RESEARCH ARTICLE

Stroke in the adult Qatari population (Q-stroke) a hospital-based retrospective cohort study

Yahia Z. Imam1*, Saadat Kamran1, Maher Saqqur1, Faisal Ibrahim2, Prem Chandra2, Jon D. Perkins3, Rayaz A. Malik3, Naveed Akhtar3, Salman Al-Jerdi3, Dirk Deleu1, Osama Elalamy1, Yasir Osman1, Gayane Malikyan3, Hisham Elkhider1, Suha Elmakki1, Lubna ElSheikh1, Noha Mhjob1, Mohamed S. Abdelmoneim1, Nima Alkhawad1, Ahmed Own1, Ashfaq Shuaib4

1 Neuroscience Institute, Hamad Medical Corporation, Doha, Qatar, 2 Medical Research Center, Hamad Medical Corporation, Doha, Qatar, 3 Weill Cornell Medicine-Qatar, Doha, Qatar, 4 Division of Neurology, Department of Medicine, University of Alberta, Edmonton, Canada

* yimam@hamad.qa

Abstract

Background

Studies assessing the burden of stroke in Qataris are limited. We aim to study stroke in the Qatari population.

Methods

A retrospective review was undertaken of all Qatari adults presenting with stroke to Hamad Medical Corporation over a 5-year period. Descriptive statistics were used to summarize demographic and all other clinical characteristics of the patients. The primary outcome was the incidence of stroke in the Qatari patients. Comparison was made between the sexes.

Results

862 patients were included, with 58.9% being male. The average incidence of stroke over the 5-year period was 92.04 per 100,000 adult Qatari population. The mean age of the cohort was 64.3 ± 14.4 years, (range 19–105 years). The mean age of first ever cerebrovascular event was 63.2 ± 14.5 years. The diagnosis was ischemic stroke in (73.7%), transient ischemic attack in (13.8%), intracerebral hemorrhage (ICH) in (11.6%), subarachnoid hemorrhage in (0.7%) and (0.2%) cerebral venous sinus thrombosis. Small vessel disease was the most common cause of ischemic stroke accounting for (46.5%), followed by large artery atherosclerosis (45.5%). Hypertension (82.7%) and diabetes (71.6%) were particularly prevalent in this cohort. Females were older (65.8 ± 14.1 vs 63.4 ± 14.5 years), had more hypertension and diabetes and more disability or death at 90 days (p<0.05) compared to Qatari males.
Conclusion
Stroke occurs at a significantly lower age in Qatari compared to the western population. This study has uncovered sex differences that need to be studied further.

Introduction
Stroke poses a global threat and is ranked second to heart disease as the leading cause of death worldwide [1]. Major risk factors for stroke include hypertension, smoking, dyslipidemia, diabetes and obesity. Over the last 40 years, the Arabian Gulf region has transitioned to a more sedentary life style with a parallel rapid increase in the prevalence of major risk factors for stroke [2]. Recent data from the Gulf show that females presenting with atrial fibrillation (AF), a major stroke risk factor, were older, had more co-morbidities and were less likely to undergo cardioversion, although the one year transient ischemic attack (TIA)/stroke rate was comparable to males [3].

Qatar is a peninsula that is located in the Northeastern boarder of the Arabian Peninsula and has a sole land border with Saudi Arabia [4, 5]. It is an oil and gas rich country, but native Qatari represent only 15% of the total population [6]. Qatar is considered to be endemic with obesity, diabetes and cardiovascular disease [7]. Whilst the epidemiology of stroke in Qatar has been well documented [6, 8–10], most studies have focused on the entire population (a population of over 2.7 million) which is disproportionately represented by young able-bodied expatriates working in the country whereas the local Qatari population is only around 300,000.

We have undertaken a detailed assessment of Qatari’s presenting with stroke in relation to clinical and demographic variables, underlying etiology and outcomes. The aim of this work was to describe the demographics and clinical features of stroke in Qatari and to calculate the incidence of stroke in this native population. This study will focus solely on the indigenous Qatari population, which might reflect trends in the region and inform future research.

Methods
All patients presenting with stroke to Hamad Medical Corporation (the sole provider of acute stroke care in Qatar), from January 2013 thru 2017 were identified. Chart review was undertaken from the 1st of January 2013 to the 31st December 2013, thereafter the Stroke Database (initiated on the 1st of January 2014) was interrogated until 31st December 2017.

Patients were reviewed and included if they were Qatari nationals, ≥18 years of age and had an acute cerebrovascular event (stroke or transient ischemic attack) documented on the discharge, the death summery or labeled as stroke on the Stroke Database. Stroke was defined as per the World Health Organization [9] as: “rapidly developing clinical signs of focal (or global) disturbance of cerebral function, with symptoms lasting 24 hours or longer or leading to death, with no apparent cause other than vascular origin”. Ischemic stroke was defined as rapidly developing clinical symptoms and/or signs of focal disturbance of cerebral function, lasting longer than 24 hours or leading to death, or based on neuroimaging showing an abnormal area matching the clinical picture [8]. TIA was defined as “a brief episode of neurologic dysfunction caused by focal brain or retinal ischemia, with clinical symptoms typically lasting less than one hour, and without evidence of acute infarction” on computed tomography (CT) brain [11]. The stroke was confirmed by documented clinical assessment, CT, magnetic resonance imaging (MRI) scan, or a combination of these [12]. Patients with cerebral infarction,
intracerebral hemorrhage (ICH), or subarachnoid hemorrhage (SAH) identified by CT scan or MRI were included. Subdural and extradural hematomas were excluded. Stroke severity was assessed by the National Institute of Health Stroke Scale (NIHSS) [13]. Ischemic strokes were etiologically categorized based on of the Trial of Org 10172 in Acute Stroke Treatment (TOAST) classification [14]. Clinical outcomes were assessed by the modified Rankin Scale (mRS) [15] at 90 days. Additionally, Diabetes Miletus (DM) was defined as per American Diabetes Association criteria [16], dyslipidemia, hypertension, Atrial fibrillation, coronary artery disease and congestive heart failure, were defined as per these respective guidelines [17–20].

Statistical analysis
Descriptive statistics were used to summarize demographic, clinical, laboratory and other related parameters. Results were reported with the mean and the standard deviation and non-parametric data were presented by the median and the interquartile range (IQR). Categorical data were summarized using frequencies and percentages. Where values were missing the respective percentage was computed based on non-missing values. The primary outcome measure, incidence of stroke, was estimated and presented with the corresponding 95% confidence intervals (CI). Associations between two or more qualitative variables (such as the different risk factors and the types of stroke with sex) were assessed using Chi-square (χ²) test and/or Fisher Exact test as appropriate. Quantitative data (such as age, HbA1c, NIHSS, mRS score etc.) between males and females were analyzed using independent t tests or Mann Whitney U tests where appropriate.

All p values presented were two-tailed, and values <0.05 were considered statistically significant. Data analyses were performed using statistical packages SPSS version 22.0 (SPSS Inc. Chicago, IL).

Ethical consideration
This study was approved by the Hamad Medical Corporation Medical Research Center, research protocol #15030/15.

Results
862 patients were included in our study, with 58.9% being male. The mean age of the cohort was 64.3±14.4 years, ranging between 19–105 years. The mean age of first ever cerebrovascular event was 63.2±14.5 years.

The diagnoses were ischemic stroke (IS) in 635(73.7%), TIA in 119 (13.8%), intracerebral hemorrhage (ICH) in 100 (11.6%), subarachnoid hemorrhage (SAH) in 6 (0.7%) and CVST in 2 (0.2%).

TOAST classification was available for 592 of the 635 IS (93.2%). Small vessel disease was the most common cause of IS accounting for 275 (46.5%), followed by large artery atherosclerosis 145 (24.5%), cardio-embolic (CE) 81 (13.7%), other etiologies 21 (3.5%) and cryptogenic 70 (11.8%). Hypertension (82.7%) and diabetes (71.6%) were particularly prevalent in this cohort and AF was present in 104 patients across all the cohort (12.1%) (Table 1).

On average, patients had strokes which were moderate with a mean NIHSS score of 6.37±5.98. There was no significant difference observed in mean NIHSS between the sexes (Table 1).

Females with stroke were older 65.8±14.1 vs 63.4±14.5 years (p<0.05) (Table 1), had higher rates of diabetes (78.5% vs 88.8%) (p<0.05), and had a trend towards a higher incidence of AF compared to their male counterparts (14.4% vs 10.4% p = 0.08). At 90 days they were more
likely to end up with disability (mRS >2) 50.9% vs 39.5% (p < 0.005) and a higher mortality (10.4% vs 6.5%) (p = 0.04) (Table 1).

The average incidence of stroke over the 5-year period was 92.04 per 100,000 adult Qatari population. The yearly incidence rate and the percentage with first ever stroke /TIA are shown in (Table 2). The first observed incidence was 81.2/100,000 in 2013 then there was a significant increase in incidence 2014 and 2015 thereafter it has stabilized in 2016 and 2017.

### Discussion

The demographics of the Qatari cohort presenting with stroke is different to previous reports which included predominantly expatriates. The Qataris in general are older, had a greater number of risk factors and higher prevalence of obesity, diabetes, dyslipidemia and higher prevalence of AF and large artery atherosclerosis compared [6, 22] to non-Qataris.

### Incidence and prevalence

The increase in stroke incidence from 2013 to 2014, 2015 mirrors the establishment of the stroke ward, the stroke database and improvement of patient ascertainment. Thereafter rates have remained static and in keeping with the steady growth of the Qatari population.

---

### Table 1. Stroke subtype and risk factors by sex.

|                           | Male N = 508 | Female N = 354 | P-value* |
|---------------------------|-------------|---------------|---------|
| Mean Age (years)          | 63.4±14.5   | 65.8±14.1     | 0.02    |
| Mean NIHSS                | 6.1±6.1     | 6.6±6.3       | 0.27    |
| Mean Door-to-needle time (mins) | 52.1±28.4  | 87±97.5       | 0.07    |
| Ischemic Stroke           | 369 (72.6%) | 266 (75.1%)   | 0.5     |
| Large vessel disease      | 93 (20.6%)  | 52 (19.7%)    |         |
| Small vessel disease      | 164 (35.6%) | 111 (36.8%)   |         |
| Cardioembolic             | 40 (8.4%)   | 41 (12.1%)    |         |
| Other etiologies          | 10 (4.7%)   | 11 (3.9%)     |         |
| Unknown etiology          | 45 (8.1%)   | 25 (8.1%)     |         |
| Hemorrhagic stroke        | 62 (12.2%)  | 38 (10.7%)    | 0.36    |
| Subarachnoid hemorrhage   | 3 (0.6%)    | 3 (0.8%)      | 0.4     |
| TIA                       | 74 (14.6%)  | 45 (12.7%)    | 0.4     |
| CVST                      | 0 (0%)      | 2 (0.6%)      | 0.4     |
| †Diabetes Miletus         | 350 (68.8%) | 269 (75.8%)   | 0.02    |
| Hypertension              | 412 (80.9%) | 303 (85.1%)   | 0.02    |
| Dyslipidemia              | 255 (50.2%) | 177 (49.9%)   | 0.9     |
| Coronary heart disease    | 157 (30.8%) | 114 (32.0%)   | 0.7     |
| Heart failure             | 34 (6.7%)   | 27 (7.6%)     | 0.6     |
| Atrial fibrillation       | 53 (10.4%)  | 51 (14.4%)    | 0.08    |
| Prior stroke/TIA          | 114 (22.4%) | 73 (20.5%)    | 0.5     |
| Thrombolysis              | 33 (6.5%)   | 20 (5.6%)     | 0.46    |
| Mean mRS                  | 1.9±1.9     | 2.2±2.1       | 0.10    |
| Mean mRS at 90 days       | 2.1±2.2     | 2.6±2.2       | 0.001   |
| Death at 90 days          | 33 (6.5%)   | 37 (10.4%)    | 0.04    |

Key: NIHSS = National Institute of Health Stroke Scale, mRS = modified Rankin Scale TIA = transit ischemic attack, CVST = cerebral venous sinus thrombosis.

*Significant at p<0.05.

https://doi.org/10.1371/journal.pone.0238865.t001
In 1997 Hamad et al. [10] reported a crude incidence of stroke to be 75 per 100,000 in the Qatari population. Similarly, El-Hajj et al. [23] reported incidence rates ranging from 15.9–188 per 100,000 when only adults above 18 years of age are included. However, when compared to other local populations in the region (Table 3) [24–31], the incidence of stroke in Qatar within the confines of limited hospital based data appears higher than Saudi Arabia and Kuwait but less than what is reported in Bahrain and Iran. Furthermore, it remains lower than reported in Western cohorts [32–34].

Type of stroke

Ischemic stroke was the most prevalent form of stroke, followed by ICH in agreement with data from the region [23] and the world [32–35]. Among those with IS, small vessel disease (SVD) was the most prevalent etiological subtype (36.1%), which is in keeping with regionally reported studies [23]. This is followed by large artery atherosclerotic disease and cardioembolic (CE) etiologies. Previous work has demonstrated that a higher percentage of Qataris have large vessel disease as compared to the younger non-Qatari population [6]. Of note, the etiological subtypes observed here differ significantly from Caucasian populations where CE, large artery atherosclerosis (LAA) or undetermined etiology are more prevalent than SVD [36, 37]. ICH occurred in 11.6% of the cohort, in keeping with data from western countries such as USA, UK and Australia [38] but considerably less than previously reported by Ibrahim et al. (19%) for the mixed population in Qatar predominately composed of South Asians [6].

### Table 2. Estimated stroke incidence per 100,000 per year.

| Year | Total population (Qatar) | Estimated Qatari population | Estimated Qatari adult population | Total number of stroke/TIA cases (n) | Incidence (per 100,000) adult population | 95% CI for incidence (lower limit, upper limit) | Number/percentage of first ever stroke/TIA cases |
|------|--------------------------|-----------------------------|----------------------------------|-------------------------------------|------------------------------------------|-----------------------------------------------|-----------------------------------------------|
| 2013 | 2,101,288                | 252,155                     | 163,900                          | 133                                 | 81.2                                     | 68.5, 96.2                                     | 75 (56.4%)                                     |
| 2014 | 2,172,065                | 269,648                     | 175,271                          | 183                                 | 104.4                                    | 90.4, 120.7                                    | 113 (61.7%)                                    |
| 2015 | 2,404,776                | 290,000                     | 188,500                          | 187                                 | 99.2                                     | 86.0, 114.5                                    | 158 (84.5%)                                    |
| 2016 | 2,586,776                | 313,000                     | 203,450                          | 177                                 | 87.0                                     | 75.1, 100.8                                    | 152 (85.9%)                                    |
| 2017 | 2,643,991                | 322,000                     | 209,300                          | 185                                 | 88.4                                     | 76.5, 102.1                                    | 164 (88.6%)                                    |

Key. CI = confidence interval.
$\text{=}\text{census [21].}$

https://doi.org/10.1371/journal.pone.0238865.t002

### Table 3. Stroke incidence in Qatar and the region.

| Study | Study period | Country | Population | Number of patients | Crude incidence per 100,000 |
|-------|--------------|---------|------------|--------------------|----------------------------|
| Al-Rajeh et al. [24] | 1982–1992 | KSA | Saudi nationals | 500 | 43.8 |
| Al-Rajeh et al. [29] | 1989–1993 | KSA | Saudi nationals | 488 | 29.8 |
| Al-Shenqiti et al. [30] | 2014 | KSA | Mixed population¥ | 164 | 13.9 |
| Al-Jishi et al. [28] | 1995 | Bahrain | Bahraini nationals | 103 | 57.4 |
| Al Banna et al. [27] | 2011 | Bahrain | Bahraini nationals | 521 | 110 |
| Abdul-Ghaffar et al. [25] | 1989,1992–1993 | Kuwait | Mixed population¥ | 241 | 27.6 |
| Azarpazhooh et al. [31] | 2006–2007 | Iran | Iranian population | 624 | 139.0 |
| Ahangar et al. [26] | 2001–2003 | Iran | Iranian population | 250 | 52.0 |
| Hamad et al. [10] | 2001 | Qatar | overall | 217 | 41.0 |
| | | | Qataris | 132 | 73.0 |

https://doi.org/10.1371/journal.pone.0238865.t003
Age
Previous data of stroke from Qatar have been generated predominantly from the expatriate population, which is comprised of young working males from the Indian subcontinent and Far East. In the current study Qatari patients with stroke were approximately 6–8 years older than previously reported Qatar based studies (64 versus 56–58 years) [6]. However, this age of stroke is similar to other countries in the region [39–42] but almost a decade younger than that described in Caucasian populations [35, 43].

Sex
Sex disparities in stroke are well established [44–46], although it is controversial whether sex per se is an independent risk factor for poor prognosis [44, 47]. In our study females were significantly older than males, which is consistent with reports from the region and the West [44, 45, 48]. There was no significant difference in stroke severity as measured by NIHSS or stroke type between the sexes but there was a non-significant trend towards increased AF and CE among female Qatari. Furthermore, females were observed to have a significantly higher prevalence of hypertension, diabetes mellitus, disability at 90 days and mortality, this may be due to sedentary life style with smartphone data showing a lower step/day count for residents in Qatar compared to other countries with women in particular taking 38% less steps [49]. This could be due to availability of household help, unavailability of socially acceptable fitness establishments and the desert climate [50]. Additionally, a recent study [51] hypothesized that maybe poststroke depression and isolation could be a contributing factor for the poor short term outcomes observed in Qatari females, however, this requires more in-depth research.

Vascular risk factors
Hypertension (82.3%), diabetes (74.4%) and a sedentary life style were very common in this population [52], reflecting the endemic levels of obesity and diabetes found in this part of the world [53]. This contrasts with data from the West, where hypertension and DM are relatively less common, and AF features more often in that older population [54]. The proportion with AF related stroke among the Qatari cohort are more than double that was published for the entire population which is young, male, South Asian predominate [22] but are much less than reported in Western cohorts [55]. Younger age and relatively low utilization of prolonged monitoring, particularly for cryptogenic stroke, [56], maybe contributing to the low incidence of AF reported here.

Strength and weakness
The major strength of this analysis is the comprehensive search with predefined criteria from a single referral center dealing with the majority of people presenting with stroke in Qatar. A weakness is the retrospective nature of the study with missing data and recall bias.

Conclusion
The incidence of stroke in Qatari patients has increased compared to 2013 and the proportion of new cases have gone up. Strokes occur a decade earlier than in the western population possibly due to the higher prevalence of vascular risk factors. Additionally, Qatari women with stroke are relatively older, have more atrial fibrillation, diabetes mellitus and hypertension with increased risk of recurrent strokes, disability and higher mortality. Further prospective
studies in this population are needed to identify potentially modifiable risk factors and develop effective preventive strategies to limit the increasing incidence of stroke in Qatar’s.

Supporting information
S1 Data.
(XLSX)

Author Contributions
Conceptualization: Yahia Z. Imam, Saadat Kamran, Faisal Ibrahim, Dirk Deleu, Hisham Elkhider, Mohamed S. Abdelmoneim, Ashfaq Shuaib.
Data curation: Yahia Z. Imam, Faisal Ibrahim, Hisham Elkhider, Suha Elmakki, Lubna ElSheikh, Noha Mhjob, Nima Alkhawad.
Formal analysis: Yahia Z. Imam, Prem Chandra, Nima Alkhawad.
Methodology: Yahia Z. Imam, Prem Chandra.
Project administration: Nima Alkhawad.
Resources: Naveed Akhtar.
Supervision: Yahia Z. Imam, Maher Saqqur, Osama Elalamy, Ahmed Own, Ashfaq Shuaib.
Validation: Jon D. Perkins, Ahmed Own, Ashfaq Shuaib.
Visualization: Yahia Z. Imam, Saadat Kamran, Maher Saqqur, Jon D. Perkins, Rayaz A. Malik, Salman Al-Jerdi, Mohamed S. Abdelmoneim, Ashfaq Shuaib.
Writing – original draft: Yahia Z. Imam, Rayaz A. Malik.
Writing – review & editing: Yahia Z. Imam, Saadat Kamran, Maher Saqqur, Faisal Ibrahim, Prem Chandra, Jon D. Perkins, Rayaz A. Malik, Naveed Akhtar, Salman Al-Jerdi, Dirk Deleu, Osama Elalamy, Yasir Osman, Gayane Malikyan, Hisham Elkhider, Suha Elmakki, Lubna ElSheikh, Noha Mhjob, Mohamed S. Abdelmoneim, Ashfaq Shuaib.

References
1. Krisberg K. Heart disease, stroke remain top killers in US, worldwide. The Nation’s Health. 2016; 46(1): E2.
2. Christos PJ, Chemaitelly H, Abu-Raddad LJ, Gehani AR, Deleu D, Mushlin Al. Prevention during the epidemiologic shift to chronic illness: a case control study of risk factors associated with cardiovascular disease in Qatar. Journal of Local and Global Health Perspectives. 2013, 4.
3. Shehab A, Zubaid M, Bhagavathula AS, Rashed WA, Alsheikh-Ali AA, AlMahmeed W, et al. Sex differences in management and outcomes of patients with atrial fibrillation in the Middle East. Gulf survey of atrial fibrillation events (Gulf SAFE). PLoS One. 2017; 12(5):e0175405. https://doi.org/10.1371/journal.pone.0175405 PMID: 28520719
4. Ibrahim F, Deleu D, Akhtar N, Al-Yazeedi W, Mesraoua B, Kamran S, et al. Burden of Stroke in Qatar. Journal of stroke and cerebrovascular diseases: the official journal of National Stroke Association. 2015.
5. Qatar Population (2018)—Worldometers. 2018.
6. Ibrahim F, Deleu D, Akhtar N, Al-Yazeedi W, Mesraoua B, Kamran S, et al. Burden of Stroke in Qatar. J Stroke Cerebrovasc Dis. 2015; 24(12):2875–9. https://doi.org/10.1016/j.jstrokecerebrovasdis.2015.08.024 PMID: 26604108
7. Alhyas L, McKay A, Balasanthiran A, Majeed A. Prevalences of overweight, obesity, hyperglycaemia, hypertension and dyslipidaemia in the Gulf: systematic review. JRSM Short Rep. 2011; 2(7):55. https://doi.org/10.1258/srshorts.2011.011019 PMID: 21847437
8. Akhtar N, Kamran SI, Deleu D, D’Souza A, Miyares F, Elsotouhy A, et al. Ischaemic posterior circulation stroke in State of Qatar. Eur J Neurol. 2009; 16(9):1004–9. https://doi.org/10.1111/j.1468-1331.2009.02709.x PMID: 19538206

9. Khan FY, Yasin M, Abu-Khattab M, El Hiday AH, Errayes M, Lotf AK, et al. Stroke in Qatar: a first prospective hospital-based study of acute stroke. J Stroke Cerebrovasc Dis. 2008; 17(2):69–78. https://doi.org/10.1016/j.jstrokecerebrovasdis.2007.11.004 PMID: 18346648

10. Hamad A, Hamad A, Sokrab TE, Momeni S, Mesraoua B, Lingren A. Stroke in Qatar: a one-year, hospital-based study. J Stroke Cerebrovasc Dis. 2001; 10(5):236–41. https://doi.org/10.1053/jscd.2001.30382 PMID: 17903831

11. Albers GW, Caplan LR, Easton JD, Fayad PB, Mohr JP, Saver JL, et al. Transient ischemic attack—proposal for a new definition. The New England journal of medicine. 2002; 347(21):1713–6. https://doi.org/10.1056/NEJMsb020987 PMID: 12444191

12. Ryan R, Santesso N, Lowe D, Hill S, Grimshaw J, Prictor M. Interventions to improve safe and effective medicines use by consumers: an overview of systematic reviews. Cochrane Database Syst Rev. 2014;4.

13. Kwah LK, Diong J. National Institutes of Health Stroke Scale (NIHSS). J Physiother. 2014; 60(1):61. https://doi.org/10.1016/j.jphys.2013.12.012 PMID: 24856948

14. Adams HP Jr., Bendixen BH, Kappelle LJ, Biller J, Love BB, Gordon DL, et al. Classification of subtype of acute ischemic stroke. Definitions for use in a multicenter clinical trial. TOAST. Trial of Org 10172 in Acute Stroke Treatment. Stroke. 1993; 24(1):35–41. https://doi.org/10.1161/01.str.24.1.35 PMID: 7678184

15. Banks JL, Marotta CA. Outcomes validity and reliability of the modified Rankin scale: implications for stroke clinical trials: a literature review and synthesis. Stroke. 2007; 38(3):1091–6. https://doi.org/10.1161/01.STR.0000258355.23810.c6 PMID: 17272767

16. AAD. Diagnosis and classification of diabetes mellitus. Diabetes care. 2012;35 Suppl 1(Suppl 1):S64-71.

17. Catapano AL, Graham I, De Backer G, Wiklund O, Chapman MJ, Drexel H, et al. 2016 ESC/EAS Guidelines for the Management of Dyslipidaemias. European heart journal. 2016; 37(39):2999–3058. https://doi.org/10.1093/eurheartj/ehw272 PMID: 27567407

18. Mancia G, Fagard R, Narkiewicz K, Redon J, Zanchetti A, Böhm M, et al. 2013 ESH/ESC Guidelines for the management of arterial hypertension: the Task Force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). Journal of hypertension. 2013; 31(7):1281–357. https://doi.org/10.1097/01.hjh.0000431740.32696.cc PMID: 23817082

19. Montalescot G, Sechtem U, Achenbach S, Andreotti F, Arden C, Budaj A, et al. 2013 ESC guidelines on the management of stable coronary artery disease: the Task Force on the management of stable coronary artery disease of the European Society of Cardiology. European heart journal. 2013; 34(38):2949–3003. https://doi.org/10.1093/eurheartj/eht296 PMID: 23996286

20. January CT, Wann LS, Alpert JS, Calkins H, Cigarroa JE, Cleveland JC Jr., et al. 2014 AHA/ACC/HRS guideline for the management of patients with atrial fibrillation: executive summary: a report of the American College of Cardiology/American Heart Association Task Force on practice guidelines and the Heart Rhythm Society. Circulation. 2014; 130(23):2071–104. https://doi.org/10.1161/CIR.000000000000040 PMID: 24682348

21. Authority QPaS. The Qatar 2015 Mini-Census of Population, Housing and Establishment 2015 [Available from: https://www.psa.gov.qa/en/statistics1/StatisticsSite/Census/Census2015/Pages/default.aspx.

22. Imam YZ, Kamran S, Akhtar N, Deleu D, Singh R, Malik RA, et al. Incidence, clinical features and outcomes of atrial fibrillation and stroke in Qatar. International journal of stroke: official journal of the International Stroke Society. 2020; 15(1):85–9.

23. El-Hajj M, Salameh P, Rachidi S, Hosseini H. The epidemiology of stroke in the Middle East. European Stroke Journal. 2016; 1(3):180–98. https://doi.org/10.1177/2396987316654338 PMID: 31008279

24. al Rajeh S, Awada A, Niazi G, Lati E. Stroke in a Saudi Arabian National Guard community. Analysis of 500 consecutive cases from a population-based hospital. Stroke. 1993; 24(11):1635–9. https://doi.org/10.1161/01.STR.000000000000040 PMID: 24682348

25. Abdul-Ghaffar NU, el-Sonbaty Mr Fau—el-Din Abdul-Baky MS, el-Din Abdul-Baky Ms Fau—Marafie AA, Marafie Aa Fau—al-Said AM, al-Said AM. Stroke in Kuwait: a three-year prospective study. (0251–5350 (Print)).

26. Ahangar AA, Ashraf Vaghefi Sb Fau—Ramaezani M, Ramaezani M. Epidemiological evaluation of stroke in Babol, northern Iran (2001–2003). (0014–3022 (Print)).
27. Al Banna M, Baldawi H, Kadhim A, Humaidan H, Whitford DL. Stroke in Bahrain: rising incidence, multiple risk factors, and suboptimal care. (1747–4949 (Electronic)).
28. Al-Jishi AA, Mohan PK. Profile of stroke in Bahrain. (1319–6138 (Print)).
29. al-Rajeh S, Larbi Eb Fau—Bademosi O, Bademosi O Fau—Awada A, Awada A Fau—Yousef A, Yousef A Fau—al-Freihl H, al-Freihl H Fau—Miniai H, et al. Stroke register: experience from the eastern province of Saudi Arabia. (1015–9770 (Print)).
30. Al-Shenqiti AM, Ibrahim Sr Fau—Khale OA, Khale OA Fau—Ali ARH, Ali Ar Fau—Ahmed MS, Ahmed MS. Incidence of First Time Stroke: A Saudi Experience. (1421–9913 (Electronic)).
31. Azarpazhooh MR, Etemadi Mm Fau—Donnan GA, Donnan Ga Fau—Mokhber N, Mokhber N Fau—Majdi MR, Majdi Mr Fau—Ghayour-Mobarhan M, Ghayour-Mobarhan M Fau—Ghandehary K, et al. Excessive incidence of stroke in Iran: evidence from the Mashhad Stroke Incidence Study (MSIS), a population-based study ed. (1524–4628 (Electronic)).
32. Incidence of stroke in Oxfordshire: first year's experience of a community stroke register. British Medical Journal (Clinical research ed). 1983; 287(6394):713–7.
33. Zhang Y, Chapman A-M, Plested M, Jackson D, Purroy F. The Incidence, Prevalence, and Mortality of Stroke in France, Germany, Italy, Spain, the UK, and the US: A Literature Review. Stroke Research and Treatment. 2012: 2012–11.
34. Williams GR. Incidence and Characteristics of Total Stroke in the United States. BMC Neurology. 2001; 1(1):2.
35. Kolominsky-Rabas PL, Sarti C, Heuschmann PU, Graf C, Siemonsen S, Neundoerfer B, et al. A Prospective Community-Based Study of Stroke in Germany—The Erlangen Stroke Project (ESPPro). Incidence and Case Fatality at 1, 3, and 12 Months. 1998; 29(12):2501–6.
36. Kolominsky-Rabas PL, Weber M, Gefeller O, Neundoerfer B, Heuschmann PU. Epidemiology of Ischemic Stroke Subtypes According to TOAST Criteria. Incidence, Recurrence, and Long-Term Survival in Ischemic Stroke Subtypes: A Population-Based Study. 2001; 32(12):2735–40.
37. Petty GW, Brown RD, Whisnant JP. Sicks JD, O’Fallon WM, Wiebers DO. Ischemic Stroke Subtypes. A Population-Based Study of Functional Outcome, Survival, and Recurrence. 2000; 31(5):1062–8.
38. An SJ, Kim TJ, Yoon B-W. Epidemiology, Risk Factors, and Clinical Features of Intracerebral Hemorrhage: An Update. Journal of stroke. 2017; 19(1):3–10. https://doi.org/10.5853/jos.2016.00864 PMID: 28178408
39. Al-Shammri S, Shahid Z, Ghali A, Mehndiratta MM, Swaminathan TR, Chadha G, et al. Risk factors, subtypes and outcome of ischaemic stroke in Kuwait—a hospital-based study. Medical principles and practice: international journal of the Kuwait University, Health Science Centre. 2003; 12(4):218–23.
40. Banna MA, Baldawi H, Kadhim A, Humaidan H, Whitford DL. Stroke in Bahrain: Rising Incidence, Multiple Risk Factors, and Suboptimal Care. International Journal of Stroke. 2015; 10(4):615–8. https://doi.org/10.1111/ijs.12513 PMID: 25846214
41. Daneshfard B, Izadi S, Shariat A, Toudaji MA, Beyzavi Z, Niknam L. Epidemiology of stroke in Shiraz, Iran. Iranian Journal of Neurology. 2015; 14(3):158–63. PMID: 26622981
42. Robert AA, Zamzami MM. Stroke in Saudi Arabia: a review of the recent literature. The Pan African Medical Journal. 2014; 17:14.
43. Guilli G, Rutten-Jacobs LCA, Kalra L, Rudd AG, Wolfe CDA, Markus HS. Differences in the distribution of stroke subtypes in a UK black stroke population—final results from the South London Ethnicity and Stroke Study. BMC Medicine. 2016; 14:77. https://doi.org/10.1186/s12916-016-0618-2 PMID: 27197724
44. Caso V, Paciaroni M, Agnelli G, Corea F, Ageno W, Alberti A, et al. Gender Differences in Patients with Acute Ischemic Stroke. Women’s Health. 2010; 6(1):51–7. https://doi.org/10.2217/whe.09.82 PMID: 20088729
45. Santalucia P, Pezzella FR, Sessa M, Monaco S, Torgano G, Anticoli S, et al. Sex differences in clinical presentation, severity and outcome of stroke: Results from a hospital-based registry. European Journal of Internal Medicine. 2013; 24(2):167–71. https://doi.org/10.1016/j.ejim.2012.10.004 PMID: 23167980
46. Petrea RE, Beiser AS, Seshadri S, Kelly-Hayes M, Kase CS, Wolf PA. Stroke in women—Gender Differences in Stroke Incidence and Post-stroke Disability in the Framingham Heart Study. Stroke; a journal of cerebral circulation. 2009; 40(4):1032–7.
47. Gibson CL. Cerebral ischemic stroke: is gender important? Journal of Cerebral Blood Flow & Metabolism. 2013; 33(9):1355–61.
48. Zafar A, Al-Khamis FA, Al-Bakr AI, Alsulaiman AA, Msmar AH. Risk factors and subtypes of acute ischemic stroke: A study at King Fahd Hospital of the University. Neurosciences. 2016; 21(3):246–51. https://doi.org/10.17712/nsj.2016.3.20150731 PMID: 27356657
49. Althoff T, Sosić R, Hicks JL, King AC, Delp SL, Leskovec J. Large-scale physical activity data reveal worldwide activity inequality. Nature. 2017; 547(7663):336–9. https://doi.org/10.1038/nature23018 PMID: 28693034

50. Khatri S. Qatar residents among world’s most inactive. Doha News; 2017

51. Akhtar N, Kate M, Kamran S, Singh R, Bhutta Z, Saqquir M, et al. Sex-Specific Differences in Short-Term and Long-Term Outcomes in Acute Stroke Patients from Qatar. European Neurology. 2020.

52. Freedman SP, Ali S, Oleszczuk M, Gouin S, Hartling L. Treatment of acute gastroenteritis in children: an overview of systematic reviews of interventions commonly used in developed countries. Evid-Based Child Health. 2013;8.

53. Butler J, Bourke PJ. Diabetes and stroke in Qatar: results of a prospective stroke register. International Diabetes Nursing. 2015; 12(2):63–8.

54. O’Donnell MJ, Chin SL, Rangarajan S, Xavier D, Liu L, Zhang H, et al. Global and regional effects of potentially modifiable risk factors associated with acute stroke in 32 countries (INTERSTROKE): a case-control study. Lancet (London, England). 2016; 388(10046):761–75.

55. Wagstaff AJ, Overvad TF, Lip GYH, Lane DA. Is female sex a risk factor for stroke and thromboembolism in patients with atrial fibrillation? A systematic review and meta-analysis. QJM: An International Journal of Medicine. 2014; 107(12):955–67.

56. Kernan WN, Ovbiagele B, Black HR, Bravata DM, Chimowitz MI, Ezekowitz MD, et al. Guidelines for the Prevention of Stroke in Patients With Stroke and Transient Ischemic Attack. A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. 2014.