ARYA Atherosclerosis J

Original Article Open Access

Six-month survival and predictors of mortality after ischemic stroke: A prospective cohort study in Iran

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Received: 2025-06-11
Accepted: 2025-09-29

How to cite this article:
Foroozanfar Z, Parsaeian M, Abdi S, Mehrpour M, Gheini M, Mashakhi Sarbangoli R, Yazdani A, Mohammadi M, Fotouhi A. **Six-month survival and predictors of mortality after ischemic stroke: A prospective cohort study in Iran.** ARYA Atheroscler. 2025; 21(6): 51-60.

DOI:
https://doi.org/10.48305/arya.2025.45310.3060

Abstract

BACKGROUND: The burden of stroke can be reduced by controlling its mortality risk factors. We aimed to identify the predictors of mortality within six months after ischemic stroke.

METHODS: This prospective cohort study was performed on 703 ischemic stroke patients in Tehran, Iran, during 2018–2019. Data on demographic and clinical characteristics were collected through interviews and hospital records. The patients' survival status was followed up by telephone interviews at 28 days, 3 months, and 6 months after stroke. Cox proportional hazard model and extended Cox model were used to determine the predictors of mortality after stroke.

RESULTS: The 6-month mortality rate was 19.50% (95% CI: 16.70–22.67). Age (HR=1.01; 95% CI: 1.001–1.03), higher educational levels (HR=1.05; 95% CI: 1.01–1.10), and blood sugar levels on admission (HR=1.04; 95% CI: 1.01–1.08) were significantly associated with an increase in 6-month mortality. However, alcohol consumption (HR=0.09; 95% CI: 0.02–0.38), alteplase administration (HR=0.65; 95% CI: 0.43–0.98), and higher hemoglobin values (HR=0.80; 95% CI: 0.72–0.88) were associated with a decrease in 6-month mortality. The hazard ratio of death for diastolic blood pressure, socioeconomic status, cholesterol levels, and stroke severity varied over time.

CONCLUSION: Some characteristics significantly increased or decreased the risk of mortality after stroke. Additionally, the effect of some variables changed over time, suggesting that stroke prognosis may be associated with dynamic risk factors. Identifying and addressing these factors can inform targeted strategies to improve post-stroke survival outcomes.

Keywords: Ischemic Stroke; Six-Month Survival; Prognostic Factors; Prospective Cohort Study; Cox Proportional Hazards Model; Iran

Introduction

Stroke is currently the second leading cause of death and the third leading cause of disability globally. The global rate of stroke prevalence is increasing, and it is considered the most common and complex neurological disorder. There are two types of stroke, including hemorrhagic strokes and ischemic strokes, of which ischemic stroke is more common, accounting for 87% of strokes globally[1]. Stroke-related deaths account for 11% of deaths worldwide, with an annual mortality rate of about 6.6 million, of which 85% occur in developing countries[2]. The incidence of stroke in Iran is significantly higher than that in Western societies, and approximately 80–90% of stroke cases are ischemic[3,4].

Research indicates that stroke outcomes are influenced by a variety of factors, including demographic characteristics (age, gender), clinical factors (comorbidities, stroke severity), and healthcare accessibility. Understanding these variables is vital, as they can inform clinical practices and public health strategies aimed at improving outcomes for stroke patients[5]. Despite existing studies on stroke outcomes globally, there is a notable gap in focused research that examines these factors specifically within the Iranian context[6].

Identifying region-specific prognostic factors is therefore crucial to tailoring interventions that can improve survival rates in local contexts. Hence, there is a need for prospective cohort studies on factors affecting stroke mortality due to the occurrence of stroke at a younger age in Iran compared with that in other countries[3,7]. This prospective cohort study aims to fill this gap by investigating the six-month survival rate and prognostic factors associated with post-stroke mortality in a sample of ischemic stroke patients in Tehran, Iran.

Materials and methods

Patients and settings

This prospective cohort study was performed on 703 acute ischemic stroke patients attending Shariati, Firoozgar, and Sina teaching hospitals in Tehran, Iran, from June 2018 to September 2019[8]. This study was approved by the Ethics Committee at Tehran University of Medical Sciences under the Code of Ethics IR.TUMS.SPH.REC.1397.4979. Patients who presented with ischemic stroke, confirmed by imaging studies (CT or MRI) based on WHO diagnostic criteria, were eligible for inclusion. Transient ischemic attack and hemorrhagic stroke were considered exclusion criteria. All study participants met the inclusion criteria and signed a written informed consent form. Other types of stroke, including hemorrhagic stroke and transient ischemic attack, were excluded from the study.

Data Collection

Demographic information (age, sex, level of education, and marital status), medical history and risk factors (history of stroke, diabetes, hypertension, heart disease, smoking, alcohol consumption, and history of contraceptive use), in-hospital medication (alteplase administration, antiplatelets, and anticoagulants), socioeconomic status based on asset lists[9], and patients' functional status (using the Modified Rankin Scale (MRS); MRS ≤2: good performance and MRS >2: poor performance) were recorded through interviews. Stroke severity (based on NIHSS scores; NIHSS ≤7: mild stroke severity, 7 < NIHSS ≤16: moderate, and NIHSS >16: severe stroke), systolic and diastolic blood pressure, blood sugar on admission, fasting blood sugar, triglyceride levels, cholesterol levels, hemoglobin, and hematocrit values were collected from patients' medical records.

Follow-up assessments were conducted via telephone interviews at 28 days, 3 months, and 6 months post-stroke to determine each patient's survival status. In case of death, the date of death was recorded. To increase responsiveness, at least three contact numbers of the patient and the patient's close relatives were obtained.

Statistical analysis

Quantitative independent variables were summarized using descriptive statistics, including mean and standard deviation,

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while qualitative variables were expressed as frequencies and percentages. Cox proportional hazards regression model and the extended Cox model were used to identify factors related to stroke mortality rates. The Schoenfeld residuals and the graphical approach of log-log plots were utilized to evaluate the proportional hazard assumption. The Cox proportional hazards model was applied when the proportional hazard assumption was satisfied for single variables. Conversely, the extended Cox model was utilized when the proportional hazard assumption was not met, incorporating the variables as a function of time. Variables with p-values <0.2 in univariate analysis were entered into the multiple analysis. Data analysis was performed using Stata software, version 14.

Results

Study Population

A total of 703 patients diagnosed with ischemic stroke were included in this study, comprising 260 females (37%) and 443 males (63%). The mean age of the participants was 65.47±14.53 years (64.91±14.48 for men and 66.42±14.60 for women). Patient demographic and clinical characteristics, along with stroke severity and patients' functional status stratified by death outcome, are shown in Table 1.

Mortality Rate and Survival Probability

During the six-month follow-up, 54 patients (7.7%) were lost, and their survival outcomes could not be determined. A total of 134 patients (52 women and 82 men) died within this period. The incidence rate of six-month mortality was 19.50% (95% CI: 16.70–22.67), with specific rates of 19.17% for men (95% CI: 15.74–23.24) and 20.12% for women (95% CI: 15.72–25.54). Correspondingly, the survival probability over six months was 80.50% overall, 81.00% for men, and 80.00% for women (Figure 1).

Predictors of Mortality; univariate analysis

The univariate analysis results, detailed in Table 2, indicated that risk factors such as age, functional status, alteplase administration, admission blood sugar, fasting blood sugar, and recurrent stroke were significantly associated with higher six-month mortality rates. In contrast, alcohol consumption, body mass index, hemoglobin, and hematocrit values were associated with a decrease in six-month mortality. Some predictors, such as diastolic blood pressure, socioeconomic status, cholesterol levels, and stroke severity, demonstrated time-dependent effects on mortality, with interactions over time that were statistically significant. Hazard ratios for these variables at 28, 90, and 180 days post-stroke are provided in Table 3.

Predictors of Mortality; multiple analysis

Multivariate analysis revealed that age (HR 1.01; 95% CI: 1.001–1.03), educational levels (HR 1.05; 95% CI: 1.01–1.10), and elevated blood sugar on admission (HR 1.04; 95% CI: 1.01–1.08) were associated with increased stroke mortality rates. Conversely, alcohol consumption (HR 0.09; 95% CI: 0.02–0.38), alteplase administration (HR 0.65; 95% CI: 0.43–0.98), and higher hemoglobin values (HR 0.80; 95% CI: 0.72–0.88) were associated with reduced post-stroke mortality risk (Table 4).

Hazard ratios for variables with time-varying effects, including diastolic blood pressure, socioeconomic status, cholesterol levels, and stroke severity, are shown in Table 5. Diastolic blood pressure initially showed a protective effect, reducing mortality within the first 28 days post-stroke (HR 0.75; 95% CI: 0.62–0.91); however, its protective effect diminished over time. Socioeconomic status was significantly associated with decreased mortality rates within 90 and 180 days, with its protective influence strengthening over time (HR 0.71; 95% CI: 0.60–0.85 after 90 days and HR 0.42; 95% CI: 0.29–0.62 after 180 days). Stroke severity consistently increased mortality risk across all time intervals, with its impact intensifying over time (HR 1.22; 95% CI: 1.16–1.28 after 28 days, HR 1.29; 95% CI: 1.24–1.36 after 90 days, and HR 1.41; 95% CI: 1.29–1.54 after 180 days). Additionally, cholesterol level was linked to reduced mortality within 180 days, with its protective effect

Table 1. Characteristics of ischemic stroke patients stratified by survival

Characteristics	Total (n=703)	Dead (n=134)	Alive (n=515)
Age (years)	65.47±14.53	70.61±13.92	64.45±14.51
Sex			
Male	443(63.0)	82(61.2)	316(61.4)
Female	260(37.0)	52(38.8)	82(61.2)
Age (years)			
<65	337(47.9)	43(32.1)	260(50.5)
65-74	158(22.5)	33(24.6)	114(22.1)
75-84	156(22.2)	43(32.1)	107(20.8)
84≤	52(7.4)	15(11.2)	34(6.6)
Marital status			
Never married	24(3.4)	8(6.0)	14(2.70)
Married	488(69.4)	73(54.5)	373(72.4)
Widowed	170(49.6)	51(38.1)	111(21.6)
Divorce	21(3.0)	2(1.5)	17(3.3)
Smoking	124(17.6)	22(16.4)	84(16.3)
Alcohol consumption	48(6.8)	2(1.5)	43(8.3)
Years of education			
0	176(25.0)	43(32.1)	122(23.7)
1-5	203(28.9)	35(26.1)	155(30.1)
6-8	67(9.5)	16(11.9)	48(9.3)
9-12	165(23.5)	26(19.4)	117(22.7)
12<	92(13.1)	14(10.4)	73(14.2)
Socioeconomic status			
Lowest	141(20.1)	43(32.1)	89(17.3)
Low	141(20.1)	30(22.4)	103(20.0)
Middle	139(19.8)	26(19.4)	101(19.6)
High	142(20.2)	19(14.2)	114(22.1)
Highest	140(19.9)	16(11.9)	108(21.0)
History of hypertension	418(59.5)	88(65.7)	302(58.6)
History of diabetes mellitus	240(34.1)	42(31.3)	178(34.1)
History of hyperlipidemia	253(36.0)	53(39.6)	179(34.8)
History of heart disease	328(46.7)	60(44.8)	241(46.8)
History of contraceptive use(in women)	89(34.2)	20(14.9)	65(12.6)
Previous stroke	203(28.9)	45(33.6)	147(28.5)
BMI(kg/m²)	26.67±4.53	25.7±4.42	27.6±4.48
Systolic blood pressure (mmHg)	133.71±20.83	136.21±21.61	133.74±21.27
Diastolic blood pressure (mmHg)	79.9±10.66	80.05±10.72	79.81±10.96
FBS(mg/dL)	138.86±39.85	148.97±45.10	136.66±37.46
Blood sugar on admission(mg/dL)	146.89±47.94	157.94±47.80	144.83±47.41
Cholesterol(mg/dL)	173.34±36.25	171.34±39.76	173.88±35.6
TG(mg/dL)	129.68±37.03	125.34±41.36	130.47±35.67
HB(g/dL)	13.93±2.96	13.27±1.83	14.09±3.24
HCT(%)	40.08±7.58	38.54±6.29	40.41±8.02
Length of hospital stay(day)	7.47±6.13	7.03±5.63	8.43±6.95
Alteplase administration	195(27.7)	113(25.5)	82(31.5)
Antiplatelet agent	628(89.3)	125(93.3)	457(88.7)
Anticoagulant	619(88.1)	113(84.3)	462(89.7)
NIHSS score	6.78±4.15	10.98±3.78	5.69±3.53
Stroke severity			
Mild (NIHSS ≤7)	402(57.2)	15(11.2)	335(68.9)
Moderate (7 < NIHSS≤16)	276(39.3)	100(74.6)	156(30.3)
Severe (NIHSS> 16)	25(3.6)	19(14.2)	4(0.8)
MRS score	2.54±1.80	4.18±1.44	2.09±1.63
Functional status			
Good (MRS≤ 2)	353(50.2)	17(12.7)	311(60.4.6)
Poor (MRS >2)	350(49.8)	117(87.3)	204(39.6)

Data reported as N (%), mean ±SD

#BMI, Body Mass Index; FBS, Fasting Blood Sugar; TG, Triglycerides; HB, Hemoglobin; HCT, Hematocrit; NIHSS, National Institutes of Health Stroke Scale; MRS, Modified Ranking Scale

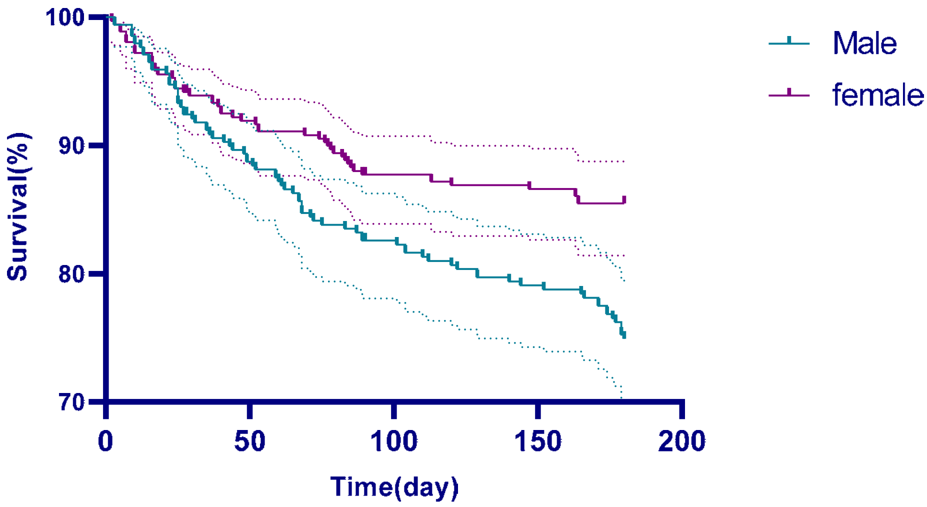

Figure 1. Kaplan–Meier survival curves by sex

Table 2. Factors associated with 6-month mortality: univariate analysis

Characteristics	HR	95% CI	P value
Age(year)	1.03	1.01-1.05	0.005*
Sex			
Male	1		
Female	1.37	0.75-2.49	0.299
Smoking	0.92	0.58-1.45	0.734
Alcohol consumption	0.19	0.05-0.77	0.020*
Years of education	0.97	0.94-1.01	0.085
Socioeconomic status	1.03	0.85-1.06	0.731
Socioeconomic status*time	0.995	0.992-0.998	0.001*
History of hypertension	1.31	0.92-1.87	0.135
History of diabetes mellitus	0.85	.59-1.23	0.401
History of hyperlipidemia	1.18	0.84-1.67	0.331
History of heart disease	0.91	0.65-1.29	0.611
History of contraceptive use	1.15	0.72-1.86	0.551
Previous stroke	1.26	0.88-1.81	0.202
BMI(kg/m^2)	0.92	0.88-0.96	0.001*
Systolic blood pressure (mmHg)	1.006	0.99-1.01	0.145
Diastolic blood pressure (mmHg)	0.77	0.59-0.98	0.038*
Diastolic blood pressure * time	1.004	1.001-1.006	0.006*
Blood sugar on admission(mg/dL)	1.04	1.01-1.07	0.002*
FBS(mg/dL)	1.06	1.03-1.09	0.001*
Cholesterol(mg/dL)	1.05	0.98-1.12	0.163
Cholesterol* time	0.998	0.997-0.999	0.018
TG(mg/dL)	0.96	0.91-1.01	0.136
HB(g/dL)	0.82	0.74-0.90	0.001*
HCT (%)	0.97	0.94-0.99	0.008*
Functional status (MRS score)	2.09	1.90-2.42	0.001*
Stroke severity (NIHSS score)	1.16	1.09-1.22	0.001*
Stroke severity* time	1.001	1.0003-1.002	0.003*
Alteplase administration	1.64	1.16-2.33	0.005*

* Significant at 0.05 level; CI: confidence interval

#BMI, Body Mass Index; FBS, Fasting Blood Sugar; TG, Triglycerides; HB, Hemoglobin; HCT, Hematocrit; NIHSS, National Institutes of Health Stroke Scale; MRS, Modified Ranking Scale

#Variables of fasting blood sugar, blood sugar on admission, cholesterol, triglyceride, systolic and diastolic blood pressure were changed and were divided into 10.

Table 3. Hazard ratio of variables that did not have a constant hazard ratio over time - univariate analysis

Variables	HR in day 28 (95% CI)	HR in day 90 (95% CI)	HR in day 180 (95% CI)
Diastolic blood pressure(mmHg)	0.86(0.70-1.04)	1.09(0.93-1.2)	1.56(1.10-2.21)*
Stroke severity (NIHSS score)	1.18(1.14-1.24)*	1.26(1.21-1.31)*	1.38(1.27-1.49)*
Cholesterol(mg/dL)	1.02(0.96-1.07)	0.95(0.87-1.01)	0.86(0.77-0.97)*
Socioeconomic status	0.90(0.77-1.04)	0.66(0.56-0.78)*	0.42(0.29-0.61)*

* Significant at 0.05 level; CI: confidence interval

#Variables of cholesterol and diastolic blood pressure were changed and were divided into 10.

Table 4. Factors associated with 6-month mortality: Multiple analysis

Characteristics	HR	95% CI	P value
Age(year)	1.01	1.001-1.03	0.031*
Sex			
Male	1		
Female	0.70	0.47-1.04	0.082
Alcohol consumption	0.09	0.02-0.38	0.001*
Years of education	1.05	1.01-1.10	0.024*
Socioeconomic status	1.20	0.96-1.49	0.103
Socioeconomic status*time	0.994	0.991-0.997	0.001*
BMI(kg/m²)	0.96	0.92-1.002	0.062
Diastolic blood pressure (mmHg)	0.68	0.53-0.87	0.002*
Diastolic blood pressure * time	1.003	1.001-1.006	0.010*
Blood sugar on admission(mg/dL)	1.04	1.01-1.08	0.016*
Cholesterol(mg/dL)	1.01	1.01-1.16	0.022*
Cholesterol* time	0.998	0.997-0.999	0.003*
HB(g/dL)	0.80	0.72-0.88	0.001*
Stroke severity (NIHSS score)	1.19	1.12-1.26	0.001*
Stroke severity* time	1.001	1.0003-1.002	0.007*
Alteplase administration	0.65	0.43-0.98	0.043*

* Significant at 0.05 level; CI: confidence interval

#BMI, Body Mass Index; HB, Hemoglobin; NIHSS, National Institutes of Health Stroke Scale.

#Variables of blood sugar on admission, cholesterol, systolic and diastolic blood pressure were changed and were divided into 10.

Table 5. Hazard ratio of variables that did not have a constant hazard ratio over time - Multiple analysis

Variables	HR in day 28 (95% CI)	HR in day 90 (95% CI)	HR in day 180 (95% CI)
Diastolic blood pressure(mmHg)	0.75(0.62-0.91)	0.95(0.80-1.12)	1.33(0.93-1.90)
Stroke severity(NIHSS score)	1.22(1.16-1.28)*	1.29(1.24-1.36)*	1.41(1.29-1.54)
Cholesterol(mg/dL)	1.04(0.99-1.09)	0.95(0.91-1.01)	0.84(0.73-0.95)
Socioeconomic status	1.02(0.86-1.21)	0.71(0.60-0.85)	0.42(0.29-0.62)

* Significant at 0.05 level; CI: confidence interval

#Variables of cholesterol and diastolic blood pressure were changed and were divided into 10.

increasing over time (HR 0.84; 95% CI: 0.73–0.95 after 180 days).

Discussion

This study investigated six-month survival and predictors of mortality among ischemic stroke patients in Iran, providing valuable insights into demographic and clinical factors impacting stroke outcomes in an Iranian cohort. The six-month mortality rate in our study was 19.50%. Age, educational level, and blood sugar on admission were risk factors for stroke mortality, while alcohol consumption, alteplase administration, and elevated hemoglobin were protective factors against post-stroke death. Moreover, the hazard ratio of death varied over time based on diastolic blood pressure, cholesterol level, stroke severity, and socioeconomic status.

Time-Independent Effects in Stroke Mortality

Age was a notable predictor of mortality, as each additional year increased the risk of six-month post-stroke death. This finding is consistent with other research[10,11], where older age is commonly associated with poorer post-stroke outcomes due to age-related physiological decline and coexisting medical conditions.

Interestingly, higher educational level was associated with increased mortality, a finding contrary to the protective effects of education observed in other studies[12,13]. This counterintuitive result could indicate unique cultural or behavioral patterns in this cohort. For instance, individuals with higher educational levels may engage in lifestyle or occupational habits that contribute to elevated stress or other health risks. Additional research into this relationship within the Iranian context may clarify potential confounders.

Alcohol consumption was associated with a lower risk of mortality, although the specific patterns of consumption were not detailed in this study. Consistent with the present study, some studies have reported that a safe amount of alcohol consumption can protect against death from stroke[14,15]. In the present study, the exact amount of alcohol consumption was not measured, and this may have affected the results. However, it should be interpreted cautiously due to the complex health effects of alcohol and the variability in individual tolerance.

The results showed that blood sugar on admission is a risk factor for stroke mortality. According to studies, fasting blood sugar and blood sugar on admission can be significant risk factors for stroke mortality[16]. Hyperglycemia is known to exacerbate ischemic injury by increasing oxidative stress and inflammation, making glucose control critical in acute stroke management[17]. This finding highlights the importance of tight glucose management in reducing early mortality among stroke patients.

The present study revealed the contribution of alteplase administration to a decline in stroke mortality. Similar studies have also reported that alteplase administration can prevent post-stroke death[18,19]. As alteplase helps dissolve clots and restore blood flow, it remains a cornerstone of acute ischemic stroke treatment in eligible patients, reinforcing the need for rapid diagnosis and treatment[20]. Nevertheless, a large percentage of patients miss the golden time for alteplase administration due to delayed referral.

Consistent with the findings of Zhanzhan et al., this study showed that higher hemoglobin levels were linked to a decreased risk of death, likely due to improved oxygen-carrying capacity and better systemic oxygenation[9]. Numerous studies have investigated the association between post-stroke death and anemia and revealed that higher hemoglobin concentrations can prevent post-stroke death[21,22].

Time-Dependent Effects in Stroke Mortality

The concept of time-dependent effects in mortality risk after ischemic stroke refers to how the impact of certain predictors on patient outcomes can change over different time intervals following the initial event. In this study, we observed that several factors exhibited varying effects on mortality risk at different follow-up points (28, 90, and 180 days). Understanding these dynamics is crucial for tailoring post-stroke care and intervention strategies.

Consistent with other studies[23,10,24], stroke severity consistently demonstrated an increasing risk of mortality across all time intervals, possibly due to post-stroke complications. More severe strokes can lead to complications, including common infections such as pneumonia, which can increase the risk of stroke mortality over time[25,26]. This finding demonstrates that the severity of the initial stroke has a long-term impact on recovery, with severe strokes leading to greater impairments and increased mortality risk over time. It underscores the importance of intensive monitoring and targeted rehabilitation, especially as recovery challenges intensify in the months post-stroke.

Socioeconomic status had a significant and evolving impact on mortality risk, which improved over time. Other studies have reported similar results[12,13,27]. This pattern suggests that patients from higher socioeconomic backgrounds may have better access to healthcare resources, rehabilitation services, and support systems that facilitate recovery and improve long-term outcomes. Vivanco-Hidalgo and Juliet Addo have also reported changes in the protective role of socioeconomic status over time. While all patients admitted with stroke can receive similar services in the hospital, after discharge, people with higher economic status are more likely to have access to comprehensive post-hospital stroke care. Hence, long-term stroke mortality is associated with socioeconomic status[28,29].

This study demonstrated that high blood cholesterol level is associated with reduced death within 180 days after stroke. Similar studies have also suggested that a high cholesterol level is a protective factor for long-term survival after stroke, while a low cholesterol level is a risk factor[29,30]. Interestingly, cholesterol levels exhibited a time-varying protective effect on mortality. The HRs indicated an initial risk of 1.04 after 28 days, decreasing to 0.95 at 90 days and 0.84 at 180 days. This suggests that managing cholesterol levels may contribute positively to long-term survival following a stroke, possibly due to improved vascular health and reduced risk of recurrent strokes or cardiovascular events. The increasing protective effect over time highlights the cumulative benefits of lifestyle changes or medications for lowering cholesterol.

Diastolic blood pressure showed a significant initial protective effect on mortality within the first 28 days post-stroke. However, this protective effect diminished over time. Elevated diastolic blood pressure may be beneficial to maintain blood flow in the ischemic brain after acute ischemic stroke, and this beneficial effect may decrease over time[31,32]. This shift may imply that while good blood pressure control is vital initially, long-term management of DBP becomes more complex due to other underlying factors or health changes that arise after the acute phase of the stroke.

The observation of time-dependent effects underscores the necessity for dynamic and adaptable management strategies in post-stroke care. Healthcare providers should not only focus on immediate post-stroke risks but also consider how the influence of various factors can change over time.

This study is one of the few prospective cohort studies conducted in Iran. In this multicenter study, three large hospitals in Tehran were included. Moreover, a high percentage of patients were adherent to follow-up visits (92.3%).

Conclusion

This study examined six-month survival rates and mortality predictors in ischemic stroke patients in Tehran, revealing a 19.50% mortality rate. Key risk factors for increased mortality included older age, higher education, and higher blood sugar at admission, while protective factors were moderate alcohol consumption, alteplase treatment, and higher hemoglobin levels. Some factors, such as diastolic blood pressure, cholesterol levels, stroke severity, and socioeconomic status, showed changing impacts over time on mortality risk.

These results suggest that effective post-stroke care requires not only acute intervention but also ongoing, adaptable management strategies tailored to the changing needs of patients as they progress through recovery. Furthermore, the unique findings related to educational attainment and socioeconomic status in this Iranian cohort call for further research to explore potential cultural, behavioral, and healthcare access differences. Overall, this study advances our understanding of ischemic stroke mortality predictors in an Iranian setting and supports the need for tailored, longitudinal post-stroke care to improve survival and quality of life for stroke patients in diverse populations.

Limitations

Some limitations must be noted. Specific patients, including those with more severe diseases, might have been referred to these referral hospitals. Moreover, the follow-up questions were limited to the outcome under investigation (death), and other independent variables—including smoking, alcohol consumption, medications, blood pressure, etc.—were recorded only at the beginning of the study. Rehabilitation adherence, diet, and post-discharge care access were not recorded during follow-up. Additionally, the time-varying nature of certain variables indicates that longer follow-up studies are warranted to understand their changing impacts on mortality.

Acknowledgements
This manuscript is part of the Ph.D. thesis of Zohre Foroozanfar, conducted at Tehran University of Medical Sciences, Tehran, Iran. We would like to express our gratitude to all individuals and institutions who supported the implementation of this research.

Conflict of interests
The authors declare no conflict of interest.

Funding
There is no funding in this study.

Author's Contributions
Study Conception or Design: ZF
Data Acquisition: ZF, SA, RMS, MMo,
Data Analysis or Interpretation: ZF, MP, SA, MMe, MG, RMS, AY, MMo, AF
Manuscript Drafting: ZF, MP, AY, AF
Critical Manuscript Revision: MP, MMe, MG, AF
All authors have approved the final manuscript and are responsible for all aspects of the work.

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