ORIGINAL ARTICLE

Temporal Trends in Suspected Stroke Incidents: A Time Series Analysis of Emergency Medical Service Calls

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Abstract

Background: Stroke is recognized as the second leading cause of death and the primary cause of disability in developing and underdeveloped countries. This study investigated the time trend of calls for suspected stroke received by the Emergency Medical Services (EMS) from 2013 to 2019 in Shiraz, Iran.

Methods: This was a descriptive - ecological study using time series data. The necessary data were extracted from the Shiraz Emergency Medical Center from 2013 to 2019. Excel 2013 and SPSS (version 24.0) were used for data analysis. The results were then presented in figures and tables.

Results: From 2013 to 2019, the EMS call center in Shiraz City received 844,004 calls, of which 6,620 were suspected stroke cases. The number of suspected stroke cases demonstrated a steady trend within a certain range from 2013 to 2016. However, there was a significant increase between 2016 and 2017, after which the number of stroke cases reached relative stability. In the short-term seasonal trend, we found that the number of suspected stroke cases reported to EMS was higher in cold seasons compared to warm seasons.

Conclusion: The results showed that the long-term trend of reported suspected stroke cases to EMS is currently stable, following a previous increase in Iran.

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Keywords: Emergency medical services, Iran, Stroke, Time series Analysis, Trends

Introduction

Stroke is the second leading cause of death and disability in developing and underdeveloped countries.[1-3] In the United States, stroke ranks as the seventh leading cause of death.[4] According to the World Health Organization (WHO), there were 6.1 million deaths due to stroke in 2019.[5]

Although global mortality rates have decreased over the past two decades, the absolute number of people who experience a stroke each year, stroke survivors, stroke-related deaths, and the overall stroke burden (measured by the Disability-Adjusted Life Year (DALYs)) have shown an increasing trend. Temporal changes in stroke incidence and mortality from cerebrovascular disease have been investigated in several studies across different countries with various climatic conditions. However, contradictory findings have obscured the conclusions.[6-11]

A systematic review of a population-based stroke study across 28 countries revealed an increasing trend in stroke incidence in low-income and middle-income countries. In contrast, there has been a 42 percent reduction in high-income countries over the last four decades.[12] According to a study by Wang et al. (2017) conducted on the population of rural and urban areas of China, the trend of mortality rates among these populations has been declining over the last three decades.[13] With the increasing awareness of stroke symptoms in the community, the trend of long-term calls suspected of having a stroke to emergency

medical services has increased.[14] A short-term trend review in Finland showed a seasonal increase in the trend of acute ischemic and hemorrhagic strokes during the winter season.[15]

Given that the management of acute stroke is time-dependent, early detection of symptoms and swift transportation to a hospital can reduce related mortality and disabilities[5]. Emergency Medical Services (EMS) personnel are expected to be proficient enough to diagnose, examine, manage, treat, triage, and transport stroke patients on time.[16] In Iran, the '724' system, which provides specific services for acute stroke patients seven days a week and 24 hours a day, and the SAMA (Emergent Stroke) code, aimed at the rapid identification and screening of patients suspected of acute stroke, have been established since July 2015.[17] These initiatives aim to establish better communication and coordination between the EMS system and stroke centers for faster transmission by either air or land. There are challenges and potential areas for improvement in stroke care in Iran that can be addressed by increasing public awareness and implementing an organized program in the healthcare system.[18]

Since the short-term and long-term course of stroke in Iran is not well known, and due to the crucial role of diagnosis, treatment, and early transfer of stroke patients by EMS, this study was conducted to determine the seasonal trend of suspected stroke calls in Iran (Fars). The findings of this study could be useful for presenting to authorities for educational planning in pre-hospital and hospital emergencies, as well as for raising public awareness and training relevant personnel.

Methods

The current study is a descriptive-analytical ecological one, utilizing time series data. A time series is a set of statistical data collected at regular intervals, and the statistical methods that employ these data are referred to as time series analysis.[19] The data for this study were extracted from 2013 to 2019 from Shiraz City's emergency medical call center. The software registered these data in this center by month and year. Shiraz is the capital of Fars province and is the sixth metropolis of Iran.[20] According to the 2016 Census data, the population of Shiraz city is 1,565,572.[21] The initial data included all Emergency Medical Service Center calls from 2013 to 2019. In this study, the number of calls made to Shiraz's emergency medical services from 2013 to 2019 diagnosed with suspected stroke based on the diagnosis by Emergency Medical Technicians (EMTs) or EMS physicians were used as a time series. Excel 2013 was used to sort the time series data based on stroke classification. This data was then entered into SPSS16 software, and the frequency of suspected stroke cases and the ratio of these calls to total calls based on month and year were determined. The trend chart of suspected stroke calls was plotted monthly and yearly in SPSS. This study was approved by the ethics committee of Shahid Sadoughi University of Medical Sciences-Iran (IR.SSU.REC.1399.268).

Results

According to this study's findings, Shiraz EMS received 844,004 calls, categorized into 15 separate sections. Out of these, 522,266 calls resulted in the dispatch of an ambulance. Among these dispatched calls, 6,620 were emergency calls for suspected strokes. Table 1 provided detailed data on calls for suspected stroke, broken down by month between 2013 and 2019.

Figure 1 shows the annual trend of suspected stroke calls to the Shiraz Emergency Center from 2013 to 2019.

As depicted in Figure 1, the overall long-term time trend of stroke incidence experienced a significant increase between 2016 and 2017. Following this increase, it has reached a state of relative stability and is projected to maintain this stability in the upcoming years.

Figure 2 shows seasonal trends of suspected stroke contacts with Shiraz Emergency Center (2013-2019).

As illustrated in the chart above, stroke-related calls have generally risen from 2013 to 2019 and are higher each year in winter and lower in summer compared to other seasons.

Discussion

The results of our study revealed that the time trend of

Table 1: Annual and Monthly Distribution of Suspected Stroke-Related Calls (2013-2019)

Month / Year	April	May	June	July	August	September	October	November	December	January	February	March
2013	48	32	49	47	51	51	41	58	59	55	53	42
2014	44	49	54	53	37	56	33	56	57	74	48	50
2015	53	43	31	29	39	35	55	53	54	40	53	55
2016	67	67	52	54	37	39	47	41	36	41	86	65
2017	70	78	71	88	82	117	96	114	107	145	137	130
2018	100	112	112	115	153	114	115	116	126	129	164	131
2019	114	137	127	107	106	131	106	121	139	127	172	115

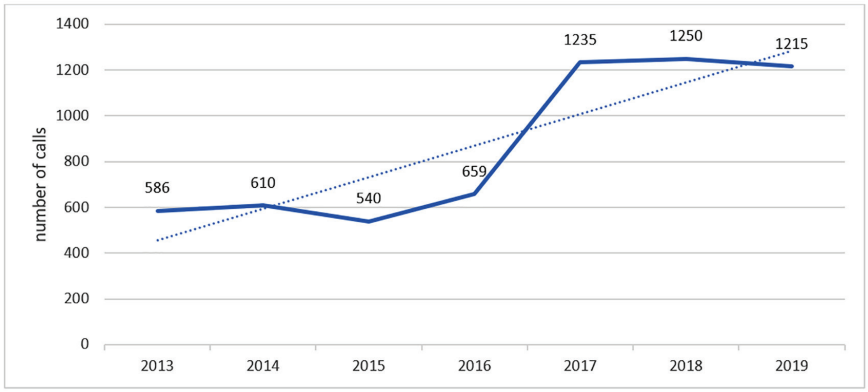

Figure 1: Annual Trend of Suspected Stroke Calls Received by Shiraz Emergency Center (2013-2019)

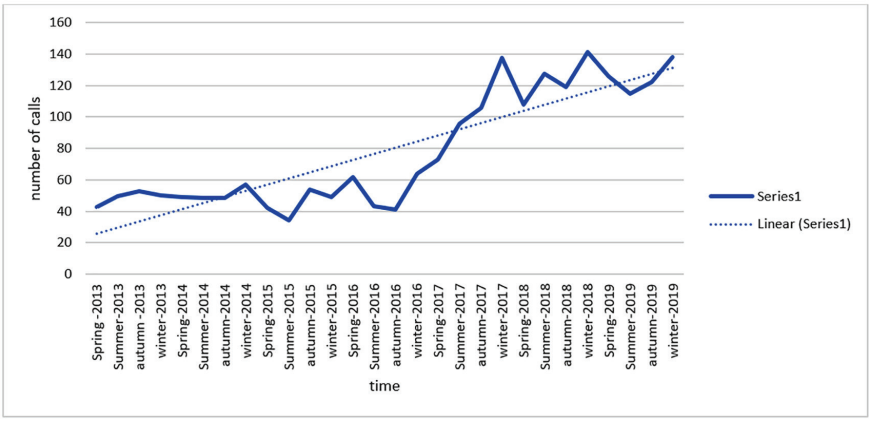

Figure 2: Seasonal Trends of Suspected Stroke Case Contacts at Shiraz Emergency Center

incidents leading to contact with the EMS call center, suspected of stroke, after a rise, is currently at a steady annual level. However, in seasonal and monthly surveys, this prevalence is more pronounced in winter, especially in February, compared to other seasons. Other studies corroborated these findings. For instance, Farhang and colleagues investigated the seasonal prevalence of thrombotic stroke in two seasons, the winter and summer of 1998-1999, at the Loghman Hakim Medical Training Center. They demonstrated that 63% of patients with thrombotic stroke in the neurology ward of Loghman Hospital occurred in winter and 37% in summer.[22] Similarly, Jalkorevic and colleagues assessed seasonal variations in the prevalence of stroke in the Finnish adult population between 1982 and 1992 and reported the prevalence of stroke as 12% higher in winter than in summer.[15] However, another cross-sectional study aimed at assessing the frequency of stroke patients who were referred to the emergency department in summer and winter in 2020 in Tehran indicated that the prevalence of stroke was higher in hot seasons than in cold seasons.[23] These contradictory results may be attributed to the classification of types of strokes. Overall, the prevalence of stroke was higher in winter than in summer, which may be due to the increased prevalence of respiratory infections in the winter. Respiratory infections can also increase plasma fibrinogen and anti-cardiolipin antibodies and reduce protein C levels.[24] Cold climate is also associated with high blood pressure, so cold weather, especially in winter, raises blood pressure, especially in older people, and increases the risk of stroke.[25]

The results of our study demonstrated that the trend of suspected stroke events has remained almost constant annually. This stability began around 2017 and continued until 2019, with a slight decline (e.g., 4 percent per year), which is expected to persist. This finding aligns with the results of previous studies. For instance, a study on stroke incidence and 10-year survival in Sweden from 1975 to 2001 found that stroke rates and short-term mortality exhibited a stable pattern in Sweden between 1975 and 1990.[26] Other studies have also indicated that the incidence of stroke in most industrialized countries remained stable from the second half of the 1970s to the end of the 1980s.[27-29] Another study conducted between 1990 and 2010 revealed that strokes decreased by approximately 10% in developed countries and increased by 10% in developing countries.[30] It appears that in Shiraz City, representing Iran, the increasing trend of strokes has ceased, and a decreasing trend has begun, signifying the end of the silent peak of strokes. This shift mirrors the change in disease trends in developed countries, where the rate of reduction in stroke incidence began many years ago, potentially due to increased public awareness about stroke risk factors or lifestyle changes in the community.

Conclusion

Our study's results revealed that after an initial increase, the long-term trend of reported suspected stroke cases in EMS is stable. In the short-term seasonal trend, we found that the number of suspected stroke cases in EMS was higher in cold seasons compared to warm seasons.

Authors' Contribution

SS &MJM & MS & SM & KHN conceptualized and designed the study. SS& MJM collected the data. SS & MS & SM & KHN analyzed the data. All authors have met criteria for authorship and had a role in preparing the manuscript. Also all authors approved the final manuscript.

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Ethical Approval

This work received approval from the ethics committee of Shahid Sadoughi University of Medical Sciences-Iran (IR.SSU.REC.1399.268). Consent to participate is not applicable.

Conflict of Interest: None declared.

References

1 Johnson W, Onuma O, Owolabi M, Sachdev S. Stroke a global response is needed. Bulletin of the World Health Organization. 2016; 94(9):634. doi: 10.2471/BLT.16.181636. PMID: 27708464.

2 Ter-Stepanyan A, Azizian A, Gasparyan K, Ghazaryan G, English P. Assessing initial psychometric properties of the Armenian version of the Miller Forensic Assessment of Symptoms Test (M-FAST) with psychiatric patients and simulator participants. Journal of Forensic Psychology Research and Practice. 2021; 21(4):355-72. doi: 10.1080/24732850.2021.1879209.

3 Thomas Q, Crespy V, Duloquin G, Ndiaye M, Sauvant M, Béjot Y, et al. Stroke in women: When gender matters. Revue Neurologique. 2021; 177(8):881-9. doi: 10.1016/j.neurol.2021.01.012.

4 Collins J, Rybinnik I, Fischberg B, McCoy J. Stroke, Oxygen and Prehospital Care: A Commentary on Current Treatments and Opportunities for Improvement. Journal of Experimental Neurology. 2021; 2(1). doi: 10.33696/Neurol.2.034.

5 Bhutta ZA, Pathan SA, Puolakka T, Akhtar N, Thomas SH, Harris T, et al. Awareness and Community Response to Stroke Signs and Symptoms Following the National 'Act Fast'Campaign in an Ethnically Diverse Population. 2021. doi: 10.21203/rs.3.rs-798434/v1.

6 Shinkawa A, Ueda K, Hasuo Y, Kiyohara Y, Fujishima M. Seasonal variation in stroke incidence in Hisayama, Japan. Stroke. 1990; 21(9):1262-7. doi: 10.1161/01.str.21.9.1262. PMID: 2396260.

7 Douglas A, Allan T, Rawles J. Composition of seasonality of disease. Scottish medical journal. 1991; 36(3):76-82. doi: 10.1177/003693309103600304. PMID: 1925507.

8 Rothwell P, Slattery J, Warlow C, Wroe S. Is stroke incidence related to season or temperature? The Lancet. 1996; 347(9006):934-6. doi: 10.1016/s0140-6736(96)91415-4. PMID: 8598757.

9 Sobel E, Zhang Z, Alter M, Lai S, Davanipour Z, Friday G, et al. Stroke in the Lehigh Valley: seasonal variation in incidence rates. Stroke. 1987; 18(1):38-42. doi: 10.1161/01.str.18.1.38. PMID: 3810768.

10 Biller J, Jones MP, Bruno A, Adams Jr HP, Banwart K. Seasonal variation of stroke–does it exist? Neuroepidemiology. 1988; 7(2):89-98. doi: 10.1159/000110140. PMID: 3374731.

11 Tsementzis S, Kennet R, Hitchcock E, Gill J, Beevers D. Seasonal variation of cerebrovascular diseases. Acta neurochirurgica. 1991; 111(3):80-3. doi: 10.1007/BF01400492. PMID: 1950692.

12 Feigin VL, Lawes CM, Bennett DA, Barker-Collo SL, Parag V. Worldwide stroke incidence and early case fatality reported in 56 population-based studies: a systematic review. The Lancet Neurology. 2009;8(4):355-69. doi: 10.1016/S1474-4422(09)70025-0. PMID: 19233729.

13 Wang W, Wang D, Liu H, Sun H, Jiang B, Ru X, et al. Trend of declining stroke mortality in China: reasons and analysis. Stroke and Vascular Neurology. 2017; 2(3). doi: 10.1136/svn-2017-000098. PMID: 28989803. PMCID: PMC5628381.

14 Bray JE, Straney L, Barger B, Finn J. Effect of public awareness campaigns on calls to ambulance across Australia. Stroke. 2015; 46(5):1377-80. doi: 10.1161/STROKEAHA.114.008515. PMID: 25828236.

15 Jakovljević D, Salomaa V, Sivenius J, Tamminen M, Sarti C, Salmi K, et al. Seasonal variation in the occurrence of stroke in a Finnish adult population:

the FINMONICA Stroke Register. Stroke. 1996; 27(10):1774-9. doi: 10.1161/01.str.27.10.1774. PMID: 8841328.

16 Crocco T, Grotta J, Jauch E, Kasner S, Kothari R, Larmon B, et al. EMS management of acute stroke—prehospital triage (resource document to NAEMSP position statement). Prehospital Emergency Care. 2007; 11(3):313-7. doi: 10.1080/10903120701347844. PMID: 17613906.

17 Kolivand P-H, Faraji Sabokbar H, Saberian P, Bahmanabadi M, Hasani-Sharamin P, Baratloo A. Spatial analysis of geographic distribution and accessibility of suspected acute stroke patients transferred to acute stroke centers by emergency medical services in Tehran, Iran: a cross-sectional study. Iranian Red Crescent Medical Journal. 2020; 22(7): e101502. doi: 10.5812/ircmj.101502.

18 Shahjouei S, Bavarsad-Shahripour R, Assarzadegan F, Rikhtegar R, Mehrpour M, Zamani B, et al. Acute management of stroke in Iran: Obstacles and solutions. Iranian journal of neurology. 2017; 16(2):62. PMID: 28761627. PMCID: PMC5526779.

19 Esling P, Agon C. Time-series data mining. ACM Computing Surveys (CSUR). 2012; 45(1):1-34. doi: 10.1145/2379776.2379788.

20 Asgari Q, Sarkari B, Amerinia M, Panahi S, Mohammadpour I, Sarvestani AS. Toxoplasma Infection in farm animals: a seroepidemiological survey in Fars province, south of Iran. Jundishapur Journal of Microbiology. 2013; 6(3):269-72. doi: 10.5812/jjm.5195.

21 Iran SCo. Results of the 2016 census by city. 2016. https://irandataportal.syr.edu/wp-content/uploads/Iran_Census_2016_Selected_Results.pdf data avilibality: 1.1.2024.

22 FARHANG A, HEMATI A. THE STUDY OF THE SEASONAL PREVALENCE OF THROMBOTIC STROKE IN WINTERS AND SUMMERS OF 1998.99 LOGMAN HAKIM HOSPITAL. 2003.

23 Forouzanfar MM, Sepehrirad A, Heydari K, Mirbaha S. Statistical Comparison of Stroke Patients Visiting an Emergency Department During Summer Versus Winter: A Cross-Sectional Study. Archives of Neuroscience. 2020; 7(2). doi: 10.5812/ans.101946.

24 Ogata T, Kimura K, Minematsu K, Kazui S, Yamaguchi T, Collaboration JMSI. Variation in ischemic stroke frequency in Japan by season and by other variables. Journal of the neurological sciences. 2004; 225(1-2):85-9. doi: 10.1016/j.jns.2004.07.002. PMID: 15465090.

25 Kawahara J, Sano H, Fukuzaki H, Saito K, Hiroucht H. Acute effects of exposure to cold on blood pressure, platelet function and sympathetic nervous activity in humans. American journal of hypertension. 1989; 2(9):724-6. doi: 10.1093/ajh/2.9.724. PMID: 2529881.

26 Terént A. Trends in stroke incidence and 10-year survival in Soderhamn, Sweden, 1975-2001. Stroke. 2003;34(6):1353-8. doi: 10.1161/01.STR.0000074038.71700.1C. PMID: 12750535.

27 Brown RD, Whisnant JP, Sicks J, O'Fallon WM, Wiebers DO. Stroke incidence, prevalence, and survival: secular trends in Rochester, Minnesota, through 1989. Stroke. 1996; 27:373-80. PMID: 8610298.

28 Numminen H, Kotila M, Waltimo O, Aho K, Kaste M. Declining incidence and mortality rates of stroke in Finland from 1972 to 1991: results of three population-based stroke registers. Stroke. 1996; 27(9):1487-91. doi: 10.1161/01.str.27.9.1487. PMID: 8784117.

29 Morikawa Y, Nakagawa H, Naruse Y, Nishijo M, Miura K, Tabata M, et al. Trends in stroke incidence and acute case fatality in a Japanese rural area: The Oyabe study. Stroke. 2000; 31(7):1583-7. doi: 10.1161/01.str.31.7.1583. PMID: 10884458.

30 Feigin VL, Forouzanfar MH, Krishnamurthi R, Mensah GA, Connor M, Bennett DA, et al. Global and regional burden of stroke during 1990–2010: findings from the Global Burden of Disease Study 2010. The lancet. 2014;383(9913):245-55. doi: 10.1016/s0140-6736(13)61953-4. PMID: 24449944. PMCID: PMC4181600.