therefore, high prevalence of diabetes complications was observed in Sudanese individuals with type 1 diabetes. For instance, peripheral neuropathy, visual impairment, diabetic foot, and myocardial infarction were seen in 50%, 48.8%, 18.8%, and 2.5% of Sudanese individuals with type 1 diabetes, respectively.[6] Other serious complications of diabetes like acute coronary syndrome, retinopathy and diabetic septic foot were also being identified in different epidemiological studies. For instance, Ahmed *et al*. found that the prevalence of acute coronary syndrome among Sudanese individuals with diabetes was 5.44% and main risk factors were HTN, an increase in age and increase in duration of diabetes.[7] The prevalence of heart failure in Sudanese individuals with diabetes was found to be 12.06% and risk factors were HTN and high cholesterol.[8] In the view of high level of uncontrolled diabetes, it is possible to predict high level of diabetes complications in Sudan. For instance, Awadalla *et al*. showed high prevalence of diabetes complications among Sudanese individuals living with diabetes like peripheral neuropathy, retinopathy and diabetic foot were observed in 68.2%, 72.6% and 12.7% respectively. They also suggested these complications were significantly associated with longer duration of diabetes ($P < 0.001$), and living in urban areas ($P < 0.004$).[9] Diabetes is one of the important and modifiable risk factors for stroke (ischemic and hemorrhagic stroke).[10] Several epidemiological studies showed an increase in the adjusted hazard ratios with diabetes and ischemic stroke, hemorrhagic stroke, and for unclassified stroke.[11-13] It is worth mentioning that diabetes is also associated with an increase in incidence of stroke in black American before the age of 55 years.[14] Therefore, it is important to assess the prevalence of stroke in Sudanese population with diabetes. Importantly, stroke is disease associated with high risk of morbidity and mortality. In country like Sudan, where health system is struggling, the cost of treatment and rehabilitation of individuals with stroke could be burden and families may need to contribute toward the financial cost. Therefore, this study will help in understanding of the prevalence and modifiable risk factors of stroke among Sudanese individuals with diabetes.

Methodology

Study design
This was a descriptive cross sectional, health facility-based study. It recruited 283 individuals with diabetes in two centers in Khartoum and one center in Atbara in North of Sudan between May and November 2018.

Inclusion and exclusion criteria
Adult patients more than 18 years of both sexes with diabetes mellitus (DM), agreed to participate in the study, attending diabetes centers during the study period were included. Patients refused participation or unable to participate were excluded from the study. We have also excluded those individuals with 6 months or less with diagnosis of diabetes.

Tool and materials
The data were collected through direct interviewing the selected participants using a predesigned standardized questionnaire.

Materials
A combined weighing and height scale was used for height and weight to calculate BMI.

Using electronic sphygmomanometer, blood pressure (BP) was measured three times and the average was taken.

Glycemic control was determined based on HbA1c results.

Data analysis
Data were analyzed using the computerized program; Statistical Package for Social Science, version 20, (IBM, SPSS, Illinois, Chicago, USA). Results were presented as tables and figures. Chi-square test was used for cross tabulation at 0.05 margins of error (*P* value). Descriptive statistics (frequency tables, median, histogram, means, standard deviation [SD]) and inferential statistics (Chi-square test, and logistic regression test) were performed.

Ethical consideration
It was obtained from SUMASRI Institutional Review Board of faculty of Medicine, University of Medical Sciences and Technology, Khartoum, Sudan. The information was communicated verbally. Refusal to participate in the study did not deny the patient the appropriate management. The participants did not bear any cost.

Results

The study recruited 283 individuals with diabetes and average age of participants was 51 (±12 SD). Furthermore, 35% of participants were at the age between 51 and 60 years old. Females were 66.8% and most of the participants (73.9%) from urban areas and 66.1% received formal education between primary school and university. BMI classification of the participants showed that 34.3% were obese, 31.8% overweight, and 30.4% normal BMI and 3.5% underweight [Table 1]. Diabetes for 1–5 years

was observed in 71.7%, for more than 10 years in 12%. The majority (94.3%) had type 2 DM while only 5.7% had type 1. Only one-third of the participants were able to achieve HbA1c target for diabetes control [Table 2]. The prevalence of cerebrovascular accident (CVA) was 2.5%, HTN was 20%, ischemic heart disease (IHD) 3.2%, and neuropathy was 45.6% [Table 3]. The prevalence of risk factors for CVA like smoking was observed in 8.8%, alcohol in 4.6%, while regular exercise was observed only in 36.3%. Importantly, more than two-thirds of the participants had achieved low-density lipoprotein cholesterol (LDL-C) and plasma cholesterol level within the target, while more than three quarters the participants had TG and HDL-c levels within the target. Regarding renal status of the studied participants, we found that the majority of them had normal serum creatinine (Scr) and blood urea nitrogen (BUN) level (85.9%, 87.3% respectively).

Chi-square test

This showed significant association between HbA1c, Scr, total cholesterol, TG, LDL, and HDL levels and the presence of CVA. Among those who had controlled HbA1c, only 5% had CVA ($P = 0.017$), 92.6% had normal Scr ($P = 0.02$), 81.1% had controlled cholesterol and LDL level ($P = 0.001, 0.002$), respectively; 88.4% had normal TG level ($P = 0.002$) and 89.5% had normal HDL level ($P = 0.00$). Moreover, there are significant associations between the duration of diabetes, HTN, Scr, BUN, LDL, and the presence of CVA.

Of those who have diabetes for 1–5 years (71.7%), only 1.5% had developed CVA while among those who have diabetes for more than 10 years (12%), 8.8% had developed CVA ($P = 0.013$). Importantly, HTN was found only in 10% of those have diabetes for 1–5 years, while diabetes for more than 10 years was associated with significant increase in prevalence of HTN (20% and $P = 0.00$).

Logistic regression test

We performed logistic regression test to determine the predictors and the risk factors that can affect the development of CVA. We found that HbA1c and the duration of diabetes are significantly associated with the presence of CVA ($P = 0.010, 0.014$). Despite the fact that stroke was not statistically significantly associated with the age of the participants, neuropathy, IHD s, cholesterol level, and HTN, these factors showed an increase in odd ratio. For instance, females with diabetes are more likely to get stroke by 4.5 times than males, increasing diabetes duration for more than 10 years will increase the risk of patients with diabetes to develop stroke by 5 times than those with a duration of diabetes <5 years. Moreover, individuals with diabetes who have IHD are more likely to get stroke

Table 1: Distribution of the participants according to sociodemographic characteristics (*n*=283)

Sociodemographic characteristics (*n*=150)	*n* (%)
Age group (years)	
20-30	11 (3.9)
31-40	25 (8.8)
41-50	66 (23.3)
51-60	99 (35.0)
61-70	76 (26.9)
>70	6 (2.1)
Gender	
Male	94 (33.2)
Female	189 (66.8)
Residence	
Rural	74 (26.1)
Urban	209 (73.9)
Level of education	
Illiterate	96 (33.9)
Primary	88 (31.1)
Secondary	66 (23.3)
University graduate and above	33 (11.7)
Marital status	
Single	24 (8.5)
Married	233 (82.3)
Divorced	2 (0.7)
Widowed	24 (8.5)
BMI	
Underweight	10 (3.5)
Normal weight	86 (30.4)
Overweight	90 (31.8)
Obese	97 (34.3)

BMI: Body mass index

Table 2: Distribution of the participants according to disease characteristics (*n*=283)

DM information	*n* (%)
Duration of DM (years)	
1–5	203 (71.7)
6-10	46 (16.3)
>10	34 (12)
Type of DM	
Type 1	16 (5.7)
Type 2	267 (94.3)
HbA1c	
Controlled (<7%)	95 (33.6)
Uncontrolled (>7%)	188 (66.4)

DM: Diabetes mellitus, HbA1c: Glycosylated hemoglobin

Table 3: Distribution of the participants according to diabetes complications

Other chronic diseases	*n* (%)
CVA (*n*=283)	6 (2.1)
HTN (*n*=193)	40 (20.7)
IHDs (*n*=283)	9 (3.2)
Neuropathy (*n*=283)	129 (45.6)

CVA: Cerebrovascular accident, HTN: Hypertension, IHDs: Ischemic heart diseases

8 times, individuals with diabetes with high cholesterol level are more likely to get stroke by 1.4 times, and

those with HTN are more likely to develop stroke by 1.2 times [Table 4].

Discussion

The risk factors associated with stroke in 26,919 participants recruited from 32 countries were shown to be previous history of HTN or BP of 140/90 mmHg, physical activity, waist-to-hip ratio, current smoking, cardiac causes, alcohol consumption and DM.[15] Importantly, the annual stroke incidence in Arab countries ranged from 27.5 to 63/100,000 population and prevalence was between 42 and 68/100,000 population. HTN, DM, hyperlipidemia, and cardiac disease were the commonest risk factors.[16] Interestingly, several studies in Sudan about stroke showed that diabetes, HTN, dyslipidemia, smoking, heart disease, and previous transient ischemic attack were among the risk factors.[17-19] In this study, we found that the prevalence of stroke was 2.5% among Sudanese individuals with diabetes. This can be attributed to the fact that Sudanese individuals with diabetes have alarmingly high level of uncontrolled diabetes. For instance, in Sudanese individuals with type 1 and type 2 diabetes, poor glycemic control (HbA1c >7%) was noted in 83.8% and 85% respectively.[5,6] Importantly, this rate is higher than both the global prevalence of stroke and the prevalence in the Arab world.[15,16] Obviously, this can be attributed to the fact that these studies included patients with different risk factors like diabetes, HTN and dyslipidemia. It is possible it suggests that diabetes is strong risk factor for stoke. In this study, we showed the level of HbA1c and duration of diabetes are important risk factors for stroke. Several epidemiological studies in Sudan showed that high HbA1c and duration of diabetes can be associated with diabetes complications like diabetic septic foot, heart failure, retinopathy, nephropathy and ischemic heart disease[7-9,19,20] HTN was also one of the risk factor in our study especially with an increase in duration of diabetes. Importantly, Tagelsir *et al.* showed that HTN and smoking in Sudanese individuals diagnosed with stroke were associated with significant changes in carotid arteries.[21] Sokrab *et al.* showed that HTN was

the commonest risk factor in 46.9% of Sudanese patients with stroke.[17] Therefore, the health authorities in Sudan should aim to optimize glycemic control as well as tight BP control in order to decrease the risk of stroke in individuals living with diabetes. The Pan-African Society of Cardiology (PASCAR) have made road map and guidelines for the prevention and management of HTN in Africa. One of the ambitions of the PASCAR for health authorities in Africa is to achieve 25% control of HTN in Africa by 2025.[22-24]

This study is not without limitation. The cross-sectional design may not allow for the temporal relationship for the potential risk factors and outcomes. The study may not represent all Sudan as recruitment of patients was not from all areas in Sudan and large sample size may allow for more accurate estimation of prevalence and risk factors. Despite these limitations, the study is novel and its findings reflects the strong association between diabetes, HTN and stroke.

Conclusion

The prevalence of stroke among Sudanese individuals with diabetes was around 2.5%. The main risk factors were HbA1c, HTN, and duration of diabetes.

Conflicts of interest
There are no conflicts of interest.

Table 4: Cerebrovascular accident and its associated factors by using logistic regression test (*n*=283)

	B	SE	χ^2	P	OR
Gender	1.513	1.328	1.298	0.255	4.539
Duration of DM	1.552	0.634	5.983	0.014	4.720
Neuropathy	0.054	0.941	0.003	0.954	1.055
IHD	2.062	1.291	2.550	0.110	7.859
Cholesterol level	0.352	1.045	0.113	0.736	1.422
HbA1c level	−3.266	1.267	6.646	0.010	0.038
HTN	0.181	1.343	0.018	0.893	1.199
Constant	−6.537	2.108	9.616	0.002	0.001

DM: Diabetes mellitus, IHD: Ischemic heart disease, HbA1c: Glycosylated hemoglobin, SE: Standard error, OR: Odds ratio, HTN: Hypertension

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