

ISCHEMIC STROKE IN YOUNG ADULTS 18-45 YEARS IN NORTH INDIA: ROLE OF HYPERTENSION, SMOKING, AND STRESS - A 2-YEAR HOSPITAL-BASED STUDY

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Abstract

Ischemic stroke in young adults is a major public health concern because it affects individuals during their most productive years and can result in long-term disability, economic hardship and family burden. Although traditional vascular risk factors are commonly studied in older populations, younger patients increasingly present with hypertension, tobacco exposure, unhealthy lifestyle patterns and psychosocial stress. This proposed 2-year hospital-based study examines the role of hypertension, smoking and stress among young adults aged 18-45 years admitted with ischemic stroke in North India. The study design includes clinical assessment, neuroimaging confirmation, risk-factor profiling, laboratory investigations, stroke subtype classification and follow-up for recurrence, disability and risk-factor control. The paper presents the rationale, objectives, methodology, analytical plan, ethical safeguards and expected contribution of the study. The central argument is that young stroke should not be interpreted as a rare event alone; rather, it should be examined through modifiable vascular and behavioural determinants that can be prevented through early screening, counselling and long-term secondary prevention. For a January 2023 publication timeline, the study is framed using literature available up to 2022 and avoids claiming completed outcomes without actual data collection.

Keywords: ischemic stroke, young adults, hypertension, smoking, stress, North India, hospital-based study, stroke risk factors, 2-year follow-up, secondary prevention

1. Introduction

Stroke is one of the leading causes of death and disability worldwide. Although it is commonly associated with older age, ischemic stroke among young adults has become increasingly important in clinical practice and public health research. Young adults aged 18-45 years may experience sudden neurological deficits, prolonged rehabilitation needs and long-term occupational consequences. In this age group, stroke not only affects survival and functional ability but also disrupts education, employment, family responsibilities and social participation. Therefore, understanding preventable risk factors in young stroke patients is essential for reducing disease burden.

The proposed topic focuses on ischemic stroke in young adults in North India and examines three major modifiable determinants: hypertension, smoking and stress. Hypertension contributes to vascular endothelial damage, arterial stiffness, small-vessel disease and thrombotic risk. Smoking promotes atherosclerosis, platelet activation, vascular inflammation and reduced oxygen delivery. Psychosocial stress may act through sympathetic activation, poor sleep, unhealthy coping behaviours, blood-pressure elevation and metabolic changes. When these factors coexist, the risk profile may become stronger, even in comparatively young individuals.

The North Indian context is clinically relevant because hospitals receive young stroke patients from urban, semi-urban and rural backgrounds with variable awareness of blood pressure, tobacco risk and mental stress. Many young adults do not undergo regular screening because they perceive stroke and hypertension as diseases of older people. Delayed recognition of symptoms, late arrival to hospital and poor continuation of preventive medicines may worsen outcomes. A hospital-based study can therefore generate useful evidence on the risk profile and follow-up needs of young ischemic stroke patients.

Current stroke literature emphasizes that modifiable risk factors remain central to prevention and secondary prevention. International and Indian studies have shown that hypertension and smoking are important contributors to

stroke, while emerging literature also highlights stress and lifestyle-related vulnerabilities. However, localized evidence from North India focusing specifically on young adults, combined exposure patterns and 2-year follow-up is still needed. This study is designed to address that gap through structured clinical assessment and follow-up.

1.1 Research Problem

The research problem is that ischemic stroke among young adults is often under-recognized as a preventable vascular event. Many young patients have undiagnosed or poorly controlled hypertension, tobacco exposure and high psychosocial stress before the stroke episode. There is limited hospital-based evidence from North India on how these factors interact, how frequently they occur among young ischemic stroke patients and how they influence 2-year outcomes such as recurrence, disability and adherence to secondary prevention. Without such evidence, prevention remains generalized rather than targeted to local risk patterns.

1.2 Objectives of the Study

- To assess the prevalence of hypertension, smoking and perceived stress among young adults aged 18-45 years admitted with ischemic stroke in selected North Indian hospital settings.
- To examine the association between hypertension, smoking and stress with clinical severity and stroke subtype.
- To evaluate 2-year follow-up outcomes including recurrent stroke, functional disability, mortality and risk-factor control.
- To identify demographic, behavioural and clinical predictors of poor outcome among young ischemic stroke patients.
- To develop a practical hospital-based monitoring framework for early prevention, counselling and secondary prevention in young adults.

Table 1. Research objectives, analytical focus and supporting literature

Objective area	Analytical focus	Main supporting sources
Risk-factor burden	Hypertension, smoking and stress among young stroke patients	O'Donnell et al. (2016); Putaala (2020)
Stroke profile	Clinical severity, imaging pattern and stroke subtype	Powers et al. (2019); Kleindorfer et al. (2021)
Follow-up outcomes	Recurrence, disability and mortality over 2 years	Kernan et al. (2014); Campbell & Khatri (2020)
Behavioural risks	Tobacco exposure, lifestyle and stress-related vulnerability	Boehme et al. (2017); Kivimaki & Steptoe (2018)
Local relevance	Hospital-based evidence for North Indian young adults	Pandian et al. (2018); Sylaja et al. (2020)

2. Conceptual Background

2.1 Young Adult Ischemic Stroke

Ischemic stroke occurs when blood supply to a part of the brain is interrupted due to arterial occlusion, thrombosis, embolism or small-vessel pathology. In young adults, causes may be more diverse than in older adults. They may include premature atherosclerosis, hypertension-related vascular disease, cardioembolism, arterial dissection, prothrombotic conditions, substance use and unexplained causes. This diversity makes young stroke evaluation more complex and requires systematic clinical and laboratory assessment.

Young adult stroke deserves special attention because the consequences are long-lasting. A person who develops stroke at 25, 35 or 45 years may live for decades with disability if recovery is incomplete. This creates a strong need for early risk-factor recognition and secondary prevention. Hypertension, smoking and stress are important because

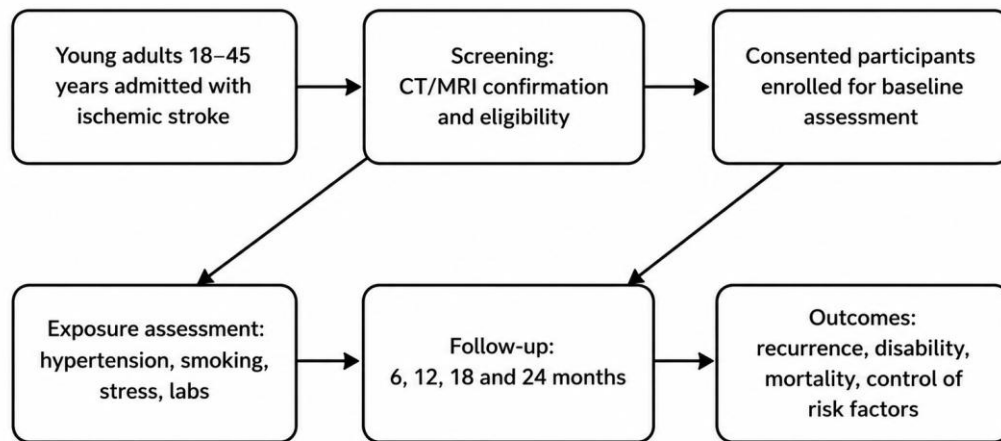
they are common, measurable and modifiable through clinical care, lifestyle changes and public health interventions.

2.2 Hypertension, Smoking and Stress as Modifiable Risks

Hypertension is one of the strongest modifiable risk factors for ischemic stroke. In young adults, it may remain undiagnosed because routine blood pressure checks are often neglected. Persistent elevation of blood pressure injures the vascular endothelium, accelerates atherosclerosis and increases the risk of both large-vessel and small-vessel ischemic events. Even borderline or untreated hypertension can be clinically important when combined with smoking, obesity or family history.

Smoking contributes to stroke through multiple mechanisms including endothelial dysfunction, oxidative stress, platelet aggregation and vascular narrowing. In many young adults, smoking is associated with social habits, occupational stress and low perception of health risk. Psychosocial stress is also relevant because it can indirectly worsen stroke risk through poor sleep, alcohol use, tobacco use, unhealthy diet and poor adherence to medical advice. The combined analysis of these factors is therefore important for understanding young stroke in real-life hospital settings.

Figure 1. Proposed participant flow for the 2-year hospital-based study



3. Review of Literature

The literature on ischemic stroke demonstrates that vascular risk factors remain central to stroke occurrence and recurrence. Large international evidence indicates that hypertension, smoking, diabetes, dyslipidemia, diet and psychosocial factors together account for a substantial proportion of stroke risk. These findings are important for young adults because many of the same risk factors are now appearing earlier in life due to lifestyle changes, urbanization, tobacco exposure, stress and reduced physical activity.

Studies on young stroke have shown that etiological evaluation must be broad. Some young patients have conventional risk factors such as hypertension and smoking, while others may have cardioembolic sources, arterial dissection, prothrombotic states or undetermined etiology. This means that a hospital-based study should not assume a single cause. Instead, it should record demographic profile, vascular risk factors, behavioural exposure, stress indicators, imaging findings and follow-up outcomes.

Guidelines for acute ischemic stroke and secondary prevention emphasize early diagnosis, vascular risk-factor modification, antithrombotic treatment when indicated, blood-pressure control, lipid management, smoking cessation and rehabilitation. These recommendations support the need for follow-up-based research. For young adults,

prevention counselling must be strong because the future risk period is long. A 2-year follow-up can help examine whether patients maintain risk-factor control after discharge and whether recurrence or disability occurs.

Table 2. Thematic synthesis of selected literature

Theme	Representative insight	Relevance to proposed study	Key sources
Global stroke risk	Modifiable vascular and behavioural factors explain a large share of stroke risk.	Supports focus on hypertension, smoking and stress.	O'Donnell et al. (2016); Boehme et al. (2017)
Young stroke	Young adults have diverse etiologies and require systematic evaluation.	Justifies hospital-based risk and subtype assessment.	Putala (2020); Singhal et al. (2013)
Acute management	Early imaging, classification and treatment influence prognosis.	Supports standardized diagnosis and baseline severity recording.	Powers et al. (2019)
Secondary prevention	Risk-factor control, antiplatelet/statin therapy and lifestyle change reduce recurrence.	Supports 2-year follow-up and counselling outcomes.	Kernan et al. (2014); Kleindorfer et al. (2021)
Psychosocial stress	Stress can influence vascular risk through biological and behavioural pathways.	Supports inclusion of stress assessment.	Kivimaki & Steptoe (2018)

3.1 Research Gap

Existing literature provides strong evidence that hypertension and smoking are important stroke risk factors, but there is a need for localized research focusing on young adults in North India. The specific combination of hypertension, smoking and stress, along with 2-year follow-up outcomes, remains insufficiently documented in many hospital settings. This proposed study addresses the gap by linking baseline risk-factor assessment with recurrence, functional outcome and secondary prevention adherence over time.

4. Research Methodology

4.1 Research Design

The study is designed as a prospective, observational, hospital-based follow-up study. Young adults aged 18-45 years with radiologically confirmed ischemic stroke will be enrolled after eligibility screening. Participants will undergo baseline assessment during admission or early outpatient review, followed by scheduled follow-up for 2 years. The study will use clinical records, structured interviews, blood pressure measurement, smoking history, stress assessment, laboratory data and imaging findings to examine risk factors and outcomes.

4.2 Study Setting and Population

The proposed setting includes neurology, medicine and emergency departments of selected hospitals in North India. The target population includes young adults aged 18-45 years diagnosed with first-ever or recurrent ischemic stroke confirmed by CT or MRI. Patients will be recruited from inpatient wards, stroke units and outpatient follow-up clinics. The hospital-based design is appropriate because stroke diagnosis, imaging and clinical severity assessment require medical confirmation.

4.3 Inclusion and Exclusion Criteria

Table 3. Eligibility criteria for participant selection

Inclusion criteria	Exclusion criteria
Age 18-45 years with clinically suspected and radiologically confirmed ischemic stroke.	Hemorrhagic stroke, traumatic brain injury or stroke mimic.

Resident of North India or accessible for 2-year follow-up.	Severe illness preventing consent or follow-up participation.
Admission or presentation within a defined recruitment period.	Known brain tumour, CNS infection or demyelinating disease presenting as stroke mimic.
Consent from participant or legally acceptable representative where required.	Incomplete baseline records or refusal to participate.

4.4 Variables and Measurements

The main exposure variables will include hypertension status, smoking history and perceived stress. Hypertension will be assessed through previous diagnosis, current antihypertensive use and repeated blood pressure measurements. Smoking will be recorded as current, former or never smoking, with pack-year estimation where possible. Stress will be assessed using a structured perceived stress scale or comparable questionnaire adapted to the clinical setting. Additional variables will include age, sex, residence, education, occupation, diabetes, dyslipidemia, alcohol use, body mass index, family history, stroke severity and imaging subtype.

4.5 Outcome Measures

Table 4. Primary and secondary outcome measures

Outcome type	Measure	Assessment method
Primary outcome	Composite poor outcome at 2 years: recurrent stroke, death or significant functional disability.	Follow-up interview, medical records and modified Rankin Scale.
Secondary outcome	Recurrent ischemic stroke or transient ischemic attack.	Clinical diagnosis and supporting records.
Secondary outcome	Functional disability at 3 months, 12 months and 24 months.	Modified Rankin Scale / Barthel Index.
Risk-factor outcome	Blood pressure control, smoking cessation and stress reduction status.	Clinical measurement and structured questionnaire.
Adherence outcome	Continuation of antiplatelet/statin/antihypertensive therapy where prescribed.	Medication history and follow-up record.

4.6 Data Collection Procedure

Baseline data will be collected using a structured case record form. Clinical information will include presenting symptoms, time to hospital arrival, vascular risk factors, blood pressure readings, medication history, laboratory findings and neuroimaging results. Stroke severity may be recorded using a standard clinical scale if available. Follow-up will be conducted at 3 months, 6 months, 12 months, 18 months and 24 months through clinic visits or telephone contact. Each follow-up will record recurrence, disability, medicine adherence, blood pressure control, smoking status, stress level and rehabilitation status.

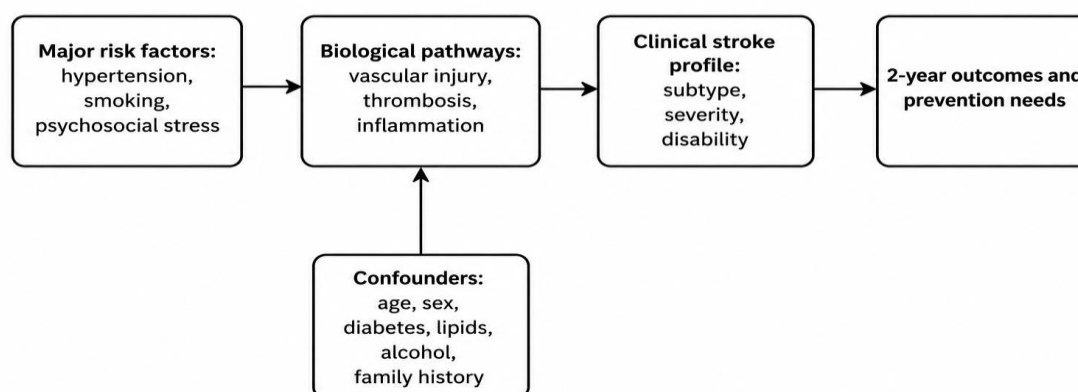
4.7 Statistical Analysis Plan

Data will be analysed using descriptive and inferential statistics. Continuous variables such as age and blood pressure will be summarized as mean and standard deviation or median and interquartile range according to distribution. Categorical variables such as hypertension, smoking and stress categories will be presented as frequencies and percentages. Associations between risk factors and outcomes will be examined using chi-square tests, t-tests, Mann-Whitney U tests and logistic regression as appropriate. Multivariable regression may adjust for age, sex, diabetes, dyslipidemia, alcohol use, stroke subtype and baseline severity. Time-to-event analysis may be used for recurrent stroke if follow-up dates are available.

4.8 Ethical Considerations

The study must be conducted only after approval from an institutional ethics committee. Written informed consent will be obtained from participants or legally acceptable representatives where applicable. Patient confidentiality will be maintained by using coded identifiers and secure data storage. Since the study is observational, no clinically necessary treatment will be withheld. All patients will receive standard stroke care according to treating physician decisions and institutional protocols. Participants identified with uncontrolled blood pressure, ongoing tobacco use or severe psychological distress will be referred for appropriate clinical support.

Figure 2. Analytical framework for young adult ischemic stroke risk assessment



5. Risk-Factor Assessment Protocol

The risk-factor assessment protocol will ensure that the three core exposures are measured in a consistent manner. Hypertension assessment will include previous diagnosis, current medicine use, admission blood pressure and follow-up blood pressure control. Smoking assessment will include current use, duration, quantity and cessation attempts. Stress assessment will use a structured questionnaire or clinically documented stress indicators. The protocol will also record related factors such as alcohol use, sleep disturbance, physical inactivity, obesity and family history because these may confound or strengthen the relationship between the main exposures and stroke outcomes.

Table 5. Strategic protocol for exposure and follow-up assessment

Protocol element	Hypertension	Smoking	Stress	Safety / quality control
Baseline review	Previous diagnosis, current medicine and repeated BP readings.	Current/former/never smoking and pack-year estimate.	Perceived stress score and major recent stressors.	Use standardized case record form.
Clinical linkage	Stroke subtype, severity and comorbidity profile.	Tobacco-related vascular risk and counselling need.	Stress-related behaviours such as sleep loss or substance use.	Treating physician review.
Follow-up	BP control and treatment adherence.	Smoking cessation or relapse.	Stress level and support needs.	Repeat measurement at each follow-up.

Prevention plan	Antihypertensive care and lifestyle advice.	Cessation counselling and referral.	Counselling or mental-health referral if required.	No delay in standard care.
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6. Analytical Indicators for Trial/Study Assessment

Although this is a sample manuscript/protocol and does not report real results, the following indicators can help organize analysis after valid data collection. They should be calculated only from actual study records and interpreted with clinical judgement.

Hypertension Prevalence Rate (%) = (Number of young stroke patients with hypertension / Total enrolled patients) x 100

Current Smoking Rate (%) = (Number of current smokers / Total enrolled patients) x 100

High Stress Proportion (%) = (Number of participants above stress cut-off / Total assessed participants) x 100

Poor Outcome Rate (%) = (Number with recurrence, death or significant disability at 2 years / Total followed participants) x 100

Follow-up Completion Rate (%) = (Number completing 2-year follow-up / Total enrolled participants) x 100

Table 6. Formula-based interpretation for clinical assessment

Indicator	Question answered	Clinical implication
Hypertension prevalence rate	How common is hypertension among young ischemic stroke patients?	Higher rate supports early BP screening in young adults.
Current smoking rate	How many patients had active tobacco exposure?	Higher rate supports hospital-based cessation programmes.
High stress proportion	How frequently is high stress reported?	May support integrated counselling and mental-health screening.
Poor outcome rate	How many patients have recurrence, death or disability at 2 years?	Indicates long-term burden and prevention gaps.
Follow-up completion rate	How many participants remain in follow-up until 2 years?	Low rate affects validity and shows continuity-of-care challenges.

7. Expected Findings and Interpretation Plan

As this document is a sample manuscript/protocol, no real findings are reported. After actual data collection, the study may show that hypertension, smoking and high stress are common among young adults with ischemic stroke. It may also reveal that patients with multiple risk factors have more severe presentation, poorer functional recovery or higher recurrence over 2 years. Interpretation should consider the combined effect of biological, behavioural and social determinants rather than treating each risk factor in isolation.

If hypertension is strongly associated with poor outcomes, the study would support routine blood-pressure screening in young adults and strict secondary prevention after stroke. If smoking is highly prevalent, hospital-based tobacco cessation counselling should become part of stroke discharge planning. If perceived stress is common, psychological support and stress-management counselling may be required along with pharmacological prevention. The interpretation should also recognize that hospital-based samples may over-represent more severe cases and may not capture all community strokes.

8. Discussion

The proposed study is important because ischemic stroke in young adults is both clinically serious and potentially preventable. Unlike many older patients, young adults may not be aware that hypertension, smoking and prolonged

stress can create substantial vascular risk. A hospital-based study with 2-year follow-up can help connect acute stroke presentation with long-term prevention needs. This is particularly relevant for North India, where patient awareness, access to regular screening and continuity of care may vary widely across social and geographic groups.

The main strength of the proposed study is its practical clinical orientation. It records risk factors that can be measured during admission and followed after discharge. It also includes outcomes that matter to patients and families, such as recurrence, disability and treatment adherence. By focusing on modifiable risks, the study can support actionable recommendations for physicians, hospitals and community health programmes. It can also help shift young stroke care from emergency treatment alone to long-term prevention and rehabilitation.

The study also has limitations. A hospital-based design may not represent all young adults in the community because patients who do not reach hospital are excluded. Self-reported smoking and stress may be affected by recall or social desirability bias. The 2-year follow-up can assess medium-term outcomes but may not fully capture lifetime recurrence risk. Despite these limitations, the study can provide a valuable foundation for larger multicentre research in North India.

9. Findings / Expected Contributions

- The study will identify the burden of hypertension, smoking and stress among young ischemic stroke patients aged 18-45 years.
- It will describe clinical and imaging patterns of young adult ischemic stroke in a North Indian hospital-based population.
- It will assess 2-year outcomes including recurrence, disability, mortality and control of modifiable risk factors.
- It will help distinguish single-risk exposure from combined risk patterns such as hypertension plus smoking or stress.
- It will support the development of targeted counselling and secondary prevention strategies for young adults.

10. Recommendations

- Young adults should be encouraged to undergo periodic blood pressure screening, especially if they smoke, have family history or report persistent stress.
- All young ischemic stroke patients should receive structured risk-factor assessment before discharge.
- Smoking cessation counselling should be included as a routine component of stroke care and follow-up.
- Patients with high stress levels should be offered counselling, sleep advice, lifestyle support and referral where required.
- Hospitals should maintain young stroke registries to monitor recurrence, disability and adherence to secondary prevention.
- Future research should include multicentre samples, longer follow-up and objective stress biomarkers where feasible.

11. Conclusion

Ischemic stroke in young adults aged 18-45 years is a serious condition with lifelong clinical, social and economic consequences. The proposed 2-year hospital-based study from North India provides a structured approach to examining the role of hypertension, smoking and stress in young adult ischemic stroke. These factors are important because they are common, measurable and modifiable through early detection, counselling, treatment and follow-up.

The paper emphasizes that young stroke should be understood not only as an acute neurological emergency but also as a warning signal for preventable vascular risk. A framework combining baseline risk assessment, imaging confirmation, follow-up monitoring and secondary prevention can help clinicians identify high-risk patients and reduce recurrence. If implemented with ethics approval and real clinical data, the study may contribute useful local evidence for strengthening young stroke prevention and rehabilitation services in North India.

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