Austin Journal of Cerebrovascular Disease & Stroke

Open Access

Austin Publishing Group

Research Article

The Relation between Seasonal Variation and the Incidence of Acute Ischemic Stroke

Elham Pishbin[1]; Mohsen Foroughi Pur[2]; Mohammad Bastan[3]; Masumeh Sadeghi[4]; Mahdi Foroughian[5]; Zahra Ahmadi[6]; Saeedeh Anvari[6]; Nayereh Esmaeilzadeh[8]; Elnaz Vafadar Moradi[9*]

[1]Associate Professor, Department of Emergency Medicine, Faculty of Medicine, Mashhad University of Medical Science, Mashhad, Iran

[2]Professor, Department of Neurology, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran

[3]Student Research Committee, Faculty of Medicine, Mashhad University of Medical Science, Mashhad, Iran

[4]Assistant Professor, Department of Epidemiology, Faculty of public health, Mashhad University of Medical Science, Mashhad, Iran

[5]Associate Professor, Department of Emergency Medicine, Faculty of Medicine, Mashhad University of Medical Science, Mashhad, Iran

[6]Student research Committee, Faculty of Medicine, ShahrKord University of Medical Science, Shahrkord, Iran

[7]Department of Neurology, Mashhad University of Medical Science, Mashhad, Iran

[8]Assistant Professor, Department of Epidemiology, School of Health, Mashhad University of Medical Sciences, Mashhad, Iran

[9]Assistant Professor, Department of Emergency Medicine, Faculty of Medicine, Mashhad University of Medical Science, Mashhad, Iran

***Corresponding author: Elnaz Vafadar Moradi**
Assistant Professor, Department of Emergency Medicine, Faculty of Medicine, Mashhad University of Medical Science, Mashhad, Iran.
Tel: 05148525312; Fax: 05138525312
Email: Vafadarme@mums.ac.ir

Received: May 16, 2024
Accepted: June 06, 2024
Published: June 13, 2024

Abstract

Background: Stroke is a serious and potentially life-threatening condition that requires immediate medical attention. Climate change is a pressing global issue with far-reaching implications for human health. One area of concern is the potential link between climate change and the incidence of ischemic stroke. Understanding the relationship between climate and stroke is crucial for developing effective strategies to mitigate its impact on public health.

Objectives: This study aims to investigate this complex relationship in the context of Mashhad, Iran, shedding light on the potential health consequences of climate change in this region.

Method: This retrospective study conducted on the file records of patients admitted with an initial diagnosis of stroke to an institutional referral hospital in eastern Iran in2019. Patients with the confirmed diagnosis based on the physical findings, Computed Tomography (CT), or Magnetic Resonance Imaging (MRI) of brain were included.

Results: 56,039 patients (52.1% women) were referred (21 March 2018 to 20 March 2019). 75.4% of them were over 30 years old (N: 42245), and 51.5% of them were women. The average age of these patients was 58.25 ± 16.51 years. Study showed that acute ischemic stroke was more in men, and more strokes occur in autumn and summer than in spring and winter; the highest number of patients were recorded in summer (N: 577).

Conclusion: Our study showed the seasons and months in which stroke patients are more likely, in order to prepare for a larger number of patients in the months with an increased risk of stroke.

Key words: acute stroke, attack, transient ischemic, seasons

Citation: Pishbin E, Pur MF, Bastan M, Sadeghi M, Foroughian M, et al. The Relation between Seasonal Variation and the Incidence of Acute Ischemic Stroke. Austin J Cerebrovasc Dis & Stroke. 2024; 10(1): 1091.

Introduction

Stroke is a medical condition that occurs when the blood supply to a part of the brain is interrupted or reduced, leading to damage or death of brain cells [1]. It is a serious and potentially life-threatening condition that requires immediate medical attention [2,3].

Ischemic stroke is a type of stroke that occurs when a blood vessel supplying blood to the brain becomes blocked, leading to a lack of oxygen and nutrients to brain tissue [3-5]. This blockage can be caused by a blood clot or plaque buildup in the blood vessels [6]. Ischemic strokes account for the majority of all strokes and can result in permanent damage to the brain if not treated promptly [7]. Symptoms of an ischemic stroke can include sudden weakness or numbness on one side of the body, difficulty speaking or understanding speech, and sudden vision changes [8,9].

Understanding the risk factors, symptoms, and treatment options for stroke is crucial in order to prevent and manage this debilitating condition [10].

Several risk factors can increase the likelihood of experiencing an ischemic stroke [11,12]. These risk factors include high blood pressure, diabetes, high cholesterol, smoking,

Obesity, physical inactivity, family history, and older age [13,14].

Climate change can indirectly impact the risk of ischemic stroke through various pathways [15]. One of the key ways in which climate change is impacting the risk of ischemic stroke is through extreme heat events [16]. As global temperatures rise, heatwaves are becoming more frequent and intense [15,17]. Prolonged exposure to high temperatures can increase the risk of dehydration, heat exhaustion, and heatstroke, all of which are risk factors for ischemic stroke. Additionally, extreme heat can exacerbate existing health conditions such as high blood pressure and diabetes, which are also risk factors for stroke [18].

Climate change is also affecting air quality, another important factor in the development of ischemic stroke [19,20]. Rising temperatures and changing weather patterns are leading to increased levels of air pollution, particularly in urban areas [21]. Poor air quality has been linked to a higher risk of cardiovascular diseases, including stroke. Fine particulate matter and other pollutants in the air can trigger inflammation and oxidative stress in the body, leading to damage to blood vessels and an increased risk of blood clots [20,22].

Furthermore, climate change is impacting patterns of infectious diseases, which can also contribute to the risk of ischemic stroke. Changes in temperature and precipitation can alter the distribution and prevalence of vector-borne diseases such as Lyme disease and West Nile virus, both of which have been associated with an increased risk of stroke. In addition, climate change is creating conditions that are conducive to the spread of certain bacteria and viruses that can cause infections that may lead to stroke [18].

To address the growing threat of ischemic stroke in the context of climate change, it is essential for policymakers, healthcare providers, and individuals to take action [19]. This includes implementing measures to reduce greenhouse gas emissions and mitigate the effects of climate change, such as transitioning to renewable energy sources and promoting sustainable transportation options [20]. This study aimed to evaluate climate change and incidence of ischemic stroke in patients referring to a neurologic center of an academic hospital.

Material and Methods

The present study was a retrospective study of file records of patients admitted with an initial diagnosis of stroke to an institutional referral hospital in eastern Iran in 2019. This study was conducted before the covid-19 pandemic because after the covid-19 pandemic, studies showed some association between infection and vaccination.

All patients suspected of stroke enrolled in this study, and patients with a confirmed diagnosis based on the physical findings, Computed Tomography (CT), or Magnetic Resonance Imaging (MRI) of brain were included. So, out of 56039 patients admitted in the study period, 2073 people were finally admitted with the diagnosis of ischemic stroke. Patients with intra parenchymal hemorrhage (CIH), Subarachnoid Hemorrhage (SAH), or any occupational mass were excluded from the study.

As this was a retrospective study on patient health records, neither an informed consent was required, nor did we intervene in the treatment of patients.

The demographic information of patients, including main signs and symptoms, and the clinical outcome (remission or death) were extracted from archived health records.

Daily weather information of "40745-Mashhad" station was obtained using the meteorological site of the Meteorological Organization of Iran (http://www.irimo.ir). Data included daily mean temperature, and minimum and maximum temperature (degrees Celsius).

To manage the data, Excel and SPSS Ver 25 software were used. The quantitative variables of temperature and age were reported using the central indicators of the mean and standard deviation and their appropriate graphs. The data related to gender variables and outcome/s of patients (qualitative variables) were reported using percentages. Qualitative data were compared using a chi-square test and quantitative data were compared between two groups using independent T-test. To evaluate the relationship/effect of temperature changes on the occurrence of stroke and transient ischemic attacks by controlling the effect of age, a logistic regression model was used. P-value>0.05 was considered significant in all statistical tests.

The study was approved by the National Committee for Ethics in Biomedical Research of Mashhad University of Medical science (IR.MUMS.MEDICAL.REC.1400.619).

Results

56,039 patients (52.1% women) were referred to Ghaem Hospital during one year (April 1 to March 8, 2016). 75.4% of

Table 1: Variables between stroke group and other patients.

		Ischemic stroke or TIA	Other patients	P- value
		%	%	
Sex	*Male*	(30/5) 1089	(70/94) 19388	001/0>
	Female	(50/4) 984	(50/95) 20784	
Seasons	*Spring*	(70/4) 506	(30/95) 10204	
	Summer	(20/5) 577	(80/94) 10492	
	Autumn	(40/5)496	(60/94) 10344	001/0>
	Winter	(10/4) 394	(90/95) 9132	
Standard deviation ± mean				
Age (Year)		25/14±22/69	42/16±69/57	001/0>

Table 2: Adjusted odds ratio of stroke occurrence (logistic regression results).

Variables		Crude	P-Value	Adjusted	P-Value
		OR (95% CI)		OR (95% CI)	
Mean Temperature		(01/1 - 00/1) 00/1	Mar-00	(01/1 - 001/1) 005/1	Feb-00
Age (Year)		(05/1 - 04/1) 04/1	001/0>	(05/1 - 04/1) 04/1	001/0>
Sex	Female (Reference)	1		1	0/25
	Male	(30/1 - 09/1) 19/1	001/0>	(15/1 - 96/0) 05/1	

Table 3: Adjusted odds ratio of stroke occurrence (logistic regression results).

Variables		Crude	P-Value	Adjusted	P-Value
		OR (95% CI)		OR (95% CI)	
Age (Year)		(05/1 - 04/1) 04/1	001/0>	(05/1 - 04/1) 04/1	001/0>
Sex	Female (Reference)	1		1	23/0
	Male	(30/1 - 09/1) 19/1	001/0>	(16/1 - 96/0) 06/1	
Season	Spring (reference)	1		1	
	Summer	(99/0 - 76/0) 87/0	Apr-00	(10/1 - 78/0) 92/0	38/0
	Autumn	(31/1 - 03/1) 16/1	Feb-00	(37/1 - 04/1) 19/1	Jan-00
	Winter	(25/1 - 98/0) 11/1	Sep-00	(27/1 - 95/0) 10/1	19/0

them were over 30 years old (N: 42245), and 51.5% of them were women. The average age of these patients was 58.25 ± 16.51 years. 5% (2073) were admitted with the diagnosis of stroke and Transient Ischemic Attack (TIA). The diagnosis of TIA (450) and stroke (1623) was confirmed by the neurologist treating the patient. The lowest and the highest number of patients were in January and November, respectively. 80% of these patients were finally discharged from the hospital and 6% of them died. About 13% also left the hospital with personal consent.

Study showed that acute ischemic stroke was more in men, and it was statistically significant (Table-1). Ischemic stroke was also investigated in different seasons of the year. Our study showed that more strokes occur in autumn and summer than in spring and winter; the highest number of patients were recorded in summer (N: 577).

The average age of the patients in our study was higher than other patients who were admitted to the hospital with another complaint (average age: 69.22).

The analysis of the relationship between average air temperature or time of admission and occurrence of stroke or TIAs by controlling the confounding effect of age and gender variables using multiple logistic regression model is reported in Tables 2 and 3. Based on this, the results show that temperature changes have a significant relationship with the occurrence of stroke by controlling the effect of age and gender variables of the studied subjects in the period from April to March 2017, although the effect size (OR=1.005, 95% CI=1.001-1.001) is very insignificant (Table 2).

The results of multiple logistic regression related to the relationship between time of admission (season) and occurrence of stroke or TIA showed that the chance of occurrence of stroke was compared with controlling the effect of age and gender variables in autumn season compared to the spring season, it was 1.19 times or equal to 19% more (Table 3).

Discussion

In this study, the relationship between seasonal changes and the incidence of acute ischemic stroke was investigated. A total of more than 2000 patients who were hospitalized with a diagnosis of stroke or TIA during one year were included in the study, it was shown that the highest and lowest number of patients were admitted in November and January, respectively, and November admission was nearly 6.5% of all patients and this amount reached 3.6% in January. It was shown that in the occurrence of acute ischemic stroke, the highest number (compared to the total number of admitted patients) were admitted in the fall season and the lowest number were hospitalized in the winter season.

In 2018 [22], Fodor et al investigated seasonal variations in the incidence of different types of strokes in Romania. More than 1000 patients with different types of strokes (ischemic, hemorrhagic, and SAH) were included in this study. They showed that the incidence of ischemic stroke has two peaks, one peak in summer and one peak in winter [22]. Also, the lowest rate of ischemic stroke was observed in September and the highest rate was observed in January. It should be noted that the city where Fodor et al.'s study was conducted is located in the center of Europe and has a relatively mild climate, while our study was conducted in Mashhad, which has a hot and dry climate, which can also lead to to the difference of the results of two studies. Mild climates are associated with lower rates of hypertension, a major risk factor for ischemic stroke. Additionally, people in mild climates may be more physically active and have better access to fresh fruits and vegetables, which can help reduce the risk of stroke [18].

On the other hand, in dry climates, where humidity levels are low and temperatures can fluctuate significantly, there may be an increased risk of dehydration, which is a known risk factor for ischemic stroke [12]. Dehydration can lead to thickening of the blood and increased blood viscosity, which can increase the risk of blood clots forming and causing a stroke. Dry climates are also associated with higher rates of respiratory infections, which can increase the risk of stroke through inflammation and other mechanisms [11].

In 2022, Fuji et al. [23] reviewed 1.4 million Japanese patients enrolled in a stroke registry, in which 6688 strokes were reported over 3 years, of which 4480 were ischemic strokes. The lowest occurrence of stroke was in summer and the highest was in winter.

The findings obtained in our study are not consistent with this study because the incidence of stroke in winter was lower in our study. One reason that may lead to different results is that in our study, TIA cases were also evaluated as cerebrovascular events, but Fuji et al. evaluated only stroke. Also, as previously mentioned, the differences in climate between the two countries can lead to differences in results.

Another study in 2021 by Cortez et al. examined seasonal changes in the incidence of stroke in Brazil over a 10-year period. The health system data available in the Brazilian were evaluated and a total of more than 1 million and 400 thousand hospitalizations due to stroke were examined. The results showed that the incidence of stroke in the cold months of winter was higher than in other months. However, the authors stated that the type of stroke (hemorrhagic or ischemic) was not reported in more than 70% of cases, and the findings were reported for the total number of strokes (excluding ischemic or hemorrhagic) [24]. Overall, Iran and Africa have different climates due to their geographical locations, with Iran having a mix of arid and subtropical climates, while Africa has a wide range of climates from

desert to tropical to temperate. These climate differences can impact various aspects of disease, including stroke. Of course, Kurtz's study has two strengths that have led to an increase in the accuracy of their study compared to ours. Firstly, by using the coordinated information of hospital systems in this country, the authors were able to provide a relatively large sample size, and secondly, the duration of the study was 10-years.

In-hospital mortality of our studied patients was equal to 5.9%. In 2021, Huang et al. [25] investigated the in-hospital mortality rate of more than 800,000 patients with ischemic stroke in China, and the results showed that the mortality rate was less than 1%, which is much lower than the mortality has been in the study. On the other hand, Seminario et al. [26] in Peru reported in-hospital mortality of ischemic stroke equal to 6.9%, which is higher than our study.

When comparing in-hospital mortality rates for stroke between different countries, it is important to consider these factors and analyze the data in the context of the specific healthcare systems, population characteristics, and socio-economic conditions of each country. Research studies and international collaborations can provide valuable insights into understanding and addressing disparities in stroke outcomes worldwide.

Conclusion

Our study showed the seasons and months in which stroke patients are more likely, so physicians can use this information to prepare in advance for a larger number of patients in the months with an increased risk of stroke. This research sheds light on the potential health consequences of climate change in this region and underscores the importance of implementing mitigation strategies to protect public health.

One of the limitations of the current study was that the survey was conducted within one year, and if the duration of the study was longer, the results would have been more accurate.

Failure to investigate the amount of air pollution and its relationship with the incidence of stroke was another limitation of this study.

Author Statements

Ethical Consideration

This study was supported by the Research Vice-Chancellor of Mashhad University of Medical Science (IR.MUMS.MEDICAL.REC.1400.619)**.**

Authors Contribution

EVM and EP Conceptualization; Methodology, MS, and NS; Data curation, MB and ZA; Software and Writing- Original draft preparation by EVM and MFP and MF. Visualization, Investigation by SRAK and EP; all authors finalized the manuscript**.**

Acknowledgment

This thesis study was conducted by Dr. EVM as a supervision of MB to graduate as a Medical Doctor, which was approved by the research committee of Mashhad University of Medical Science (4001009).

References

1. Campbell BCV, De Silva DA, Macleod MR, Coutts SB, Schwamm LH, Davis SM, et al. Ischaemic stroke. Nat Rev Dis Primers. 2019; 5: 70.
2. Campbell BC, Mitchell PJ, Yan B, Parsons MW, Christensen S, Churilov L, et al. A multicenter, randomized, controlled study to investigate EXtending the time for Thrombolysis in Emergency Neurological Deficits with Intra-Arterial therapy (EXTEND-IA). Int J Stroke. 2014; 9: 126-32.
3. GBD 2016 Neurology Collaborators. Global, regional, and national burden of neurological disorders, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet Neurol. 2019; 18: 459-480.
4. GBD 2016 Lifetime Risk of Stroke Collaborators, Feigin VL, Nguyen G, Cercy K, Johnson CO, Alam T, et al. Global, Regional, and Country-Specific Lifetime Risks of Stroke, 1990 and 2016. N Engl J Med. 2018; 379: 2429-2437.
5. Boehme AK, Esenwa C, Elkind MS. Stroke Risk Factors, Genetics, and Prevention. Circ Res. 2017; 120: 472-495.
6. Ovbiagele B, Goldstein LB, Higashida RT, Howard VJ, Johnston SC, et al. American Heart Association Advocacy Coordinating Committee and Stroke Council. Forecasting the future of stroke in the United States: a policy statement from the American Heart Association and American Stroke Association. Stroke. 2013; 44: 2361-75.
7. Yeboah J, Young R, McClelland RL, Delaney JC, Polonsky TS, et al. Utility of Nontraditional Risk Markers in Atherosclerotic Cardiovascular Disease Risk Assessment. J Am Coll Cardiol. 2016; 67: 139-147.
8. Miraj S, Alesaeidi S, Kiani S. A systematic review of the relationship between dystemprament (sue Mizaj) and treatments and management of diseases (Ilaj and Eslah-e-Mizaj). Electron Physician. 2016; 8: 3378-3384.
9. Lim JS, Kwon HM, Kim SE, Lee J, Lee YS, Yoon BW. Effects of Temperature and Pressure on Acute Stroke Incidence Assessed Using a Korean Nationwide Insurance Database. J Stroke. 2017; 19: 295-303.
10. Lu Zhou, Cheng He, Ho Kim, Yasushi Honda, Whanhee Lee,et al. The burden of heat-related stroke mortality under climate change scenarios in 22 East Asian cities. Environment International. 2022; 170: 107602.
11. Arboix A, Cartanyà A, Lowak M, García-Eroles L, Parra O, Oliveres M, et al. Gender differences and woman-specific trends in acute stroke: results from a hospital-based registry (1986-2009). Clin Neurol Neurosurg. 2014; 127: 19-24.
12. Chen Z, Liu P, Xia X, Wang L, Li X. Temperature variability increases the onset risk of ischemic stroke: A 10-year study in Tianjin, China. Front Neurol. 2023; 14: 1155987.
13. Marshall IJ, Wang Y, Crichton S, McKevitt C, Rudd AG, Wolfe CD. The effects of socioeconomic status on stroke risk and outcomes. Lancet Neurol. 2015; 14: 1206-18.
14. Qi X, Wang Z, Xia X, Xue J, Gu Y, et al. Potential Impacts of Meteorological Variables on Acute Ischemic Stroke Onset. Risk Manag Healthc Policy. 2020; 13: 615-621.
15. Thornton PK, Ericksen PJ, Herrero M, Challinor AJ. Climate variability and vulnerability to climate change: a review. Glob Chang Biol. 2014; 20: 3313-28.
16. Foroughian M, Pishbin E, Ziyaei M, Vafadar moradi E, Foroughipour M, Javadzadeh R. Ten-year Causes of Cerebral Venous Sinus Thrombosis in Patients Referred to Ghaem Hospital during the Years 2009 to 2019. Bulletin of Emergency And Trauma. 2024; 12: 8-14.
17. Bahonar A, Khosravi A, Khorvash F, Maracy M, Saadatnia M. Seasonal and Monthly variation in stroke and its subtypes-10 Year Hospital-Based Study. Mater Sociomed. 2017; 29: 119-123.

18. Asadi MH, Changizi-Ashtiyani S. The Relationship between Stroke and Seasonal Variations in Persian Medicine. Int J Prev Med. 2020; 11: 79.

19. Shigematsu K, Watanabe Y, Nakano H, Kyoto Stroke Registry Committee. Higher ratio of ischemic stroke to hemorrhagic stroke in summer. Acta Neurol Scand. 2015; 132: 423-9.

20. Kumar N, Venkatraman A, Garg N. Seasonality in acute ischemic stroke related hospitalizations and case fatality rate in the United States. Int J Cardiol. 2015; 195: 134-5.

21. Gomes J, Damasceno A, Carrilho C, Lobo V, Lopes H, et al. The effect of season and temperature variation on hospital admissions for incident stroke events in Maputo, Mozambique. J Stroke Cerebrovasc Dis. 2014; 23: 271-7.

22. Fodor DM, Fodor M, Perju-Dumbravă L. Seasonal variation of stroke occurrence: a hospital based-study. Balneo Research Journal. 2018; 9: 82-87.

23. Fujii T, Arima H, Takashima N, Kita Y, Miyamatsu N, et al. Seasonal Variation in Incidence of Stroke in a General Population of 1.4 Million Japanese: The Shiga Stroke Registry. Cerebrovasc Dis. 2022; 51: 75-81.

24. Kurtz P, Bastos LS, Aguilar S, Hamacher S, Bozza FA. Effect of seasonal and temperature variation on hospitalizations for stroke over a 10-year period in Brazil. Int J Stroke. 2021; 16: 406-410.

25. Huang ZX, Gu HQ, Yang X, Wang CJ, Wang YJ, Li ZX. Risk factors for in-hospital mortality among acute ischemic stroke patients in China: a nationwide prospective study. Neurol Res. 2021; 43: 387-395.

26. Labán-Seminario LM, Carrillo-Larco RM, Bernabé-Ortiz A. Stroke-related length of hospitalization trends and in-hospital mortality in Peru. PeerJ. 2022; 10: e14467.