



ST. PAUL'S HOSPITAL MILLENNIUM MEDICAL COLLEGE

**PREVALENCE OF SIGNIFICANT INTERNAL CAROTID ARTERY STENOSIS
AMONG ISCHEMIC STROKE PATIENTS WHO HAD CAROTID DOPPLER STUDY IN
ZEWDITU MEMORIAL HOSPITAL, ADDIS ABABA, ETHIOPIA: A 4-YEAR
HOSPITAL-BASED DESCRIPTIVE CROSS-SECTIONAL STUDY.**

BY: DR.SABONA GIRMA (MD, INTERNAL MEDICINE RESIDENT)

**A RESEARCH THESIS TO BE SUBMITTED TO DEPARTMENTS OF INTERNAL
MEDICINE AND PUBLIC HEALTH, SPHMMC, IN PARTIAL FULFILLMENT OF THE
REQUIREMENT FOR SPECIALTY CERTIFICATE IN INTERNAL MEDICINE.**

October 17, 2022



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A research thesis to be submitted to departments of Internal Medicine and Public Health, St. Paul's Hospital Millennium Medical College in partial fulfillment of the requirement for specialty certificate in Internal Medicine.

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Sabona Girma (MD, Internal Medicine Resident)

Abstract

Background: Cerebrovascular accident is an important health problem worldwide. Globally, ischemia accounts for 62% of all incident strokes. Atherosclerosis is one of the major causes of ischemic stroke. 15-20% of ischemic stroke is estimated to be caused by internal carotid artery stenosis of $\geq 50\%$. Smoking, old age, male sex, increasing blood pressure, hyperlipidemia and diabetes mellitus are associated with an increased prevalence of significant internal carotid artery stenosis. Doppler Ultrasound plays an important role in establishing the presence and severity of extra cranial arterial atherosclerosis, stenosis and or occlusion in ischemic stroke.

Objective: The aim of this study was to study the prevalence of internal carotid artery stenosis and to assess the significance of common risk factors for internal carotid artery stenosis in ischemic stroke patients admitted to Zewditu Memorial Hospital.

Methods: This was a 4-year descriptive cross sectional study of ischemic stroke patients who have Doppler study of bilateral carotid artery from September, 2018 to August 2022. All ischemic stroke patients with Doppler ultrasound of bilateral carotid artery were used as study population. Significant ICA stenosis was defined as internal carotid artery stenosis of $\geq 50\%$. Data was entered into the Epi-data version 3.1 and analyzed using SPSS version 25.

Result: A total of 591 card numbers with a diagnosis of ischemic stroke were collected from HMIS. Of these only chart of 412 patients was able to be found from card room. Among these 158 patients fulfilled inclusion criteria and included in the study. There were 66 males (41.8%) and 92 females (58.2%) with minimum age of 34 and maximum 90, with a mean value of 63 years. 6 (3.8%) had moderate (CAS $\geq 50\%$ - 69%) stenosis, 2 (1.3%) had severe (CAS $\geq 70\%$ -99%) stenosis and none of them had total occlusion.

Conclusion and Recommendation: Among ischemic stroke patients who had Doppler study of Internal carotid artery the prevalence of significant internal carotid artery stenosis is low (5.1%). This finding raise question regarding the applicability and cost-effectiveness of routine carotid ultrasound screening in our study area. We recommend further large scale multi centered prospective study for better characterization of patients with ischemic stroke.

Key words: Doppler ultrasound, Internal Carotid Artery, Ischemic stroke, Zewditu Hospital

Acronyms and Abbreviations

2D	Two-Dimensional
3D.....	Three-Dimensional
AIS	Acute Ischemic Stroke
CAS	Carotid Artery Stenosis
CEA	Carotid Endarterectomy
CI	Confidence Interval
CT.....	Computed Tomography
DM.....	Diabetes Mellitus
HDL.....	High-Density Lipoprotein
HT.....	Hypertension
ICA	Internal Carotid Artery
IHD.....	Ischemic Heart Disease
IMT	Intima-Medial Thickness
IRB.....	Institutional Review Board
LDL.....	Low Density Lipoprotein
LMICs	Low-income and Middle-Income Countries
MRI.....	Magnetic Resonance Imaging
OR.....	Odds Ratio
PSV	Peak Systolic Velocity
RBS.....	Random Blood Sugar
SPHMMC.....	St. Paul's Hospital Millennium Medical College
SPSS.....	Statistical Package for the Social Science
TB.....	Tuberculosis
TIA.....	Transient Ischemic Attacks
TGL.....	Triglyceride
US.....	Ultrasound
ZMH.....	Zewditu Memorial Hospital

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Introduction

1.1 Background of the study

Ischemic stroke is an episode of neurological dysfunction caused by focal cerebral, spinal, or retinal infarction. CNS infarction is brain, spinal cord, or retinal cell death attributable to ischemia, based on 1. Pathological, imaging, or other objective evidence of cerebral, spinal cord, or retinal focal ischemic injury in a defined vascular distribution; or 2. Clinical evidence of cerebral, spinal cord, or retinal focal ischemic injury based on symptoms persisting ≥ 24 hours or until death, and other etiologies excluded.(1)

Stroke is the second leading cause of both disability and death worldwide, with the highest burden of the disease shared by low- and middle-income countries(2).

Global prevalence of stroke in 2019 was 101.5 million people, with ischemic stroke accounting for 77.2 million and hemorrhage for 20.7 million, and that of subarachnoid hemorrhage was 8.4 million(3). Each year, ≈ 795000 individuals in the United States experience a stroke, of which 87% (690000) are ischemic and 185000 are recurrent. In 2017 in Europe, There were an estimated 1.12 million cases of incident stroke, 9.53 million prevalent stroke cases, 0.46 million stroke deaths, and 7.06 million disability-adjusted life years (DALYs) lost(4). According to one Community-based studies; the burden of stroke in Africa revealed an age-standardised annual stroke incidence rate of up to 316 per 100 000 population, and age-standardised prevalence rates of up to 981 per 100 000(5). According to study done on 104 patients with stroke in Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia, Ischemic stroke accounted for 44% of stroke subtype(6).

Atherosclerosis is one of the major causes of ischemic stroke, it can lead to Stroke through progressive stenosis, occlusion of the extra or intracranial vessels and or arterio-arterial embolization from an athermanous plaque(7). The prevalence of internal carotid artery stenosis (CAS) of $\geq 50\%$ in acute ischemic stroke (AIS) patients has previously been estimated to be between 15% and 20%(8). Smoking, higher age, male sex, increasing blood pressure, hyperlipidemia and diabetes mellitus are associated with an increased prevalence of both $\geq 50\%$ and $\geq 70\%$ ICA stenosis(9). Duplex Ultrasound plays an important role in establishing the presence, and severity of extra cranial arterial atherosclerosis, stenosis and or occlusion in acute stroke.

Internal carotid artery (ICA) should be diagnosed as (i) normal when ICA peak systolic velocity (PSV) is < 125 cm/sec and no plaque or intimal thickening is visible; (ii) $<50\%$ stenosis when ICA PSV is < 125 cm/sec and plaque or intimal thickening is visible; (iii) 50% – 69% stenosis when ICA PSV is 125 – 230 cm/sec and plaque is visible; (iv) $\geq 70\%$ stenosis to near occlusion when ICA PSV is > 230 cm/sec and visible plaque and lumen narrowing are seen; (v) near occlusion when there is a markedly narrowed lumen at color Doppler US; and (vi) total occlusion when there is no detectable patent lumen at gray-scale US and no flow at spectral, power, and color Doppler US(10).

Demonstration of significant internal carotid stenosis may suggest the need for further investigation and for carotid endarterectomy to prevent further strokes. For neurologically symptomatic patients with stenosis $< 50\%$ or asymptomatic patients with stenosis $<60\%$ diameter reduction optimal medical therapy is indicated(11).Optimal medical management includes antithrombotic therapy, high-potency statin therapy, and risk factor modification, including blood pressure control, glucose control, weight control, and lifestyle modification with smoking cessation, exercise, and recommended dietary modifications. Treatment options for symptomatic carotid atherosclerotic disease include carotid endarterectomy (CEA), carotid artery stenting (CAS), and medical management. The aim of this study was to study the prevalence and risk factors of significant internal carotid artery stenosis among patients with acute ischemic stroke in Zewditu Memorial Hospital.

1.2 Statement of the problem

Age-standardized stroke incidence and mortality are declining substantially in high-income countries. However, 70% of strokes and 87% of both stroke related deaths and disability-adjusted life-years occur in low-income and middle-income countries (LMICs), in which people have proportionally more hemorrhagic strokes and on average die of stroke at a younger age(12).

In the 2017 Global Burden of Disease Report, worldwide, 5.5 million deaths and 132 million are left permanently disabled related to stroke. In the same year in Asia (41.2%), in Europe (19%), and in Australia (14.9%) of the stroke admission died. In Africa, the burden of stroke is high and ranges from 29% to 84% of stroke-related deaths and 14.3% of the disabled.

In 2017 in Europe, There were an estimated 1.12 million cases of incident stroke, 9.53 million prevalent stroke cases, 0.46 million stroke deaths, and 7.06 million disability-adjusted life years (DALYs) lost.(4)

According to systematic review in Africa between January 1960 and October 2014, Community-based studies revealed an age-standardized annual stroke incidence rate of up to 316 per 100 000 population, and age-standardized prevalence rates of up to 981 per 100 000.(5)

According to systematic review and meta-analysis performed between 1st January 2000 to 31st December 2019 in Sub-Saharan Africa; the one-month pooled stroke case-fatality rate was 24.1% [95% CI: 21.5–27.0] and 33.2% [95% CI: 23.6–44.5] at one year. At three and five years, the case-fatality rates were respectively 40.1% [95% CI: 20.8–63.0] and 39.4% [95% CI: 14.3–71.5] with high heterogeneity.(13)

In Ethiopia, the burden of stroke is increasing and has become the reason for 7.5% to 19.3% of hospital admission and approximately (11% to 42.8%) death between 2014–2019(14).

Population-based studies have estimated that about 15% of ischemic strokes are caused by large-vessel cerebrovascular disease(15). To the best of the authors knowledge there was no study regarding prevalence of internal carotid artery stenosis in Ethiopia.

1.3 Significance of the study

So far, there are limited published studies regarding prevalence of internal carotid artery atherosclerosis in ischemic stroke patients in Ethiopia. The purpose of this study was to estimate the prevalence of significant ICA stenosis. Knowing how much ICA stenosis contributes to ischemic stroke burden in our local population is very important for preventive measures and designing strategies to combat the disease burden in our community and the country at large. This study added valuable information to the limited local information available on the subject matter so that the hospital policy makers can use it as a base to allocate health budget on the more common public health problems. For the first time in history data generated by this study showed us the magnitude of significant internal carotid artery stenosis in our local study participants.

2. Literature Review

The brain parenchyma is supplied by bilaterally paired internal carotid arteries (ICAs) and bilateral vertebral arteries. The ICA carries about 80% of the total blood to the brain (16). Carotid artery atherosclerosis or stenosis accounts for at least 20% of all ischemic strokes(17). Carotid artery stenosis refers to a $\geq 50\%$ stenosis of the extracranial internal carotid artery (ICA). Carotid stenosis is defined as 'symptomatic' if associated with symptoms in the preceding 6 months(18).

Atherosclerosis is hardening of a blood vessel from a buildup of plaque. Plaque is made of fatty deposits, cholesterol, and calcium. Plaque buildup causes the artery to narrow and harden which in turn can slow and even stop blood flow. This means the tissue supplied by the artery is cut off from its blood supply. This condition can cause a number of serious health problems. Depending on the location of the blockage, it can cause: ischemic heart disease, stroke or peripheral arterial disease(19). Atherosclerosis develops over the course of 50 years, beginning in the early teenage years. However, the rate of development is faster in patients with risk factors such as hypertension, tobacco smoking, diabetes mellitus, obesity, and genetic predisposition(20). The presence of several risk factors in a given individual heightens the risk considerably(21). A high level of serum total Cholesterol (TC) and LDL-C is well known to be major risk factors for ischemic stroke. Recently, higher TG levels also have been repeatedly reported to increase atherosclerotic risks. In contrast, HDL-C levels are inversely associated with risks for the development of atherosclerosis and ischemic stroke(17). Elevated LDL cholesterol levels are considered to be the primary risk factor for the development of atherosclerosis. LDL levels $< 100\text{mg/dl}$ are classified as optimal, $100\text{-}129\text{mg/dl}$ are classified in the near or above optimal, $130\text{-}159\text{mg/dl}$ are classified in the borderline high, $160\text{-}189\text{ mg/dl}$ are classified in the high and $\geq 190\text{mg/dl}$ are classified as very high(22). According to 2021 European society of cardiology; CVD risk is increased when fasting triglycerides are $>150\text{ mg/dl}$ (23). HDL (good) cholesterol protects against atherosclerotic disease, so for HDL, higher numbers are better. HDL level $<40\text{ mg/dl}$ for male and $<50\text{mg/dl}$ for female are considered low (22). HDL levels of $\geq 60\text{ mg/dl}$ is normal for both gender and help to lower the risk for heart disease. Total cholesterol $<200\text{ mg/dl}$ is desirable level that puts an individual at lower risk for atherosclerotic disease. Total cholesterol $200\text{ to }239\text{ mg/dl}$ is categorized as borderline high and a value $\geq 240\text{ mg/d}$ is high blood cholesterol(22).

There is a significant dose-response relationship between the status of hypertension and the severity of carotid atherosclerosis. Compared with the normotensive subjects, the ORs (and 95% CIs) for the hypertensive patients to develop carotid atherosclerosis were 5.0 (3.0 to 8.4)(24). The 2018 European society of cardiology guidelines defines hypertension as office SBP values ≥ 140 mmHg and/or diastolic BP (DBP) values ≥ 90 mmHg it also classifies blood pressure into optimal blood pressure; SBP < 120 mmHg and DBP < 80 mmHg; Normal blood pressure SBP 120-129 mmHg and/or DBP 80-84 mmHg; High normal blood pressure SBP 130-139 mmHg and/or DBP 85-89 mmHg; Grade 1 Hypertension = SBP 140-159 mmHg and/or DBP 90-99 mmHg; Grade 2 hypertension SBP 160-7 and/or DBP 100-109 mmHg; Grade 3 hypertension SBP ≥ 180 mmHg and/or DBP ≥ 110 mmHg (25).

Globally in 2019, there were 12.2 million (95% UI 11.0–13.6) incident cases of stroke, 101 million (93.2–111) prevalent cases of stroke, 143 million (133–153) disability-adjusted life-years (DALYs) due to stroke, and 6.55 million (6.00–7.02) deaths from stroke. Globally, stroke remained the second-leading cause of death (11.6% [10.8–12.2] of total deaths) in 2019. From 1990 to 2019, the absolute number of incident strokes increased by 70.0% (67.0–73.0), prevalent strokes increased by 85.0% (83.0–88.0), deaths from stroke increased by 43.0% (31.0–55.0), and disability-adjusted life-years (DALYs) due to stroke increased by 32.0% (22.0–42.0)(26).

In people aged 30-79 years in 2020, the global prevalence of increased carotid intima-media thickness is estimated to be 27.6% (95% CI 16.9-41.3), equivalent to 1066.70 million affected people and a percentage change of 57.46% from 2000; of carotid plaque is estimated to be 21.1% (13.2-31.5), equivalent to 815.76 million affected people and a percentage change of 58.97% from 2000; and carotid stenosis is estimated to be 1.5% (1.1-2.1), equivalent to 57.79 million affected people and a percentage change of 59.13% from 2000. The prevalence of increased carotid intima-media thickness, carotid plaque, and carotid stenosis increased consistently with age and was higher in men than in women. Current smoking, diabetes, and hypertension were common risk factors for increased carotid intima-media thickness and carotid plaque. In 2015, the Western Pacific region had the largest share of global cases of increased carotid intima-media thickness (317.62 million [33.36%] of 952.13 million affected people) and carotid plaque (240.77 million [33.20%] of 725.25 million), whereas the African region had the smallest share of cases of

increased carotid intima-media thickness (59.08 million [6.21%]) and the Eastern Mediterranean region had the smallest share of carotid plaque cases (44.59 million [6.15%])(27).

In a retrospective review of 883 patients admitted to two large hospitals in the Netherlands in 2014 with the diagnosis of ischemic stroke (65.2%), TIA (28.3%) and Retinal ischemic stroke or retinal TIA (6.4%), 110 patients (12.5%; 95% CI 10.4–14.9) had an ICA stenosis of 50–99%. In the univariable analysis, the group with 50–100% ICA stenosis was older (odds ratio [OR] (per 10 years) 1.26; 95% confidence interval [CI] 1.10–1.45), included more men (OR 2.58; 95% CI 1.77–3.81), was more likely to be treated with statins (OR 1.53; 95% CI 1.08–2.18) and suffered more from comorbidities such as hypertension (OR 1.42; 95% CI 1.00–2.03), hyperlipidaemia (OR 1.43; 95% CI 1.01–2.04) and symptomatic peripheral vascular disease(9).

According to a 1-year (from 1 July 2014 to 30 June 2015) prospective observational study of consecutive patients presenting with ischaemic stroke, TIA or ischaemic retinal artery occlusion to a central London hyperacute stroke unit, significant carotid stenosis of $\geq 50\%$ was seen in 238 (prevalence 19.0 (95% C.I. 16.6–21.4)%). In total, 1252 patients with carotid imaging were included for analysis. Carotid stenosis was defined as the cause of stroke (symptomatic carotid stenosis) in 99 patients (7.9% (6.3 to 9.5)). The overall mean age of the patients was 71.4 years, 677 (54.1%) were men and 71.2% were taking secondary preventive medication for cardiovascular diseases before admission (either antiplatelet therapy, warfarin, antihypertensives or statins). 63.3% and 24.1% of their patients have hypertension and DM respectively. In addition 55% of their patients are also dyslipidemic and 35% are cigarette smoker. Compared to other study they found lower prevalence of symptomatic carotid stenosis. They put different reasons for their findings. First a large proportion of patients in their population (71.2%) were taking at least one secondary preventive medication.(28)

According to a community-based survey of the prevalence of carotid-artery stenosis in subjects older than 49 years among 320 participants in health district of Baiano di Spoleto (Umbria, Italy), internal carotid-artery stenosis of 50–100% was found in 5% of the sample. They also found that hypertension, advanced age, and carotid bruit are the most powerful predictors of carotid stenosis.(29)

A prospective study carried out in Sri Lanka, south Asia, over 5 years (2014–2019) on total of 550 patients with ischemic stroke who underwent carotid Doppler studies, Carotid artery stenosis (CAS) of $\geq 50\%$ was seen in 22 (4.0%) patients and CAS 70–99% in 1.3% and total occlusion in 0.5%. Age was independently associated with both CAS $\geq 50\%$ (OR 1.12, $p = 0.001$) and CAS $\geq 70\%$ (OR 1.14, $p = 0.016$)(30).

In a cross-sectional retrospective study carried out in Pasig city, Philippines, on a total of 577 patients with ischemic stroke who underwent carotid Doppler studies from 2013 to 2018, twenty nine patients (5.0%) had significant Carotid stenosis (stenosis of $\geq 70\%$). The most common risk factors for those with significant stenosis were hypertension (76%), smoking (40%), and diabetes (36%)(31).

In a cross sectional Hospital Based Prevalence Study done in a sample of 100 patients admitted in Chennai, India tertiary care hospital during the period of July 2017 to June 2018, 10% of patients were found to have significant stenosis ($>70\%$). The prevalence of carotid stenosis increases with increase in age, male gender, smoking, DM, HT & Hyperlipidemia(32).

In a cross sectional hospital-based prevalence study done in Andhra Pradesh, India, on 50 patients significant stenosis ($>70\%$) was found in about 12% patients. The authors also found the percentage of patients who had carotid stenosis, increased with increase in age and prevalence of carotid stenosis was more in males (53%) than females (20%). Regarding other risk factors associated with carotid stenosis, carotid artery stenosis was more common in diabetics (77%) than in non-diabetics (31%) and more in hypertensives (73%) than in normotensives (33%).

More smokers (60%) had carotid stenosis than non-smokers (36%) Prevalence of carotid stenosis, also increases with hyper cholesterol ($>200\text{mg/dl}$) and Increased LDL ($>150\text{mg/dl}$) and Increased TGL($>130\text{mg/dl}$) and decreased HDL ($<40\text{mg/dl}$)(33).

In a one year prospective study of 185 patients with Cerebrovascular stroke (CVS) among Egyptian patients, significant ($\geq 70\%$ ICA stenosis) was observed in 44 patients (23.8%). most of

them were males 43 (97.7%) and older than 60 years (95.5%). The most prevalent risk factors among this group were Hypertension (97.7%), hyperlipidemia (88.6%), smoking (75%), DM (65.9%) and IHD (54.5%)(7).

According to prospective study conducted on 672 patients who underwent bilateral carotid Doppler Ultrasound for the diagnosis of stroke or TIA in Karachi, Pakistan, from August 2005 to October 2006 Doppler revealed 0% to 50% stenosis in 526 (78%), 51% to 69% stenosis in 57 (8%), 70% to 99% stenosis in 82 (12%), and total occlusion in 7 patients (1%). Potentially surgically correctable disease, defined as 70% to 99% carotid artery stenosis, was present in only 79 (12%) patients.

Hypertension was found in 392 (59%), Diabetes mellitus in 249 (37%) and Smoking in 168 (25%)(34).

In prospective study done in University Hospital Centre of Yaoundé, Cameroon, from January 2013 to October 2013, on 35 ischemic stroke patients, 17 patients had an abnormal carotid ultrasound, from which 14 had carotid irregularities and non-ulcerated atheroma with no significant stenosis, 3 presented a stenosis between 50-75%, there was no lesion above 75%.(35)

According to Post-Stroke Carotid Ultrasound Findings from an Incident Tanzanian Population, 132 incident stroke cases were identified in the Hai DSS between 15th June 2003 and 15th June 2006 of which 56 (42.4%) patients underwent Duplex ultrasound to identify stenosis of the carotid artery. Only 1 (1.8%) case (female, aged 56 years) had evidence of right ICA stenosis, with a mild degree of stenosis of around 50%. This patient was diagnosed as having had an ischaemic stroke by CT scan. This patient had not had a previous stroke and no significant previous medical history. She was a non-smoker, moderate drinker and worked as a farmer. She was a known hypertensive who had her blood pressure measured every 3 months and was on antihypertensive medication.(36)

2.1 Conceptual framework

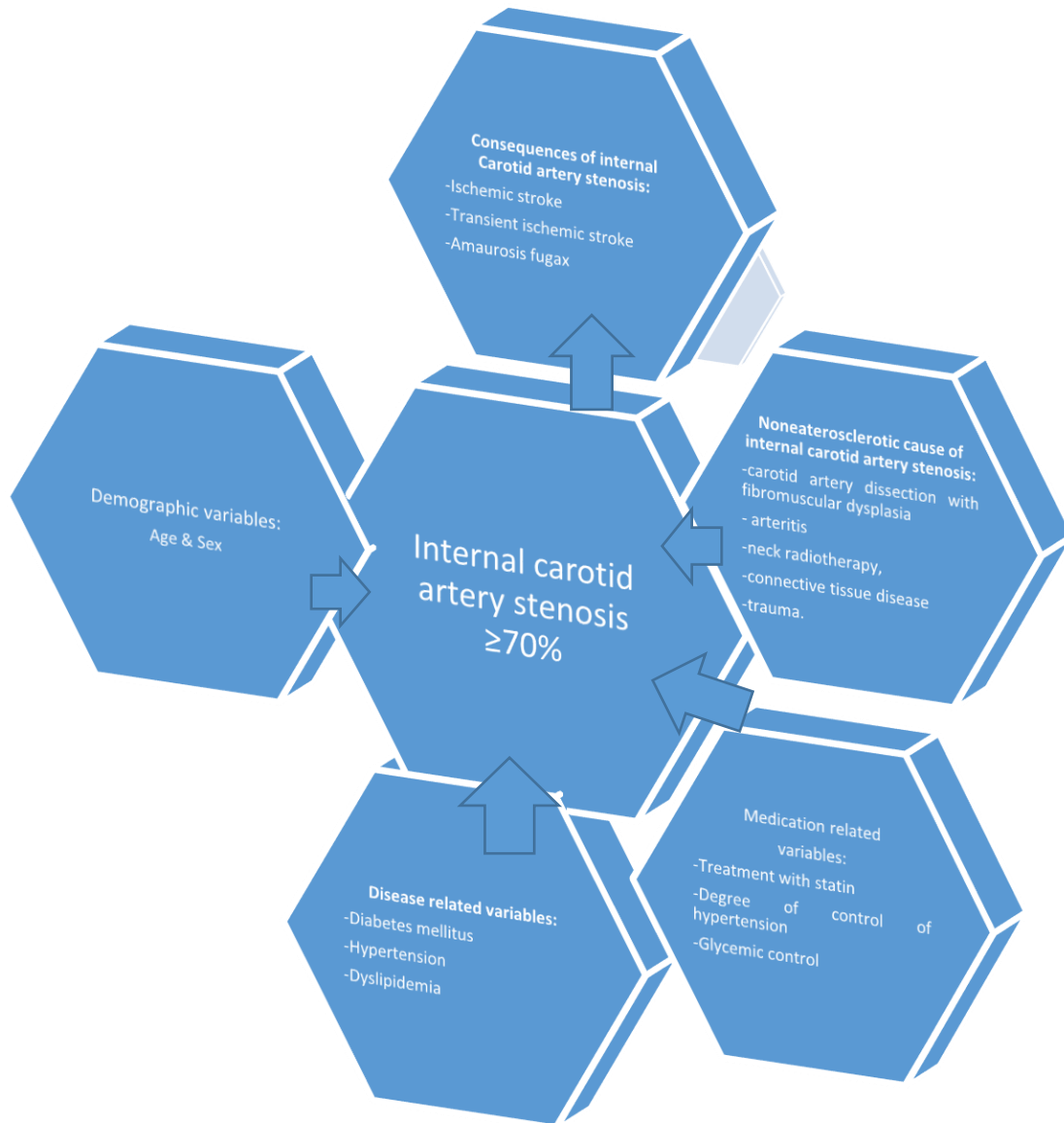


Figure 1: Conceptual framework for showing relationship between independent and dependent variables (self-prepared)

3. Study Objectives

3.1 General Objective

- To determine the prevalence of significant internal carotid artery stenosis and associated factors among patients diagnosed with ischemic stroke in Zewditu Memorial Hospital.

3.2 Specific Objectives

- To determine the prevalence of significant internal carotid artery stenosis among patients diagnosed with ischemic stroke in Zewditu Memorial Hospital.
- To find out the magnitude of association between internal carotid artery stenosis and its risk factors such as diabetes mellitus, hypertension, hyperlipidemia, smoking, sex and age.

4. Methods and Materials

4.1 Study Design

Descriptive Cross-sectional study design was used.

4.2 Study Area

The study was conducted at Zewditu Memorial Hospital, a hospital in central Addis Ababa, Ethiopia. It was built, owned and operated by the Seventh - day Adventist church, but was nationalized during the Derg Regime in around 1976. This hospital is named after Empress Zawditu, the cousin and predecessor on the throne of Empereor Haile Silassie. Today the hospital is operated by ministry of Health. The hospital has 188 beds and serves about 9,171 inpatient and 89,540 outpatients per year. Under the department of internal medicine there are two neurologist who give continuous service for the neurology patients.

4.3 Study Period

The study was carried out from October 1, 2021 to October 20, 2022

4.3.1. Source Population

All adult Ischemic stroke patients attending follow up clinic or admitted to medical ward of internal medicine department at Zewditu memorial hospital.

4.3.2. Study Population

The study population were ischemic stroke patients that meet the inclusion criteria and had Doppler ultrasound study of carotid artery.

4.4 Inclusion Criteria

- Age ≥ 18 years
- Ischemic stroke patients as diagnosed with CT/MRI or clinically who have Doppler ultrasound of extra cranial carotid artery

4.5 Exclusion Criteria:

- Patients with hemorrhagic stroke.
- Patients with head injury that is not due to ischemic stroke. i.e if the stroke caused falling down accident and patient sustained head injury; these patients are included in the study.
- Systemic illness patients presenting with stroke symptoms like Malignancy, TB, metabolic emergencies.
- Patients with echocardiographic evidence of left ventricular thrombus.

- Patients with echocardiographic evidence of left atrial thrombus.
- Patients with echocardiographic evidence of mitral stenosis.
- Patients with documented atrial fibrillation before the stroke.
- Patients who do not have Doppler ultrasound of internal carotid artery

4.6 Sampling Method

All patients with CT/MRI or clinical diagnosis of ischemic stroke who underwent Doppler study of internal carotid artery were included.

4.7 Variables

4.7.1 Independent Variables

- Sex
- Age
- Hypertension
- Diabetes mellitus
- Dyslipidemia
- Cigarette smoking
- Alcohol drinking
- Previous history of ischemic stroke
- Previous history of transient ischemic attack
- Previous history of Amaurosis fugax

4.7.2 Dependent Variable

- Internal carotid artery stenosis of $\geq 50\%$

4.8 Data Collection Procedure and Data Quality Management

Data was collected from April to May 2022 G.C. Data collection checklist was prepared in English language from review of similar prior literatures with 4 components: part 1: Sociodemographic data; part two: Risk factors for ischemic stroke; part 3: Laboratory parameters and Imaging findings; part 4: Doppler study findings . Two weeks before the actual data collection, a pre-test was performed using 12 charts at Sphmmc to evaluate the clarity of questions and validity of the tool.

An hour-long training was given to eight data collectors (Internal Medicine residents of SPHMMC) on the components of the checklist and how to fill the data into a computer. Records of the study population was assessed for completeness before data entry and the entered data was checked by the data supervisor on a daily basis for any incompleteness and/or inconsistency.

4.9 Data Analysis

Data was analyzed using the Statistical Package of Social Sciences (SPSS) version 25.0 for Microsoft Windows. Means, standard deviations and percentages were calculated and cross-tabulation was used to compare different variables. The results are presented by the use of charts, tables, and texts. Microsoft Excel 2016 was used to make graphs and charts.

5. Operational Definition

- ❖ Acute ischemic stroke = time since ischemic stroke of <4.5hours
- ❖ Significant internal carotid stenosis= Internal carotid artery stenosis $\geq 50\%$ (18)
- ❖ Ischemic Stroke = is an abrupt onset of a neurologic deficit that is attributable to a focal vascular cause which last for >24 h or brain infarction is demonstrated on brain imaging.
- ❖ Moderate carotid artery stenosis= Internal carotid artery stenosis of $\geq 50\%$ –69%
- ❖ Severe carotid artery stenosis = Internal carotid artery stenosis of $\geq 70\%$ (10).
- ❖ Normal random blood sugar= RBS <200mg/dl
- ❖ Abnormal RBS= RBS ≥ 200 mg/dl

National cholesterol education program adult treatment panel III (NCEP ATP III) classification of lipid panel(22) and European Society of Cardiology classification of Hypertension(25).

- ❖ Normal triglyceride level = Triglyceride <150mg/dl
- ❖ Borderline high triglyceride level = Triglyceride of 150-199mg/dl
- ❖ High triglyceride level = Triglyceride level of 200-499mg/dl
- ❖ Very high triglyceride level = Triglyceride level ≥ 500 mg/dl
- ❖ Normal HDL cholesterol level = HDL cholesterol level ≥ 60 mg/dl for both male and female.
- ❖ Moderate HDL cholesterol level = HDL cholesterol level of 40-59mg/dl for male and 50-59mg/dl for female

- ❖ Low HDL cholesterol level = HDL cholesterol level of <40mg/dl for male and <50mg/dl for female
- ❖ Optimal LDL cholesterol level = LDL cholesterol level of <100mg/dl
- ❖ Near optimal/above optimal LDL cholesterol level = LDL cholesterol level of 100-129 mg/dl
- ❖ Borderline high LDL cholesterol level = LDL cholesterol level of 130-159mg/dl
- ❖ High LDL cholesterol level = LDL cholesterol level of 160-189mg/dl
- ❖ Very high LDL cholesterol level = LDL cholesterol level $\geq$ 190mg/dl
- ❖ Desirable total cholesterol level = Total cholesterol level <200
- ❖ Borderline high total cholesterol level = Total cholesterol level of 200-239mg/dl
- ❖ High total cholesterol level = total cholesterol level $\geq$ 240
- ❖ Optimal blood pressure = SBP <120mmHg and DPB <80mmHg
- ❖ Normal blood pressure = SBP 120-129mmHg and/or DBP 80-84mmHg
- ❖ High normal blood pressure = SBP 130-139mmHg and/or DBP 85-89mmHg
- ❖ Grade 1 Hypertension = SBP 140-159mmHg and/or DBP 90-99mmHg(25).
- ❖ Grade 2 hypertension = SBP 160-7and/or DBP 100-109mmHg
- ❖ Grade 3 hypertension = SBP $\geq$ 180mmHg and/or DBP $\geq$ 110mmHg

6. Ethical Consideration

Ethical clearance was obtained from the Institutional Review Board of ZMH and SPHMMC Institutional Review Board (IRB), and then permission was given from the school administration through the academic provost of the school to carry out the study. Each patient's information was collected using a structured checklist. The collected information was only used for this particular study and will be kept confidential.

6.1 Dissemination of Results

The output of this study will be communicated to the Department of Internal Medicine and Public Health, St. Paul's Hospital Millennium Medical College in partial fulfillment of the requirement for a specialty certificate in Internal Medicine. It will also be submitted to Zewditu Memorial Hospital department of Internal Medicine. Attempts will be made to publish the information in peer-reviewed journals and make presentations in scientific conferences.

7. Result

A total of 591 card numbers with a diagnosis of ischemic stroke were collected from HMIS of ZMH over 4 years from September, 2018 to August 2022. Of these only chart of 412 patients was able to be found from card room. Among these patients only 176 (42.7%) had undergone carotid Doppler studies. Three patients with echocardiographic finding of left ventricular thrombus, five Patients with echocardiographic evidence of left atrial thrombus and two Patients with echocardiographic evidence of mitral stenosis were excluded from study. Eight Patients who had documented atrial fibrillation before the stroke were also excluded. 158 patients who fulfilled the inclusion criteria are included in this study.

The results are as follows:

There were 66 males (41.8%) and 92 females (58.2%) with median age of 62.58 years and minimum and maximum age of 34 and 90 years respectively (Table 1). 34 (21.5%) patients have diabetes. Among the 34 patients, 26 (76.5%) had diabetes for less than 10 years. 98 (62%) of the study patients have hypertension. Among the 98 patients with hypertension, 90 (91.8%) have been hypertensive for less than 10 years. 18 (11.4%) patients were diagnosed with dyslipidemia. 14 (8.9%) of the patients had previous history of ischemic stroke. All 158 (100%) patients didn't have previous history of TIA and Amaurosis Fugax.

Regarding cigarette smoking history 6 (3.8%) patients smoke cigarettes, 116 (73.4%) do not smoke cigarette while 36 (22.8%) of the patient's smoking history wasn't documented. Among the 6 smoker patients, 2 (33.3%) patients have smoked 30 pack years, 2 (33.3%) patients have smoked 37.5 pack years, 2 (33.3%) patients have smoked 7.5 pack years. None of the patients have quit smoking.

Two male patients that make up 1.3% of the patients drink alcohol and both of them drink less than one standard drinks per day.

On physical examination the lowest blood pressure recorded at initial emergency was 100/60 mmHg, the highest 206/119 mmHg and the most frequent 140/90 mmHg. The most frequently measured BP category was grade I hypertension 52 (32.9%) followed by optimal 39 (24.7%) and grade 2 hypertension 29 (18.4%). The remaining had normal 5 (3.2%), high normal 21 (13.3%) and stage 3 hypertension 12 (7.6%).

Table 1: sociodemographic and clinical characteristics of patients

Variables	Category	Carotid artery stenosis		Total N (%)
		<50% stenosis	>50% stenosis	
Sex	Male	64 (42.7%)	2 (25.0%)	66 (41.8%)
	Female	86 (57.3%)	6 (75%)	92 (58.2%)
Age(in years)	Mean (SD)	62.58 (12.427)		158(100%)
Diabetes mellitus	Yes	30(20%)	4(50%)	34(21.5%)
	No	120(80%)	4(50%)	124(78.5%)
Hypertension	Yes	94(62.7%)	4(50%)	98(62.0%)
	No	56(37.3%)	4(50%)	60(38%)
Previous Hx of Ischemic Stroke	Yes	14(9.3%)	0(0%)	14(8.9%)
	No	136(90.7%)	8(100%)	144(91.1%)
Alcoholic	Yes	2(1.3%)	0(0%)	2(1.3%)
	No	148(98.7%)	8(100%)	156(98.7%)
Smoking	Yes	6(4%)	0(0%)	6(3.8%)
	No	110(73.3%)	6(75%)	116(73.4%)
	Not documented	34(22.7%)	2(25%)	36(22.8%)
Duration of hypertension	<10years	86(91.5%)	4(100%)	90(91.8%)
	≥10years	8(8.5%)	0(0%)	8(8.2%)
Duration of diabetes	<10 years	22(73.3%)	4(100%)	26(76.5%)
	≥10years	8(26.7%)	0(0%)	8(23.5%)
Previous Hx of dyslipidemia	Yes	18(12%)	0(0%)	18(11.4%)
	No	132(88%)	8(100%)	140(88.6%)
Initial blood pressure at emergency room(mmHg)	Optimal	35(23.3%)	4(50%)	39(24.7%)
	Normal	5(3.3%)	0(0%)	5(3.2%)
	High normal	21(14%)	0(0%)	21(13.3%)
	Grade 1 HTN	48(32%)	4(50%)	52(32.9%)
	Grade 2 HTN	29(19.3%)	0(0%)	29(18.4%)
	Grade 3 HTN	12(8%)	0(0%)	12(7.6%)
Pulse rhythm	Regular	124(82.7%)	8(100%)	132(83.5%)
	Irregular	26(17.3%)	0(0%)	26(16.5%)

132(83.5%) patients had regular pulse rhythm while 26(16.5%) had irregular heart rate first diagnosed after stroke diagnosis. 146 (92.4%) patients had random blood sugar measurement recorded in their chart and among these 138(94.5%) of them had RBS <200mg/dl. The average value of the measurements is 147.05mg/dl with the most frequent value being 132mg/dl and minimum and maximum results being 68 mg/dl and 408mg/dl respectively.

Table 2: Laboratory and imaging findings of the study patients

Variables		Category	Carotid artery stenosis		Total N (%)
			<50% Stenosis	>50% stenosis	
Dyslipidemia	Low density lipoprotein(LDL)	Optimal(<100mg/dl)	42(51.2%)	2(100%)	44(52.4%)
		Near optimal(100-139mg/dl)	26(31.7%)	0(0%)	26(31.0%)
		Borderline high(130-159mg/dl)	10(12.2%)	0(0%)	10(11.9%)
		High (160-189mg/dl)	2(2.4%)	0(0%)	2(2.4%)
		Very high($\geq$ 190mg/dl)	2(2.4%)	0(0%)	2(2.4%)
	High density lipoprotein(HDL)	Normal ($\geq$ 60mg/dl)	58(59.2%)	2(50%)	60(58.8%)
		Moderate(40-59mg/dl)	22(22.4%)	2(50%)	24(23.5%)
		Low(<40mg/dl)	18(18.4)	0(0%)	18(17.6%)
	Triglyceride	Normal(<150mg/dl)	80(81.6%)	2(33.3%)	82(78.8%)
		Borderline high(150-199mg/dl)	18(18.4%)	4(66.7%)	22(21.2%)
	Total cholesterol	desirable(<200mg/dl)	94(88.7%)	4(66.7%)	98(87.5%)
		Borderline high(1500-239mg/dl)	8(7.5%)	2(33.3%)	10(8.9%)
		High($\geq$ 240mg/dl)	4(3.8%)	0(0%)	4(3.6%)
RBS		<200mg/dl	130(94.2%)	8(100%)	138(94.5%)
		$\geq$ 200mg/dl	8(5.8%)	0(0%)	8(5.5%)
Infarction on CT scan		Right side	42(40.4%)	2(25%)	44(39.3%)
		Left side	52(50%)	4(50%)	56(50%)
		Bilateral	10(9.6%)	8(100%)	12(10.7%)
Infarction on MRI		Right side	10(38.5%)	0(0%)	10(35.7%)
		Left side	14(53.8%)	2(100%)	16(57.1%)
		Bilateral	2(7.7%)	0(0%)	2(7.1%)
Arterial territory involved		Anterior cerebral artery	8(9.3%)	0(0%)	8(8.5%)
		Middle cerebral artery	38(44.2%)	8(100%)	46(48.9%)
		posterior cerebral artery	8(9.3%)	0(0%)	8(8.5%)
		Lacunar	32(37.2%)	0(0%)	32(34.0%)

On lipid panel assessment; 112 patients have total cholesterol level determined while 104 have triglyceride level determination, 102 HDL cholesterol and 84 LDL cholesterol determination. The average value of total cholesterol is 156.49 mg/dl, the most frequent value being 134 mg/dl, the

minimum 42 mg/dl, and the maximum 258 mg/dl. Out of the 112 patients who have total cholesterol determination; 98(87.5%) have desirable total cholesterol (total chol. <200mg/dl.)(Table 2). 82(78.8%) have normal triglyceride (triglyceride of <150 mg/dl). The average triglyceride level is 106 mg/dl, the most frequent value being 70, the minimum 11 mg/dl, the maximum 197 mg/dl. None of our patients had triglyceride more than 200mg/dl. The average HDL cholesterol is 46.32 mg/dl, the most frequent value being 33.87, the minimum 13 mg/dl and maximum 142.34 mg/dl. 60(58.8%) patients have normal HDL value (HDL>60mg/dl). The average value of LDL cholesterol is 96.87 mg/dl, the most frequent value being 104 mg/dl, the minimum 31.89mg/dl, and the maximum 142.34mg/dl. Among the 84 patients with LDL cholesterol records, 44(52.4%) had optimal LDL (LDL<100mg/dl) while only 2 patients (2.4%) very high LDL cholesterol (LDL≥90mg/dl).

Table 3: cross tabulation of patients who were on secondary cardiovascular risk reduction therapy

Parameter	Category	Medication	
		Yes	No
Diabetes mellitus	New	6(100.0%)	0(0.0%)
	Known	23 (85.2%)	4(14.8%)
Hypertension	New	14(87.5%)	2(12.5%)
	Known	58(72.5%)	22(27.5%)
Dyslipidemia	Yes	14(87.5%)	2(12.5%)
	No	132(97.1%)	4(2.9%)

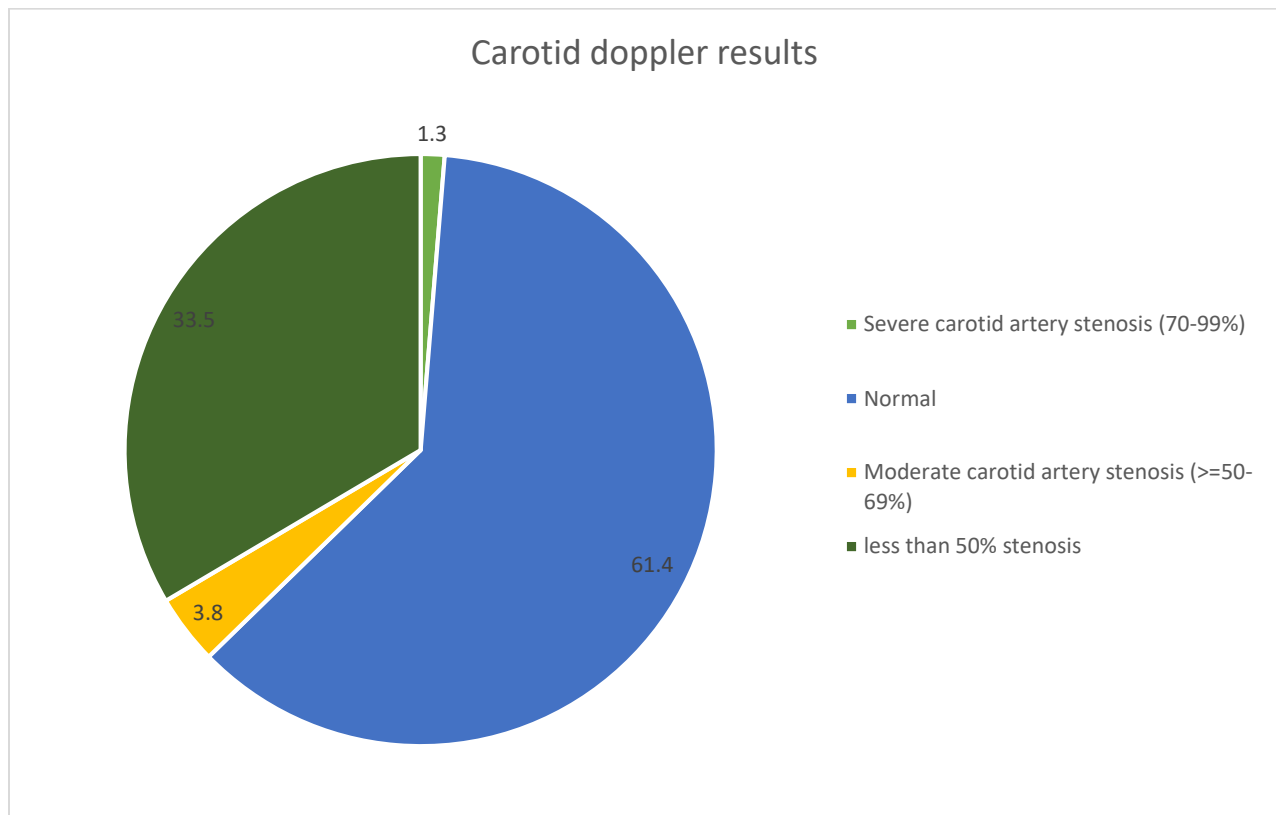
On the imaging results 112 (70.89) patients had Brain CT scan and 28 (17.7%) had Brain MRI out of which 10 had both brain CT and MRI. 44(39.3%) of patient who had CT scan image have right side infarction, 56(50%) have left side infarction while 12(10.7%) got bilateral infarction.

The MRI results showed 10 (35.7%) right side infarction, 16 (57.1%) left side infarction and 2 (7.1%) with unremarkable finding. Out of the 132 patients with brain imaging the specific location of the brain infarct was documented in 122 (92.42%), out of which 8 (8.5%) has infarction in the anterior and posterior cerebral artery circulation each, 46(48.9%) in middle cerebral circulation and 32(34.0%) got lacunar infarction.

Regarding secondary cardiovascular risk reduction; 23 (85.2%) of the known diabetic patients were on hypoglycemic medication and 58 (72.5%) of the known hypertensive patients were on anti-hypertensive medication (table 3).

With regard to the carotid Doppler result of the patients, 97 (61.4%) had normal carotid doppler study, 53 (33.5%) had less than 50% stenosis, 6 (3.8%) had moderate $\geq 50\%$ - 69%) stenosis, 2 (1.3%) had severe ($\geq 70\%$ -99%) stenosis and none of them had total occlusion.

Figure 2: Carotid artery stenosis frequency distribution pie chart



On Chi-square analysis all the variables didn't fulfill One of the Chi-square assumption which states that 'Expected value of cells should be 5 or greater in at least 80% of cells'. For this reason logistic regression and association was not done and this data is summarized with descriptive statistics.

8. Discussion

The characteristics of ischemic stroke are poorly defined despite cerebrovascular disease being an important cause of morbidity and mortality from few available studies. This study has shown females outnumber males with female to male ratio of 1.39:1. The median age of our study population was 62.58($\pm$ 12.427). 21.5% of patients had diabetes while 98 (62%) have hypertension and 18 (11.4%) patients have been diagnosed with dyslipidemia. Only 8.9% of the patients had previous history of ischemic stroke. 6(3.8%) patients were cigarette smoker. Among those patients who smoke cigarette; 2(33.3%) patients have smoked 30 pack years, 2(33.3%) smoked 37.5 pack years and the other 2 (33.3%) smoked 7.5 pack years. None of them quit smoking. Two male patients that make up 1.26% drink alcohol. Both of them drink fewer than 2 standard drinks.

The lowest and highest blood pressure recorded at initial emergency visit was 100/60 mmHg and 206/119 mmHg respectively. The most frequently measured BP category was grade I hypertension 52(32.9%) followed by optimal 39(24.7%) and grade 2 hypertension 29(18.4%). 132 patients had regular pulse rhythm while 26 had irregular heart rate first diagnosed after stroke diagnosis.

146 (92.4%) patients had random blood sugar measurement recorded in their chart and among these 138(94.5%) of them had RBS <200mg/dl. The average value of the measurements is 147.05mg/dl with the most frequent value being 132mg/dl and minimum and maximum results being 68 mg/dl and 408mg/dl respectively.

On lipid panel assessment; 112 patients have total cholesterol level determined. The average value of total cholesterol is 156.49 mg/dl. Based on total cholesterol classification; 98 (87.5%) have desirable (<200mg/dl). The remaining 10 (8.9%) and 4 (3.6%) had borderline high (200-239mg/dl) and high ($\geq$ 240mg/dl) level. 104 patients had triglyceride level determination. The average triglyceride level is 106 mg/dl. Among the patients with triglyceride level recorded 82 (78.8%) had normal (<150mg/dl) and 22 (21.2%) borderline high (150-199mg/dl) triglyceride levels. None of our patients had high or very high triglyceride value. 38 male patients had HDL cholesterol determination, 4 (10.5%) have normal ($\geq$ 60mg/dl), 18 (47.4%) (40-59mg/dl) moderate and 16 (42.1%) low (<40mg/dl). Among 64 (62.7%) female patients who had HDL cholesterol

determination, 14 (21.9%) have normal ($>60\text{mg/dl}$), 6 (9.4%) moderate ($50\text{-}59\text{mg/dl}$) and 44 (68.8%) low ($<50\text{mg/dl}$) values.

84 patients had LDL cholesterol determination. The average value of LDL cholesterol is 96.87mg/dl . Among those with LDL cholesterol determination; 44 (52.4%) had optimal ($<100\text{mg/dl}$), 26 (31.0%) near optimal ($100\text{-}129\text{mg/dl}$), 10 (11.9%) borderline high ($130\text{-}159\text{mg/dl}$), 2 (2.4%) high ($160\text{-}189\text{mg/dl}$) and 2 (2.4%) very high ($\geq 190\text{mg/dl}$) LDL cholesterol levels.

On the imaging results 112 (70.89) patients had Brain CT scan and 28 (17.7%) had Brain MRI out of which 10 had both brain CT and MRI. 44 (39.3%) of patient who had CT scan image have right side infarction, 56 (50%) have left side infarction while 12 (10.7%) got bilateral infarction. The MRI results showed 10 (35.7%) right side infarction, 16 (57.1%) left side infarction and 2 (7.1%) with unremarkable finding. Out of the 132 patients with brain imaging the specific location of the brain infarct was documented in 122 (92.42%), out of which 8 (8.5%) has infarction in the anterior and posterior cerebral artery circulation each, 46 (48.9%) in middle cerebral circulation and 32 (34.0%) got lacunar infarction.

With regard to the carotid Doppler result of the patients, 97 (61.4%) had normal carotid doppler study, 53 (33.5%) had less than 50% stenosis, 6 (3.8%) had moderate ($\geq 50\%$ - 69%) stenosis, 2 (1.3%) had severe ($\geq 70\%$ - 99%) stenosis and none of them had total occlusion.

This study found exactly similar finding of severe ICA stenosis of 70-99% (1.3% vs 1.3%) to prospective study done in Sri Lankan tertiary care hospital over 5 years (2014–2019) (30). Even though their study participants are relatively younger (mean age of 58.9 years); only age was independently associated with both $\text{CAS} \geq 50\%$ (OR 1.12, $p = 0.001$) and $\text{CAS} \geq 70\%$ (OR 1.14, $p = 0.016$). The other vascular risk factors studied, i.e. male sex, hypertension, diabetes mellitus, smoking, past history of TIA, stroke or ischemic heart disease were not significantly associated with CAS. In our study it was difficult to study association because of low percent of event rate. The authors of the article claim that the reason of having lower prevalence rates seen in their study compared to other South Asian countries may be related to better vascular risk factor management in Sri Lanka.

This study depicted lower prevalence of significant internal carotid artery stenosis (5.1%) compared with study done in Netherlands in 2014 (5.1% Vs 12.5%)(9). The Dutch study and our study used almost similar inclusion and exclusion criteria even though the Dutch patients had higher prevalence of risk factors for ICA stenosis such as older age of the patients (70 vs 62 years), higher prevalence of dyslipidemia and smoking history (36.8% Vs 11.4% and 28.6% vs 3.8%) respectively. In our study more patients have hypertension compared to Dutch patients (62% Vs 53.2%) and there is comparable prevalence of diabetes mellitus in both studies (21.2 % vs 21.5%). In this Netherlands study 110 patients (12.5%; 95%CI 10.4–14.9) had an ICA stenosis of 50–99% and 71 (8.0%; 95% CI 6.4–10.1) had 70–99% ICA stenosis. Our study showed 8 (5.1%) patients with ICA stenosis of 50–99% and 2 (1.3%) with ICA stenosis of 70–99%. This significant difference could be due to the large sample size (The Dutch study used more patients (883 vs 158), the use of two different setups and prevalence of more atherosclerotic risk factors in Dutch patients as stated above.

Compared to hospital based cross-sectional study performed in south Egypt from August 2017 to August 2018, our study showed a very low prevalence of significant ICA stenosis (23.8% Vs 1.3%)(7). In their study they used CAS cut point of >70%. This Egyptian study also used prospective hospital based study which enabled them to take complete history including the demographic data, and risk factors, such as smoking, hypertension, diabetes, dyslipidemia, any history of cardiac disease compared to our retrospective study in which case it was difficult to find smoking and alcoholic history from retrospective chart study. Even though both study had comparable study population and mean age of patients (185 Vs 158 patients and 63 Vs 62.58 years) respectively their patients had a very high cardiovascular risk factors compared to our patient population, namely; Hypertension (74.8% Vs 62 %), DM (75.4 % Vs 21.5%), smoking (71.9% Vs 3.8%), dyslipidemia (68.4% Vs 11.4%). In conclusion the lower prevalence of significant ICA stenosis in our study could be due to low prevalence cardiovascular risk factors and retrospective nature of study which was a limitation to obtain detailed history of smoking and alcohol history.

Compared to study done in patients presenting to the HASU and TIA clinic at University College London Hospitals from 1 July 2014 to 30 June 2015, our study found comparable prevalence of ICA stenosis of $\geq 50\%$ (7.9% Vs 5.1 %) (28). The baseline patient characteristics of their patients compared to ours was similar with regard to hypertension and diabetes, the two most important

cardiovascular risk factors, (63.3% Vs 62% and 24.1% vs 21.5%) respectively. With regard to other baseline patient characteristics; their patients are older (71 vs 62 years) and are more dyslipidemic (55% Vs 11.4%) and smoker (35% Vs 3.8%). Even though there appears to be more atherosclerotic risk factors in their study; they have been on optimum risk factor management before admission. i.e. 71.2% were taking secondary preventive medication for cardiovascular diseases before admission (either antiplatelet therapy, warfarin, anti-hypertensive or statins). Similarly in our study 23 (85.2%) of the known diabetic patients were on medication (either oral hypoglycemic agents or insulin), while 58 (72.5%) of the known hypertensive patients were also on anti-hypertensive therapy. This optimum management of cardiovascular risk factors could have resulted in lower prevalence of ICA stenosis in both studies.

When compared to a prospective multi-center descriptive study conducted at the Aga Khan University, Ziauddin Medical University, and Advanced Radiology Centre, major tertiary care facilities in the private sector, in Karachi, Pakistan from August 2005 to October 2006, our study found lower prevalence of significant ICA stenosis (20% Vs 5.1%)(34). Their findings revealed 0% to 50% stenosis in 526 (78%), 51% to 69% stenosis in 57 (8%), 70% to 99% stenosis in 82 (12%), and total occlusion in 7 patients (1%). In this Pakistan's study, population are patients from upper-middle class or upper-class income groups who can afford for Doppler ultrasound study and all patients admitted with diagnosis of ischemic stroke to this private sectors had Doppler ultrasound of ICA which was not a case in our study. In our study only 176 out of 412 patients (42.7%) had Doppler study of ICA. So the higher prevalence of surgically correctable ICA stenosis (ICA stenosis 70-99%) in their study could be due to effective screening of all patients admitted with stroke or TIA because prevalence of disease increases as more patients are screened.

One interpretation of our findings on low prevalence of ICA stenosis could be that the prevalence of ICA stenosis is overestimated in previous literature, but this is difficult to conclude due to heterogeneity. A probable explanation for a decrease in prevalence could be the change of several risk factors concerning ischemic stroke in the past years. We speculate that a possible decrease in prevalence can largely be attributed to the start of secondary prevention after cardiovascular events with platelet aggregation inhibiting drugs and statins and due to low prevalence of cardiovascular risk factors such as smoking and alcohol drinking.

Even though a total of 591 ischemic stroke patients were admitted to ZMH over the 4 years, only 176 had undergone carotid Doppler studies of whom 158 patients fulfilled inclusion criteria. Because of this, it is likely that some patients with significant carotid stenosis would be missed.

Strengths of our study include long study period (4 years), and being first study to be conducted in our study area. However, some limitations need to be acknowledged: Only 42.7% of patients admitted with ischemic stroke during the study period had carotid Doppler assessments. All the carotid study was done in private setup which could be the reason for low investigation rate. Other patients may be too ill to be transported to the Radiology department for Doppler scanning while the rest might not afford the cost of duplex scan. Some chart documentations were also incomplete with difficulty to get full data. There were also lost patient charts which may have decreased the total number of the study populations. The other limitations are being a single center study and retrospective study in which case it was difficult to find some important information such as smoking alcohol history. This study was also not adequately powered to study the association between risk factors and outcome.

9. Conclusion

Majority of patients were >60 years and females. Hypertension was the most common cardiovascular risk factor identified. Majority of the patients had normal lipid profile. Alcohol drinking and cigarette smoking were rarely found in the study subjects. None of study subjects had previous Hx of TIA or Amourosis Fugax. Majority of patients with previous history of DM, HTN and dyslipidemia were on treatment. Clinically significant CAS of $\geq 50\%$ and 70–99% was seen among 5.1% and 1.3% of study participants respectively.

10. Recommendation

Cost-effectiveness of carotid imaging in all patients with Ischemic stroke is questionable in ZMH and probably we need to adopt western guidelines with suitable amendments to suit local disease epidemiology.

We recommend the researchers and upcoming graduating residents to do further large scale multi centered prospective study for better characterization of internal carotid artery stenosis among ischemic stroke patients.

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12. Annex

Annex I: QUESTIONNAIRE

Instruction: This questionnaire is designed to assess prevalence of internal carotid stenosis of $\geq 50\%$ among ischemic stroke patients.

How are you, I am ----- I am working in the research team of Saint Paul's Hospital Millennium Medical College. This research will be helpful to understand the prevalence of internal carotid stenosis of $\geq 50\%$ among ischemic stroke patients. It would need only few minutes of your time to fill out a questionnaire which forms a comprehensive part of my research. Your responses hold a great significance in my quest of data collection. Would you be kind enough to respond to this brief questionnaire? Thank you very much in advance for your assistance.

001 Questionnaire Identification No: _____

002 Date of Interview: ____/____/____

SOCIODEMOGRAPHIC CHARACTERISTIC (please encircle on the appropriate answer)

1) Gender A) Male B) Female

2. Age (in years)

CHRONIC ILLNESS

3. Diabetes A) Yes B) No

Duration of diabetes years

4. Hypertension A) Yes B) No

Duration of hypertension years

5. Dyslipidemia A) Yes B) No

PAST MEDICAL HISTORY

6. Did the patient had previous history of ischemic stroke? A) Yes B) No

7. Did the patient had previous history of transient ischemic attack (neurologic deficit lasting <24hours) A) Yes B) No

8. Did the patient had previous history of Amaurosis fugax(Monoocular blindness lasting < 24 hours) A) Yes B) No

16) CURRENT MEDICATIONS

Table 1: list of current medications the patient is taking

number	Drug name	Dose	Frequency
1			
2			
3			
4			
5			
6			
7			

17. Is the patient on Oral contraceptive pills (Only for female patient)? A) Yes B) No

PHYSICAL EXAMINATION

18. BP reading in mmHg during initial emergency visit

19. pulse rhythm A) Regular B) Irregular

20. Where is body weakness lateralized to?

A) On the same side of internal carotid artery stenosis

B) On the Opposite side of internal carotid artery stenosis

Annex II

LABORATORY RESULTS

i) Lipid panel results

- A) Total cholesterol level.....mmol/L
- B) Triglyceride level.....mmol/L
- C) HDL cholesterol level. mmol/L
- D) LDL cholesterol level.....mmol/L

ii) Fasting blood glucose.....mg/dl

iii) Brain imaging results

- 1) CT/MRI brain infarction A) Right side B) left side
- 2) For question number ‘iii’ please specify where the brain infarct is located on the CT/MRI?
 - A) Anterior cerebral artery circulation
 - B) Middle cerebral artery circulation
 - C) Posterior cerebral artery circulation
 - D) Lacunar infarction

2) Carotid Doppler Ultrasound finding

- A) Normal
- B) Less than 50%
- C) Moderate carotid artery stenosis (internal carotid artery stenosis of $\geq 50\%$ –69%)
- D) Severe carotid artery stenosis (internal carotid artery stenosis of 70%- 99%)
- E) Total occlusion
- F) What is the Doppler description of plaque morphology? (please document the Doppler report)

ANNEX III: Declaration

I the undersigned resident that this thesis is my original work, in partial fulfillment of the requirement for certificate of specialty in internal medicine. I also declare that it has never been presented in this or any higher institution and all the resources and materials used in the research work have duly acknowledged.

Name of the Resident: _____

Signature: _____

Date: _____

Approval of Advisors

This research work has been submitted for examination with my approval

Name of Public Health Advisor: _____

Signature: _____

Date: _____

Name of Clinical Advisor: _____

Signature: _____

Date: _____