

## Computed tomographic pattern of stroke among adult patients in north-eastern Nigeria

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### Abstract

Stroke and its complications are major health problems in developing countries including Nigeria. It could be a major cause of death or disability especially when only clinical assessment is relied upon for diagnosis. Computed Tomography (CT) is a valuable tool for the diagnosis of stroke. CT pattern of stroke in the North Eastern Nigeria has not been fully described. This was a prospective descriptive study conducted at the Federal Teaching Hospital, Gombe, Nigeria from June 2016 to December 2016. One hundred and eleven patients who presented with clinical features of stroke and were referred to Radiology department for cranial CT were consecutively selected. Data were analysed using SPSS version 16.0 package. A p-value of  $\leq 0.05$  and confidence interval of 95% were adapted for statistical analysis. The variables were expressed as range, percentage and mean plus standard deviation. All comparison of variables was done applying kappa statistic and point-biserial correlation coefficient for the correlation analysis. There were 69 (62.2%) males and 42 (37.8%) females aged 18-90 years (mean  $\pm$  SD of 57.49 $\pm$ 13.47 years). Ninety-four (94) patients (84.7%) had ischaemic stroke, while the remaining 17 (15.3%) had haemorrhagic stroke. Lobar location was identified as the most common site of ischaemic stroke while thalamo-ganglionic area was the commonest location for haemorrhagic stroke. Age and hypertension were found to be the commonest risk factors associated

with stroke. It is evident from this study that ischaemic stroke is the most prevalent stroke subtype. The middle cerebral artery territory was the commonest vascular territory involved in stroke while hypertension and age are common risk factors for both ischaemic and haemorrhagic stroke.

### Introduction

According to World Health Organization (WHO), stroke or CVA has been defined as a syndrome of rapidly developing clinical symptoms and signs of focal or global loss of cerebral functions lasting 24 hours or longer or resulting in the individual demise traceable only to vascular pathology.<sup>1,2</sup> This can be due to ischemia caused by thrombosis or embolism or due to a haemorrhage.<sup>3</sup> A stroke is a medical emergency and can cause permanent neurological damage, complications and death. It is the leading cause of adult disability in the United States and Europe and the second cause of death worldwide.<sup>4</sup>

In Southeast Asia and Africa, where peak age of the disease is 1 to 2 decades earlier than in industrialized countries and accounting for 0.9% - 4% of hospital admissions.<sup>5</sup> In industrialised countries, the prevalence of stroke is much higher in males than females with a ratio of 1.7:1. However, this reverses after the age of 85yrs with higher prevalence in females than males.<sup>6</sup>

The current prevalence of stroke in Nigeria is 1.14 per 1000 while the 30-day case fatality rate is as high as 40%.<sup>6</sup> The factors that determine outcome following stroke include the stroke subtype, patient bio-profile (age and gender), disease severity, physiological parameters (blood pressure on admission, blood glucose and level of consciousness), and presence of complication.<sup>7-9</sup>

There are two major subtypes of stroke; ischaemic and haemorrhagic with the Ischemic stroke accounting for the majority of cases (80%) globally.<sup>1</sup> The clinical features are similar in both types, but the neurological deficits vary according to the location and severity of the bleed or infarct. With advances in technology, neuroimaging has become integral for the evaluation and management of acute stroke patients.<sup>10-12</sup> A non-enhanced Computed Tomography (CT) scan has been shown to be the first imaging tool for diagnosis of cerebral haemorrhage and infarcts and to rule out other brain lesions that may mimic stroke, such as tumours, extradural hematomas and abscesses.<sup>13</sup> In addition CT is the most suitable for critically ill patient; it is fast, rela-

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Key words: Stroke; cranial; CT scan; North-eastern Nigeria.

Conflict of interest: The authors have no conflict of interest to declare.

Availability of data and materials: All data generated or analyzed during this study are included in this published article.

Ethics approval and consent to participate: Ethical Committee of the Federal Teaching Hospital Gombe, Nigeria. The study is in conformity with the Helsinki Declaration of 1964, as revised in 2013, concerning human and animal rights. All patients participating in this study signed a written informed consent form for participating in this study.

Informed consent: Written informed consent was obtained from a legally authorized representative(s) for anonymized patient information to be published in this article.

Received for publication: 23 April 2019. Revision received: 19 January 2020. Accepted for publication: 19 January 2020.

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Pyramid Journal of Medicine 2021; 4:50  
doi:10.4081/pjm.2021.50

tively available and has fewer restrictions when compared to MRI.

Ischaemic stroke is the commonest among the stroke subtypes, accounting for the majority of cases (80%) globally.<sup>1</sup> Adeyekun *et al.*<sup>14</sup> reported the incidence of ischaemic stroke as 73.8% of all patients with stroke in Nigerians. In the same vein, higher incidence of ischaemic stroke was found in studies conducted by Chhetri *et al.*<sup>15</sup> in Asia and Kehinde *et al.*<sup>16</sup> in Nigeria.

Saad *et al.*<sup>17</sup> reported that, carotid territory was involved in 66.9% of the 174 stroke patients they studied, while the vertebro-basilar territory was involved in 28.5%. In another study conducted by Alkali *et al.*<sup>18</sup> in Nigeria in which stroke patients were reviewed, 61.8% had cerebral infarction, 34.7% had Intracerebral Haemorrhage (ICH), and 3.4% had SAH. In those with

ICH, lobar haemorrhage was most common (35.1%), followed by bleeding at the basal ganglia (28.7%), thalami (18.1%), pons (9.6%), cerebellum (5.3%) and midbrain (2.1%).

Waila *et al.*<sup>19</sup> in their study conducted in Maiduguri, North-Eastern Nigeria highlighted that the most frequent risk factors were hypertension 87%, past history of stroke 11.5%, diabetes mellitus 10.1%, alcohol consumption 8.8%, smoking 6.8%, TIA 5.3% and heart failure 2.4% while 19,7% of their study population had more than one risk factors. Ukoha *et al.*'s<sup>20</sup> study of stroke risk factors revealed systemic hypertension as the commonest risk factors. They documented that deranged lipid profile and diabetes mellitus were seen in 46% and 24% respectively.

In comparison to other geopolitical zones in the country, there is paucity of data on CT assessment of stroke patients in North-eastern Nigeria. The aim of this study was to evaluate the pattern of CT findings in patients with stroke in this locality in order to provide the baseline data that will enable accurate diagnosis in patients affected by stroke.

## Materials and Methods

This is a prospective descriptive study conducted at the Federal Teaching Hospital Gombe (FTH Gombe) between June 2016 and December 2016. Gombe is the capital of Gombe State, located in the North-Eastern Nigeria. The radiology department, FTH Gombe had the only functional CT Scan in the geopolitical zone serving citizens of the neighboring Adamawa state, Taraba state, Bauchi, Borno and Yobe states. Patients referred for Cranial CT scan from units within the hospital, Hospitals within the state and from neighboring states were recruited for the study using continuous consecutive sampling technique after certifying the inclusion criteria.

Inclusion criteria include: Patients with clinically suspected stroke, patients 18 years and above and for patients who had more than one CT scan, only the first CT scan was used for analysis. While, exclusion criteria were: Patients with history of head injury in the past 6 months, Patients on anticoagulant drugs, Patients presenting with history of stroke of more than two weeks duration and Patients with confirmed stroke mimics at imaging *e.g.* extra-axial haemorrhages, tumours and abscess.

One hundred and eleven consented adult patients with clinical features of stroke who were referred to the Radiology department for cranial CT and fulfilled the

inclusion criteria for this study were recruited consecutively. The relevant clinical information was retrieved from the patient or patient relatives, CT request form and patient's folder. This included age, sex, clinical diagnosis, duration of symptoms, history of previous systemic arterial hypertension (blood pressure of 160/95 mm Hg or more; previous or current treatment of hypertension), diabetes mellitus, heart failure, obesity, hyperlipidaemia, alcohol consumption, previous history of stroke or TIA and cigarette smoking.

Non contrast CT scan of the head was performed on 111 consented participants using Philips brilliance (16 slices) 1622, 2010 multidetector CT Machine. Patient was placed supine on the scanner table with head resting on the head support and positioning aided by the external alignment lights. The patient was then moved into the gantry and the table was raised to bring the scan reference point to the level of EAM.

A lateral skull scanogram was obtained, from 5 cm below to 12 cm above the baseline. Subsequently 5 mm thick axial contiguous sections of non-contrast images were acquired from the foramen magnum to the superior border of the petrous bone, parallel to the orbitomeatal baseline using the scanogram as a reference image. Further 10 mm thick contiguous sections were done from the superior border of the petrous bone to the skull vertex. The exposure factors used were 120 kV and 250 mA. Fifty (50) mL of non-ionic contrast medium (350mg/mL) was administered via antecubital vein at 2ml/s using infusion pump to obtain the post contrast images only where acute intracranial haemorrhage is ruled out from the initial precontrast study. All images obtained were automatically reformatted to sagittal and coronal sections. The images obtained were reviewed by two consultant radiologists independently. Discrepancies in interpretation between two

observers were resolved by consensus.

Hyperdense lesion (Figure 1) represents haematoma and hypodense lesion (Figure 2) represent infarction. Haemorrhages were categorized as Intracerebral Haemorrhage (ICH), Subarachnoid Haemorrhage (SAH), and Intraventricular Haemorrhage (IVH). Lesions were classified based on location as either lobar (frontal, parietal, temporal or

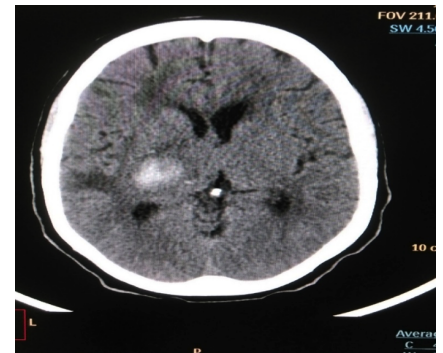


Figure 1. Non contrast cranial CT of the brain showing an oval shaped hyperdensity (hematoma) in the right basal ganglia (putamen) with compression of the adjacent lateral ventricle.

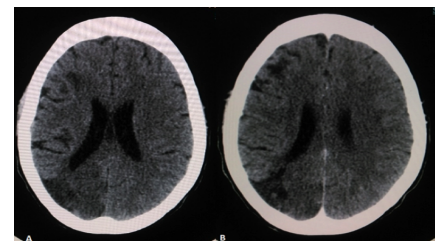


Figure 2. Axial CT brain (A) precontrast and (B) post contrast images showing a nonenhancing wedge shaped hypodensity in the right occipital lobe in keeping with infarction.

Table 1. Age and gender distribution of the study population with CT features of stroke.

Age group (yrs)	Male	Female	Total
18-20	0(0%)	1(0.9%)	1(0.9%)
21-30	0(0%)	2(1.8%)	2(1.8%)
31-40	0(0%)	7(6.3%)	7(6.3%)
41-50	21(18.9%)	9(8.1%)	30(27.0%)
51-60	20(18.0%)	9(8.1%)	29(26.1%)
61-70	18(16.2%)	5(4.5%)	23(20.7%)
71-80	6(5.4%)	8(7.2%)	14(12.6%)
81-90	4(3.6%)	1(0.9%)	5(4.5%)
Total	69(62.2%)	42(37.8%)	111(100%)

occipital), Thalamic-ganglionic hematoma (caudate, putamen and thalamic), brainstem (mid-brain, pons and medulla) and/or cerebellar. The extent, location, vascular territory and other associated features were determined. Informed written consent was obtained from each patient before enlistment into the study. An approval to carry out the study was obtained from the Ethical Committee of the Federal Teaching Hospital Gombe, Nigeria.

## Results

### Demographic characteristic of the study population

A total of 111 had CT scan features of acute stroke, of which 69 (62.2%) were males and 42 (37.8%) were females. The age range of the participants was 18 to 90 years with a mean age ( $\pm$  SD) of 57.49 ( $\pm$ 13.47) years. Twenty-seven percent of these patients were in the age group of 41-50 years (Figure 3) making it the age group with the highest of frequency while the least number of participants were in the age group of 11-20 years (0.9%). Table 1 shows the distribution based on age and gender of the patients. The table shows that patients aged between 41 and 60 were most affected in both male and female patients. It is important to note that between the age of 11 and 40 no case was recorded for the males; however, among females 10 (9%) cases were recorded.

### Computed tomographic patterns of stroke of the studied population with stroke

Figure 4 shows the distribution of CT subtypes among the participants. Ninety-four (94; 84.7%) patients had ischaemic stroke while 17 patients (15.3%) had haemorrhagic stroke. Both ischaemic and haemorrhagic stroke were commoner in males than females; Ischaemic stroke accounted for 53.2% in males and 31.5% in female while haemorrhagic stroke accounted for 9.0% and 6.3% in males and females respectively.

The lobar location (Table 2) was the most common site of Ischaemic stroke (64.9%) with medulla and internal capsule location being the least (1.1% each). Similarly, the lobar location was the commonest site (Table 3) for Haemorrhagic stroke accounting for 29.4% followed by Basal ganglia location accounting for 23.5% while the least location was sub-arachnoid (7.1%).

The side of involvement as shown on Table 4, shows 55 (49.4%) occurring on the

left side, 39 (35.4%) on the right side and 17 (15.2%) were bilateral. The most common vascular territory affected was MCA seen in 69 patients (62.2%) and in 34 patients (30.6%) multiple vascular territories were involved.

### Correlation of CT stroke subtypes with risk factors

Age and hypertension as risk factors were associated in all participants with haemorrhagic stroke (17; 100%) while ischaemic stroke was associated with age

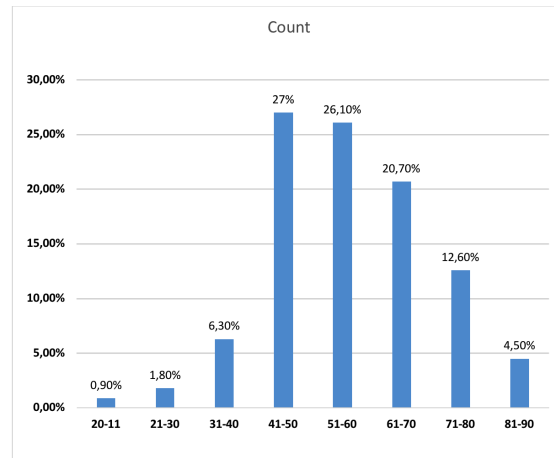


Figure 3. Bar chart showing the various age groups and the frequency of their distribution.

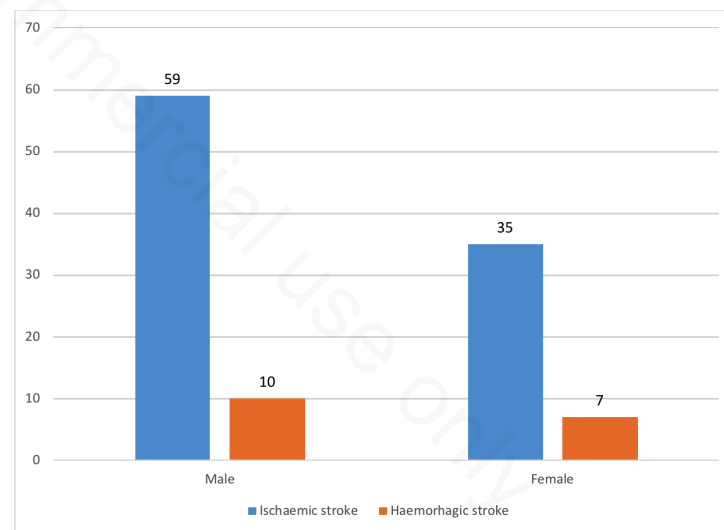


Figure 4. Bar chart showing distribution of CT stroke subtypes according to gender of the patients studied.

Table 2. Distribution of ischaemic stroke based on location.

Location	N	Percentage (%)	N=116
Lobar	61	64.9%	
Basal ganglia	6	6.4%	
Internal capsule	1	1.1%	
Thalamus	6	6.6%	
Pons	3	3.2%	
Medulla	1	1.1%	
Cerebellum	3	3.2%	
Multiple location	13	13.8%	
Total	94	100%	



and hypertension as risk factors in 93.6% and 95.7% of participants respectively. All cases with DM, cardiac diseases and obesity as risk factors were associated with ischaemic stroke (Table 5). Correlation between ischaemic stroke and its risk factors was determined using point-biserial correlation. This showed that age and hypertension were associated with ischaemic stroke with the risk factors demonstrating moderate ( $r_{pb}=0.38$ ) and strong ( $r_{pb}= 0.75$ ) positive correlation respectively. However, only age was found to be statistically significant,  $p=0.000$  (Table 6).

## Discussion

This study shows that there was a male preponderance over female with regards to the incidence of stroke, where 69 (62%) of the population studied were males and 42 (37.8%) were females giving a male to female ratio of 1.6: 1. This finding was similar to that of Luntsi *et al.*<sup>21</sup> who reported 1.7: 1 of male to female ratio in the North-East Nigeria. This higher male preponderance was also reported in other studies; Bwala<sup>22</sup> reported a 2.5: 1 male to female ratio in Maiduguri North-Eastern Nigeria. The increased incidence of stroke in males compared to females might be due to increase risk factors of stroke in males such as HTN, DM, smoking and excess alcohol consumption. More so, the male gender is a non-modifiable risk factor for stroke.

This study shows that the highest incidence of stroke was among persons between 41–60 years' age group (53, this finding is in agreement with reports from most developing countries where stroke presents in comparatively younger population. In contrast Ukoha *et al.*<sup>20</sup> reported highest incidence of stroke among 60-69 years age group. Chiewvit *et al.*<sup>23</sup> also reported high incidence of haemorrhagic stroke at 5<sup>th</sup>-6<sup>th</sup> decade in their study. The relatively early presentation of stroke noted in this study might suggest poor management of the risk factors of stroke from poor compliance of patients to drugs and follow-up regime. The high poverty index and illiteracy rate in the North-East sub region compared to the other geopolitical zones in Nigeria may also contribute for this poor compliance.

About 84.7% of the studied subjects had ischaemic stroke whereas 15.3% had haemorrhagic stroke. These findings were in conformity with the global trend of incidence of stroke subtypes. Study conducted by Robbins *et al.*<sup>24</sup> reported preponderance of ischaemic stroke accounting for 80% and

**Table 3. Distribution of haemorrhagic stroke based on location.**

Location	N	Percentage (%)	N=17
Lobar	5	29.4%	
Basal ganglia	4	23.5%	
Thalamus	2	11.8%	
Internal capsule	1	5.9%	
Intra ventricular	2	11.8%	
Subarachnoid	1	5.9%	
Multiple location	2	11.8%	
Total	17	100%	

**Table 4. Distribution of stroke based on the side and vascular territory involvement.**

Location	N	Percentage (%)
Vascular territory		
ACA		0.9%
MCA	69	62.2%
PCA	2	1.8%
VBA	5	4.5%
Multiple	34	30.6%
Total	111	100%
Side		
Left	55	49.4%
Right	39	35.4%
Both side	17	15.2%
Total	11	100%

**Table 5. Frequencies of risk factors in ischaemic and haemorrhagic stroke.**

Risk Factors	Ischaemic stroke		Haemorrhagic stroke	
	N (94)	percentage (%)	N (17)	percentage (%)
Age	88	93.6	17	100
Sex (male gender)	63	67	12	70.6
Hypertension	90	95.7	17	100
Diabetes mellitus	18	19.1	0	0
Cardiac diseases	6	6.4	0	0
Obesity	3	3.2	0	0
Repeated stroke	3	3.2	4	23.5

**Table 6. Correlation of ischaemic stroke subtype with risk factors.**

Risk Factors	Pearson Correlation (r)	p-value
Age	0.38	0.00
Sex (male gender)	0.19	0.03
Hypertension	0.75	0.39
Diabetics mellitus	0.17	0.06
Cardiac diseases	0.10	0.82
Obesity	0.04	0.34
Repeated stroke	0.04	0.36
Age	0.38	0.00
Sex (male gender)	0.19	0.03
Hypertension	0.75	0.39
Diabetics mellitus	0.17	0.06
Cardiac diseases	0.10	0.82
Obesity	0.04	0.34
Repeated stroke	0.040	.36



haemorrhagic stroke accounting for 15%. Similarly, Ikpeme *et al.*<sup>25</sup> in their study conducted in Nigeria reported an incidence of 81% for ischaemic and 19% for haemorrhagic stroke. Furthermore, Watila *et al.*<sup>19</sup> in their study conducted in Maiduguri, North-Eastern Nigeria also recorded high incidence of ischaemic stroke (62%), while haemorrhagic stroke accounted for 32% and SAH was the least accounting for just 1.2%. The high incidence of ischaemic stroke might be explained by the multiple risk factors associated with it, whereas the single most important risk factor for haemorrhagic stroke is hypertension.

On the contrary Obiako *et al.*<sup>26</sup> studied adult patients who presented to the medical emergency unit of University College Hospital Ibadan, Nigeria in coma from acute stroke. They highlighted that in this group of stroke patients, intracerebral haemorrhage was more frequent (78.8%) while cerebral infarction accounted for 21.2%. The higher incidence of haemorrhagic stroke in their study may be explained by the design of the study population; biased to acute stroke presenting with coma. It is a well-known fact that haemorrhagic stroke presents with loss of consciousness more than ischaemic stroke due to the associated mass effect exerted on the brain parenchyma by the haemorrhage. More so, haemorrhagic stroke is usually a sudden episode against a more insidious ischaemic stroke.

In this study lobar location is the most common site for ischaemic stroke (64.9%) with medulla location being the least (1.1%) site of occurrence. Similarly, the lobar location is also the commonest site for Haemorrhagic stroke accounting for 28.4% followed by basal ganglia location accounting for 23.5% while the least location was the Subarachnoid Space (SAH). However, if the thalamic and basal ganglia location for haemorrhagic stroke were combined as thalamo-ganglionic location as described by many authors, then the thalamo-ganglionic location would be the commonest location (35.3%) for haemorrhagic stroke in this study. This is in agreement with the findings of Chiewvit *et al.*<sup>23</sup> where they found that the commonest location of haemorrhagic stroke was thalamo-ganglionic (53/131 cases, 40.5%), followed by lobar location (5/131 cases, 3.8%), brainstem (8/131 cases, 6.1%) and cerebellum (5/131 cases, 3.8%).

Alkali *et al.*<sup>18</sup> in a review of 272 patients in Abuja, Nigeria documented that, lobar location was most common site (35.1%) for haemorrhagic stroke, followed by the basal ganglia (28.7%), thalami (18.1%), pons (9.6%), cerebellum (5.3%)

and the midbrain was the least (2.1%). These findings are in keeping with the result of this study.

The most common side of occurrence of stroke in this current studied population is the left side 55 (49.4%), with 39 (35.4%) on the right side and 17 (15.2%) bilateral. This is in conformity with the findings of Ikpeme *et al.*<sup>25</sup> who reported 53% on the left side, 40% on the right side and 6.6% bilateral. This might be explained by the fact that majority of people are right handed thus the left half of the brain is the most active and multi-tasking hemisphere hence more prone to stroke.

This study also observed that the most common vascular territory involved is MCA territory seen in 69 patients (62.2%) while the least is the ACA territory (0.9%). This is similar to the report of a study conducted by Chhetri *et al.*<sup>15</sup> who reported a 75% involvement of the MCA and 10% of ACA. The preponderant involvement of the MCA is probably because the MCA is the largest cerebral vessel and the one in direct continuity with the internal carotid artery thus prone to direct transmission of thrombus.

In this study age and hypertension as risk factors exist in all subjects with haemorrhagic stroke (100%) while ischaemic stroke was associated with age and hypertension in 93.6% and 95.7% respectively. All cases with DM, cardiac diseases and obesity as risk factors were associated with ischaemic stroke only. This finding is in agreement with many studies.<sup>18,23,27</sup> Likewise, Ukoha *et al.*<sup>20</sup> in their study of stroke risk factors revealed systemic hypertension as the commonest risk factor associated with both ischaemic and haemorrhagic stroke.

In another study conducted by Watila *et al.*<sup>19</sup> the most frequent risk factors found were hypertension 87%, past history of stroke 11.5%, diabetes mellitus 10.1%, alcohol consumption 8.8%, smoking 6.8% and heart failure 2.4% while 19.7% had more than one risk factor. Similarly Abubakar *et al.*<sup>27</sup> in their study indicated that, systemic hypertension as a risk factor was documented in 51% of ischaemic stroke, and was found to be higher in haemorrhagic stroke 62%. Diabetes mellitus was less frequent in haemorrhagic stroke (8%). They also found that almost all patients with previous history of TIA had ischaemic stroke and constituted 13% of patients with stroke.

Chiewvit *et al.*<sup>23</sup> found 75% of all stroke patients had associated systemic hypertension which is in agreement with the findings of this study. However, the remaining 25% of their studied patients had no

associated risk factors and this contradicted our findings where all the patients reviewed had one or more associated risk factors.

## Conclusions

This study has highlighted the CT pattern of stroke in Gombe, North-Eastern Nigeria. Ischaemic stroke is the commonest stroke subtype and commonly affect left side of the brain. The MCA territory is the commonest vascular territory involved in stroke. Hypertension, male gender and age are the most common risk factors identified for both ischaemic and haemorrhagic stroke. It is important to emphasise that just like in most developing countries stroke may occur younger age hence the need for early identification of risk factors and good compliance to management.

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