Scholars Journal of Applied Medical Sciences
Abbreviated Key Title: Sch J App Med Sci
ISSN 2347-954X (Print) | ISSN 2320-6691 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

Neurosurgeon

Comparison of CNN and RNN Approaches for Brain Tumor Detection Using MRI Image Datasets

Zia ullah [1], Jehanzeb [2], Anwar ullah [3], Hanif Ur Rehman[4*], Mewat shah [5], Fazal ghani [6]

[1]Consultant Neurologist dhq Hospital timergira lower dir , Pakistan
[2]Consultant Neurosurgeon dhq hospital charsadda Pakistan
[3]Consultant Neurosurgeon dhq hospital timergira Pakistan
[4]Consultant Neurosurgeon Prime Hospital Peshawar, Pakistan
[5]Assistent Prof Gajju khan medical hospital shah mansoor swabi Pakistan
[6] consultant neurosurgeon Khyber teaching hospital Peshawar Pakistan

DOI: 10.36347/sjams.2022.v10i03.022 | **Received:** 25.02.2022 | **Accepted:** 22.03.2022 | **Published:** 31.03.2022

***Corresponding author:**Jehanzeb , Anwar ullah
[2]Consultant Neurosurgeon dhq hospital charsadda Pakistan
[3]Consultant Neurosurgeon dhq hospital timergira Pakistan

Abstract **Original Research Article**

Introduction: Heart disease and cancer are the top two killers in the world, but strokes are the third most common cause of death worldwide. Furthermore, one-third of stroke victims are left with long-term disabilities. An Ischemic-strokes account for 80% of all strokes, while hemorrhagic strokes account for 20% of all strokes. ***Aim of this study***:the study was conducted in department of neurology dhq hospital timergira lower dir Pakistan the aim of this study is comparing the haemorrhagic and ischemic stroke patients – analysis of mortality, clinical development and relationship between stroke variables. ***Methodology:*** *out of 100 patients This study has a descriptive and exploratory design. The current study comprised 100 participants with a known stroke incidence (57 men and 43 women). The difference in statistics between infarct and haemorrhage on demographic and clinical variables was established using univariate and multivariate analysis.*. ***Data analysis:*** The data on a total of 100 patients with the two types of strokes were evaluated using various statistical tools on clinical and demographic factors. Conclusion: When compared to ischemic stroke, hemorrhagic stroke impacted a younger age group. According to the unilabiate analysis, using spss 2.4 for calculation of sample size and and demographically calculation for stroke patients with a history of hypertension showed a statistically negligible connection between their hypertensive history and the occurrence of the condition.

Keywords: Comparison,Cnn and Rnn, Haemorrhage, stroke, clinical, risk etc.

1. INTRODUCTION

Stroke is one of the top causes of mortality and disability around the world. Due to the accessibility of intense therapies, ischemic stroke is currently viewed as a period subordinate and records for 87% of all strokes. Intracerebral bleed, which represents 10% of all strokes, and aneurysmal subarachnoid bleed, which represents 3% of all strokes, are instances of hemorrhagic strokes[1]. 27 million individuals kicked the bucket of ischemic stroke in 2017, 3 million from intracerebral bleed and 0.4 million from an aneurysmal subarachnoid heamorrhage in 2017.[2,3] By in large, ischemic stroke has a preferable result over hemorrhagic stroke, which is bound to result in mortality in the acute and subacute stages.[4] Because "stroke" comes from the Greek word "apoplexia," which means "deadly blow," drawing direct comparisons between our modern understanding of stroke and what has traditionally been referred to as apoplexy would be incorrect. [12,13]

A stroke is a medical disease in which blood flow to the brain is disrupted. The brain begins to die within minutes without the oxygen and nutrients carried by blood resulting in various combination of weakness in the limbs, facial muscels. [14] swaolluwing,speech, memory vison and hearing.stroke can also cause various Gait problems, movement disorders and dementias. A stroke is a health related crisis that requires prompt consideration.Early mediation and intervention can restore blood flow to the brain parenchyma and hence

major disabilities can be prevented. Ischemic strokes represent most strokes (87%). [5] Blood is carried to the brain by anterior and posterior circulation and when at any point this blood flow is disrupted, ischemic stroke occurs. Ischemic strokes are often caused by blood clots, emboi from heart and other areas [6]. Ischemic strokes happen when the blood supply routes that transport blood to the mind become stopped up, bringing about the deficiency of blood flow to cerebrum tissue. [7]Ischemic strokes can be isolated into two classes.Thrombotic Strokes - Thrombotic strokes happen when a thrombus is formed in blood circulation of the brain Embolic Strokes - Embolic strokes result from emboli that are formed outside the brain and iscarried to the brain by blood .they are most commonly from heart and is thrown into brain circulation.bllod clots from other parts of the body can also reach the brain via systemic blood flow. [8,9]

A hemorrhagic stroke happens when an artery mostly small arteries in brain ruptures and causing spelling of the blood to brain parenchyma.this results in various forms of weakness in the body and may be even death. A hemorrhagic stroke can be very lethal if it occurs in the brain stem and can cause sudden death. Bleed may occur in brain parenchyma or in between skull and the meninges . About 20% of all strokes are caused by this condition. [10] A hemorrhagic stroke occurs when a blood vessel ruptures in the brain and causes bleeding into the brain. Intracerebral haemorrhage (ICH) and subarachnoid haemorrhage are two additional types of hemorrhagic stroke (SAH) [4]. Hemorrhagic strokes are classified into two groups based on the location of the bleeding and the aetiology:

Intracerebral haemorrhage - A broken blood vessel in the brain causes intracerebral haemorrhages.

Subarachnoid haemorrhage - When a blood vessel ruptures and bleed into the subarachnoid space .they are known as subarachnoid heamorhge .When the brain loses access to its important blood supply due to bleeding from a blood artery, hemorrhagic strokes occur. Ischemic strokes, on the other hand, occur when one of the blood arteries feeding the brain becomes blocked Several risk factors can raise your possibility of having an ischemic stroke or a hemorrhagic or ischemic stroke:

- High -cholesterol
- High- blood- pressure
- Heart -disease
- Diabetes
- Advancing -age
- Alcohol & drug abuse
- Poor diet choices

Emilia Salvadori, *et al*. (2021)Studies comparing the recovery outcomes of ischemic (IS) and hemorrhagic (HS) strokes have shown inconsistent results. [15] We needed to assess useful results upon release from a serious restoration medical clinic, think about IS versus HS, and break down potential indicators in this review observational examination of successive IS and HS patients. The key outcome was the Modified Rankin Scale (mRS) at discharge. HS was found in 81 of the 229 patients (mean age 72.9 13.9 years, 48 percent men) (35 percent). HS patients were significantly younger (75 ± 12.5 vs. 68.8 ± 15.4 years, p = 0.002), required longer hospitalizations both in acute (23.9 ±36.7 vs. 35.2 ±29.9 days, p = 0.019) and rehabilitation hospitals (41.5 ±31.8 vs. 77.2 ±51.6 days, p = 0.001), and had more severe initial clinical deficits (mean number of neurological impairments: 2.0 ±1.1 vs. 2.6 ± 1.4. Rosa De Lima Renita Sanyasi and Rizaldy Taslim Pinzon (2018) -Because stroke is a life-threatening disorder, it is critical to recognise and recognise various stroke symptoms. [16,17] Stroke treatment is delayed due to a lack of awareness about the symptoms of a stroke. The goal of this study is to examine ischemic versus hemorrhagic stroke clinical symptoms and risk variables. This was a case-control experiment. Ischemic and hemorrhagic stroke patients were the participants of this investigation. Subject information was entered into an electronic stroke registry at Yogyakarta's Bethesda Hospital. [18] Leg weakness was the most prevalent clinical complaint in both groups (76.4 percent vs 71.4 percent), while facial drooping was the least common (2 percent vs 3.6 percent). The most prevalent risk factor in both groups (48 percent vs. 71.4 percent) was hypertension, while atrial fibrillation was the most uncommon. [19] Amelia K. Boehme, *et al*. (2017) Because stroke is such a diverse sickness, establishing risk factors and treatment is dependent on the pathogenesis of the disease. There are two kinds of hazard factors for stroke: modifiable and non-modifiable. Non-modifiable danger factors for both ischemic and hemorrhagic stroke incorporate age, sexual orientation, and race/identity, while modifiable danger factors incorporate hypertension, smoking, diet, and actual latency. The focal point of stroke anticipation has generally been modifiable danger factors. [20] Changes in way of life and conduct, for example, dietary changes or stopping smoking, bring down the danger of stroke, yet additionally, bring down the danger of other cardiovascular diseases. [21] Zhang Y, *et al.* (2011) The combined effects of many lifestyle factors on stroke risk are yet unknown, particularly in the case of hemorrhagic stroke. We studied the relationship between different lifestyle indicators (smoking, BMI, physical activity, and vegetable and alcohol consumption) and total and type-specific stroke incidence in 686 Finnish participants aged 25 to 74 who were free of coronary heart disease and stroke at the start of the study. [22] 1478 patients had an incident stroke event over the course of a 13.7-year follow-up period

(1167 ischemic and 311 hemorrhagic). Both men and women had comparable inverse relationships. [23]

Ivica Bilić, *et al*. (2009) The goal of the research was to prove that risk factors for ischemic and hemorrhagic strokes are the same. [24] A total of 1066 stroke patients were included in this retrospective analysis. Patients with ischemic and hemorrhagic stroke were compared in terms of risk variables and hospital-based survival. Patient records were consulted for information. For dependent samples, statistical analysis was performed using the chi2-test and the t-test. There were 70 (47.9%) female patients and 76 (52.1%) male patients in the hemorrhagic stroke group. Ischemic stroke patients were split into two groups: 450 (48.9%) females and 470 (51.1%) males. Finally, data analysis revealed differences between hemorrhagic and ischemic strokes in terms of risk factors as well as stroke outcomes. [25]

Problem statement

There were very few research dedicated to the topic of stroke until recently. However, as a result of a shifting trend, several prospective and retrospective studies are now being done to shed more light on the riddle of stroke. Some studies discovered a relationship between high cholesterol and an increased risk of ischemic stroke, whereas others did not. It solely examined hemorrhagic stroke and discovered a negative connection, with an elevated risk even at the lowest total cholesterol level. However, no clear findings could be obtained from these studies on stroke risk factors. As a result, the study is titled "Comparative Study on Hemorrhagic and Ischemic Strokes - Analysis of Mortality, Clinical Development, and the Relationship Between Stroke Variables."

Objectives of the study

- To discuss the concept of hemorrhagic and ischemic stroke
- To think about clinical discoveries and hazard factors in hemorrhagic and ischemic stroke patients.
- To estimate the variables that influence the mortality result of a stroke in the medical clinic.

5. MATERIALS & METHODS

The design of this research is descriptive and exploratory. The study conducted in department of neurology dhq hospital timergira lower dir Pakistan sample size 100 divided in two group after the reeving ethical approval form hospital ethical board . The current study included 100 patients (57 men and 43 women) who had been admitted with a confirmed stroke, which was defined as a sudden start of a neurological deficit or a subarachnoid haemorrhage with symptoms lasting at least 24 hours. (Unless death occurred within 24 hours of symptom onset or CT/MRI revealed a lesion consistent with the symptoms) and there is no underlying brain trauma, tumour, or infection that is causing the symptoms.This study was carried out at dhq hospital timergira lower dir Pakistan primarily low-income rural and urban residents with low literacy rates.

Type of Stroke

Using all available data, skilled physicians classified stroke cases as ischemic or hemorrhagic. When the abstractor was unable to determine the type of stroke based on the physical diagnosis or imaging reports, the documentation was evaluated by a study physician in consultation with a neurologist to classify the stroke type.

Criteria of the study

Inclusion Criteria

- Patients over the age of 45 were included because they make up the majority of that age group.
- Patients with a CT scan that shows a lesion.

Exclusion Criteria

- Stroke in people under the age of 45.
- Patients with cardioembolic and venous thrombosis who have had a stroke.

Tools and Methods used in this study

In each case, a complete history of the onset, predisposing factors, and nature of the stroke was recorded. Following that, a thorough clinical examination was performed to check for the GCS and the existence of seizures. Patients were asked about risk factors such as SHT, DM, smoking, and alcohol consumption.

Patients were then sent for extra tests, for example, a total hemogram, glucose, urea, creatinine, serum electrolytes, and a chest X-ray. Within 48 hours of the beginning of a stroke, all patients had a fasting lipid profile performed by a computerized analyzer. In intense stroke, serum TG fixations don't change, and estimation inside the initial 48 hours seems, by all accounts, to be a decent impression of typical TG esteems in individual patients.

Reverberation was utilized to check and screen the cardiovascular framework depending on the situation. ALOKA echocardiography was utilized to perform two-dimensional and M mode echocardiography with the patient in the left horizontal position. The echocardiogram was performed by a senior cardiologist. This cardiologist, who was dazed too, did not settle the presence of blood clots sooner rather than later. The construction of the mitral, aortic, tricuspid and aspiratory valves (different phases of spewing forth and stenosis were evaluated) just as the

presence of vegetations were given exceptional consideration.

- In all instances, an EKG was performed to rule out acute coronary syndrome, arrhythmias, and signs of long-term hypertension.
- All cases received a CT scan within 24 hours. For patients who had a posterior circulatory stroke, an MRI was performed.
- For analysis, all of the data's results are presented in tabular form.

Statistical tools used in this study

- Clinical and demographic data, with frequencies and percentages assigned to qualitative forms.
- Clinical and demographic data, with mean and standard deviation for quantitative forms.
- Univariate analysis was used to determine whether there was a substantial distinction between haemorrhage and infarct on demographic and clinical variables.
- A multivariate calculated relapse examination was utilized to decide the factual importance contrast among discharge and infarct dependent on segment and clinical factors.
- P-value of less than 0.05 was considered to be significant.

6. DATA ANALYSIS AND RESULTS

6.1 Demographic profile

The table and figure below show the stroke subtypes that occur:

Table-1: Type of the stroke

Type of Stroke	F	%
Hemorrhage	22	22%
Infarct	74	74%
SAH	4	4%
Total	100	100

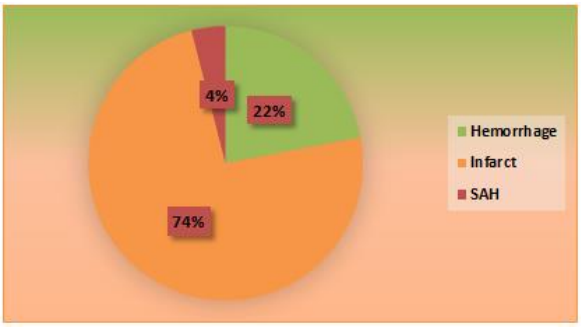

Fig-1: Type of the stroke

It is stated from the above table that 22% of the patients suffer from Hemorrhage, 74% suffer from Infarct and the remaining 4% suffer from SAH. The below table and figure depicting the sex shows a preponderance of ischemic stroke in the male gender.

Table-2: Gender of the Patient

Type of stroke	Male	Female
Hemorrhage	9	13
Infarct	50	24
SAH	1	3

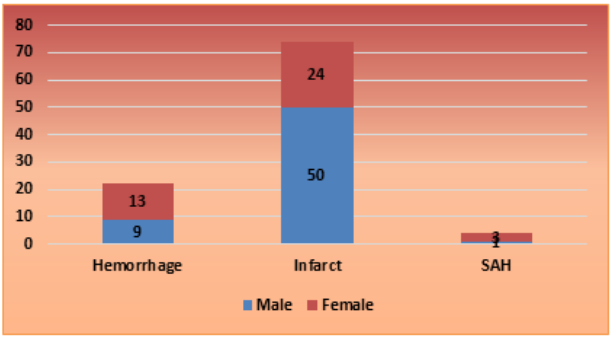

Fig-2: Gender of the Patient

It is stated that 9 males and 13 females suffer from Hemorrhage, 50 males, 24 females suffer from Infarct and 1 male, 3 females suffer from SAH stroke.

Table-3: Age group of the Patient

Age group	Hemorrhage	Infarct
46-55	2	5
56-65	15	23
66-75	5	39
76-85	0	7

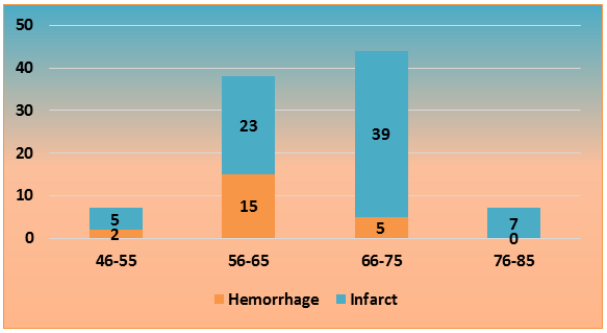

Fig-3: Age group of the Patient

Although the figure and table show a linear relationship between stroke and age in the 45-75 age group, it is worth noting that the incidence of hemorrhagic stroke decreases in the 66-75 age group.

Table-4: Relationship between smoking and stroke

Opinion	Infarct	Haemorrhage
Smoking	43	5
No smoking	5	4

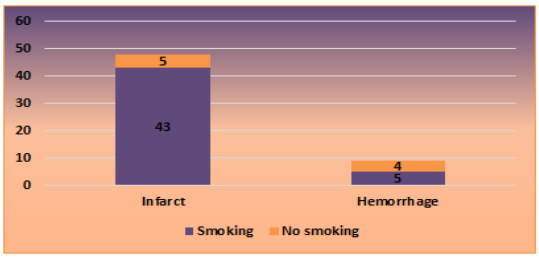

Fig-4: Relationship between Smoking and Stroke

It is stated from the above table and figure that 43 from infarct and 5 from Haemorrhage have come under smoking while remaining comes under the no-smoking category.

Relationship between Demographic and ClinicalVariablesofStroke

Table-5: Relationship between DemographicandClinicalVariablesofStroke

Variables	Infarct	Hemorrhage	SAH	P value*
Sex(M: F)	48:26	8:14	1:3	0.03
Hypertension history	47%	50%	50%	0.97
Diabetichistory	50%	36%	50%	0.53
Smoking	58%	22%	25%	0.01
Alcohol	51%	14%	25%	0.01
Seizures	14%	59%	50%	0.001

*P<0.05issignificant

Men outmatched women overall, and in cases of infarction, men had a higher incidence of hemorrhagic stroke. The discovery that people with a history of hypertension, diabetes, smoking, and alcohol consumption were more likely to have an infarct is a significant step forward during the study.

6.3 Relationship among types of strokes and Variables through Univariate analysis

Table-6: Relationship among types of strokes and Variables through Univariate analysis

Variables	Infarct (Mean ±SD)	Hemorrhage (Mean ±SD)	SAH (Mean ±SD)	Pvalue*
Age	67.69±8.55	62.40±8.06	62.40±7.91	0.006
SBP	162.90±18.75	184.74±28.66	173.02±29.72	0.001
Diastolic blood pressure	108.47±16.59	122.10±21.42	117.01±27.34	0.005
High density lipoprotein	36.55±8.12	48.37±5.12	47.03±2.32	0.001
Low density lipoprotein	164.82±30.39	134.28±25.78	138.24±25.33	0.001
Totalcholesterol	231.10±24.13	229.16±21.63	227.15±22.11	0.71
TGL	252.29±31.60	231.46±31.16	228.26±33.25	0.01

*P<0.05issignificant

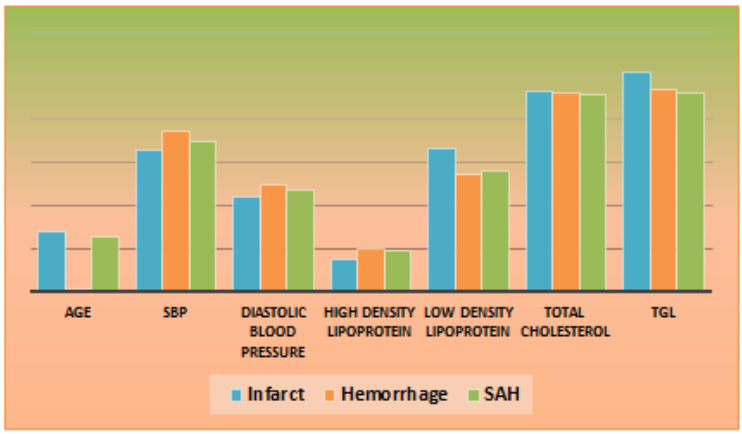

Fig-5: Mean of the variables

Compared to ischemic stroke, hemorrhagic stroke affects younger people. Ischemic stroke victims were on average 67.69 years old, compared to 62.40 for hemorrhagic stroke victims. Subarachnoid haemorrhage patients were, on average, 59.75 years old. Because aneurysms are the most common cause of subarachnoid haemorrhage, it occurs early. Patients between the ages of 56 and 65 are most commonly affected by

hemorrhagic stroke. Cerebral infarction, on the other hand, usually strikes people between the ages of 66 and 75.

On the other hand, our research found a larger tendency toward bleeding (48.37) than ischemia in terms of mean HDL levels (36.55). A similar link was found in a previous study done in Western Washington between 1989 and 2000. HDL values were found to be 55 in hemorrhagic stroke patients and 50 in ischemic stroke patients. According to another case-control study, the link between HDL cholesterol and stroke was stronger in those with atherosclerotic vascular disease, and our findings support this. The presence of a low HDL-C concentration was found to be associated with an increased risk of dying from an ischemic stroke in a 1997 multivariate analysis. A 5% drop in HDL cholesterol was linked to a 1.18 relative risk (95 percent confidence interval, 1.04 to 1.35). Higher HDL –C levels, on the other hand, were shown to be more closely associated with nonfatal stroke in a study published in 2000. Stroke death did not have any connections to anything in the study. The theory put forth was that fatal stroke patients who were also heavy drinkers had greater HDL levels. When it came to subarachnoid haemorrhage and cerebral infarction, higher levels of HDL cholesterol were linked to lower risk, but not to a higher risk of bleeding inside the brain itself. All of the subgroups had cholesterol levels above 200 on average. Hemorrhagic patients, on the other hand, had a mean blood pressure of 227.15±22.11. [231.10±24.13] was lower than in ischemic stroke. According to the results of a study done in Western Washington, hemorrhagic strokes have a lower mean TC level (229) than ischemic strokes (235). Low levels of serum cholesterol may cause endothelial weakness in the tiny intracerebral arteries, resulting in hemorrhagic stroke when combined with hypertension.

Univariate Analysis of steady factors uncovered that age, LDL, complete cholesterol and greasy substances had a straight relationship with infarct and more raised degrees of systolic circulatory strain, diastolic pulse and HDL were more associated with hemorrhagic stroke.

6.4 Development of the stroke through Multivariate analysis

It is shown by the Multivariate assessment of hazard factors for stroke by strategic relapse that the high HDL-C level has in reverse association with the improvement of ischemic stroke however the high LDL-C has a direct relationship.

Table-7: Development of the stroke through Multivariate analysis

Variables	Significant	Exp(B)
Diastolic blood pressure	0.97	1.036
High density lipoprotein cholesterol	0.001	.812
Low density lipoprotein cholesterol	0.23	1.029
Seizures	0.12	.254

Diastolic and high diastolic blood pressure were found to be strongly linked to hemorrhagic stroke as well. All variables' significant values are less than or equal to 1.00, so it's noteworthy.

Variables including diastolic blood pressure, low-density lipoprotein cholesterol, and total cholesterol were found to be strongly correlated with mortality rates exclusively in patients who had ischemic strokes.

6.5 Mortalityofstrokepatients in Hospitals

Table-8: Mortalityofstrokepatients in Hospitals

Variables	Significant	Odds ratio	Lower limit	Upper limit
Diastolic blood pressure	0.023	1.31	1.18	1.69
High density lipoprotein	0.108	0.840	0.679	1.041
Low density lipoprotein	0.001	1.35	1.13	1.88
Totalcholesterol	0.001	1.277	1.12	1.461

CONCLUSION

The examination arrived at the accompanying resolutions: Although smoking, liquor, high LDL and low HDL are earnestly associated with ischemic stroke, the autonomous danger factors for the improvement of stroke are high LDL and low HDL.

High levels of diastolic circulatory strain, LDL – C, outright cholesterol are independent danger factors for mortality in stroke patients. Ischemic stroke is normal resident than for hemorrhagic stroke. Males are ordinarily impacted than females.

FINDINGS

Our study conclusion that Hemorrhagic stroke accounted for just 26% of the cases, whereas infarct stroke accounted for 74%. (ICH 22 percent, SAH 4 percent).

Hemorrhagic stroke patients had lower mean LDL cholesterol levels (134.28 mg/dL) than those with ischemia (164.82 mg/dL; P = 0.001). It is clear from the univariate LDL cholesterol study that having a higher LDL – C level raises your risk of heart disease and stroke.

We found that our study group had higher TGL levels in infarct patients (252.2±31.60) compared to hemorrhagic patients (231.46±31.16) while considering triglycerides. As indicated by David Tanne *et al*., Director of the stroke unit at Sheeba Medical Center in Israel, high fatty oil levels are related to an expanded danger of ischemic stroke. This connection is huge. As per our discoveries, men dwarf ladies with regards to ischemic strokes, which are more normal. Hemorrhagic strokes were likewise more normal in ladies. The average age was determined to be 65 for both sexes.

REFERENCES

1. Coupland, A. P., Thapar, A., Qureshi, M. I., Jenkins, H., & Davies, A. H. (2017). The definition of stroke. *Journal of the Royal Society of Medicine*, *110*(1), 9-12.
2. Gebreyohannes, E. A., Bhagavathula, A. S., Abebe, T. B., Seid, M. A., & Haile, K. T. (2019). In-hospital mortality among ischemic stroke patients in Gondar University Hospital: a retrospective cohort study. *Stroke research and treatment*, *2019*.
3. Rojsanga, W., Sawanyawisuth, K., Chotmongkol, V., Tiamkao, S., Kongbonkiat, K., & Kasemsap, N. (2019). Clinical risk factors predictive of thrombotic stroke with large cerebral infarction. *Neurology International*, *11*(2), 12-14.
4. Mehta, P., & Aka, Unnithan. (2020). Hemorrhagic Stroke. https://www.ncbi.nlm.nih.gov/books/NBK559173/
5. Silva, G. S., Koroshetz, W. J., González, R. G., & Schwamm, L. H. (2011). Causes of ischemic stroke. *Acute ischemic stroke*, 25-42.
6. Salvadori, E., Papi, G., Insalata, G., Rinnoci, V., Donnini, I., Martini, M., ... & Poggesi, A. (2020). Comparison between ischemic and hemorrhagic strokes in functional outcome at discharge from an intensive rehabilitation hospital. *Diagnostics*, *11*(1), 38.
7. Rosa De Lima Renita Sanyasi and Rizaldy Taslim Pinzon. (2018). Clinical symptoms and risk factors comparison of ischemic and hemorrhagic stroke.jkki, 9(1)
8. Boehme, A. K., Esenwa, C., & Elkind, M. S. (2017). Stroke risk factors, genetics, and prevention. *Circulation research*, *120*(3), 472-495.
9. Zhang, Y., Tuomilehto, J., Jousilahti, P., Wang, Y., Antikainen, R., & Hu, G. (2011). Lifestyle factors on the risks of ischemic and hemorrhagic stroke. *Archives of internal medicine*, *171*(20), 1811-1818.
10. Bilić, I., Džamonja, G., Lušić, I., Matijaca, M., & Čaljkušić, K. (2009). Risk factors and outcome differences between ischemic and hemorrhagic stroke.
11. *Acta Clinica Croatica*, *48*(4), 399-403. Wu, D.; Rice, C.M.; Wang, X. Cancer bioinformatics: A new approach to systems clinical medicine. BMC Bioinform. 2012, 13, S7. [CrossRef] [PubMed]
12. Kumar, S.; Dabas, C.; Godara, S. Classification of brain MRI tumor images: A hybrid approach. Procedia Comput. Sci. 2017, 122, 510–517. [CrossRef]
13. Fathallah-Shaykh, H.M.; DeAtkine, A.; Coffee, E.; Khayat, E.; Bag, A.K.; Han, X.; Warren, P.P.; Bredel, M.; Fiveash, J.; Markert, J. Diagnosing growth in low-grade gliomas with and without longitudinal volume measurements: A retrospective observational study. PLoS Med. 2019, 16, e1002810. [CrossRef] [PubMed]
14. Ghassemi, N.; Shoeibi, A.; Rouhani, M. Deep neural network with generative adversarial networks pre-training for brain tumor classification based on MR images. Biomed. Signal Process. Control 2020, 57, 101678. [CrossRef]
15. Mohan, G.; Subashini, M.M. MRI based medical image analysis: Survey on brain tumor grade classification. Biomed. Signal Process. Control 2018, 39, 139–161. [CrossRef]
16. Akkus, Z.; Galimzianova, A.; Hoogi, A.; Rubin, D.L.; Erickson, B.J. Deep learning for brain MRI segmentation: State of the art and future directions. J. Digit. Imaging 2017, 30, 449–459. [CrossRef]
17. Lundervold, A.S.; Lundervold, A. An overview of deep learning in medical imaging focusing on MRI. Z. Med. Phys. 2019, 29, 102–127. [CrossRef]

18. Chuquicusma, M.J.M.; Hussein, S.; Burt, J.; Bagci, U. How to fool radiologists with generative adversarial networks? A visual turing test for lung cancer diagnosis. In Proceedings of the 2018 IEEE 15th International Symposium on Biomedical Imaging (ISBI 2018), Washington, DC, USA, 4–7 April 2018; pp. 240–244.
19. Litjens, G.; Kooi, T.; Bejnordi, B.E.; Setio, A.A.A.; Ciompi, F.; Ghafoorian, M.; Van Der Laak, J.A.; Van Ginneken, B.; Sánchez, C.I. A survey on deep learning in medical image analysis. Med. Image Anal. 2017, 42, 60–88. [CrossRef] [PubMed]
20. Yousefi, M.; Krzyzak, A.; Suen, C.Y. Mass detection in digital breast tomosynthesis data using convolutional neural networks and ˙ multiple instance learning. Comput. Biol. Med. 2018, 96, 283–293. [CrossRef]
21. Gu, Y.; Lu, X.; Yang, L.; Zhang, B.; Yu, D.; Zhao, Y.; Gao, L.; Wu, L.; Zhou, T. Automatic lung nodule detection using a 3D deep convolutional neural network combined with a multi-scale prediction strategy in chest CTs. Comput. Biol. Med. 2018, 103, 220–231. [CrossRef]
22. Elshennawy, N.M.; Ibrahim, D.M. Deep-Pneumonia Framework Using Deep Learning Models Based on Chest X-Ray Images. Diagnostics 2020, 10, 649. [CrossRef] [PubMed]
23. Pacal, I.; Karaboga, D.; Basturk, A.; Akay, B.; Nalbantoglu, U. A comprehensive review of deep learning in colon cancer. Comput. Biol. Med. 2020, 126, 104003. [CrossRef]
24. Yao, Z.; Li, J.; Guan, Z.; Ye, Y.; Chen, Y. Liver disease screening based on densely connected deep neural networks. Neural Netw. 2020, 123, 299–304. [CrossRef] 15. Zuo, H.; Fan, H.; Blasch, E.; Ling, H. Combining convolutional and recurrent neural networks for human skin detection. IEEE Signal Process. Lett. 2017, 4, 289–293. [CrossRef]
25. Charron, O.; Lallement, A.; Jarnet, D.; Noblet, V.; Clavier, J.-B.; Meyer, P. Automatic detection and segmentation of brain