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Assessment of Stroke Risk, Awareness, and Preventive Behaviours Among Diabetic and Hypertensive Patients Attending Non-Communicable Disease Clinics in a Tertiary Care Hospital: A Cross-Sectional Study

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Abstract:

- ***Background:***
Stroke is a major cause of death and disability worldwide, with diabetes mellitus and hypertension significantly increasing the risk. Awareness regarding stroke symptoms, risk factors, and preventive practices remains essential for early intervention and better outcomes.

- ***Aim:***
To assess the risk of stroke among diabetic and hypertensive patients attending NCD clinics in a tertiary care hospital using a standardized risk assessment tool.

- ***Methods:***
A cross-sectional study was conducted amongst patients diagnosed with diabetes mellitus and hypertension attending NCD clinics using pre tested semistructured questionnaire and stroke risk assessment tool (Stroke riskometer app).

- ***Results:***
Most participants (82.2%) had heard about stroke, and hypertension was the most commonly recognized risk factor (70.7%). However, awareness regarding lifestyle-related risk factors such as obesity, unhealthy diet, and physical inactivity was limited. Stroke risk assessment showed that 37.8% of participants were at high risk and 38.9% at moderate risk for stroke. Increasing age and the coexistence of diabetes mellitus and hypertension were significantly associated with higher stroke risk ($p < 0.001$).

- ***Conclusion:***
Despite reasonable awareness of stroke, important gaps remain in knowledge regarding warning signs, risk factors, and emergency response. A considerable proportion of participants were found to have moderate-to-high stroke risk, particularly older adults and those with both diabetes and hypertension. Strengthening stroke awareness and preventive education within NCD clinics may help reduce stroke burden among high-risk populations.

Keywords: *Stroke, Stroke Awareness, Stroke Risk, Diabetes Mellitus, Hypertension, Preventive Behaviour, NCD Clinics, Stroke Prevention, Stroke Riskometer, Cerebrovascular Accident.*

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I. INTRODUCTION

Stroke, also known as cerebrovascular accident (CVA), is defined as the sudden onset of a neurological deficit resulting from a focal vascular cause affecting cerebral circulation.[1] It is one of the leading causes of mortality and long-term disability worldwide, particularly in low- and middle-income countries.[2] Stroke is broadly classified into ischemic stroke and haemorrhagic stroke.[3] Ischemic stroke accounts for nearly 85% of all stroke cases globally, while haemorrhagic stroke contributes to the remaining 15%.[4]

Globally, approximately 93.8 million people were living with stroke in 2021, with nearly 11.9 million new cases reported annually.[5] Between 1990 and 2021, stroke-related deaths increased by 44%, while disability-adjusted life years (DALYs) increased by 32%, reflecting the rising global burden of stroke.[6] Nearly 87% of stroke deaths and 89% of stroke-related DALYs occur in low- and middle-income countries.[7] In India, the incidence of stroke has increased considerably, ranging between 116–163 cases per 100,000 population.[8] Factors such as urbanization, sedentary lifestyle, unhealthy dietary habits, delayed healthcare access, poor awareness, and inadequate preventive strategies contribute significantly to this trend.[9]

Stroke is largely preventable because many of its risk factors are modifiable.[10] Hypertension is regarded as the most important modifiable risk factor for stroke and contributes significantly to both ischemic and hemorrhagic stroke.[11] Diabetes mellitus also substantially increases the risk of stroke through accelerated atherosclerosis, endothelial dysfunction, and microvascular disease.[12] Other modifiable risk factors include smoking, alcohol consumption, obesity, dyslipidemia, unhealthy diet, physical inactivity, and psychosocial stress.[13] Advancing age, male gender, ethnicity, and family history are important non-modifiable risk factors associated with stroke.[14]

Since neuronal injury progresses rapidly during stroke, the phrase “time is brain” highlights the importance of early diagnosis and prompt intervention.[15] The FAST acronym — Face drooping, Arm weakness, Speech difficulty, and Time to seek medical help — has been widely promoted for early recognition of stroke symptoms and timely hospital presentation.[16]

Awareness regarding stroke warning signs, risk factors, and preventive measures plays a crucial role in reducing stroke morbidity and mortality.[17] Individuals with chronic conditions such as hypertension and diabetes mellitus represent a particularly high-risk group and require targeted education regarding stroke prevention and symptom recognition.[18] Adequate awareness can improve medication adherence, encourage lifestyle modifications, and promote timely healthcare-seeking behaviour.[19]

Several studies conducted in India and other developing countries have reported inadequate awareness regarding stroke symptoms and risk factors among high-risk populations.[20] Poor recognition of stroke symptoms and delayed response contribute significantly to prehospital delay and missed opportunities for acute stroke management.[21] Risk assessment tools such as the Stroke Riskometer™ application can help identify individuals at high risk and facilitate early preventive interventions.[22]

Therefore, this study was undertaken to assess stroke risk, awareness regarding stroke symptoms and risk factors, and preventive behaviours among diabetic and hypertensive patients attending non-communicable disease clinics in a tertiary care hospital setting. The findings of this study may help identify gaps in awareness and strengthen community-based stroke prevention strategies among vulnerable populations.[23]

- *Pathophysiology of Stroke*

Stroke can broadly be classified into ischemic stroke and hemorrhagic stroke. Ischemic stroke occurs due to obstruction of cerebral blood flow, most commonly caused by thrombosis or embolism within cerebral arteries.[24] Major etiological mechanisms include large artery atherosclerosis, cardioembolism, small vessel disease, and systemic hypoperfusion.[25] Chronic hypertension and diabetes mellitus contribute significantly to endothelial dysfunction and atherosclerotic plaque formation, which predispose individuals to arterial occlusion.[26]

The pathophysiology of ischemic stroke involves sudden reduction in cerebral perfusion leading to deprivation of oxygen and glucose supply to brain tissue.[27] This results in ATP depletion, failure of sodium-potassium pumps, cytotoxic edema, excitotoxic glutamate release, calcium influx, oxidative stress, and eventual neuronal death.[28] The central irreversibly damaged area is known as the ischemic core, while the surrounding salvageable tissue is termed the ischemic penumbra.[29]

Hemorrhagic stroke occurs due to rupture of cerebral blood vessels, resulting in bleeding into or around the brain tissue.[30] Common causes include chronic hypertension, cerebral aneurysms, anticoagulant therapy, arteriovenous malformations, trauma, and cerebral amyloid angiopathy.[31] Long-standing hypertension causes hyaline arteriosclerosis and microaneurysm formation, particularly in small penetrating arteries supplying deep brain structures.[32]

The rupture of cerebral vessels leads to accumulation of blood within the brain parenchyma, producing mass effect, increased intracranial pressure, inflammatory injury, reduced cerebral perfusion, and secondary ischemic damage to adjacent neurons.[33] In some cases, hemorrhagic

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transformation may occur following ischemic stroke due to reperfusion injury in previously infarcted tissue.[34]

Ultimately, both ischemic and hemorrhagic strokes result in neuronal injury, neurological deficits, long-term disability, and increased mortality if not recognized and treated promptly.[35]

➢ *Justification of Study:*

Awareness of stroke amongst the population especially those with underlying comorbidities such as Diabetes and Hypertension is crucial in the prevention of Stroke. People with awareness learn to recognise risk factors and learn to control them very early on. Those with the knowledge of FAST signs, learn to recognise them and reach hospital on time as they know that time plays an essential role in preventing the debilitating impacts of stroke.

Lifestyle changes, adherence to medication and diligent efforts in behavioural change can only happen if there is adequate knowledge and awareness of the consequences of stroke. By studying the awareness of stroke amongst those with Diabetes and Hypertension, pitfalls and gaps in knowledge of stroke can be identified and hence intervention at early stages helps in the prevention of stroke and the overall quality of life.

The risk of developing stroke in five years or ten years in diabetic and hypertensive patients depends on the knowledge of awareness, preventive behaviours adopted by these patients and sociodemographic factors. So, calculating the risk scores can be such a remarkable tool for the primary health care physicians to encourage early intervention to manage risk factors.

➢ *Objectives of the Study:*

The primary aim of the study is to assess the risk of stroke amongst diabetic and hypertensive patients attending NCD clinics in a tertiary care hospital using a standardized risk assessment tool.

Secondarily, level of awareness regarding stroke symptoms, risk factors and complications along with its association with sociodemographic factors and preventive behaviours adopted by these patients is identified, assessed and evaluated through this study.

II. METHODOLOGY OF THE STUDY

➢ *Study Design and Setting:*

This was a cross-sectional, questionnaire-based survey conducted from June 2025 to August 2025 in Non-Communicable Disease (NCD) clinics at UPHC, Pudupet and RHTC, Poonamallee attached to GMC, OGE, in Chennai, Tamil Nadu, India

➢ *Study Population and Sampling*

Patients diagnosed with diabetes mellitus and/or hypertension attending the NCD clinics.

- *Inclusion Criteria:*

Adults aged ≥30 years, diagnosed with diabetes and/or hypertension for at least 1 year, attending regular follow-up at the NCD clinic, willing to give informed consent.

- *Exclusion Criteria:*

Patients with a known history of stroke, severely ill patients unable to respond to the questionnaire.

- *Sample Size:*

A total of 185 diabetic and hypertensive patients satisfying the inclusion criteria attending Non-Communicable Disease (NCD) clinics at UPHC, Pudupet and RHTC, Poonamallee attached to GMC, OGE were selected based on consecutive sampling depending on OPD flow.

➢ *Instruments*

Pre-tested semi-structured questionnaire and stroke risk assessment tool (Stroke Riskometer app) are the data collection tools.

- *Questionnaire:*

A pre tested semi structured questionnaire that was used as one of the study tools comprehensively assess multiple domains related to stroke among diabetic and hypertensive patients. The following domains that it assesses are:

✓ Demographic profile: Age, gender, education, occupation, address and existing comorbidities (DM, HTN)
✓ Knowledge of stroke warning signs: Recognition of classic FAST features and ability to differentiate true signs from distractors (fever, chest pain)
✓ Knowledge of stroke risk factors: Awareness of modifiable (HTN, DM, smoking, diet, inactivity, obesity, stress) and non-modifiable risk factors (age).
✓ Perception of stroke as a medical emergency
✓ Knowledge of immediate action to be taken: Whether participant knows to take patient to hospital immediately
✓ Knowledge of time window for treatment: Awareness of early hospital arrival
✓ Belief about treatability and preventability of stroke: Attitude toward early treatment and prevention
✓ Sources of prior information: Media, doctors, social circle, schools, etc.
✓ Willingness to participate in awareness programs
✓ Preferred learning methods
✓ Clinical risk profile of the participant: BP, BMI, glucose levels and stroke riskometer score.

- *Stroke Riskometer App:*

The app is able to calculate your risk through evaluating a series of risk factors such as age, gender, ethnicity, lifestyle and other health factors that directly influence your likelihood of a stroke within the next five and ten years. It will supply essential information on how you can reduce your chance of having a stroke and will monitor your risk as you start to modify your personal risk factors. The app is suitable for people aged 20 - 90+.

Developed by AUT University (New Zealand). The app project already involves over 300 renowned stroke experts

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from 102 countries, making it the largest international collaborative mobile health project in the world. The app provides advice & suggestions for reducing risk: lifestyle changes, health behavior goals, reminders, etc. It is also endorsed by the World Stroke Organisation. The free Stroke Riskometer app for lay people and PreventS-MD for health professionals has been awarded the Innovation Challenge winner by WHO.

Permission to use the app for the study has been obtained from the Stroke Riskometer app team as well as the World Stroke Organisation through email.

➢ *Procedure:*

Eligible participants satisfying inclusion and exclusion criteria were approached through google forms. After obtaining informed consent, participants completed an online questionnaire in a quiet setting, typically requiring 10–15 minutes. They were also introduced to Stroke Riskometer app wherein they answered questions in the app and obtained their ten year risk score that the app calculated. Completed questionnaires were submitted immediately after completion to minimize missing data.

➢ *Statistical Analysis*

Data were entered into Microsoft Excel and analyzed using SPSS version 26.0.

- Descriptive statistics-Frequencies and percentages were used for descriptive analysis.
- Stroke risk scoring- Stroke risk was assessed using the Stroke Riskometer application endorsed by the World Stroke Organization.

Participants were categorized into low-, moderate-, and high-risk groups based on the application-generated risk estimates Associations were tested using chi-square analysis, while logistic regression was performed to identify predictors of high stroke risk. p-value <0.05 was considered statistically significant.

➢ *Ethical Considerations*

Ethical approval for the study was obtained from the Institutional Ethics Committee of Government Medical College, Omandurar Government Estate, Chennai, prior to commencement of the study. Written informed consent was obtained from all participants before enrollment into the study. Participants were informed regarding:

- The purpose and objectives of the study
- Voluntary nature of participation
- Confidentiality of collected information
- Their right to refuse participation or withdraw from the study at any stage without affecting their treatment or healthcare services.

III. RESULTS

A total of 185 young adults completed the questionnaire. Table 1 represents the demographic details of the participants.

Table 1 Sociodemographic Characteristics of the Study Participants

Variable	Category	n	%
Gender	Female	94	50.9
	Male	91	49.1
Age Group	30–40	5	2.7
	41–50	41	22.2
	51–60	57	30.8
	>60	82	44.3
Education	No formal education	25	13.5
	Primary	33	17.8
	Secondary	77	41.6
	Graduate	37	20.0
	Postgraduate	13	7.0

The gender distribution was nearly equal, with 94 females (50.9%) and 91 males (49.1%), indicating balanced representation of both sexes in the study population. With respect to age, the majority of participants belonged to the older age groups. Nearly half of the participants (44.3%) were aged above 60 years, followed by 30.8% in the 51–60 years age group and 22.2% in the 41–50 years category. Only 2.7% of participants were between 30–40 years. Regarding educational status, secondary education was the most commonly reported level of education (41.6%), followed by graduate-level education (20.0%). A smaller proportion had primary education (17.8%), while 13.5% had no formal education. Only 7.0% of participants had completed postgraduate education.

Table 2 Comorbidity Status of the Study Participants

Comorbidity	N	%
Diabetes	46	24.9
Hypertension	50	27.0
Both	89	48.1

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Among the 185 participants included in the study, nearly half (89 participants, 48.1%) were diagnosed with both Ddiabetes mellitus and hypertension, making it the most common comorbidity pattern observed in the study population. Participants with hypertension alone accounted for 50 cases (27.0%), while 46 participants (24.9%) had diabetes mellitus alone.

Table 3 Awareness of Stroke

Question		Count	%
Have you heard of the condition called stroke?	No	33	17.8%
	Yes	152	82.2%

Among the 185 participants 82.2% were aware of the condition called stroke.

Table 4 Awareness of Risk Factors of Stroke

Risk Factor	Frequency (n)	Percentage (%)
High blood pressure	130	70.7
Mental stress	91	49.5
Alcohol use	90	48.9
Diabetes	86	46.7
Smoking	74	40.2
High-fat/salty diet	62	33.7
Physical inactivity	57	31.0
Obesity	56	30.4
High cholesterol	55	29.9
Lack of sleep	51	27.7

High blood pressure was the most commonly identified risk factor, recognized by 130 participants (70.7%), followed by mental stress (49.5%), alcohol use (48.9%), and diabetes mellitus (46.7%). Awareness of other modifiable risk factors such as smoking (40.2%), high-fat/salty diet (33.7%), physical inactivity (31.0%), obesity (30.4%), high cholesterol (29.9%), and lack of sleep (27.7%) was comparatively lower.

Table 5 Awareness of duration of Stroke Symptoms

Is stroke a medical emergency	Frequency (n)	Percentage (%)
Yes	138	74.6
No	18	9.7
Don’t know	29	15.7

Table 6 Awareness of Age Affecting Stroke

Question	Count	%
a day or more	25	13.5%
don't know	103	55.7%
few minutes to hours	49	26.5%
few seconds	8	4.3%

When participants were asked about the duration of stroke symptoms, more than half (103 participants, 55.7%) reported that they did not know how long stroke symptoms could last. Only 49 participants (26.5%) correctly identified that stroke symptoms may last from a few minutes to several hours, while 25 participants (13.5%) believed that symptoms could last a day or more. A small proportion (8 participants, 4.3%) incorrectly reported that stroke symptoms last only a few seconds.

Table 7 Awareness of Stroke as a Medical Emergency

Does age affect stroke	Frequency (n)	Percentage (%)
Yes	56	30.3
No	79	42.7
Don’t know	50	27.0

When participants were asked whether age affects the risk of stroke, only 56 participants (30.3%) correctly recognized age as an important risk factor. In contrast, 79 participants (42.7%) believed that age does not influence stroke risk, while 50 participants (27.0%) were uncertain.

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Table 8 Awareness of First Action During Signs of Stroke

first action they would take if someone showed signs of stroke	Frequency (n)	Percentage (%)
Take to a hospital immediately	127	68.6
Don't know	25	13.5
Give water/food	14	7.6
Call a local doctor	14	7.6
Wait and observe	5	2.7

Table 9 Source of Information of Stroke

What is your Source of Information on stroke	Frequency (n)	Percentage (%)
Friends/Family	121	65.8
TV/Radio	30	16.3
Doctors/Health workers	30	16.3
Social media	24	13.0
Newspapers	21	11.4
Never heard of stroke before	21	11.4
Schools/Colleges	5	2.7

Table 10 Awareness Regarding Stroke in the Community

Whether people in their community are generally aware of stroke	Frequency (n)	Percentage (%)
No	74	40.0
Yes	64	34.6
Not sure	47	25.4

Table 11 Interest in Stroke Awareness Programs

Whether they would be interested in attending stroke awareness programs	Frequency (n)	Percentage (%)
Yes	127	68.6
No	58	31.4

Table 12 Preferred Method of Awareness of Stroke

Preferred method for learning about stroke prevention and awareness	Frequency (n)	Percentage (%)
Talks by doctors	97	52.4
Videos/Social media	41	22.2
Health camps	35	18.9
Pamphlets/Posters	12	6.5

Table 13 Awareness if Stroke Can be Prevented

Whether stroke can be prevented	Frequency (n)	Percentage (%)
Yes	129	69.7
No	11	5.9
Don't know	45	24.3

Table 14 Assessment of Stroke Risk

Stroke Risk Category	N(frequency)	%
Low Risk	43	23.2
Moderate Risk	72	38.9
High Risk	70	37.8

Table 15 Association of stroke risk and age

Age Group (Years)	Low Risk n (%)	Moderate Risk n (%)	High Risk n (%)	Total n (%)
30–40	5 (100.0)	0 (0.0)	0 (0.0)	5 (2.7)
41–50	26 (63.4)	14 (34.1)	1 (2.4)	41 (22.2)
51–60	10 (17.5)	37 (64.9)	10 (17.5)	57 (30.8)
>60	2 (2.4)	21 (25.6)	59 (72.0)	82 (44.3)
Total	43 (23.2)	72 (38.9)	70 (37.8)	185 (100.0)

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Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	47.630[a]	6	<.001
Likelihood Ratio	51.701	6	<.001
N of Valid Cases	185		

The association between age group and stroke risk category among the study participants. The analysis revealed a highly statistically significant association between age and stroke risk (Pearson $\chi^2 = 47.63$, df = 6, $p < 0.001$).

Table 16 Association of Stroke Risk and Comorbidity Status

Comorbidity Status	Low Risk n (%)	Moderate Risk n (%)	High Risk n (%)	Total n (%)
Diabetes only	21 (45.7)	18 (39.1)	7 (15.2)	46 (24.9)
Hypertension only	17 (34.0)	23 (46.0)	10 (20.0)	50 (27.0)
Both Diabetes and Hypertension	5 (5.6)	31 (34.8)	53 (59.6)	89 (48.1)
Total	43 (23.2)	72 (38.9)	70 (37.8)	185 (100.0)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	46.863[a]	4	<.001
Likelihood Ratio	50.657	4	<.001
N of Valid Cases	185		

The association between comorbidity status and stroke risk category among the study participants. The analysis demonstrated a highly statistically significant association between the presence of comorbidities and stroke risk (Pearson $\chi^2 = 46.86$, df = 4, $p < 0.001$).

Table 17 Association of Stroke Risk and Gender

Gender	Low Risk n (%)	Moderate Risk n (%)	High Risk n (%)	Total n (%)
Female	27 (28.7)	32 (34.0)	35 (37.2)	94 (50.8)
Male	16 (17.6)	40 (44.0)	35 (38.5)	91 (49.2)
Total	43 (23.2)	72 (38.9)	70 (37.8)	185 (100.0)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.655[a]	2	.161
Likelihood Ratio	3.688	2	.158
N of Valid Cases	185		

The association between gender and stroke risk category among the study participants. The analysis showed that the association between gender and stroke risk was not statistically significant (Pearson $\chi^2 = 3.66$, df = 2, $p = 0.161$).

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Table 18 Association of Stroke Risk and Educational Qualification

Educational Qualification	Low Risk n (%)	Moderate Risk n (%)	High Risk n (%)	Total n (%)
No formal education	8 (32.0)	7 (28.0)	10 (40.0)	25 (13.5)
Primary	6 (18.2)	9 (27.3)	18 (54.5)	33 (17.8)
Secondary	16 (20.8)	35 (45.5)	26 (33.8)	77 (41.6)
Graduate	10 (27.0)	16 (43.2)	11 (29.7)	37 (20.0)
Postgraduate	3 (23.1)	5 (38.5)	5 (38.5)	13 (7.0)
Total	43 (23.2)	72 (38.9)	70 (37.8)	185 (100.0)

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	8.004[a]	8	.433
Likelihood Ratio	7.880	8	.445
N of Valid Cases	185		

The association between educational qualification and stroke risk category among the study participants. The analysis showed that the association was not statistically significant (Pearson $\chi^2 = 8.00$, df = 8, p = 0.433).

Table 19 Logistic Regression Analysis of Predictors of High Stroke Risk Among Study Participants

Variable	Category	Coef (B)	S.E	Odds Ratio (Exp(B))	95% CI Lower	95% CI Upper	P-value
Age	Age in years	0.290	0.048	1.337	1.217	1.468	<0.001
Gender	Male (Ref)	—	—	1	—	—	—
	Female	0.473	0.541	1.605	0.556	4.637	0.382
Education	Graduate (Ref)	—	—	1	—	—	—
	No formal	1.306	0.924	3.690	0.603	22.591	0.158
	Postgraduate	0.324	1.105	1.383	0.158	12.074	0.769
	Primary	1.987	0.876	7.291	1.310	40.586	0.023
	Secondary	0.521	0.723	1.683	0.408	6.944	0.471
Comorbidities	Both (Ref)	—	—	1	—	—	—
	Diabetes	-3.825	0.866	0.022	0.004	0.119	<0.001
	Hypertension	-2.191	0.654	0.112	0.031	0.403	<0.001

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	104.461[a]	.533	.726

a. Estimation terminated at iteration number 7 because parameter estimates changed by less than .001.

The regression model demonstrated good explanatory power, with a Nagelkerke R^2 value of 0.726, indicating that approximately 72.6% of the variability in high stroke risk was explained by the variables included in the model.

IV. DISCUSSION

➢ *Demographic Characteristics of the Study Population*

The present study assessed stroke risk, awareness, and preventive behaviours among diabetic and hypertensive patients attending Non-Communicable Disease (NCD) clinics attached to a tertiary care hospital in Chennai, Tamil Nadu. The demographic profile of the participants revealed nearly equal gender distribution, with females constituting 50.9% and males 49.1% of the study population. This balanced representation improves the reliability of the study findings across both sexes.

The majority of participants belonged to older age groups, with 44.3% being above 60 years and 30.8% between 51–60 years. Advanced age is a well-established non-modifiable risk factor for stroke because aging is associated with progressive vascular stiffness, endothelial dysfunction, atherosclerosis, and cumulative exposure to chronic diseases such as hypertension and Diabetes mellitus. The predominance of elderly participants in this study reflects the increasing burden of non-communicable diseases among aging populations in India.

Nearly half of the participants (48.1%) had both Diabetes mellitus and hypertension, while 27.0% had hypertension alone and 24.9% had Diabetes mellitus alone. The coexistence of diabetes and hypertension ssignificantly increases cerebrovascular risk through synergistic effects on vascular damage, inflammation, and atherosclerotic

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progression. This finding highlights the importance of aggressive cardiovascular risk reduction strategies among patients attending NCD clinics.

➢ *Awareness Regarding Stroke*

The present study demonstrated that 82.2% of participants had heard about stroke. This relatively high level of awareness may be attributed to regular exposure to healthcare professionals during follow-up visits to NCD clinics. Similar hospital-based studies have reported higher awareness levels among patients with chronic illnesses compared to the general population.

However, although most participants had heard of stroke, detailed assessment revealed several important pitfalls in stroke-related knowledge. Awareness regarding stroke warning signs, symptom progression, and preventive behaviours remained inadequate in many participants. This finding suggests that superficial awareness of the disease does not necessarily translate into comprehensive understanding of stroke prevention and management.

➢ *Awareness of Stroke Risk Factors*

High blood pressure was the most commonly recognized stroke risk factor, identified by 70.7% of participants. This finding is consistent with existing literature because hypertension is universally recognized as the strongest modifiable risk factor for stroke. Participants also identified mental stress (49.5%), alcohol use (48.9%), diabetes mellitus (46.7%), and smoking (40.2%) as contributors to stroke occurrence.

However, awareness regarding several important lifestyle-related risk factors was comparatively poor. Only one-third of participants recognized physical inactivity, obesity, unhealthy diet, and high cholesterol as stroke risk factors. Lack of sleep was identified by only 27.7% of participants. These findings are clinically important because lifestyle changes like sedentary behaviour, unhealthy dietary habits, obesity, and metabolic syndrome are major contributors to the increasing burden of stroke in India.

The relatively poor awareness regarding behavioural risk factors suggests that many participants continue to perceive stroke primarily as a disease caused by hypertension or stress rather than as a multifactorial vascular disorder influenced by lifestyle, metabolic factors, and long-term preventive behaviour.

➢ *Knowledge Regarding Duration of Stroke Symptoms*

One of the most important findings of the present study was the poor understanding regarding the duration and progression of stroke symptoms. More than half of the participants (55.7%) reported that they did not know how long stroke symptoms could last, while only 26.5% correctly identified that symptoms may persist from a few minutes to several hours.

This finding indicates inadequate awareness regarding transient ischemic attacks and acute stroke progression. Lack of understanding regarding symptom duration may contribute significantly to delayed healthcare-seeking behaviour and reduced access to early interventions.

The concept that “time is brain” is central to stroke management because neuronal injury begins within minutes of cerebral ischemia. Delayed recognition and delayed hospital seeking behaviour remain major barriers to effective stroke treatment in India. Therefore, improving awareness regarding early symptom recognition and therapeutic time windows becomes very important.

➢ *Awareness Regarding Age as a Stroke Risk Factor*

The present study revealed poor awareness regarding age as a determinant of stroke risk. Only 30.3% of participants correctly recognized that increasing age influences stroke occurrence, while 42.7% believed that age does not affect stroke risk and 27.0% were uncertain.

Stroke incidence increases substantially with advancing age due to vascular degeneration, reduced arterial elasticity, cumulative metabolic damage, and increasing prevalence of cardiovascular comorbidities. Failure to recognize age-related vulnerability may reduce preventive vigilance among elderly individuals and their caregivers.

➢ *Perception of Stroke as a Medical Emergency*

Approximately 74.6% of participants correctly identified stroke as an emergency condition requiring urgent medical attention. Similarly, 68.6% reported that they would immediately take a patient with stroke symptoms to a hospital.

These findings suggest that a substantial proportion of participants understood the need for urgent treatment during stroke events.

However, some participants reported inappropriate responses such as giving food or water, calling a local doctor, or waiting and observing symptoms before seeking hospital care. Such misconceptions may contribute to dangerous prehospital delays and poorer outcomes. Similar findings have been reported in earlier Indian studies where delayed recognition and inappropriate first-response behaviour has significantly affected stroke management outcomes.

➢ *Sources of Stroke-Related Information*

Friends and family members were identified as the most common source of information regarding stroke (65.8%), followed by television/radio and healthcare professionals. Social media contributed to awareness in only 13.0% of participants.

These findings suggest that interpersonal communication continues to play a major role in dissemination of health information within the community. However, information obtained through informal social media may not always be accurate or evidence-based. The relatively lower contribution of healthcare professionals indicates that opportunities for stroke related awareness programme remain under utilized.

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Healthcare workers and physicians therefore have an important role in providing accurate, evidence-based information regarding stroke prevention and emergency response.

➢ *Preventive Behaviour and Interest in Awareness Programs*

An encouraging finding of the study was the willingness of participants to engage in stroke-awareness activities. Nearly 68.6% expressed interest in attending awareness programs. Talks by doctors were identified as the preferred learning method by more than half of the participants, followed by videos/social media and health camps.

This finding demonstrates the high level of trust placed in healthcare professionals and indicates that physician-led counselling may be highly effective in improving stroke awareness among high-risk populations.

Additionally, 69.7% of participants believed that stroke could be prevented. This positive attitude towards prevention is encouraging because perception strongly influences adoption of healthy behaviours. However, despite this positive outlook, detailed assessment revealed decreased knowledge regarding preventive strategies such as regular exercise, dietary modification, smoking cessation, and weight control.

➢ *Sroke Risk Assessment*

Stroke risk assessment using the Stroke Riskometer application revealed that 37.8% of participants belonged to the high-risk category, while 38.9% had moderate risk and only 23.2% had low risk.

These findings indicate a considerable burden of cerebrovascular risk among diabetic and hypertensive patients attending NCD clinics. The use of a standardized risk-assessment tool endorsed by the World Stroke Organization strengthens the validity of these findings and demonstrates the usefulness of digital health technologies in identifying high-risk individuals within primary-care settings.

➢ *Association Between Age and Stroke Risk*

The study demonstrated a highly statistically significant association between age and stroke risk category ($p < 0.001$). Participants aged above 60 years showed the highest proportion of high stroke risk (72.0%), whereas younger participants predominantly belonged to the low-risk category.

This finding is consistent with previous epidemiological studies demonstrating that stroke incidence increases exponentially with advancing age. Aging is associated with cumulative vascular injury, endothelial dysfunction, and prolonged exposure to metabolic risk factors, all of which contribute significantly to stroke occurrence.

➢ *Association Between Comorbidity Status and Stroke Risk*

A highly significant association was observed between comorbidity status and stroke risk ($p < 0.001$). Participants with both Diabetes mellitus and hypertension demonstrated substantially higher stroke risk compared with participants having either condition alone.

Nearly 59.6% of individuals with both diabetes and hypertension belonged to the high-risk category. These findings highlight the synergistic impact of multiple vascular risk factors and emphasize the importance of integrated management strategies targeting both diabetes and hypertension simultaneously.

➢ *Association Between Gender and Stroke Risk*

The study found no statistically significant association between gender and stroke risk ($p = 0.161$). This suggests that both males and females attending NCD clinics may be equally vulnerable to elevated stroke risk when chronic comorbidities are present.

Although males demonstrated slightly higher proportions within the moderate-risk category, the overall difference was not statistically meaningful.

➢ *Association Between Educational Status and Stroke Risk*

Educational qualification was not significantly associated with stroke-risk category ($p = 0.433$). However, participants with higher educational status generally demonstrated better awareness regarding stroke symptoms and risk factors.

Education improves health literacy, access to information, and understanding of preventive healthcare practices. Nevertheless, the findings suggest that biological and clinical determinants such as age and comorbidity status may have a stronger influence on actual stroke risk than education alone.

➢ *Logistic Regression Analysis*

Multivariable logistic regression analysis identified increasing age as a strong independent predictor of high stroke risk. For every one-year increase in age, the odds of high stroke risk increased significantly.

Participants with Diabetes mellitus alone or hypertension alone demonstrated significantly lower odds of high stroke risk compared to participants with both conditions simultaneously. These findings reinforce the importance of combined vascular risk-factor management in preventing stroke.

The regression model demonstrated good explanatory power, with a Nagelkerke R^2 value of 0.726, indicating that approximately 72.6% of the variability in stroke risk was explained by the variables included in the model.

➢ *Public Health Implications*

The findings of the present study have important public-health implications. India is currently experiencing a rapid increase in non-communicable diseases such as Diabetes mellitus and hypertension, resulting in a growing burden of stroke-related disability and mortality.

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NCD clinics represent an ideal platform for implementing stroke-prevention programs because they routinely cater to individuals with major vascular risk factors. Integration of structured stroke education, risk assessment, lifestyle counselling, and medication-adherence programs into routine NCD services may substantially reduce stroke incidence and improve health outcomes.

Community health workers, physicians, nurses, and public-health educators can play a major role in delivering awareness programs focusing on FAST symptoms, healthy lifestyle practices, smoking cessation, dietary modification, and emergency response.

➢ *Strengths*

- The study specifically included diabetic and hypertensive patients, who are known to be at higher risk for stroke, making the findings clinically relevant.
- Use of the standardized Stroke Riskometer application endorsed by the World Stroke Organization helped improve the consistency and credibility of stroke-risk assessment.
- Different aspects related to stroke, such as awareness, risk factors, emergency response, preventive practices, and stroke-risk levels, were assessed in detail.
- Participants were recruited from both urban and rural NCD clinics, which allowed inclusion of individuals from varied backgrounds.
- Appropriate statistical methods, including chi-square test and multivariable logistic regression analysis, were used to strengthen the interpretation of the results.
- The study highlighted existing gaps in awareness and certain modifiable risk behaviours, which may help in planning future educational and preventive strategies.

➢ *Limitations*

- Since the study was carried out only in selected tertiary care NCD clinics, the findings may not fully represent the general population.
- Data were collected using self-reported questionnaires, which could have introduced recall bias and socially desirable responses.
- Lifestyle practices and preventive behaviours reported by the participants were not independently verified.
- As the participants were already attending NCD clinics, their level of awareness regarding stroke may have been comparatively higher than that of the general community.
- The relatively small sample size limits the extent to which the findings can be generalized to larger populations or different geographic settings.

V. CONCLUSIONS

The present study revealed that although most diabetic and hypertensive patients attending NCD clinics were aware of stroke, important gaps persisted in knowledge regarding warning signs, symptom duration, modifiable risk factors, and emergency response. Hypertension was the most commonly recognized risk factor, while awareness regarding lifestyle-related factors such as obesity, physical inactivity, and unhealthy diet remained limited.

A considerable proportion of participants were identified as having moderate-to-high stroke risk, particularly older adults and individuals with coexisting diabetes mellitus and hypertension. Increasing age emerged as a significant independent predictor of high stroke risk.

The findings highlight the need for structured stroke-awareness programs, routine risk assessment, and targeted educational interventions within NCD clinics. Strengthening health education and preventive strategies at the primary-care level may improve early recognition, promote healthy behaviours, and reduce the burden of stroke among high-risk populations.

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