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Outcome between Diabetic versus Non-Diabetic Acute Stroke in a Black African Population: A Cohort Study

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Abstract

Background: Post-stroke outcomes are poorer in patients with diabetes mellitus (DM). The aim of this study was to determine the prevalence of DM in acute stroke and to compare the outcome in patients with or without diabetes in a tertiary care hospital in Douala, Cameroon. Methods: This was a hospital-based prospective cohort study included both diabetic and non-diabetic acute stroke patients (ASP). Demographic, clinical profile and outcome data was collected within 3 months of stroke onset. Descriptive statistics, t-test and chi square test used for comparisons while associations between DM and stroke outcomes, were analyzed using multiple logistic regression and survival analysis. Results: Of the 701 ASP included, the overall prevalence of diabetes in stroke was 34.2% (n = 240) while 9.4% (n = 66) had newly diagnosed diabetes. Mortality was significantly elevated amongst patients with diabetes during hospitalization (p = 0.034) and at 3 months post stroke onset (p = 0.004), but on multivariate analysis, diabetes was not an independent predictor of mortality [OR = 0.984; (95% CI: 0.506 - 1.913); p = 0.961)]. On Cox proportional hazards regression model, the risk of dying was about 1.5 times higher amongst the DM patients compared to non-diabetic patients [adjusted HR (95% CI) of 1.502 (1.128 - 2.000); p = 0.005]. Diabetes was not an independent predictor of poor functional outcome within 3 months post stroke. Conclusion: About 1 in 3 ASP had DM on admission. Survival is better in non-diabetes versus diabetes mellitus ASP. DM was associated with high mortality but does not influence the functional outcome of ASP in our setting.

Keywords

Diabetes, Prevalence, Mortality, Functional Outcome, Prognosis, Africa

1. Introduction

Stroke is the second most common cause of death and major cause of disability worldwide [1] [2]. Africa is undergoing an epidemiological transition driven by socio-demographic and lifestyle changes [3]. The incidence of stroke, a cardinal complication of cardiovascular risk factors (CVRFs), appears to be rising in Africa and other low- and middle-income country (LMIC) settings (4). This is because the burden of non-communicable diseases (NCD), including CVRFs is increasing [3] [4] [5]. Consequently, 86% of all stroke deaths around the world are found in LMIC in Africa and other continents [6]. In Cameroon, it has been observed that there has been an increase in stroke admission and case-fatality over the last decade [7].

Diabetes mellitus (DM) is one of the established risk factors for stroke [8]. Like in many other countries in Africa, there is a scarcity of data on the prevalence of diabetes in Cameroon. While the prevalence of undiagnosed diabetes is also very high at about 80%, the International Diabetes Federation (IDF) estimated the prevalence of diabetes in Cameroon among adults aged 20 to 79 years at 4.4% in 2010 [9]. The prevalence of diabetes is 5.7% in urban Cameroon, with an estimated 1 million diabetic population, 70% of whom remain undiagnosed [10]. Patients presenting with stroke are more likely to have undiagnosed type 2 diabetes [11] [12]. Several studies have reported an increased risk of stroke in patients with diabetes [13] [14] [15]. A three years prospective study in Cameroon showed that 20.61% of acute stroke patients had a known history of diabetes [16]. Several studies have reported increased mortality from stroke in diabetic patients [17] [18]. Furthermore, various studies have also shown that stroke patients with DM have higher in-hospital mortality rates and the poorer outcome than those without DM [18] [19] but several studies did not [20] [21]. In sub-Saharan Africa, little data is available on the association between diabetes and stroke. Thus, exploring the clinical pattern, the outcome and independent predictors of mortality of stroke in patients with diabetes are necessary for optimal management and prevention of stroke in this group of patients. Therefore, our objectives were to determine the prevalence of DM in acute stroke and to evaluate the prognosis and functional outcome in patients with diabetes compared with patients without diabetes.

2. Methods

2.1. Patients and Study Design

We followed the same methods of Mapoure *et al.*'s recent articles in 2017 since all papers included patients from the same stroke registry [22] [23] [24]. This

stroke registry was created in 2009 and has been collecting data from all patients with acute stroke. We carried out a hospital based prospective cohort study in a tertiary care hospital in Douala, Cameroon. We included consenting patients admitted for acute stroke in the neurology unit of the department of internal medicine and the intensive care unit of the Douala General Hospital (DGH) from January 2010 to January 2016. This study was approved by the Institutional Ethics Committee of Research on Human Health of the University of Douala and the study hospital-DGH. The identity of patients was concealed and confidentiality of information was preserved. Patients who were admitted for confirmed acute stroke within 7 days of onset of symptoms were included in our study. Patients with cerebral venous thrombosis and subarachnoid hemorrhage were excluded.

2.2. Data Collection and Patient Management

Data collection and patient management have been previously described [22] [23] [24]. At presentation, demographic data, relevant medical history such as diabetes mellitus (DM), hypertension (HTN), smoking history, alcohol abuse, history of diseases like chronic kidney disease (CKD) and other cardiovascular events such as atrial fibrillation, congestive heart failure (CHF), coronary artery disease (CAD) and ischemic heart disease (IHD) were recorded. Baseline vital and anthropometric parameters such as blood pressure, pulse, respiratory rate, oxygen saturation weight, height and abdominal circumference values were recorded using standard operating procedures. Hypertension, diabetes mellitus, dyslipidemia, alcohol consumption, obesity were defined as in the previous study published by Mapoure *et al.* in 2014 [25]. Unknown or de novo diabetes was defined as a random plasma glucose level ≥ 200 mg/dl and/or in-hospital fasting glucose ≥ 126 mg/dl on two or more occasions. Metabolic syndrome is defined as per the NCEP ATP III guidelines [26]. On admission and at 3 months post stroke, the Glasgow coma scale (GCS) and the National Institute of Health Stroke Scale (NIHSS) were used to determine the stroke severity while the functional outcome was evaluated by the modified Rankin score (mRS). Poor functional outcome was considered in patients with mRS > 2 within the first 3 months post stroke discharge.

2.3. Statistical Analysis

Statistical analysis was done using the Statistical Package for Social Sciences (SPSS) Standard version, Release 20.0 (IBM Inc. 2012). Patients were divided into two groups, diabetics and non-diabetics. In the diabetes group, we included ASP with a previous history of DM, or fasting blood glucose level > 126 mg/dl, or random blood glucose level > 200 mg/dl treated or untreated, or elevated glycated hemoglobin A1C (HbA1c) ≥ 6.5%. Those ASP who had no prior history of diabetes and were normoglycemic on presentation and during stay in hospital were included in the non-diabetic group. Bivariate analysis was carried out using Chi-square or Fisher exact test for categorical variables and Student's t test was

used to compare the means of continuous variables. Multiple logistic regression model was used and the covariates were adjusted for each independent (regression) variable to find independent predictors of mortality and poor functional outcome. Variables included in the regression model were those that had a significant P value ($P < 0.2$) in the bivariate analysis. Survival rate analysis was performed using Kaplan Meier. Level of significance was considered 0.05 (two-sided).

3. Results

3.1. Baseline Characteristics of Patients

We recruited a total of 701 ASP amongst 389 (55.5%) were male patients giving a M:F ratio of 1.25:1 (5:4). The age range was from 23 to 100 years with an overall mean age of 60.6 ± 13.3 years. Of the 701 participants, 480 (68.5%) had ischemic stroke amongst which 18 (2.6%) presented with a transient ischemic attack (TIA) on admission.

3.2. Prevalence of Diabetes Mellitus

The overall prevalence of DM in stroke was 34.2% (n = 240) with pre-existing DM in 24.8% (n = 174) of patients while 9.4% (n = 66) were newly diagnosed diabetic stroke patients. Majority of diabetic stroke patients had type II diabetes mellitus (98.8%) and the mean (SD) duration of diabetes mellitus was 6.7 (0.4) years. The frequency of diabetes in ischemic stroke patients was higher compared to that amongst the hemorrhagic stroke patient and the difference was statistically significant (39.0% versus 24.0%, $p < 0.001$).

3.3. Demographics, Cerebrovascular Risk Factors and Clinical Profile

Table 1 compares differences in demographics, CVRFs and clinical profile amongst non-diabetic and diabetic patients. The mean age of the diabetic patients was significantly higher than that of non-diabetic patients (62.7 ± 11.3 years versus 59.5 ± 14.1 years, $p = 0.001$). Diabetic stroke patients had significantly higher mean fasting blood glucose levels ($p < 0.001$). Figure 1 shows the relationship between length of hospital stay and pattern of death amongst diabetic and non-diabetic stroke patients. More stroke deaths occurred within the 1st twenty days of hospitalization. During this period, the pattern of stroke deaths decreased as the length of hospital stay increased and the difference was not statistically significant ($p = 0.880$).

3.4. Outcome in Non-Diabetic and Diabetic Stroke Patients

Comparing the 2 groups (Table 2), there was no difference in the duration of hospital stay ($p = 0.071$) and stroke severity ($p = 0.148$). When comparing the two survival curves (Figure 2), there was a statistically significant difference between deaths amongst the non-diabetic stroke patients and the diabetic stroke patients (log rank test $p = 0.005$). Moreover, on Cox proportional hazards re-

gression model, the risk of dying amongst the diabetic stroke patients was about 1.5 times higher compared to the risk of dying amongst the non-diabetic stroke patients [adjusted HR (95% CI) of 1.502 (1.128 - 2.000); p = 0.005]. DM was not an independent predictive death factor while atrial fibrillation, high triglycerides levels, Glasgow < 8, NHISS > 14 and mRS > 2 were independent predictors of mortality in acute stroke within 3 months (Table 3).

On both univariate and multivariate analysis, no significant association was observed between the history of diabetes and poor functional outcome in acute stroke within 3 months. Only recurrent stroke and high serum uric acid were independent predictors of poor functional outcome (Table 4).

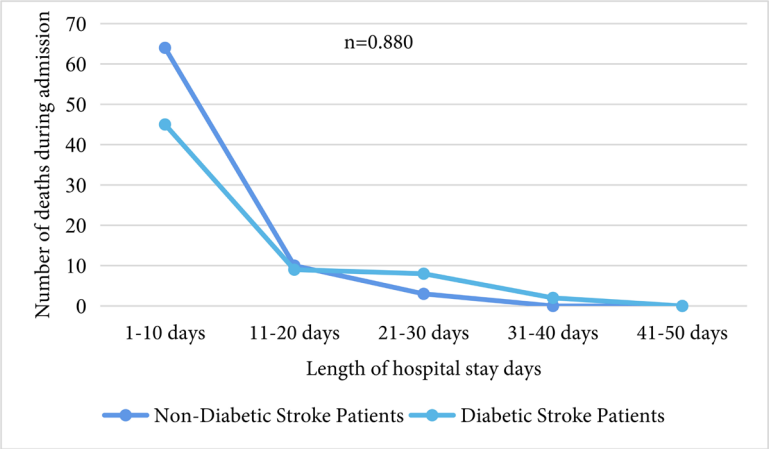

Figure 1. Relationship between length of hospital stay and pattern of death amongst diabetic and non-diabetic patients.

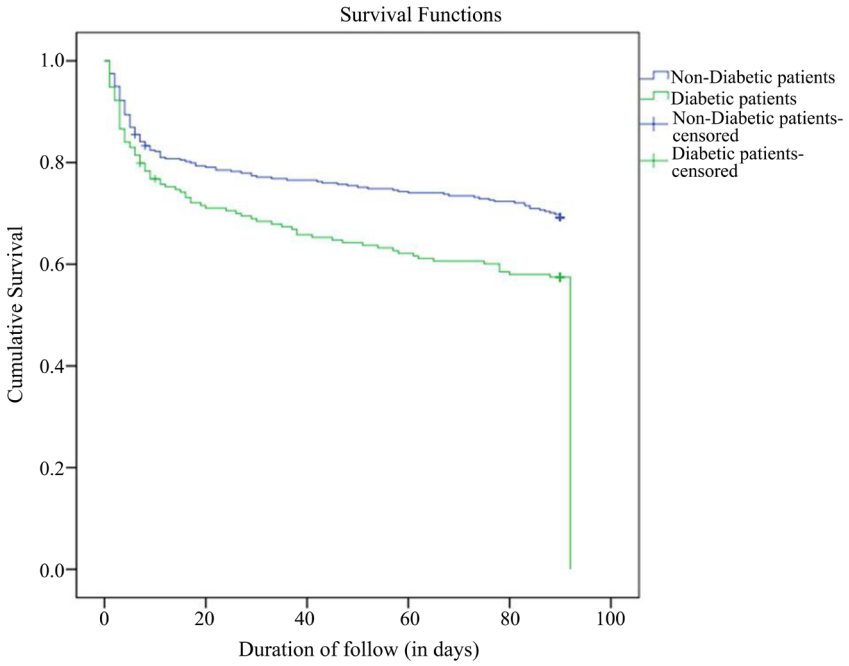

Figure 2. Kaplan-Meier survival rate of patients with diabetes compared with those without diabetes after acute stroke.

Table 1. Demographic, cerebrovascular risk factors and clinical profile of patients.

Variables	Non-Diabetic (n = 461)	Diabetic (n = 240)	P value
Demographics			
Males, n (%)	262 (56.8)	127 (52.9)	0.322
Age (Mean ± SD), years	59.5 ± 14.1	62.7 ± 11.3	0.001
Age > 60 years	204 (44.3)	127 (52.9)	0.029
Age > 80 years	30 (6.5)	16 (6.7)	0.936
Employed, n (%)	214 (46.4)	94 (39.2)	0.066
Married, n (%)	340 (73.8)	164 (68.3)	0.130
Insurance, n (%)	115 (24.9)	51 (21.2)	0.586
Stroke types			
Hemorrhagic stroke, n (%)	168 (36.4)	53 (22.1)	<0.001
Ischemic stroke, n (%)	293 (63.6)	187 (77.9)	<0.001
Ischemic stroke subtypes			
Cardioembolic stroke, n (%)	75 (25.6)	33 (17.6)	0.042
Atherosclerosis, n (%)	170 (58.0)	122 (65.2)	0.114
Lacunar infarcts, n (%)	26 (8.9)	29 (15.5)	0.026
Undetermined stroke	22 (7.5)	3 (1.6)	0.005
Cerebrovascular risk factors			
Hypertension, n (%)	431 (93.5)	233 (97.1)	0.044
History of Smoking, n (%)	78 (16.9)	32 (13.3)	0.215
Alcohol abuse, n (%)	173 (37.5)	84 (35.0)	0.510
Dyslipidemia, n (%)	337 (73.1)	189 (78.8)	0.101
Obesity, n (%)	105 (22.8)	98 (40.8)	<0.001
Metabolic Syndrome, n (%)	83 (18.0)	86 (35.8)	<0.001
Migraine, n (%)	33 (7.2)	15 (6.2)	0.651
Sleep Apnea Syndrome, n (%)	28 (6.1)	25 (10.4)	0.039
CAD/IHD, n (%)	23 (5.0)	18 (7.5)	0.179
Atrial Fibrillation, n (%)	63 (13.7)	30 (12.5)	0.666
Cardiomyopathy, n (%)	66 (14.3)	25 (10.4)	0.145
Valvulopathy, n (%)	28 (6.1)	11 (4.6)	0.414
Previous stroke, n (%)	91 (19.7)	60 (25.0)	0.108
Clinical and para-clinical profile			
Systolic blood pressure, mmHg (Mean ± SD)	166.3 ± 33.0	164.0 ± 33.0	0.609
Diastolic blood pressure, mmHg (Mean ± SD)	100.4 ± 21.5	96.8 ± 20.1	0.032

Continued

Body mass index, kg/m^2 (Mean ± SD)	28.6 ± 5.8	31.8 ± 5.3	0.509
Fasting Blood sugar, g/l (Mean ± SD)	1.1 ± 0.3	2.1 ± 1.1	<0.001
Uric acid, mg/l (Mean ± SD)	66.7 ± 24.0	72.3 ± 25.4	0.005
Creatinine, g/l (Mean ± SD)	16.7 ± 1.7	16.8 ± 1.4	0.972
Urea, g/l (Mean ± SD)	0.5 ± 0.1	0.8 ± 0.1	0.055
Total Cholesterol, g/l (Mean ± SD)	5.1 ± 3.1	2.0 ± 0.5	0.476
Triglycerides, g/l (Mean ± SD)	1.3 ± 0.2	1.3 ± 0.1	0.994
HDL cholesterol, g/l (Mean ± SD)	0.5 ± 0.01	0.5 ± 0.02	0.407
Stroke severity and functional outcome on admission			
Glasgow (Mean ± SD)	12.5 ± 3.3	12.9 ± 3.1	0.097
NIHSS (Mean ± SD)	11.8 ± 8.7	13.3 ± 9.7	0.048
Modified Rankin Scale (Mean ± SD)	3.0 ± 1.5	3.2 ± 1.6	0.090

a. CAD/IHD; coronary artery/ischemic heart disease; b. HDLc; high density lipoprotein cholesterol; c. NIHSS; National Institute of Health Stroke Scale.

Table 2. Comparison of outcome amongst non-diabetic and diabetic stroke patients.

Variables	Non-Diabetic patients	Diabetic patients	P value
Length of hospital stay (Mean ± SD)	8.5 ± 0.3	9.5 ± 0.7	0.071
In-hospital Complications			
Presence of Complications, n (%)	166 (36.0)	122 (50.8)	<0.001
Swallowing difficulties, n (%)	10 (6.0)	2 (1.6)	0.077
Chest infection, n (%)	42 (25.3)	34 (27.6)	0.655
Urinary tract infection, n (%)	58 (34.9)	45 (36.6)	0.773
Pressure ulcers, n (%)	10 (6.0)	12 (9.8)	0.237
Desaturation, n (%)	0 (0.0)	2 (1.6)	0.180
Deep Venous Thrombosis, n (%)	3 (1.8)	2 (1.6)	1.000
Severe Sepsis, n (%)	45 (29.5)	37 (30.1)	0.918
Stroke severity and outcome on admission			
NIHSS > 14 (severe stroke), n (%)	157 (34.1)	95 (39.6)	0.148
Poor outcome (mRS > 2), n (%)	282 (61.2)	163 (67.9)	0.078
Mortality, n (%)	77 (16.7)	56 (23.3)	0.034
Stroke outcome 90 days post stroke			
Poor outcome (mRS > 2), n (%)	89 (35.7)	45 (40.5)	0.385
Mortality, n (%)	110 (30.6)	83 (42.8)	0.004
Cause of death on admission			
Neurological causes	11 (14.9)	4 (7.3)	0.268
Non-neurological causes	63 (85.1)	51 (92.7)	0.268

a. NIHSS; institute of health stroke scale; b. mRS; modified Rankin scale.

Table 3. Independent predictors of mortality within 3 months post stroke.

PREDICTORS	ALIVE	DEATH	Unadjusted OR (95% CI)	P Value	Adjusted OR (95% CI)	P Value
Age > 45 years	306 (63.9)	173 (18.9)	1.527 (0.84 - 2.635)	0.127	0.984 (0.451 - 2.147)	0.967
Male gender	206 (66.7)	103 (33.3)	0.856 (0.602 - 1.216)	0.384	--	--
Hypertension	343 (65.1)	184 (34.9)	1.013 (0.443 - 2.318)	0.975	--	--
Diabetes Mellitus	111 (57.2)	83 (42.8)	1.693 (1.178 - 2.432)	0.004	0.984 (0.506 - 1.913)	0.961
Smoking	70 (76.7)	21 (23.1)	0.506 (0.300 - 0.853)	0.010	0.839 (0.372 - 1.895)	0.673
Alcohol	151 (70.9)	62 (29.1)	0.665 (0.454 - 0.946)	0.024	0.768 (0.417 - 1.412)	0.395
Dyslipidemia	285 (68.8)	129 (31.2)	0.530 (0.358 - 0.786)	0.001	0.602 (0.305 - 1.187)	0.143
OBESITY	113 (71.1)	46 (28.9)	0.684 (0.459 - 1.019)	0.061	0.429 (0.103 - 1.778)	0.243
METS	93 (69.9)	40 (30.1)	0.751 (0.492 - 1.143)	0.180	1.705 (0.359 - 8.103)	0.502
CAD/IHD	23 (67.6)	11 (32.4)	0885 (0.422 - 1.858)	0.748	--	--
AFIB	34 (49.3)	35 (50.7)	2.124 (1.275 - 3.533)	0.003	3.198 (1.386 - 7.376)	0.006
Heart Failure	36 (52.9)	32 (47.1)	1.789 (1.072 - 2.986)	0.025	1.129 (0.483 - 2.642)	0.779
Valvulopathy	20 (66.7)	10 (33.3)	0.929 (0.426 - 2.027)	0.853	--	--
Previous stroke	71 (62.3)	43 (37.7)	1.167 (0.761 - 1.788)	0.479	--	--
CKD	17 (43.7)	22 (56.4)	2.596 (1.343 - 5.017)	0.003	2.139 (0.829 - 5.522)	0.116
Hemorrhagic	104 (53.1)	92 (46.9)	2.242 (1.560 - 3.223)	<0.001	1.211 (0.635 - 2.307)	0.561
SBP > 140 mmHg	276 (63.6)	158 (36.4)	1.574 (0.885 - 2.134)	0.156	1.751 (0.803 - 3.821)	0.159
DBP > 90 mmHg	227 (62.4)	137 (37.6)	1.867 (1.225 - 2.854)	0.061	0.801 (0.405 - 1.586)	0.525
Glycaemia > 1.40 g/l	107 (52.2)	98 (47.8)	2.439 (1.699 - 3.502)	<0.001	2.263 (1.203 - 4.256)	0.011
High LDLc	270 (66.0)	139 (34.0)	0.858 (0.578 - 1.273)	0.447	--	--
Low HDLc	210 (70.9)	86 (24.7)	0.574 (0.403 - 0.817)	0.002	0.673 (0.394 - 1.148)	0.146
High TC	170 (62.7)	101 (37.3)	1.227 (0.865 - 1.741)	0.252	--	--
High TG	70 (51.1)	67 (48.9)	2.203 (1.484 - 3.270)	<0.001	1.857 (1.003 - 3.437)	0.049
High SUA	148 (56.5)	114 (40.7)	2.067 (1.449 - 2.950)	<0.001	1.265 (0.707 - 2.263)	0.428
GCS ≤ 8	8 (8.7)	84 (91.3)	33.908 (15.916 - 72.242)	<0.001	7.604 (3.221 - 17.948)	<0.001
NIHSS > 14	60 (27.6)	157 (72.4)	21.806 (13.820 - 34.407)	<0.001	6.733 (3.659 - 12.390)	<0.001
mRS > 2	184 (50.0)	184 (50.0)	19.556 (9.708 - 39.392)	<0.001	3.363 (1.456 - 7.767)	0.005
Complications	108 (46.6)	124 (53.4)	4.193 (2.894 - 6.075)	<0.001	1.631 (0.943 - 2.821)	0.080

a. METS; metabolic syndrome; b. AFIB; atrial fibrillation; c. CKD; Chronic Kidney Disease; d. CAD/IHD; coronary artery/ischemic heart disease; e. SBP; systolic blood pressure, diastolic blood pressure; f. LDLc; Low density lipoprotein cholesterol; g. HDLc; high density lipoprotein cholesterol; h. TC: Total cholesterol; i. TG; triglycerides; j. GCS; Glasgow coma scale; k. SUA; serum uric acid; l. NIHSS; institute of health stroke scale; m. mRS; modified Rankin scale.

Table 4. Independent predictors of poor outcome within 3 months post stroke.

PREDICTORS	Good outcome	Poor outcome	Unadjusted OR (95% CI)	P Value	Adjusted OR (95% CI)	P Value
AGE > 45 years	185 (60.5)	13 (24.1)	2.063 (1.061 - 4.010)	0.030	2.306 (0.966 - 5.508)	0.060
Male gender	132 (64.1)	74 (35.4)	0.878 (0.571 - 1.352)	0.555	--	--
Unemployed	123 (68.0)	58 (32.0)	0.639 (0.416 - 0.983)	0.041	1.075 (0.593 - 1.948)	0.811
Unmarried (single)	62 (68.1)	29 (31.9)	0.731 (0.441 - 1.210)	0.222	--	--
No health insurance	67 (67.7)	32 (32.3)	0.745 (0.457 - 1.214)	0.236	--	--
Hypertension	212 (61.8)	131 (38.2)	2.884 (0.813 - 10.226)	0.087	2.860 (0.670 - 12.211)	0.156
Diabetes Mellitus	66 (59.5)	45 (40.5)	1.226 (0.775 - 1.940)	0.385	--	--
Smoking	40 (57.1)	30 (42.9)	1.341 (0.789 - 2.281)	0.277	--	--
Alcohol	95 (62.9)	56 (37.1)	0.990 (0.642 - 1.527)	0.964	--	--
Dyslipidemia	175 (61.4)	110 (38.6)	1.336 (0.778 - 2.294)	0.293	--	--
OBESITY	69 (61.1)	44 (38.9)	1.112 (0.703 - 1.759)	0.649	--	--
METS	56 (60.2)	37 (39.8)	1.158 (0.713 - 1.880)	0.553	--	--
CAD/IHD	16 (69.6)	7 (30.4)	0.723 (0.290 - 1.806)	0.486	--	--
AFIB	20 (58.8)	14 (41.2)	1.202 (0.585 - 2.467)	0.616	--	--
CHF	25 (69.4)	11 (30.6)	0.719 (0.342 - 1.512)	0.383	--	--
Valvulopathy	14 (70.0)	6 (30.0)	0.710 (0.266 - 1.894)	0.492	--	--
Recurrent stroke	32 (45.1)	39 (54.9)	2.488 (1.468 - 4.220)	0.001	2.566 (1.247 - 5.280)	0.010
CKD	11 (64.7)	6 (35.3)	0.916 (0.331 - 2.537)	0.866	--	--
Hemorrhagic stroke	63 (60.6)	41 (39.4)	1.141 (0.714 - 1,822)	0.582	--	--
SBP > 140 mmHg	174 (63.0)	102 (37.0)	0.953 (0.576 - 1.576)	0.850	--	--
DBP > 90 mmHg	142 (62.6)	85 (37.4)	1.026 (0.659 - 1.598)	0.909	--	--
Hyperlycemia	59 (55.1)	48 (44.9)	1.580 (0.996 - 2.506)	0.051	1.253 (0.670 - 0.670)	0.480
High LDLc	165 (61.1)	105 (38.9)	1.339 (0.808 - 2.219)	0.257	--	--
Low HDLc	129 (61.4)	81 (38.6)	1.149 (0.744 - 1.776)	0.531	--	--
High TC	106 (62.4)	64 (37.6)	1.035 (0.675 - 1.588)	0.875	--	--
High TG	45 (64.3)	25 (35.7)	0.823 (0.536 - 1.589)	0.771	--	--
High SUA	69 (46.6)	79 (53.4)	3.268 (2.093 - 5.104)	<0.001	2.482 (1.399 - 4.404)	0.002
GCS ≤ 8	1 (12.5)	7 (87.5)	12.402 (1.509 - 101.943)	0.005	4.306 (0.439 - 42.263)	0.210
NIHSS > 14	18 (30.0)	42 (70.0)	5.275 (2.883 - 9.653)	<0.001	1.369 (0.657 - 2.854)	0.402
Complications	53 (49.1)	55 (50.9)	2.273 (1.432 - 3.606)	<0.001	1.033 (0.552 - 1.936)	0.919
Uremia	40 (50.0)	40 (50.0)	1.968 (1,189 - 3.257)	0.008	1.037 (0.532 - 2.020)	0.916
Creatinemia	56 (58.9)	39 (41.1)	1.239 (0.767 - 2.002)	0.381	--	--

a. METS; metabolic syndrome; b. AFIB; atrial fibrillation; c. CKD; Chronic Kidney Disease; d. CAD/IHD; coronary artery/ischemic heart disease; e. SBP; systolic blood pressure, diastolic blood pressure; f. LDLc; Low density lipoprotein cholesterol; h. HDLc; high density lipoprotein cholesterol; i. TC: Total cholesterol; j. TG; triglycerides; k. GCS; Glasgow coma scale; l. SUA; serum uric acid; m. NIHSS; institute of health stroke scale; n. mRS; modified Rankin scale.

4. Discussion

This is one of the few clinical studies where the prognostic role of diabetes and hyperglycemia is evaluated in Africa. Our results demonstrate that the prevalence of diabetes in stroke is high and about 10% of acute stroke patients in our setting have previously unrecognized diabetes mellitus. Secondly, even though diabetes is not an independent predictor of mortality and poor functional outcome in stroke, death rate on admission and within 3 months post stroke significantly increased in stroke patients with diabetes. Hyperglycemia was an independent predictor of stroke mortality. Stroke patients with diabetes had more severe strokes and were more likely to have in-hospital complications compared to stroke patients without diabetes.

The overall prevalence of diabetes in acute stroke in our study was 34.2%. Owolabi *et al.* showed that the prevalence of diabetes in acute stroke in North Western Nigeria was 15.9% [27]. In 2016, Mamadou *et al.* showed that the prevalence of diabetes in acute stroke in a neurology service of Cocody Teaching Hospital at Abidjan (Ivory Coast) was 13.25% [28]. Kiers *et al.* in an Australian study showed that a prevalence of 28.4% [29]. In China, 42.3% of acute stroke patients had diabetes [30] and in Austria, 20.2% of acute stroke patients had previously known diabetes [31]. The difference prevalence observed in these studies could be due to the variable methodology used in the various studies and different sample sizes. DM is a lifestyle disease; hence its resulting prevalence varies since the pattern of lifestyle varies from country to country.

Regarding the prognostic value of diabetes in the acute phase of stroke, our findings are in accordance with results globally described who described. In our study, diabetic patients were more likely to die during admission and within 3 months post stroke onset but diabetes was not an independent predictor of mortality in the acute patients. In Norway, Nacu *et al.* showed that stroke patients with diabetes had long term mortality increased [32]. Several other studies demonstrated that diabetes mellitus is an independent risk factor for death in stroke patients [33] [34]. In our study, the in-hospital mortality rate was higher amongst female ischemic stroke patients with diabetes compared to those without diabetes (20.0% vs 10.4%, $p = 0.043$). A recently published study on the impact of female gender on prognosis in type 2 diabetic patients with ischemic stroke showed that in-hospital mortality was 14.9% in diabetic women, and 8.3% in diabetic men ($p = 0.02$), which may be due to differences in age, comorbidity and stroke subtype distribution[35]. Several studies have reported that female sex was associated with a worse functional prognosis as well as in-hospital mortality [36] [37] [38]. Conversely, there was no relationship between random blood sugar at presentation and in-hospital mortality [18] [27]. Other studies showed that mortality after stroke was not increased in diabetic stroke patients compared to the non-diabetic stroke patients [20] [21] [39]. De novo diabetic stroke patients in our study were more likely to have severe stroke, urinary tract infections and had higher stroke deaths compared to the known diabetic stroke

patients. Similarly, Di Bonito *et al.* showed that in-hospital mortality was higher in newly diagnosed diabetic stroke patients compared to diabetic and non-diabetic stroke patients [40]. However, hyperglycemia during admission was an independent predictor of mortality in our study population. According to Capes *et al.*, acute hyperglycemia predicts risk of in-hospital mortality after acute ischemic stroke in non-diabetic patients but not after hemorrhagic stroke and hyperglycemia was associated with 30 days mortality in non-diabetic and diabetic stroke patients [41]. Several other studies showed that admission hyperglycemia predicts poor prognosis with respect to mortality and mortality rate is higher in patients with hyperglycemia [29] [39]. Hyperglycemia occurs in 30% - 40% of patients with acute ischemic stroke both in patients with diabetes mellitus than in patients without a previous history of diabetes and, although in some patients reflects pre-existing and unrecognized diabetes [42]. More often hyperglycemia can be considered as a stress reaction resulting in the increased production of stress hormones such as cortisol and epinephrine following the activation of the hypothalamic-pituitary-adrenal axis and the autonomic nervous system which finally results in an increased production of glucose through gluconeogenesis, glycogenolysis, lipolysis, and proteolysis. Hence identifying hyperglycemia as a marker for poor functional recovery and in-hospital mortality can provide a rationale for the pursuit of optimal glucose control.

In our study, diabetes and hyperglycemia were not independent predictors of poor outcome at 3 months post stroke onset. There was no significant difference in functional outcome between the diabetic stroke patients compared to non-diabetic stroke patients. This particular finding contradicts most studies which showed that diabetic stroke patients had worse outcomes compared to non-diabetic stroke patients [31] [32] [33] [34] [39] [43] [44]. This discrepancy could be due to the differences in trial methodologies, as functional outcome was assessed using different outcome scales and at different periods following the onset of stroke symptoms.

5. Conclusion

About one-third of acute stroke patients had DM on admission. Survival is better in non-diabetes versus diabetes mellitus ASP. DM was associated with high mortality but does not influence the functional outcome of ASP in our setting.

6. What Is Already Known on This Topic?

Diabetes mellitus is a strong cerebrovascular disease in our setting with poor control of most of the patients.

Prognosis in newly diagnosed diabetes patients is worse compare to known diabetes patients in the acute phase of stroke.

7. What This Study Adds?

This study provides in a large consecutive database in Sub-Saharan African the

prevalence of diabetes in ASP.

Findings of this study suggest that survival is better in non-diabetes versus diabetes mellitus ASP. DM was associated with high mortality but does not influence the functional outcome of ASP in our setting.

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Not applicable.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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