Advanced International Journal for Research (AIJFR)
E-ISSN: 3048-7641 ● Website: www.aijfr.com ● Email: editor@aijfr.com

Clustering of Modifiable Lifestyle Risk Factors Among Young Adults with Ischemic Stroke

Saumya Chaudhari[1], Ayush Patel[2], Kiranya B[3], Amrutha Lexmi Anil Kumar[4], Alekhya Sai Guntupalli[5]

[1]Intern, Pacific Institute of Medical Sciences
[2]MBBS, Davao Medical School Foundation, Philippines
[3]MBBS, Coimbatore Medical College, India
[4]MBBS, Smolensk State Medical University, Russia
[5]MD Anaesthesiology, Guntur Medical College, India

Abstract

Background

The incidence of ischemic stroke among young adults is rising globally, with modifiable lifestyle factors playing an increasingly important role. While individual vascular risk factors have been widely studied, less attention has been given to the co-occurrence or clustering of behavioral risks such as smoking and alcohol consumption in young stroke patients. Understanding these patterns is essential for designing targeted preventive strategies.

Objectives

To examine the prevalence and clustering of modifiable lifestyle risk factors among young adults with ischemic stroke and to evaluate their independent association with stroke occurrence relative to older patients.

Methods

We conducted a hospital-based case–control study including 180 young adults (18–45 years) and 180 elderly patients (>60 years) with first-ever ischemic stroke. Demographic characteristics, vascular risk factors, and stroke subtypes (TOAST classification) were recorded. Lifestyle risk clustering was assessed based on the co-occurrence of smoking and alcohol consumption. Multivariable logistic regression was performed to identify independent predictors of young-onset stroke.

Results

Among young adults, smoking/tobacco use was present in 45.0% and alcohol consumption in 38.3%, both significantly higher than in elderly patients (30.0% and 24.4%, respectively). Concurrent exposure to both behaviors was substantially more common in the young group. In adjusted models, smoking (adjusted OR

1.88; 95% CI 1.20–2.95) and alcohol use (adjusted OR 1.85; 95% CI 1.18–2.90) independently predicted young-onset stroke, whereas hypertension and diabetes were more strongly associated with elderly stroke. Young patients also exhibited higher proportions of strokes classified as "other determined" and "undetermined."

Conclusions

Young adults with ischemic stroke demonstrate a distinct clustering of modifiable lifestyle risk factors, particularly smoking and alcohol use. These findings highlight the need for integrated behavioral risk reduction strategies aimed at preventing early cerebrovascular disease.

Keywords:
Young stroke, elderly stroke, risk factors, ischemic stroke subtypes, case–control study, TOAST classification, India.

1. Introduction

Stroke is a leading cause of mortality and long-term disability worldwide and remains a major contributor to socioeconomic burden, particularly in low- and middle-income countries [1]. Although stroke predominantly affects older adults, recent epidemiological studies have demonstrated a concerning rise in its incidence among young adults [2,3]. This trend has significant public health implications, as younger patients experience prolonged functional, psychological, and economic consequences during their most productive years.

Ischemic stroke in young adults differs from that in older populations with respect to etiology, risk factor profiles, and clinical outcomes. While traditional vascular risk factors such as hypertension, diabetes mellitus, and atrial fibrillation are dominant in elderly patients, younger individuals more frequently exhibit lifestyle-related and non-traditional risk factors, including smoking, alcohol consumption, obesity, and substance use [4,5]. In addition, genetic predisposition, arterial dissection, and prothrombotic states contribute to stroke risk in this age group [6].

Among modifiable risk factors, tobacco use and harmful alcohol consumption have been consistently linked to increased cerebrovascular risk in young adults. Smoking promotes endothelial dysfunction, oxidative stress, and prothrombotic states, thereby accelerating atherosclerosis and increasing stroke susceptibility [7]. Excessive alcohol intake is associated with hypertension, cardiac arrhythmias, and cerebral vasculopathy, further amplifying vascular risk [8]. These behaviors are often initiated in adolescence and early adulthood, leading to prolonged exposure and cumulative vascular damage.

Importantly, lifestyle risk factors rarely occur in isolation. Individuals who smoke are more likely to consume alcohol excessively, maintain unhealthy diets, and engage in sedentary behavior [9]. This phenomenon of risk factor clustering has been recognized as a major determinant of cardiovascular morbidity and mortality [10]. The synergistic effects of multiple coexisting behaviors may substantially increase stroke risk beyond that conferred by individual factors alone.

Large population-based studies have demonstrated that clustering of modifiable risk factors is strongly associated with premature cardiovascular disease and stroke [11,12]. However, most available evidence

originates from community-based cohorts or mixed-age populations. Data specifically examining the patterns and clinical implications of lifestyle risk clustering among young adults with ischemic stroke remain limited, particularly in hospital-based settings in developing countries.

Furthermore, previous research has largely focused on the presence or absence of individual risk factors, with less emphasis on their combined impact. Understanding how modifiable behaviors cluster in young stroke patients may facilitate more effective prevention strategies, enabling clinicians and public health authorities to target high-risk individuals through integrated behavioral interventions.

In this context, the present study aimed to investigate the prevalence and clustering of modifiable lifestyle risk factors among young adults with ischemic stroke and to evaluate their independent association with young-onset disease compared with older patients. By identifying high-risk behavioral profiles, this study seeks to inform age-specific preventive strategies and contribute to the development of comprehensive stroke prevention programs.

Methods

Methods

Study Design and Population

This hospital-based case–control study was conducted at a tertiary-care neurology department. Consecutive patients admitted with first-ever ischemic stroke were screened.

Young adults aged 18–45 years were included as cases. Elderly patients aged >60 years admitted during the same period served as controls. Stroke diagnosis was confirmed by CT or MRI. Patients with hemorrhagic stroke, stroke mimics, recurrent stroke, or incomplete records were excluded.

Data Collection

Demographic characteristics and vascular risk factors were recorded using a structured case form. Risk factors included hypertension, diabetes mellitus, dyslipidemia, atrial fibrillation, chronic kidney disease, smoking/tobacco use, alcohol consumption, obesity, and family history of stroke.

Hypertension, diabetes, and dyslipidemia were defined according to standard WHO/AHA criteria. Stroke subtypes were classified using TOAST criteria.

Definition of Lifestyle Risk Clustering

Primary lifestyle exposures were:

- Smoking/tobacco use
- Alcohol consumption

Clustering was defined as the concurrent presence of two or more modifiable lifestyle risk factors. Participants were categorized as:

1. No lifestyle risk factor

2. One lifestyle risk factor
3. ≥2 clustered lifestyle risk factors

Sample Size Estimation

Sample size was calculated based on previously reported smoking prevalence among young ischemic stroke patients in an Indian tertiary-care cohort, where smoking prevalence was approximately 27% in young stroke patients compared with 15% in older patients [13].

Using a two-sided alpha of 0.05 and 80% power to detect a difference of this magnitude between groups, the required sample size was approximately 174 participants per group. To ensure adequate power and account for exclusions, 180 patients were enrolled in each group (total N = 360).

Statistical Analysis

Continuous variables were expressed as mean ± standard deviation or median (IQR). Categorical variables were summarized as frequencies and percentages. Group comparisons were performed using Student's t-test or chi-square test, as appropriate.

Multivariable logistic regression analysis was conducted to identify independent associations between lifestyle risk clustering and young-onset stroke. Adjusted odds ratios (aORs) with 95% confidence intervals were reported. Model calibration was assessed using the Hosmer–Lemeshow test. Statistical significance was defined as $p < 0.05$.

All analyses were performed using SPSS version 25.0.

Ethical Approval

The study was approved by the Institutional Ethics Committee. Written informed consent was obtained from all participants.

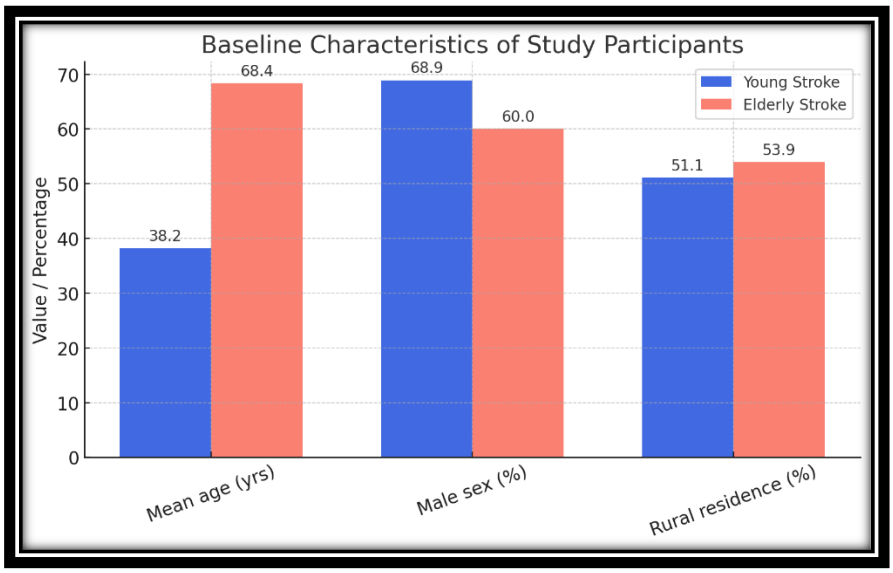
Results

Participant Characteristics

A total of 360 patients were included in the final analysis, comprising 180 young adults and 180 elderly patients with first-ever ischemic stroke. The mean age of young patients was 38.2 ± 5.9 years, compared with 68.4 ± 6.1 years in the elderly group. Male predominance was observed in both groups, with a higher proportion among young adults. The distribution of rural residence was comparable between groups. **Table 1** summarizes the baseline demographic characteristics of the study participants.

Table 1. Baseline Characteristics of Study Participants (N = 360)

Characteristic	Young Stroke (n = 180)	Elderly Stroke (n = 180)
Age, years (mean ± SD)	38.2 ± 5.9	68.4 ± 6.1
Male sex, n (%)	124 (68.9)	108 (60.0)
Rural residence, n (%)	92 (51.1)	97 (53.9)

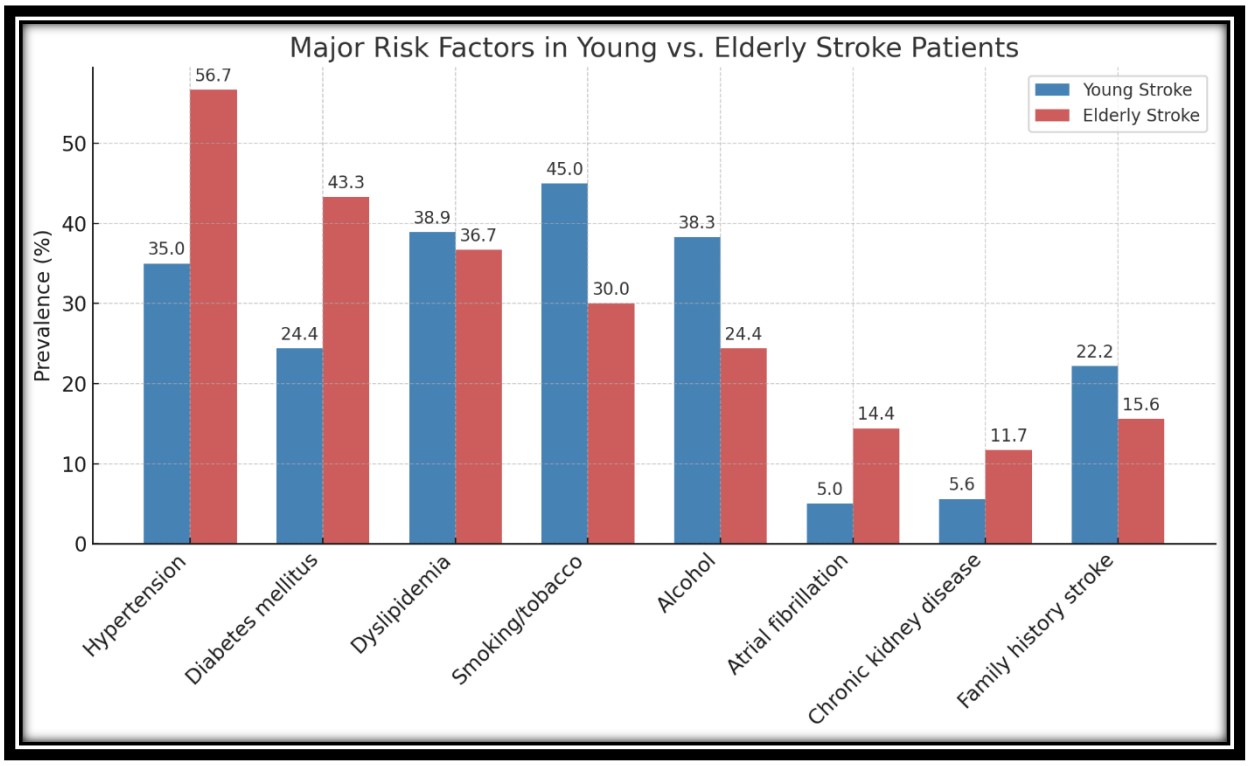


Distribution of Lifestyle and Clinical Risk Factors

Smoking/tobacco use and alcohol consumption were significantly more prevalent among young adults. In contrast, hypertension, diabetes mellitus, atrial fibrillation, and chronic kidney disease were more common in elderly patients. Dyslipidemia and family history of stroke did not differ significantly between groups.The distribution of major risk factors is presented in **Table 2**.

Table 2. Distribution of Major Risk Factors by Age Group

Risk Factor	Young (n = 180)	Elderly (n = 180)	OR (95% CI)	p-value
Hypertension	63 (35.0)	102 (56.7)	0.41 (0.27–0.61)	<0.001
Diabetes mellitus	44 (24.4)	78 (43.3)	0.42 (0.27–0.66)	<0.001
Dyslipidemia	70 (38.9)	66 (36.7)	1.09 (0.71–1.67)	0.69
Smoking/tobacco use	81 (45.0)	54 (30.0)	1.91 (1.23–2.95)	0.003
Alcohol consumption	69 (38.3)	44 (24.4)	1.91 (1.22–3.00)	0.004
Atrial fibrillation	9 (5.0)	26 (14.4)	0.32 (0.15–0.69)	0.003
Chronic kidney disease	10 (5.6)	21 (11.7)	0.45 (0.21–0.96)	0.04
Family history	40 (22.2)	28 (15.6)	1.54 (0.90–2.63)	0.11



Clustering of Modifiable Lifestyle Risk Factors

Clustering of lifestyle risk factors, defined as concurrent smoking and alcohol use, was more frequent among young adults. Over one-third of young patients exhibited two or more behavioral risk factors, compared with one-fifth of elderly patients. Conversely, elderly patients were more likely to have no lifestyle risk factors. Patterns of lifestyle risk clustering are shown in **Table 3**.

Table 3. Clustering of Modifiable Lifestyle Risk Factors

Number of Lifestyle Risk Factors	Young (n = 180)	Elderly (n = 180)	p-value
None	52 (28.9)	88 (48.9)	<0.001
One	63 (35.0)	56 (31.1)	0.43
≥2 (Clustered)	65 (36.1)	36 (20.0)	0.001

Lifestyle risk factors include smoking and alcohol consumption.

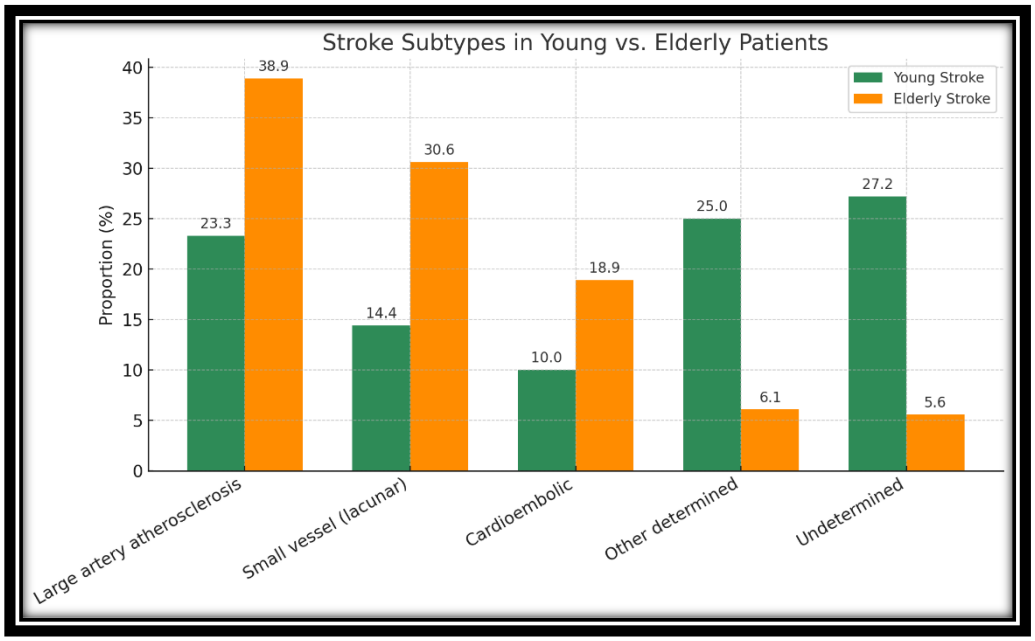
Stroke Subtype Distribution

Stroke etiology differed significantly between age groups. Large artery atherosclerosis and small vessel disease predominated in elderly patients. Young adults showed higher proportions of "other determined" and "undetermined" stroke subtypes. Cardioembolic strokes were also more frequent in the elderly group.

Stroke subtype distribution according to TOAST classification is presented in **Table 4**.

Table 4. Stroke Subtypes According to TOAST Classification

Subtype	Young (n = 180)	Elderly (n = 180)	p-value
Large artery atherosclerosis	42 (23.3)	70 (38.9)	0.002
Small vessel disease	26 (14.4)	55 (30.6)	<0.001
Cardioembolic	18 (10.0)	34 (18.9)	0.03
Other determined	45 (25.0)	11 (6.1)	<0.001
Undetermined	49 (27.2)	10 (5.6)	<0.001



Multivariable Analysis of Factors Associated With Young Stroke

On multivariable logistic regression analysis, smoking/tobacco use and alcohol consumption remained independently associated with young-onset ischemic stroke. In contrast, hypertension and diabetes mellitus were significantly associated with elderly stroke. Family history of stroke was not independently associated with young stroke.Adjusted associations are shown in **Table 5**.

Table 5. Multivariable Logistic Regression for Factors Associated With Young Stroke

Risk Factor	Adjusted OR (95% CI)	p-value
Smoking/tobacco use	1.88 (1.20–2.95)	0.005
Alcohol consumption	1.85 (1.18–2.90)	0.007
Hypertension	0.45 (0.29–0.70)	<0.001
Diabetes mellitus	0.46 (0.28–0.75)	0.002
Family history	1.48 (0.85–2.56)	0.16

Results

Discussion

Principal Findings

This study demonstrates that young adults with ischemic stroke exhibit a distinct clustering of modifiable lifestyle risk factors, particularly smoking and alcohol consumption. More than one-third of young patients had concurrent exposure to these behaviors, a significantly higher proportion than observed among elderly patients. In contrast, traditional cardiometabolic risk factors, including hypertension and diabetes mellitus, predominated in older individuals. These findings underscore the central role of behavioral risk accumulation in the pathogenesis of young-onset stroke.

Comparison With Previous Studies

Our findings are consistent with prior reports indicating that tobacco use and harmful alcohol consumption are disproportionately prevalent among young stroke patients [4,5]. Population-based studies have similarly demonstrated that clustering of unhealthy behaviors substantially increases cardiovascular and cerebrovascular risk [9–11]. The present study extends this evidence by demonstrating that such clustering is common among hospitalized young stroke patients in a real-world clinical setting.

Previous research has also highlighted age-related differences in stroke etiology, with young adults showing higher rates of cryptogenic and “other determined” subtypes, while elderly patients more frequently exhibit atherosclerotic and cardioembolic mechanisms [3,6]. Our results confirm these patterns and suggest that lifestyle risk accumulation may contribute to etiologic heterogeneity in younger populations.

Pathophysiological Considerations

The synergistic effects of smoking and alcohol consumption likely play a critical role in accelerating vascular injury in young adults. Tobacco exposure promotes endothelial dysfunction, inflammation, and hypercoagulability, while excessive alcohol intake contributes to hypertension, atrial arrhythmias, and oxidative stress [7,8]. When combined, these behaviors may overwhelm vascular repair mechanisms and reduce cerebrovascular reserve, predisposing individuals to premature ischemic events.

Furthermore, early initiation and prolonged duration of exposure to these risk factors may lead to cumulative vascular damage before the development of overt cardiometabolic disease. This phenomenon may partially explain the relatively lower prevalence of hypertension and diabetes among young stroke patients despite substantial vascular injury.

Clinical and Public Health Implications

The high prevalence of lifestyle risk clustering among young stroke patients highlights the need for integrated prevention strategies that address multiple behaviors simultaneously. Conventional approaches focusing on individual risk factors may be insufficient in this population.

Routine screening for tobacco and alcohol use should be incorporated into primary care and community health programs targeting young adults. Behavioral counseling, addiction treatment services, and workplace- and school-based interventions may be particularly effective in reducing early cerebrovascular risk.

In clinical practice, identification of clustered lifestyle risks in young stroke patients should prompt comprehensive secondary prevention strategies, including multidisciplinary support for behavior modification. Such interventions may reduce the risk of recurrent stroke and long-term disability.

Strengths and Limitations

This study benefits from a well-defined case–control design, standardized risk factor assessment, and inclusion of consecutive hospitalized patients, enhancing internal validity. The focus on lifestyle risk clustering provides novel insights into behavioral determinants of young-onset stroke.

However, several limitations should be acknowledged. First, the single-center design may limit generalizability. Second, reliance on self-reported smoking and alcohol use introduces potential reporting bias. Third, the cross-sectional nature of the study precludes causal inference. Finally, other relevant lifestyle factors, such as dietary patterns and physical inactivity, were not comprehensively assessed.

Future Directions

Prospective cohort studies are needed to evaluate temporal relationships between lifestyle risk clustering and stroke onset. Interventional trials examining multi-behavioral modification programs in high-risk young adults would provide valuable evidence for prevention strategies.

Further research should also explore sociocultural and psychosocial determinants of risk clustering to inform context-specific public health interventions.

Conclusions

Young adults with ischemic stroke demonstrate a high prevalence of clustered modifiable lifestyle risk factors, particularly smoking and alcohol consumption. These behaviors represent key independent predictors of early-onset cerebrovascular disease and contribute to distinct etiologic patterns in younger populations.

Targeted prevention strategies addressing multiple lifestyle risks simultaneously are essential to curb the rising burden of young-onset stroke. Integration of behavioral risk assessment into routine clinical care

and public health programs may substantially improve long-term outcomes and reduce preventable cerebrovascular morbidity.

Funding

No specific funding was received.

Conflicts of interest

The authors declare no competing interests.

References (Vancouver Style)

1. GBD 2019 Stroke Collaborators. Global, regional, and national burden of stroke and its risk factors, 1990–2019. Lancet Neurol. 2021;20(10):795–820.
2. Scott CA, Li L, Rothwell PM. Diverging temporal trends in stroke incidence in younger vs older people: a systematic review and meta-analysis. JAMA Neurol. 2022;79(10):1036–1047.
3. Boot EM, Ekker MS, Putaala J, et al. Ischaemic stroke in young adults: a global perspective. J Neurol Neurosurg Psychiatry. 2020;91(4):411–417.
4. George MG. Risk factors for ischemic stroke in younger adults: a focused update. Stroke. 2020;51(3):729–735.
5. Putaala J. Ischemic stroke in young adults. Continuum (Minneap Minn). 2020;26(2):386–414.
6. Adams HP Jr, Kappelle LJ, Biller J, et al. Ischemic stroke in young adults: experience in 329 patients enrolled in the Iowa Registry of Stroke in Young Adults. Arch Neurol. 1995;52(5):491–495.
7. Pan B, Jin X, Jun L, Qiu S, Zheng Q, Pan M. The relationship between smoking and stroke: a meta-analysis. Medicine (Baltimore). 2019;98(12):e14872.
8. Reynolds K, Lewis B, Nolen JD, Kinney GL, Sathya B, He J. Alcohol consumption and risk of stroke: a meta-analysis. JAMA. 2003;289(5):579–588.
9. Poortinga W. The prevalence and clustering of four major lifestyle risk factors in an English adult population. Prev Med. 2007;44(2):124–128.
10. Spring B, Moller AC, Coons MJ. Multiple health behaviours: overview and implications. Psychol Health. 2012;27(7):833–855.
11. Kvaavik E, Batty GD, Ursin G, Huxley R, Gale CR. Influence of individual and combined health behaviors on total and cause-specific mortality. BMJ. 2010;341:c6362.
12. Ding D, Rogers K, van der Ploeg H, Stamatakis E, Bauman AE. Traditional and emerging lifestyle risk behaviors and all-cause mortality. PLoS Med. 2015;12(7):e1001881.
13. Konda M, Varalakshmi EA, Patil A, Kaul S, Yada PK, Jayasree M, et al. Risk factors and subtypes of ischemic strokes in young adults: a tertiary care hospital study from southern India. J Med Sci Res. 2025;13(2):101–106.