

Risk factors and causes of Ischemic Stroke in young patients (18 to 49 years old) in Colombia – A Systematic Review.

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Introduction: A cerebrovascular accident (CVA) is the main cause of disability in the world. Its incidence is increasing, even in young people. Because of the aforementioned, risk factors and various etiologies of CVA in young people must be studied for planning preventive actions. For this reason, in Colombia it is necessary to learn about such factors and etiologies by analyzing the studies about this topic. **Methodology:** a search and analysis of papers about causes and risk factors of ischemic CVA in Colombia, published in Pubmed, Lilacs, Scielo, Google Scholar was made. After reviewing titles and summaries those that were not dealing with young people between 18 to 49 years old, or Ischemic CVA, topic reviews, duplicate works were excluded. Finally 20 papers were analyzed. **Results of the Discussion:** Most studies were reports or cases series, summing up 60 people. No sex predominance was found, except in those cases of Antiphospholipid Syndrome (APS) who were women, unlike most of the world series. The highest frequency was 56% for other determined causes as APS and dissection of craniocervical vessels, higher than other reports. A low frequency of large vessel disease was found, similar to other studies. The small vessel disease was higher than others reports in Latam. **Conclusions:** Most of the information came from reports and cases series which could not prove the actual frequency of causes and risk factors. It is important to mention Neurocysticercosis and Psychoactive substances, as CVA causes coming from the Colombian review.

Keywords: Cerebrovascular accident, young adult, risk factors, etiology, Colombia.

Introduction

The cerebrovascular accident (CVA) is the second cause of death and the main cause of disability in the world⁽¹⁾. CVA incidence has increased not only on elderly people, but as expected, it also increased in young patients, in low/medium income countries⁽¹⁾. It is a problem of developed countries or developing countries, due to incidence increase, high mortality, physical/psychosocial morbidity, and also

because of its social consequences⁽²⁾. Factors modifying the incidence and prevalence of CVA are: geographic location, sex, ethnic group, social/economic stratum, air pollution at any age⁽²⁾.

It was thought that in people younger than 50 years old, risk factors different from tobacco addiction, Diabetes, Hypertension, Hyperlipidemia or Alcohol Abuse had to be considered; however, in this age group it is increasing⁽³⁾. In young people, CVA has risk

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factors and various etiologies⁽²⁾. To identify the etiology would allow to develop preventive programs and handling strategies allowing to reduce social/physiological/ psychological effects of CVA in young people⁽²⁾. Thence the importance to learn about the etiology and risk factors of CVA in young patients in Colombia, which would allow –in the long term– to plan timely/specific preventive actions.

Methodology

A search of the terms ((stroke OR cerebrovascular) AND (Colombia)) in Lilacs, Scielo. (((“Stroke”[Mesh]) OR (stroke OR cerebrovascular))) AND Colombia en Pubmed was made. In Google Scholar the terms (stroke, cerebrovascular, epidemiology, etiology, risk factors, Colombia) was made in order to improve search specificity. For titles reading, from Google Scholar 980, from Scielo 99, from Lilacs 150, in Pubmed 330 papers were considered. An individual reading was made by each of the reviewers JDVM and SPIJ.

A review of the titles was made by searching those related with causes or etiological factors of cerebrovascular accidents in Colombia. Those related with treatment (212), prognosis (139), those not including analysis in the target population of the study (887), literature reviews (125), those related with of venous sinus thrombosis (19), only intracranial bleeding (36), duplicate (78) were excluded.

63 studies titles were chosen (13 from Scielo, 8 from LILACS, 15 from PUBMED, 27 from SCHOLAR) making reference to causes or etiological factors of cerebrovascular accidents in Colombia. Later the 63 summaries were read. Those that did not make an analysis in the target population of the study⁽²⁰⁾, aggregative studies⁽¹³⁾, reflection papers⁽¹⁾, intracranial bleeding⁽¹⁾, those not reporting CVA 7 cause were excluded. The file of a title found en LILACS 1 could not be recuperated.

For this review 20 papers were considered. These were analyzed by each author, by agreement the information of the number of patients, age, risk factors, CVA cause involved vascular area was obtained.

Results

A systematic review was made, aimed to identify risk factors and ischemic CVA causes in young patients in Colombia. The age range was 18 years old or older, but younger than 50 years old. Most data came from reports and cases series. All of the reports involved 60 people (Table 1).

After reading León Sarmiento, et al. article⁽⁴⁾ not data of this publication were included, because it did not include population within the age range of interest.

According to our findings, the amount of men and women reported was the same, considering the cases where the gender was specified. However, in the cohort whose etiology was APS⁽⁵⁾, 84% of the population was female, so a higher number of cases in women was correlated. The variability in age/gender report did not allow to identify predominance of one or the other gender, at early or late ages.

Large vessel atherosclerosis was determined in 2 people coming from a series of cases in Bogotá⁽⁶⁾. Such study encompassed 14.28% of all patients.

Small vessel disease was a CVA cause in 11 cases. Most of them had a genetic origin due to CADASIL disease⁽⁷⁻⁹⁾ and in a sporadic lower proportion^(6,10). in the series of Saavedra M, et al. was found only one Lacunar Stroke, representing 7.14% of all cases.

7 cases of cardioembolic etiology, most of them high risk sources were found. Reported causes such as Cor Triatriatum Sinistrum⁽¹¹⁾, left Atrial Myxoma⁽¹²⁾, Mitral Valve Endocarditis⁽¹³⁾. Saavedra M, et al. study⁽⁶⁾ described 3 cases of Cardioembolism related with mitral valve disease, an Acute Myocardial Infarction, a possible paradoxical embolism or arterial embolism from carotid artery, which encompassed 21.42% of all patients.

The most frequent TOAST classification found dealt with other determined causes. From the 34 cases, most of them were APS caused⁽⁵⁾ followed by dissection of craniocervical vessels^(6,14-16). Other causes included Meningovascular Neurosyphilis⁽¹⁷⁾, Neurocysticercosis⁽¹⁸⁾, Takayasu’s arteritis⁽¹⁹⁾, Primary Vasculitis of the CNS⁽²⁰⁾, cocaine

Table 1. Number of cases and CVA causes in young patients

Article	Number of patients*	CVA cause**
Ocampo Chaparro, 2019, Medical Magazine UIS.	1 (H)	Meningovascular Neurosyphilis
Rueda Cárdenas, 2019, Acta Neurológica de Colombia.	1 (M)	Neurocysticercosis
Caicedo J, 2016, Revista CES de Medicina.	1 (H)	Spontaneous Dissection of the right vertebral artery
Castrillón Marín JA, 2014, Revista Colombiana de Reumatología.	1 (M)	Takayasu's arteritis
Mora Vergara JC, 2018, Acta Colombiana de Cuidado Intensivo.	1 (H)	Spontaneous dissection of the left vertebral artery
Rozo AAL, 2013, Acta Neurológica de Colombia.	1 (H)	Vascular Microangiopathy (lacunar)
Cardona Correa D, 2017, Cardiology files of México.	1 (H)	Cor Triatriatum Sinistrum
Burgos E, 2017, Clinical Medicine.	1 (H)	Left Atrial Myxoma
Rico Mesa JS, 2017, CES Medical Magazine.	1 (H)	Cocaine consumption
Saavedra M, 2001, Magazine of the Faculty of Medicine, Universidad Nacional de Colombia.	14& (7H,7M)	Undetermined (3), Atherotrombotic Vasculopathy (2), non atherosclerotic Vasculopathy (4), Cardioembolism (3: 1 replacement of Mitral Valve, 1 IAM anteroseptal, 1 paradoxical embolism or arterio-arterial), hematological (4), lacunar stroke (1), eclampsia with secondary ischemia (1)
Silva F, 2011, Revista Colombiana de Cardiología.	2 (1H,1M)	Endocarditis of the mitral valve
Mesa M, 2012, Revista Colombiana de Reumatología.	11 (not difference gender)	APS
Voley M, 2004, Journal of Neurological Sciences.	4 (H)	Primary vasculitis of the CNS
Ardila Rodríguez W, 2011, Doctorate Thesis. Postgraduate Doctorate Thesis). Universidad de San Buenaventura.	1 (not reporting gender)	No data
Uribe CS, 1997, Revista de Neurología.	6 (1H, 5M)	Thromboembolic
González Trujillo F, 2018, Acta Neurológica Colombiana.	4 (1H, 3M)	Spontaneous Arterial Dissection (3) traumatic (1)
Lopera F, 2000, Revista de Neurología.	2 (M)	CADASIL
Arboleda-Velásquez JF, 2002. Neurology.	7 (3H, 4M)	CADASIL

* (...) specify the amount of min women when possibly differentiated.

** (...) specifies the amount of patients with an identified cause.

& The total summation is not 14, there are some patients with more than one possible etiology.

H: men;

M: women.

consumption (21), Eclampsia with secondary ischemia and hematologic alterations⁽⁶⁾. In this last study, hematologic causes and non atherosclerotic vasculopathies were 57.14%. No further details about the amount of arterial dissections were reported.

In 3 cases coming from the same study the etiology of 21.42% was not determined. There was more than one probable cause in 3 patients⁽⁶⁾. Uribe CS, et al. work⁽²²⁾ reported 6 cases with ages under 45 with Thromboembolic disease, whose etiology is unknown, even though the original available thesis was reviewed at the Neurology Service of Antioquia University. The aforementioned does not mean these cases have been proved to have a non determined cause. Similarly, the CVA cause of a young patient reported in Ardila Rodríguez W doctorate thesis is unknown⁽²³⁾.

The traditional cardiovascular risk factors, such as tobacco addiction, HTA, Dyslipidemia, obesity, alcohol consumption were frequently reported^(5-7, 9, 14, 15, 19, 21, 23). It calls our attention that Mesa M, et al.⁽⁵⁾ found that tobacco addiction was linked to cerebrovascular episodes in 33% of all cases, thus becoming the main factor of traditional risk. Similarly, Saavedra M, et al.⁽⁶⁾ reported high frequency of tobacco addiction and Dyslipidemia in 21,4% of all cases. HTA was the most frequent risk factor in 35% of all cases.

Others described risk factors were consumption of psychoactive substances^(6,21), autoimmune diseases^(5,6), infections⁽⁶⁾, Cardiopathies^(9,13), consumption of oral contraceptives in case of women⁽⁶⁾.

In the reports analyzed for Colombia the most frequent location was posterior circulation (Table 2).

Discussion

The cases reported in Colombia and searched for this review suggest a higher frequency in women regarding APS. This against the higher frequency of men in most series⁽²⁴⁻³⁴⁾, similar to reports from Italy^(35,36). A female predominance has been reported at early ages, below 30^(26-28,34).

In CVA reports searched in Colombia there was a low frequency of large vessels disease

(3,3%), similar to reports in Mexico, Norway, Switzerland, and Sweden, with frequencies between 3% to 4%^(25,31,34,37). In Europe a frequency 3 times higher than that found in this study has been reported⁽³⁸⁾.

The small vessels disease in this review of Colombia represents 18%, which is similar to results en Greece and Italy, between 14 – 17%^(25,27,28,39,40). This is higher than what has been reported in others places in Latam and Europe, between 1.7–12%^(26,29,31,34,36,38) lower than the data of Asian countries, and Bosnia–Herzegovina between 20–29%^(24,41,42). Similar to what happens with large vessels disease, the studies show a higher presence of this etiology in young adults^(26-28,38,40).

Cardioembolic etiologies reported in Colombia represented 11.6%, similar to reports in Greece and Bosnia–Herzegovina, between 13% 10%, respectively^(24,27); however, in this last study there were restrictions to perform the echocardiography, reaching close to 40% of all patients. The frequency found was higher than reports from a French study with 5.2%⁽³³⁾. However in the latter, only high risk sources of Cardioembolism were included (FA, bacterial Endocarditis, mechanical prosthetic valve, Mitral Stenosis, left Aural Thrombus). Other low/uncertain risk sources, such as PFO and Atrial Septal Aneurysm (ASA) were classified as undetermined. In the other series the frequency was higher 17–34%^(25,26,28,29,31,34-40,43). Unlike the findings of this review, a high frequency of low/uncertain risk sources has been reported as cardioembolic causes^(25,34,36,39,40). Additionally, an increasing tendency in the proportion of Cardioembolism at older ages^(26,34,37,39,40) has been reported. Low risk sources are more frequent in young people and older people with high risk^(25,38).

Most CVA series in young patients searched in the world report frequencies of other determined causes, between 19–39%^(25-29,31,33-40), except the study from Bosnia–Herzegovina, with 8,5%. This study reported scarcity of technical human resources during the diagnostic evaluation, which could explain the higher proportion of undetermined etiology in such series⁽²⁴⁾. In this review a higher proportion was found in Colombia, with 56%, which may be explained by the sources of information mostly

Table 2. Identified Compromised Territories

Article	Compromised territory
Ocampo Chaparro, 2019, Revista Medica UIS.	Left Anterior (ACMi)
Rueda Cárdenas, 2019, Acta Neurológica Colombiana.	Left Anterior (Lenticuloestriate)
Caicedo J, 2016, Revista CES de Medicina.	Right Posterior (AVd)
Castrillón Marín JA, 2014, Revista Colombiana de Reumatología.	Left Anterior (ACi)
Mora Vergara JC, 2018, Acta Colombiana de Cuidado Intensivo.	Left Posterior (AVi)
Rozo AAL, 2013, Acta Neurológica Colombiana.	Right Posterior (Medial right Thalamic and right bulbar)
Cardona Correa D, 2017, Archivos de Cardiología de México.	Left Anterior (ACMi)
Burgos E, 2017, Clinical Medicine.	Left Anterior (ACMi)
Rico Mesa JS, 2017, Revista CES of Medicine.	Left Anterior (ACMi)
Saavedra M, 2001, Magazine of the Faculty of Medicine, Universidad Nacional de Colombia.	Posterior; Anterior.
Silva F, 2011, Revista Colombiana de Cardiología.	Left Anterior (ACMi); Bilateral Posterior.
Volcy M, 2004, Journal of Neurological Sciences.	Left Anterior (ACMi), Various territories; Parietooccipital (No circulation specified).
Ardila Rodríguez W, 2011, Doctorate Thesis. Post Graduate Thesis). Universidad de San Buenaventura.	Left Anterior (ACMi).
González Trujillo F, 2018, Acta Neurológica Colombiana.	Right Posterior (ACPd); Left Anterior (ACi; ACCi); Left Posterior (AVi).
Lopera F, 2000, Revista de Neurología.	Subcortical.
Arboleda-Velásquez JF, 2002. Neurología.	Subcortical.

ACCi: left common carotid artery; ACi: left internal carotid artery; ACMd: right middle cerebral artery; ACMi: middle left cerebral artery; ACPd: right posterior cerebral artery ; AVd: right vertebral artery; AVi: left vertebral artery.

coming from cases reports, which means a higher effort from the researchers to define the cause, which probably underestimates the frequency of undetermined causes of CVA in young people. In most of the other determined causes dissection of craniocervical vessels has been identified as the main cause, in 6–24%^(25,28,31,33,34,36–40). Similar to the cases found in Colombia, in Europe, Craniocervical Dissection and Trombophilias (among them APS) have been reported as the most frequent causes^(27,28,36–38). Among the determined causes in this review, Neurocysticercosis called our attention, as it was not reported in the searched European series, unlike those in Latam, in Brazil Mexico, where frequencies of 2% 4,6%, respectively^(26,37) were found.

5% of the cases reported in this review are undetermined causes, which differs from the frequencies all over the world, between 16–62%^(24–29,31,33,34,36–40). In many of the series this is the main category, classified as per TOAST^(24,25,27–29,31,33,37,38). As an exception to the rule, and Italian study reported this subtype of diagnosis in 8.3% of all patients; however, these were older, which could mean a behavior similar to other older groups⁽³⁵⁾. The low frequency reported in this study may reflect the predominant data source for case reports, with a lower amount of publication for undetermined cause events.

Cases reviewed in Colombia were not consistent in the risk factors report; therefore the proportion of these is not known. However, in several searched sources the presence of modifiable risk factors, such as tobacco addiction, hypertension Dyslipidemia are reported, which are frequently represented in the world series. Tobacco addiction is the main factor in most of them^(24,25,27–29,31,33–37,39–43). In women the use of oral contraceptives (ACO) has also been reported as one of the main risk factors in countries, such as Italy, France and Switzerland^(29,31,33,35,36,40,43). Another risk factor frequently reported is migraine^(25,27,28,31,34–36,40), which was not included in this review. Consumption of illegal substances has been reported –in a low percentage– in European countries^(27,28,40).

In this review, in case reports analyzed in Colombia most of them were in the posterior

circulation, according to reports from most series^(25,28,30–32,34,35,37,39). Different findings have been reported in an Italian study, with a higher compromise of the posterior circulation⁽⁴⁰⁾.

At the time this review was made, we learned about the research work named “etiology and risk factors of the ischemic cerebrovascular accident, in a sample of adult patients younger than 50, at the “Hospital Universitario San Ignacio de Bogotá”, Colombia between 2011 and 2018”. It was made by Baracaldo Iván, et al., from the Universidad Pontificia Javeriana. It was presented before the 15th National Congress of Neurology Residents, from the Colombian Association Neurology, held in Yopal, Casanare, in November, 2018. Such work is to be published; therefore, it was not included in this review, but the information was provided by the main researcher on retrospective collection of 152 patients, with a high frequency of tobacco addiction, HTA, anticoagulation and migraine. The main etiologies represented were arterial dissection, PFO, ASA, Hypercoagulability and prosthetic valve. The TOAST classification was in descending order of frequency, undetermined, another determined cause, cardioembolic, large vessels atherosclerosis and lacunar. The most frequently compromised vascular area was the anterior area (including the segments of the middle cerebral artery).

Despite this is the first systematic review in Colombia about this topic we have reference of, and the comprehensive and systematic search, this study has some restrictions, such as: the data comes from cases reports, few cases series with low number of patients. Some inconsistency was observed in the report of risk factors when it was not omitted. Variability of the age range to define CVA in young patients.

Conclusions

Most of the information published on risk factors of CVA causes in young patients, in Colombia comes from case reports in a lower amount for some case series, it is important to determine its current frequency.

Despite the inconsistencies of the cardiovascular risk factors report, its frequency

deserves to implement primary/secondary prevention strategies.

Dissection of cervical vessels and Trombophilias were determined as frequent causes, as reported in the world. However, Neurocysticercosis and Infarction caused by psychoactive substances were determined as own causes in this Colombian series. These are epidemiological nuances that deserve our special attention.

References

1. Katan M, Luft A. Global Burden of Stroke. *Semin Neurol* 2018; 38: 208-211.
2. Boot E, Ekker MS, Putaala J, Kittner S, De Leeuw FE, Tuladhar AM. Ischaemic stroke in young adults: A global perspective. *J Neurol Neurosurg Psychiatry* 2020; 91: 411-417.
3. Si Y, Xiang S, Zhang Y, Lu T, Guo J, Xiao X, et al. Clinical profile of aetiological and risk factors of young adults with ischemic stroke in West China. *Clin Neurol Neurosurg* 2020; 193: 1-4.
4. Leon-Sarmiento FE, Mendoza E, Torres-Hillera M, Pinto N, Prada A J, Silva CA, et al. Trypanosoma cruzi-associated cerebrovascular disease: A case-control study in Eastern Colombia. *J Neurol Sci* 2004; 217: 61-64.
5. Mesa M, Saldarriaga C, Aguilar C, Builes C, Quiroga A, Aristizábal N, et al. Antiphospholipid syndrome: description of a cohort from Colombia and evaluation of thrombosis risk factors. *Rev Colomb Reumatol* 2012; 19: 208-217.
6. Saavedra M, González F, Parra L, Parra P, Quiroga F, Roncancio Y, et al. Factores de riesgo en enfermedad cerebro vascular isquémica en pacientes menores de 45 años. *Rev la Fac Med* 2001; 49: 89-99.
7. Lopera Restrepo F, Arboleda Velázquez J, Moreno Másmela S, Almeida N, Cuartas Arias JM, Arcos Burgos OM. Caracterización clínica de una familia numerosa con enfermedad vascular cerebral hereditaria en Colombia. *Rev Neurol* 2000; 31: 901-907.
8. Arboleda-Velasquez JF, Lopera F, Lopez E, Frosch MP, Sepulveda-Falla D, Gutierrez JE, et al. C455R notch3 mutation in a Colombian CADASIL kindred with early onset of stroke. *Neurology* 2002; 59: 277-279.
9. Lopera F, Rivera N, Arboleda J, Restrepo T, Arcos-Burgos M. Análisis de segregación compleja de una familia numerosa con enfermedad cerebrovascular hereditaria en Antioquia (Colombia). *Rev Neurol* 2001; 32: 222-225.
10. Rozo A, Cantillo G, Suárez J. ACV lacunar talámico y piramidal bulbar en adulto joven diabético: reporte de caso. *Acta Neurol Colomb* 2013; 29: 295-300.
11. Cardona-Correa D, Ochoa A, Muñoz-Ortiz E, Gándara-Ricardo J, Muñoz JPF. Cor triatriatum, an unusual cause of a cardioembolic cerebrovascular event in adults. Presentation of a case. *Arch Cardiol Mex* 2018; 88: 67-70.
12. Burgos E, Bermúdez J, Chávez W. Mixoma auricular asociado a evento cerebrovascular isquémico. *Med Clin (Barc)* 2018; 151: 69-70.
13. Silva FA, Diaz GA, Rodríguez V, Bueno MI, Carrillo S, Ruiz N, et al. Complicaciones neurológicas de la endocarditis infecciosa: controversias Neurological complications of infective endocarditis: controversies. *Rev Colomb Cardiol* 2011; 18: 212-219.
14. Caicedo J, López AO, Cardozo A, Iván J, Cajiao C. Disección espontánea de la arteria vertebral (Spontaneous vertebral artery dissection). *CES Med* 2016; 30: 93-98.
15. Mora Vergara JC, Pabón Moreno A, Meza Galeano HJ, Martínez González C, Páez Galindo M, Renowitzky Zabarrain C, et al. Disección espontánea de la arteria vertebral, una causa de accidente cerebrovascular en el adulto joven. Reporte de caso. *Acta Colomb Cuid Intensivo* 2018; 18: 122-126.

16. Sánchez Caro EM, Holguín Díaz JI. Disección de vasos arteriales cráneo cervicales. Reporte de casos presentados durante 2 años en una institución clínica de Colombia. Discusión con énfasis en tratamiento. *Acta Neurol Colomb* 2018; 34: 85-91.
17. Ocampo-chaparro JM, Ríos-quintero CA, Álvarez-payares JE, Muñoz-lombo JP. Neurosífilis meningovascular como causa de accidente cerebrovascular en paciente joven: reporte de caso. *Rev Méd UIS* 2019; 32: 53-58.
18. Rueda Cárdenas LF, Bernal Cobo RH, Franco Ruiz CA. Ataque cerebrovascular agudo como presentación de neurocisticercosis: reporte de un caso. *Acta Neurol Colomb* 2019; 35: 111-115.
19. Castrillón Marín JA, Navarro Mendoza EP. Paciente con ataque cerebrovascular isquémico secundario a arteritis de Takayasu: Reporte de caso. *Rev Colomb Reumatol* 2015; 22: 126-132.
20. Volcy M, Toro ME, Uribe CS, Toro G. Primary angiitis of the central nervous system: Report of five biopsy-confirmed cases from Colombia. *J Neurol Sci* 2004; 227: 85-89.
21. Rico-Mesa JS, Rico-Mesa MA, Berrouet MC. Ischemic stroke related to acute consumption of cocaine. *CES Med* 2018; 31: 207-214.
22. Uribe-U CS, Jiménez-R I, Mora-L MO, Arana A, Sánchez-M JL, Zuluaga L, et al. Epidemiología de las enfermedades cerebrovasculares en Sabaneta, Colombia (1992-1993). *Rev Neurol* 1997; 25: 1008-1012.
23. Rodríguez W. Perfil Neuropsicologico Y Factores De Riesgo En 4 Pacientes Que Han Sufrido Accidente Cerebrovascular Isquemico En La Arteria Cerebral Media Del Hemisferio Cerebral Izquierdo Egresados De La Fundación Cardiovascular De Colombia De La Ciudad De Bucaramang. Bogotá: Universidad San Buenaventura, 2011.
24. Smajlović D, Salihović D, Ibrahimagić OĆ, Sinanović O. Characteristics of stroke in young adults in Tuzla Canton, Bosnia and Herzegovina. *Coll Antropol* 2013; 37: 515-519.
25. Fromm A, Waje-Andreassen U, Thomassen L, Naess H. Comparison between ischemic stroke patients <50 years and ≥50 years admitted to a single centre: The Bergen stroke study. *Stroke Res Treat* 2011; 2011: 1-8.
26. Siqueira Neto JI, Santos AC, Ramos S, Fabio C, Americo C. Cerebral Infarction in Patients Aged 15 to 40 Years. *Stroke* 1996; 27: 2016-2019.
27. Spengos K, Vemmos K. Risk factors, etiology, and outcome of first-ever ischemic stroke in young adults aged 15 to 45 - the Athens young stroke registry. *Eur J Neurol* 2010; 17: 1358-1364.
28. Putaala J, Metso AJ, Metso TM, Konkola N, Kraemer Y, Haapaniemi E, et al. Analysis of 1008 consecutive patients aged 15 to 49 with first-ever ischemic stroke the Helsinki young stroke registry. *Stroke* 2009; 40: 1195-1203.
29. Varona JF, Guerra JM, Bermejo F, Molina JA, Gomez De La Cámara A. Causes of ischemic stroke in young adults, and evolution of the etiological diagnosis over the long term. *Eur Neurol* 2007; 57: 212-218.
30. Khan FY. Risk factors of young ischemic stroke in Qatar. *Clin Neurol Neurosurg* 2007; 109: 770-773.
31. Nedeltchev K, Der Maur TA, Georgiadis D, Arnold M, Caso V, Mattle HP, et al. Ischaemic stroke in young adults: Predictors of outcome and recurrence. *J Neurol Neurosurg Psychiatry* 2005; 76: 191-195.
32. Naess H, Nyland HI, Thomassen L, Aarseth J, Nyland G, Myhr KM. Incidence and short-term outcome of cerebral infarction in young adults in Western Norway. *Stroke* 2002; 33: 2105-2108.
33. Leys D, Bandu L, Hénon H, Lucas C, Mounier-Vehier F, Rondepierre P, et al. Clinical

- outcome in 287 consecutive young adults (15 to 45 years) with ischemic stroke. *Neurology* 2002; 59: 26-33.
34. Kristensen B, Malm J, Carlberg B, Stegmayr B, Backman C, Fagerlund M, et al. Epidemiology and etiology of ischemic stroke in young adults aged 18 to 44 years in Northern Sweden. *Stroke* 1997; 28: 1702-1709.
35. Musolino R, La Spina P, Granata A, Gallitto G, Leggiadro N, Carej S, et al. Ischaemic stroke in young people: A prospective and long-term follow-up study. *Cerebrovasc Dis* 2003; 15: 121-128.
36. Rasura M, Spalloni A, Ferrari M, De Castro S, Patella R, Di Lisi F, et al. A case series of young stroke in Rome. *Eur J Neurol* 2006; 13: 146-152.
37. Barinagarrementeria F, Figueroa T, Huebe J, Cantú C. Cerebral infarction in people under 40 years. Etiologic analysis of 300 cases prospectively evaluated. *Cerebrovasc Dis* 1996; 6: 75-79.
38. Yesilot Barlas N, Putaala J, Waje-Andreassen U, Vassilopoulou S, Nardi K, Odier C, et al. Etiology of first-ever ischaemic stroke in European young adults: The 15 cities young stroke study. *Eur J Neurol* 2013; 20): 1431-1439.
39. Cerrato P, Grasso M, Imperiale D, Priano L, Baima C, Giraud M, et al. Stroke in young patients: Etiopathogenesis and risk factors in different age classes. *Cerebrovasc Dis* 2004; 18: 154-159.
40. Tancredi L, Martinelli Boneschi F, Braga M, Santilli I, Scaccabarozzi C, Lattuada P, et al. Stroke care in young patients. *Stroke Res Treat* 2013; 2013:1-7.
41. Dharmasaroja PA, Muengtawepongsa S, Lechawanich C, Pattaraarchachai J. Causes of Ischemic Stroke in Young Adults in Thailand : A Pilot Study. *J Stroke Cerebrovasc Dis* 2011; 20: 247-250.
42. Lee T, Hsu W, Chen C, Chen S. Etiologic Study of Young Ischemic Stroke in Taiwan. *Stroke* 2002; 33:1950-1955.
43. Carolei A, Marini C, Ferranti E, Frontoni M, Prencipe M. A Prospective Study of Cerebral Ischemia in the Young. *Stroke* 1993; 24: 362-367.

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