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Uncovering the Silent Predictors: A Population-based Study of Stroke Risk and Lifestyle Factors

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Abstract:

Stroke impacts people all over the world and is a significant cause of death and long-term disability. The objective of this study was to investigate the relationship between stroke status and various sociodemographic, lifestyle, and clinical variables in a large population-based study. A cross-sectional analysis was done based on the national health survey. Assessment of stroke status involved considering sociological factors (gender, education, income, and marital status), behavioral variables (alcohol consumption, smoking, and physical activity), and clinical markers (BMI, glucose levels, hypertension, and heart disease). The associations investigated were evaluated by using chi-square and independent t-tests, $p<0.05$. Prevalence of stroke is significantly associated with alcohol consumption ($p=0.026$) and income level ($p=0.025$) of the studied population. But there were no differences in stroke risk by gender, area of residence, use of tobacco, eating habits, physical activity, or chronic stress. Moreover, mean values of BMI, glucose, sleep hours, and stroke risk score were not significantly different between stroke and non-stroke groups ($p>0.05$). Alcohol consumption and income level were identified to be associated with stroke. Thus, public health interventions may be warranted. All other variables showed no significant relationship, suggesting stroke risk is multifactorial.

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INTRODUCTION

A stroke can cause death in addition to a long-lasting disability. Moreover, it is a frequent reason for death throughout the world (Tento *et al.,* 2023). According to the Global Burden of Disease Study 2021, 11.9 million people in a year suffered from a stroke (GBD 2019 Stroke Collaborators, 2021). In addition, there are already 938 million people who have had a stroke. As a result, it is the third most common cause of death and the fourth most common cause of DALY. The study states that over 12% of strokes occur in the 15 to 49-year age group (Feigin *et al.,* 2023).

Stroke is a major burden in low- and middle-income countries (LMICs) with limited access to prevention and acute care. Hypertension, angina pectoris, and diabetes are major risk factors for stroke (Muhammad *et al.,* 2013; Iqbal *et al.,* 2016a,b; 2018). Socioeconomic differences affect how often strokes happen, how bad they are, and the results, so it is important to understand how to change some of these risk factors to create interventions (Li *et al.,* 2018).

Alcohol can increase the risk of stroke, but it is modifiable. The relationship between alcohol consumption and stroke risk is found to be dose-dependent. A recent study showed that about 5.2% of all strokes worldwide are due to high alcohol use. On the other hand, ischemic stroke risk can decrease from moderate alcohol consumption, though hemorrhagic stroke is not well-protected against by drinking. This finding reveals how our public health messages regarding alcohol consumption need to be refined (Chung *et al.,* 2023).

The risk and outcome of strokes are influenced greatly by the Socioeconomics (SES) of an individual. People with low Socio-Economic Status suffer more strokes and have lower odds of returning to functional living after having a stroke. The gap is due to limited access to health care, high rates of risk factors like hypertension and diabetes, and differences in health literacy. It is essential to understand the relationship between economic status and stroke to produce fair health policies (Marshall *et al.,* 2015; Pantoja *et al.,* 2025).

The duration and quality of sleep are becoming important factors for stroke risk. Sleeping for less than six hours or more than nine hours increases the risk of stroke. In addition, poor sleep quality causes an increase in risk of stroke by itself, and too little sleep and poor quality enhance risk. The assessment of sleep is necessary to prevent stroke (Cai and Atanasov, 2023).

Recent data shows that more and more young people are having strokes (Yahya *et al.,* 2020). The percentage of adults aged 18 to 64 years in the United States who had a stroke increased by 7.8% between 2011–2013 and 2020–2022 (Sultan and Elkind, 2013). The rise in such chronic disorders, especially in younger populations, is mostly due to dietary habits, physical inactivity, and substance use. As a result, we need early intervention and education (Sultan and Elkind, 2013; Yahya *et al.,* 2020).

Taken together, Stroke is caused by more than one factor. Hence, we can't find a single way out. Thus, there is a need to offer prevention and management strategies (Pandian *et al.,* 2018). Risk factors such as alcohol consumption, socioeconomic status, sleep, and other factors affect the incidence and outcomes of stroke (George *et al.,* 2011). If we start performing these actions, specific public health initiatives, and patient care may avoid a huge stroke burden. The objective of this study was to investigate the relationship between stroke status and various sociodemographic, lifestyle, and clinical variables in a large population-based study. A cross-sectional analysis was done based on the national health survey.

MATERIALS AND METHODS

Ethical considerations

This data set was taken from a public repository (Kaggle), and all data was de-

identified. Because the study did not involve any individual-level identifiers and did not collect any new data, it was not subject to a formal ethics review.

Study design and data source

This research employed a cross-sectional analytical design using secondary data from the international stroke dataset made publicly available on Kaggle (2025). The dataset contains demographic, clinical, and lifestyle information of a large cohort of persons evaluated for stroke risk and status. As the data is anonymized, no ethical approval was required for the secondary analysis.

Study population

The dataset comprised 172,000 participants, including those with a stroke history and those without. All individuals with available stroke status/response and relevant qualities on study variables were included. All inferential analyses were statistically compared with participants having missing key variables (e.g., stroke status or demographic data).

Variables assessed

Variables are classified as dependent and independent variables.

Dependent variable

Stroke status (Yes/No), as recorded in the dataset.

Independent variables

The demographic factors included age (in years), gender (male, female), marital status (ever married), income level (low, middle, high), education level (primary, secondary, tertiary, none), residence (rural/urban), and type of employment (private, government, other).

Clinical factors included the presence of hypertension, heart disease, family history of stroke, glucose level in mg/dL, body mass index values in kg/m^2, and stroke risk score.

We considered the following factors as behavioral factors: smoking status (smoker/no smoker), alcohol consumption (yes/no), physical activity (sedentary, light, moderate, active), diet (vegetarian, non-vegetarian, mixed), hours of sleep per day, and chronic stress (yes/no).

Statistical analysis

We used SPSS version 26.0 (IBM Corp., Armonk, NY, USA) for all analyses. Means and standard deviations (M±SD) were calculated for continuous variables (e.g., Age, BMI, Glucose). We calculated percentages and frequencies for categorical variables, including gender, alcohol use, and stroke status. The Chi-square (χ^2) test was used to assess the association between categorical variables and stroke status. To measure the differences in the continuous variables between the stroke group and the non-stroke group, an independent samples t-test was used. A p-value of less than 0.05 was statistically significant. All tests were two-tailed.

RESULTS

Demographic and clinical characteristics of study participants

Table 1 gives a bird's-eye view of the demographic, lifestyle, and clinical characteristics of the stroke patients studied. The mean age was 54.00 years (SD ±21.08) for the participants. The population was almost equal between males (48.04%) and females (47.96%), with 4% missing. Fifteen percent of the participants had hypertension, and 85% did not have it. Ten percent had heart disease; 90% did not. About 30% had been married, while about 70% had never been married. Fifty percent of the participants worked in the private sector, 9.9% were employed in the government sector, while 40% were in other sectors. There are equal numbers of participants from Urban and Rural places. About 90% of participants have no history of stroke, while 10% have a history of stroke. The mean blood glucose level was 184.93±66.31 mg/dL, which was high,

indicating hyperglycemia or diabetes. The average body mass index BMI of the studied population was found to be 30.02 (SD ±11.57), and it was obese. The majority of the participants were sedentary (40.1%), while light, 30% moderate 20.1% and active 9.9%. Regarding dietary habits, 50% were non-vegetarian, 30.1% vegetarian, and 19.9% mixed. Alcohol consumption was reported by 20% of respondents. Chronic stress was reported by 25% of the participants. About 15% of participants have chronic stress.

Educational level varied from primary (10%), secondary (30%), to tertiary (40%). Twenty percent of participants reported receiving no education. The level of income was low (50.1%), middle (29.9%), and high (20%). The average calculated stroke risk score was found to be 50.62±28.91. There was an average sleep duration of 7.5±288 hours.

Table 1. Demographic and clinical characteristics of study participants.

Variable	Description
Age (M±SD)	54.00±21.08
Gender (N, %):	
- Male	82626 (48.04%)
- Female	82497 (47.96%)
- Missing	6877 (4%)
Hypertension (N, %):	
- Yes	25823 (15%)
- No	146177 (85%)
Heart disease (N, %):	
- Yes	17248 (10%)
- No	154752 (90%)
Ever married:	
- Yes	51766 (30.1%)
- No	120234 (69.9%)
Work type:	
- Private	86041 (50%)
- Government	17099 (9.9%)
- Other	68860 (40%)
Residency (N, %):	
- Rural	85921(50%)
- Urban	86079 (50%)
Stroke status (N, %):	
- Yes	17096 (9.9%)
- No	154904 (90.1%)
Glucose (M±SD)	184.93±66.31
BMI (M±SD)	30.013±11.57
Physical activity (N, %):	
- Sedentary	68967 (40.1%)
- Active	16990 (9.9%)
- Moderate	34524 (20.1%)
- Light	51519 (30%)
Dietary habits:	
- Vegetarian	51765 (30.1%)
- Non-vegetarian	86006 (50%)
- Mixed	34229 (19.9%)
Alcohol consumption:	

- Yes	34429 (20%)
- No	137571 (80%)
Chronic stress:	
- Yes	43000 (25%)
- No	129000 (75%)
Family history:	
- Yes	25619 (14.9%)
- No	146381 (85.1%)
Educational level:	
- Primary	17118 (10%)
- Secondary	51675 (30%)
- Tertiary	68812 (40%)
- No education	34395 (20%)
Income level (N, %):	
- Low	86133 (50.1%)
- Middle	51493 (29.9%)
- High	34374 (20%)
Stroke risk scores (M±SD)	50.62±28.91
BMI (M±SD)	30.02±11.57
Sleeping hours (M±SD)	7.50±288

The relationship between stroke status and study variables

Our results regarding stroke occurrence, as shown in Table 2, demonstrate that most variables, such as gender, education, physical activity, and comorbidities (hypertension and heart disease), were not statistically different. There was a statistically significant difference (but a clinically small difference) for alcohol consumption (p=0.026) and income level (p=0.025). It appears that no single risk factor alone affects stroke risk. For example, it looks like both high blood pressure and inflammation affect stroke risk. There was a statistically significant difference (but a clinically small difference) for alcohol use and income level.

Table 2. The relationship between stroke status and study variables.

Variable	**Stroke status**				**p-value**
	Yes		**No**		
	N	**%**	**N**	**%**	
Gender:					0.576
- Male	8171	9.9%	74455	90.1%	
- Female	8219	10%	74278	90%	
- Missing	706	10.3%	6171	89.7%	
Hypertension:					0.313
- No	14574	10%	131603	90%	
- Yes	2522	9.8%	23301	90.2%	
Heart disease:					0.544
- No	15359	9.9%	139393	90.1%	
- Yes	1737	10.1%	15511	89.9%	
Ever married:					0.607
- No	11980	10%	108254	10%	
- Yes	5116	9.9%	46650	90.1%	
Work type:					0.225
- Private	8558	9.9%	77483	90.1%	
- Government	1638	9.6%	15461	90.4%	
- Other	6900	10%	61960	10%	
Type of residence:					0.249

- Rural	8612	10%	77309	90%	
- Urban	8484	9.9%	77595	90.1%	
Smoking status:					0.330
- Formerly smoked	3477	10.1%	30849	89.9%	
- Never smoked	10288	9.9%	93150	90.1%	
- Unknown	1677	9.8%	15390	90.2%	
- Smoker	1654	9.6%	15515	90.4%	
Physical activity:					0.353
- Sedentary	6912	10%	62055	90%	
- Active	1692	10%	15298	90%	
- Moderate	3472	10.1%	31052	89.9%	
- Light	5020	9.7%	46499	90.3%	
Dietary habits:					0.673
- Vegetarian	5096	9.8%	46669	90.2%	
- Non-vegetarian	8574	10%	77432	90%	
- Mixed	3426	10%	30803	90%	
Alcohol consumption:					0.026
- No	13577	9.9%	123994	90.1%	
- Yes	3519	10.2%	30910	89.8%	
Chronic stress:					0.539
- No	12789	9.9%	116211	90.1%	
- Yes	4307	10%	38693	90%	
Family history:					0.831
- No	14559	9.9%	131822	90.1%	
- Yes	2537	9.9%	23082	90.1%	
Educational level:					0.913
- Primary	1715	10%	15403	90%	
- Secondary	5113	9.9%	46562	90.1%	
- Tertiary	6870	10%	61942	90%	
- No education	3398	9.9%	30997	90.1%	
Income level:					0.025
- Low	8594	10%	77539	90%	
- Middle	4984	9.7%	46509	90.3%	
- High	3518	10.2%	30856	89.8%	

The relationship between study variables and stroke status using an independent T test

Table 3 presents the comparison of mean values (M ± SD) of several continuous variables between participants with and without stroke, along with p-values to determine statistical significance. All continuous variables examined, including stroke risk score, BMI, glucose level, and sleeping hours ,showed no statistically significant differences between those with and without stroke. The p-values for all variables are well above the standard threshold of 0.05, suggesting that none of these individual metrics are independently associated with stroke status in this univariate analysis. This reinforces the idea that stroke is a multifactorial condition, and individual metrics may not be strong standalone predictors.

DISCUSSION

According to results presented in tables (1-3), the demographic, clinical, and lifestyle characteristics of stroke were derived from a large international cohort study. Although the majority of variables did not have a statistical difference between stroke and non-stroke, certain results need deeper examination. This is particularly true for alcohol consumption and income level.

According to Table 2, there is a statistically significant association between alcohol consumption and stroke ($p = 0.026$). Furthermore, stroke prevalence appeared to be slightly higher among alcohol consumers (10.2%) than non-consumers (9.9%). The finding coincides with the literature that says alcohol can alter stroke risk. For instance, a

cohort study in China found moderate alcohol consumption (13–36 g/day) associated with a lower risk of total stroke (HR: 0.48; 95% CI: 0.25–0.92) compared to nondrinkers (Liu *et al.,* 2023). But once you reach that level of consumption, it will not provide any benefit. In other words, it can just be potentially harmful. The connection between alcohol and stroke is complicated (Hillbom, 1998; Ceylan-Isik *et al.,* 2010). Moreover, it may differ according to one's consumption patterns and types of alcoholic beverages and risk factors (Ceylan-Isik *et al.,* 2010).

Table 3. The relationship between study variables and stroke status.

Variable	Mean±SD	p-value
Stroke risk scores:		0.866
- No	50.62±28.91	
- Yes	50.65±28.92	
BMI:		0.611
- No	30.02±11.57	
- Yes	29.97±11.58	
Glucose:		0.929
- No	184.93±66.33	
- Yes	184.97±66.15	
Sleeping hours:		0.530
- No	7.50±2.88	
- Yes	7.51±2.87	

The data suggest that stroke status is associated with income level (p = 0.025), where the high-income group (10.2%) has the highest prevalence of stroke. Surprisingly, people who earn a higher income do not have a lower risk of it and are actually more likely to experience a stroke. This may be due to lifestyle diseases caused by affluence (Grimaud *et al.,* 2011). A study in Indonesia indicated that higher socioeconomic status was linked to lower stroke severity, underlining how income affects stroke severity and other related factors (Yamanie *et al.,* 2023).

As presented in Table 3, the average sleep duration for the stroke group and the non-stroke group was not significantly different from each other (p = 0.530).

However, both long (≥10 hours) and short (<6 hours) sleep times significantly increased stroke risk, as the researchers noted in their report (Song *et al.,* 2016). Researchers found that people who sleep either less than 6 hours or longer than 9 hours suffer from a greater risk of stroke than others (Chen *et al.,* 2023). The two groups seem to sleep approximately the same amount of time on average. Alterations from the average may impact stroke risk, however (Liu *et al.,* 2022).

Although not significant in this dataset, BMI, glucose level, and physical activity were significantly associated with stroke (Ghozy *et al.,* 2022; Jiang *et al.,* 2024). Nevertheless, these variables are established stroke risk factors and, thus, must be studied further (Lee *et al.,* 2003). Obesity and diabetes have both been linked to an increased risk of stroke, and physical inactivity is a well-established modifiable risk factor (Chen *et al.,* 2016).

CONCLUSION

The study findings indicate complex relationships among factors that affect stroke. Some associations were statistically significant (e.g., alcohol consumption, income level), but others were not. This emphasizes the need for a multifactorial approach to stroke prevention. Future research must include prospective

studies because it will shed more light on these relations.

CONFLICT OF INTEREST

The author of this article declares that there is no potential conflict of interest.

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