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Metabolic Syndrome and Acute Ischemic Stroke: An Analysis of Clinical Characteristics

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ABSTRACT

OBJECTIVE: The components of metabolic syndrome 'X,' which include elevated insulin levels, poor glucose tolerance, high triglyceride levels, central obesity (sometimes known as an "apple body"), and high blood pressure, are significant in the Indian setting. Those who suffer from metabolic syndrome are at an elevated risk of developing coronary heart disease and ischemic stroke by a factor of two to three. This research aimed to compare the components associated with metabolic syndrome and neurological examination in patients with metabolic syndrome with non-metabolic syndrome patients in cases with the acute ischaemic syndrome.

METHODS: Fifty patients were observed between October 2020 and August 2022 at the D.Y. Patil Medical College Hospital and Research Institute in Kolhapur as part of this observational research. The National Cholesterol Education Program Adult Treatment Panel III's definition of metabolic syndrome was used here.

RESULTS: In the present study, we found that out of 50 patients with ischemic stroke, 31 (62%) were found to have metabolic syndrome. In both groups, most stroke patients were from the age group 61 to 80 years (45.16% and 57.89%), respectively. Stroke patients showed the most common symptoms being weakness (96.77%) followed by deviation of the angle of the mouth (54.84%). Most stroke patients with Metabolic Syndrome and non-Metabolic Syndrome had upper limb and lower limb tone of grade 3 and power grade 0 power. Mean Waist circumference was significantly high in Metabolic Syndrome patients compared to non-Metabolic Syndrome Patients. Mean fasting Blood Sugar level, and Fasting Triglyceride was significantly high; in contrast, mean HDL values were significantly low in patients with Metabolic Syndrome compared to non-Metabolic Syndrome (p-value <0.05).

CONCLUSION: 62% of persons with acute ischemic stroke also have Metabolic Syndrome, according to our data. Our results verified the necessity of establishing preventative interventions to control MetS and each component condition to lower the risk of future ischemic stroke. This led to a better understanding of people at an increased risk for this kind of stroke.

KEYWORDS: Acute Ischaemic Stroke, Metabolic syndrome, Fasting Plasma Glucose, Hypertension, Hyperlipidaemia, Muscle tone, and Power.

1. INTRODUCTION

Stroke is the most prevalent neurological emergency and the third leading cause of mortality in developed countries.[1]Approximately 85% of strokes are ischemic, 10% are intracranial haemorrhages (ICH), and 5% are subarachnoid haemorrhages (SAH).[2,3] WHO defines stroke as a clinical illness characterised by quickly emerging clinical symptoms and evidence of localised loss of brain function, with symptoms lasting more than 24 hours or leading to death before that with no apparent cause outside vascular origin.[4]

More than 700,000 people are affected by stroke each year. [5] The risk factors for ischemic stroke are categorised as modifiable and non-modifiable and include arterial hypertension, diabetes mellitus, dyslipidemia, cigarette smoking, alcohol intake, age, gender, etc. In addition, metabolic syndrome (MetS) is recognised as a risk factor independent of CAD and stroke. [6,7] MetS prevalence is influenced by genetic and environmental factors. [8,9]
Cardiovascular events and ischemic stroke are connected with an elevated risk of metabolic syndrome. Metabolic syndrome is a collection of illnesses that increase the chance of developing atherosclerotic cardiovascular disease, insulin resistance, and type 2 diabetes, as well as vascular and neurological consequences, such as a cerebrovascular accident. Metabolic disease is considered a syndrome if a patient exhibits three of the following:

• Men with a waist circumference greater than 40 inches and women with a waist circumference greater than 35 inches

• Elevated triglycerides of 150 mg/dL or greater

• Reduced high-density lipoprotein cholesterol (HDL) of less than 40 mg/dL in men or less than 50 mg/dL in women

• Elevated fasting glucose of 100 mg/dL or greater

• Systolic blood pressure of 130 mmHg or greater and/or diastolic blood pressure of 85 mmHg or greater.[10]
According to the diagnostic criteria of the World Health Organization [11], insulin resistance is the fundamental patho- mechanism of MetS. Numerous epidemiologic and clinical investigations revealed a strong association between MetS and the development of stroke and its recurrence[12-14]. People with MetS have a considerably increased risk of ischemic stroke than those without MetS. After correcting for other risk variables, the number of MetS components correlates strongly with the frequency of ischemic stroke [15,16]. Although most people recover within the first few days after a stroke, a small but significant minority deteriorate, a condition known as early neurological deterioration (END). Notable is the fact that between 5% and 40% of patients with acute ischemic stroke have ended. In addition, END is essential for the prognosis of stroke since it may suggest a higher risk of death and a greater dependence on others for daily tasks. Consequently, it is necessary to identify and treat END-related characteristics to improve stroke outcomes[17].
Consequently, the short-term prognosis of persons who have experienced an acute ischemic stroke is connected with metabolic syndrome and its components. However, little is known about the possible association between MetS and its features and the short-term consequences of acute ischemic stroke. Consequently, the present study intends to examine the impacts of

MetS and its components on ischemic stroke and their impact on the short-term outcomes of acute ischemic stroke among our hospitalised patients.

2. MATERIAL AND METHODS

Study Design and Participants

The department of General Medicine at Dr D.Y. Patil Medical College, Hospital, and Research Institute in Kolhapur undertook observational research of fifty patients hospitalised with clinical symptoms indicative of an acute ischemic stroke. The timeframe of the study was between October 2020 and August 2022.

Inclusion criteria

The individuals were evaluated sequentially by the inclusion criteria: Patients having a first-ever atherothrombotic ischemic stroke, verified by cranial computed tomography and/or magnetic resonance imaging/angiography, less than twenty-four hours in length, who were admitted to the Medicine ward.

Exclusion Criteria

The following patients were excluded from the study: those younger than 16 years of age, those with intracranial haemorrhage, those with a known source of embolus such as atrial fibrillation (AF), those with moderate to severe valvular heart disease, those with a history of a previous stroke, and those with a severe Cardiorenal or nutritional disorder[18].

This study was authorised by Dr D.Y. Patil Medical College Kolhapur's ethical committee. Consent with knowledge was acquired from participants or their legal representatives. Multiple individuals suffering from an ischemic stroke were admitted to the hospital with severe neurological abnormalities, such as altered awareness. Therefore, their legal representatives provided their informed permission.

Diagnostic Criteria

- Diagnosis of the first symptomatic atherothrombotic ischemic stroke by the diagnostic criteria of the Trial of Org 10172 in Acute Stroke Treatment (TOAST)[19].
- Diagnosis of metabolic syndrome According to the NCEP ATP Ill definition, metabolic syndrome is present if three or more of the five following criteria are met: waist circumference greater than 40 inches (men) or 35 inches (women), blood pressure greater than 130/85 mmHg, fasting triglyceride (TG) level greater than 150 mg/dl, fasting high-density lipoprotein (HDL) cholesterol level less than 40 mg/dl (men)[10].

Data Collection

Data were collected using a standardised questionnaire based on a comprehensive manual and follow-up information. General information, present illness, previous history (including hypertension, diabetes mellitus, coronary heart disease, transient ischemic attack, and stroke), personal history (including cigarette smoking and drinking habits), family history (including hypertension, diabetes mellitus, coronary heart diseases, and cerebrovascular diseases), the data of physical examination, laboratory, ECG and imaging findings were all recorded for all participants in this study.

After a normal exhalation, the waist circumference was measured using a measuring tape positioned at the narrowest point between the lowest rib margin and the highest point of the iliac crest. Using a calibrated stadiometer, the height of a barefoot individual was measured

with an accuracy of 0.1 cm. With underwear on and using a calibrated electronic scale, body mass was determined to be the closest 0.1 kg. The BMI was computed by dividing weight by the square of height (kg/m2). After being seated for at least 5 minutes, the blood pressure was taken using a mercury sphygmomanometer on the right arm at heart level. A neurological examination was conducted to evaluate the tone and strength of both the upper and lower extremities.

Statistical Analysis

Using IBM SPSS 22.0 for Windows, all data were gathered and evaluated statistically. Quantitative variables were expressed as the mean SD and median range depending on the data type. The qualitative information was represented numerically or as a percentage. The significance of qualitative variable differences and associations was statistically examined using the chi-square test and the Fisher exact test. Differences between quantitatively independent groups were evaluated using the unpaired t-test or Friedman test of significance. P > 0.05 was deemed to lack statistical significance. P 0.05 and P 0.01 were regarded as statistically significant and highly significant, respectively.

3. RESULTS

Table 1: Prevalence of Metabolic Syndrome in the study population

Metabolic Syndrome	Frequency	Percentage
Yes	31	62
No	19	38
Total	50	100

In this study, we observed that out of 50 individuals with ischemic stroke, 31 had metabolic syndrome, representing 62% of the total (Met S).

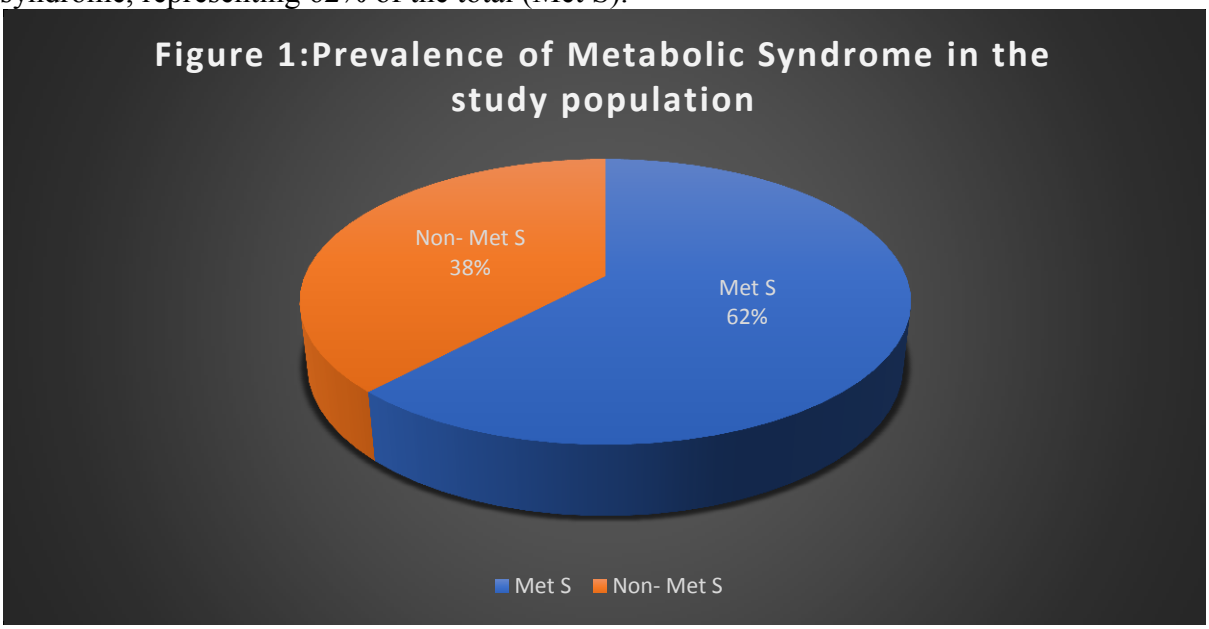


Table 2: Age distribution of the patients

Age Group	Groups		Total	Chi-Square & p-Value
	Met S	Non-Met S		
21-40 Years	7(22.58%)	2(10.53%)	9(18%)	3.103, 0.376
41-60 Years	10(32.26%)	5(26.32%)	15(30%)	
61-80 Years	14(45.16%)	11(57.89%)	25(50%)	
>80 Years	0(0%)	1(5.26%)	1(2%)	
Total	31(100%)	19(100%)	50(100%)	

In both Met S and non-Met S groups, most stroke patients were aged 61 to 80 (45.16% and 57.89%), and the difference was not statistically significant. The average age of stroke patients with metabolic syndrome was 56.52±14.59 years, while the average age of those without metabolic syndrome was 60.05±13.01 years. There was no substantial difference (p-value 0.391). There were significantly more males with Metabolic Syndrome (87.09%) than without it (63.16%), and the difference was statistically significant (p-value 0.047).

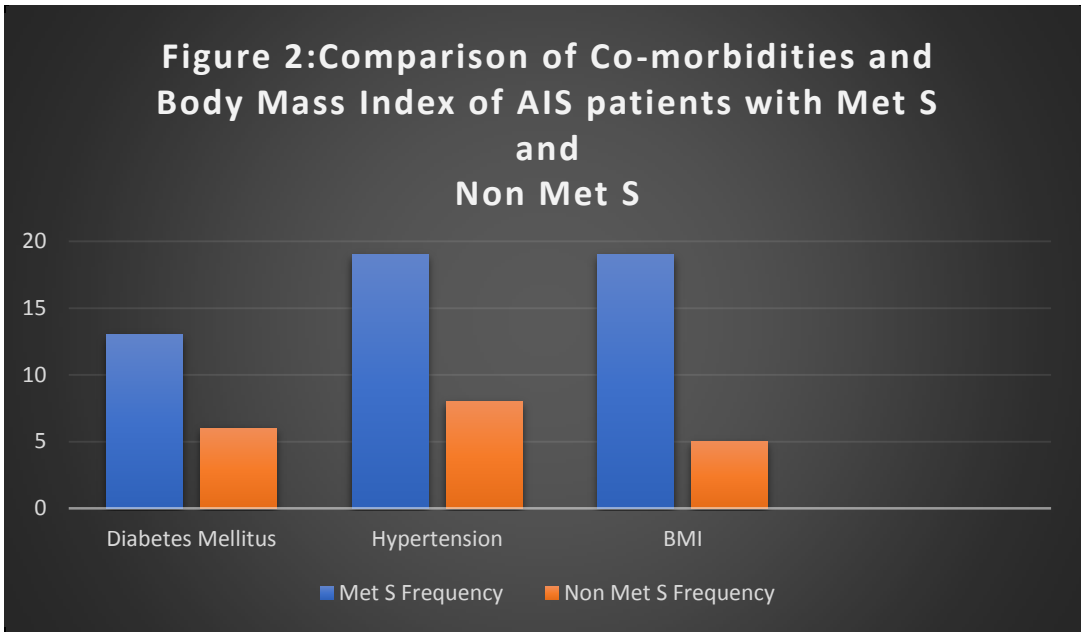
Table 3: Comparison of presenting symptoms in AIS patients with Met S and Non-Met S

Presenting Symptoms	Groups		Total	p-Value
	Met S	Non-Met S		
Weakness	30(96.77%)	18(94.74%)	48(96%)	0.721
DOAM*	17(54.84%)	9(47.37%)	26(52%)	0.608
Loss of consciousness	4(12.90%)	2(10.53%)	6(12%)	0.802
Aphasia	4(12.90%)	1 (5.26%)	5(10%)	0.382

Stroke patients showed the most common symptoms being weakness (96.77%) followed by deviation of angle of the mouth (54.84%), Loss of consciousness (12.90%) and Aphasia (12.90%), which were more common in Metabolic Syndrome as compared to non-Metabolic Syndrome (94.74%, 47.37%,10.53%, 5.26% respectively). Still, the difference between the groups was insignificant for none of the symptoms (all p-value>0.05).

Table 4: Comparison of Co-morbidities and Body Mass Index of AIS patients with Met S and Non-Met S

Co-morbidities	Met S (n=31)		Non-Met S (n=19)		Total	p-value
	Frequency	Percent	Frequency	Percent		
Diabetes Mellitus	13	41.9	6	20.7	19 (38%)	0.464
Hypertension	19	61.3	8	27.6	27 (54%)	0.186
BMI $\geq 25 Kg/m^2$	19	61.3	5	26.3	24 (48%)	0.035



Diabetes Mellitus (41.9%) and Hypertension (61.3%) were more prevalent in Metabolic Syndrome than in non-Metabolic Syndrome (20.7% and 27.6%, respectively); however, the difference was not statistically significant (all p values >0.05). 19 (61.3%) individuals with Metabolic Syndrome had a BMI of more than 25 kg/m2, compared to just 5 (26.3%) regular patients. There was a statistically significant difference (p-value 0.035).

Table 5: Comparison of ECG Findings of AIS patients with Metabolic S and Non-Met S

Major ECG Findings	Group		Total	Chi-Square & p-value
	Met S	Non-Met S		
Left Ventricular Hypertrophy	16(51.61%)	2(10.53%)	18(36%)	6.94, 0.008

Normal ECG	15(48.39%)	17(89.47%)	32(64%)	
Total	31 (100%)	19(100%)	50(100%)	

On ECG, patients who did not have metabolic syndrome had LVH in 10.53 per cent of cases, but patients with metabolic syndrome had LVH in nearly half of the cases. There was a statistically significant gap between the groups (p-value 0.008).

Table 6:Comparison of Tone in the upper limb in AIS patients with Met S and Non-Met S

Tone	Group		Total	Chi-Square & p-value
	Met S	**Non-Met S**		
0.0	5(16.13%)	200.53%)	7(14%)	
1.0	8(25.81%)	7(36.84%)	15(30%)	3.533 0.473
2.0	5(16.13%)	(5.26%)	6(12%)	
3.0	13(41.93%)	8(42.11%)	21(42%)	
4.0	0(0%)	1 (5.26%)	1(2%)	
Total	31(100%)	19(100%)	50(100%)	

Upper limb tone of grade 3 was present in most stroke patients with metabolic syndrome and those without metabolic syndrome (41.93% and 42.11%), and the difference between the two groups did not reach statistical significance (p-value 0.473).

Table 7: Comparison of Tone in the lower limb in AIS patients with Met S and Non-Met S

Tone	Group		Total	Chi-Square & p-value
	Met S	**Non-Met S**		
0.0	4(12.09%)	3(15.79%)	7(14%)	
1.0	9(29.03%)	7(36.84%)	15(30%)	3.533 0.473
2.0	5(16.13%)	1(5.26%)	6(12%)	

3.0	13(41.93%)	8(42.11)	21(42%)	
4.0	0(0%)	1 (5.26%)	1(2%)	
Total	31(100%)	19(100%)	50(100%)	

Most stroke patients with non-Metabolic Syndrome exhibited grade 3 lower limb tone (41.93% and 42.11%), and the difference between the groups was not statistically significant (p-value 0.577).

Table 8:Comparison of Power in the upper limb in AIS patients with Met S and Non-Met S

Power Grade	Group		Total	Chi-Square& p-value
	Met S	**Non-Met S**		
0.0	13(41.93%)	10(52.63%)	23(46%)	6.148 0. 292
1.0	4(12.90%)	1 (5.26%)	5(10%)	
2.0	4(12.90%)	1 (5.26%)	5(10%)	
3.0	4(12.90%)	5(26.32%)	9(18%)	
4.0	6(19.35%)	1 (5.26%)	7(14%)	
5.0	0(0%)	1 (5.26%)	1(2%)	
Total	31 (100%)	19(100%)	50(100%)	

Most stroke patients with and without Metabolic Syndrome had grade 0 upper limb power, and the difference between the groups was not statistically significant (p-value 0.292).

Table 9: Comparison of Power in the lower limb in AIS patients with Met S and Non-Met S

Power Grade	Group		Total	Chi-Square& p-value
	Met S	**Non-Met S**		
0.0	9(29.03%)	5(26.32%)	14(28%)	
1.0	8(25.81%)	5(26.32%)	13(26%)	1.529 0.958

2.0	3(9.68%)	2(10.53%)	5(10%)	
3.0	4(12.90%)	4(21.05%)	8(16%)	
4.0	5(16.13%)	2(10.53%)	7(14%)	
5.0	2(6.46%)	(5.26%)	3(6%)	
Total	31 (100%)	13(100%)	50(100%)	

Lower limb power grade 0 was present in most stroke patients with metabolic syndrome and those who did not have metabolic syndrome (29.03% and 26.32%), and the difference between the two groups was not statistically significant (p-value 0.958).

Table 10: Comparison of waist circumference in AIS patients with Met S and Non-Met S

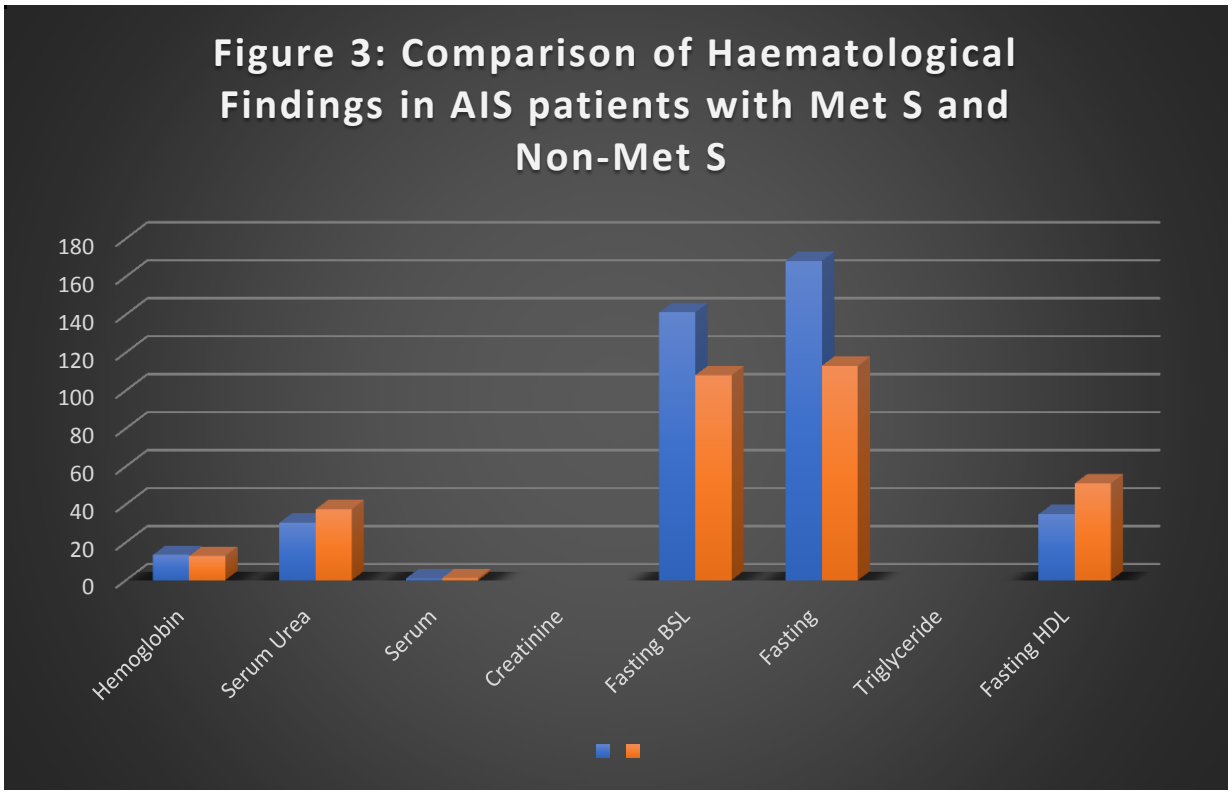
Met S		Non-Met S		P value
Mean	**Std. Deviation**	**Mean**	**Std. Deviation**	
40.65	3.72	37.95	2.76	0.000

Patients diagnosed with metabolic syndrome had a considerably larger mean waist circumference than those with other conditions (p-value 0.000).

Table 11: Comparison of Haematological Findings in AIS patients with Met S and Non-Met S

Laboratory Parameters	Met S		Non-Met S		P value
	Mean	**Std. Deviation**	**Mean**	**Std. Deviation**	
Haemoglobin	13.44	2.12	12.92	2.09	0.396
Serum Urea	30.41	14.29	37.43	32.02	0.293
Serum Creatinine	1.08	0.40	1.26	0.80	0.294
Fasting BSL	141.26	42.20	108.13	40.94	0.009

Fasting Triglyceride	168.37	52.55	113.08	24.10	0.000
Fasting HDL	34.90	4.89	51.09	11.16	0.000



Those who had Metabolic Syndrome had substantially higher levels of fasting blood sugar (141.26±42.20 mg/dl and 108.13±40.94 mg/dL) and fasting triglycerides (168.37±52.55 mg/dl and 113.08±24.10 mg/dL) when compared to patients who did not have Metabolic Syndrome (p-value 0.05).

Individuals with Metabolic Syndrome had substantially lower mean fasting HDL levels (p-value 0.05) compared to patients who did not have Metabolic Syndrome. The mean fasting HDL levels were 34.90±4.89 mg/dl and 51.09±11.16 mg/dL, respectively. Other laboratory values, such as haemoglobin, serum urea, and serum creatinine, were comparable across the two groups, and there was no statistically significant difference between them.

4. DISCUSSION

The metabolic syndrome has been recognised as a discrete risk factor for cardiovascular diseases such as coronary artery disease and stroke. [14]. A meta-analysis of 13 cohort studies revealed that participants with MetS were 1.6 times more likely to get a stroke than those without MetS. [20] Although most people recover within the first few days after a stroke, a small but significant minority deteriorate, a condition known as early neurological deterioration (END).

In this work, we analysed neurological parameters that determined the presence of metabolic syndrome and defined the clinical profile of an acute ischemic stroke. 62% of individuals with

an acute ischemic stroke were found to have MetS in our research. In two Chinese trials of acute ischemic stroke, the incidence of MetS was 51.4% and 57.2%, respectively [21,22]. In several other studies, the proportion of patients with Metabolic Syndrome was considerably higher (Mi et al., 2012; Liu et al., 2011; Iqbal et al., 2010) [23-25]. Globally, many individuals are at risk for cardiovascular illnesses such as stroke and ischemic heart disease, and metabolic syndrome is growing more prevalent and widespread (Y.H.et al., 2010). [26] Thus, this study's relatively high prevalence of Metabolic Syndrome may be related to its high prevalence of associated risk factors, namely high fasting blood glucose, high blood pressure, and large waist circumference or obesity.

Most stroke patients in the Met S and non-Met S groups were between the ages of 61 and 80 (45.16% and 57.89%, respectively), and the difference was not statistically significant. The average age of stroke patients with metabolic syndrome was 60,05±13.01 years, compared to 56,52±14.59 for those without metabolic syndrome. There was no significant change ($p = 0.391$). (Table 2). Jia et al. [27] found that middle-aged and elderly individuals with metabolic syndrome were more likely to get their first stroke. According to Akpalu et al.[28], the prevalence of metabolic syndrome increased with age and was 54% among cardiovascular disease patients and 18% among healthy controls, respectively. This study supports the notion that the prevalence of metabolic syndrome tends to increase with age and is most significant among middle-aged individuals (Akpalu et al., 2011; Jia et al., 2011) [27,28].

The mean waist circumference of Metabolic Syndrome patients was significantly greater than that of non-Metabolic Syndrome patients ($p = 0.000$). Those with Metabolic Syndrome exhibited significantly greater mean fasting glucose and fasting triglyceride levels than patients without Metabolic Syndrome (p-value 0.05). Those with Metabolic Syndrome showed substantially lower mean fasting HDL concentrations than those without Metabolic Syndrome (p 0.05). Dyslipidemia (elevated TG, reduced HDL-C, and raised LDL-C) and central obesity would accelerate the development and progression of cerebrovascular atherosclerosis [29], particularly occlusive significant artery disorders. Hypertension is the leading risk factor for all stroke subtypes [30,31]. Insulin resistance is vital in triggering numerous atherothrombotic effects on the fibrinolytic system and vascular endothelium [32]. Moreover, HDL-C promotes the generation of lipid peroxide and the oxidation of LDL-C and phospholipids in individuals with a history of coronary heart disease [33].

These findings are comparable with the findings of Ashtari et al. (2012) [12], who observed that 85 per cent of their individuals had an excessive waist circumference. According to Mi et al. (2012) [22], hypertension and excessive fasting blood glucose are becoming prevalent. In addition, Ashtari et al. (2012) [12] observed an increase in the proportion of study participants with hypertension and hyperglycemia. Iqbal et al. (2010) observed comparable outcomes in their research subjects, including decreased high-density lipoprotein (HDL) and elevated triglyceride levels[25]. The high frequency of Metabolic Syndrome components observed in this analysis may have contributed to the high prevalence of Metabolic Syndrome among study participants.

5. CONCLUSION

In our study, 62% of patients with acute ischemic stroke had Metabolic Syndrome. An ischemic stroke affects over-60-year-old males disproportionately. In people with metabolic syndrome, the most significant risk factors for stroke are a high BMI, high BSL, and low HDL values. Our findings contributed to a better understanding of those at elevated risk for ischemic stroke. They emphasised the need to develop preventative measures for the management of MetS and each of its component diseases to avoid future strokes. Diagnosis

and correct management of metabolic syndrome can play a significant role in stroke prevention. Additional population-based research may provide a more accurate picture of our culture.

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