

RESEARCH ARTICLE

# Epidemiology of spontaneous subarachnoid hemorrhage in the state of Qatar

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## ABSTRACT

**Background:** Spontaneous subarachnoid hemorrhage (SAH) is one of the significant etiologies for stroke. SAH causes higher morbidity and mortality with loss of productivity, resulting in increased disease burden. Only few studies in Qatar have reported on SAH, and the epidemiological features of SAH and aneurysmal SAH (aSAH) have not been comprehensively studied before in Qatar. Our study aimed to describe the epidemiological profile of patients with SAH and aSAH in the State of Qatar.

**Methods:** We reviewed the medical records of all patients with SAH and/or ruptured aneurysm who were consecutively admitted to Hamad General Hospital (600-bed tertiary care facility) from January 1, 2007 to December 31, 2016. We performed a quantitative analysis of demographics, clinical characteristics, diagnostic findings, interventions, and overall mortality. We used SPSS version 18 for data entry. We used chi-square and student t tests to compare the groups. We considered  $p < 0.05$  as statistically significant.

**Results:** The study included 323 patients with aneurysmal and non-aneurysmal SAH. The mean age at presentation was  $47.4 \pm 12.2$  years. Men comprised 68.7% of the cases. Further, 86.6% of the patients presented with acute-onset headache. Additionally, 217 patients had 1 aneurysm, and 32 patients had multiple aneurysms. Anterior communicating artery aneurysm has been found to be the most common aneurysm. Non-aneurysmal SAH occurred in 74 patients (22.9%), with male predominance. Moreover, 23.7% and 52.6% of the patients underwent microsurgical clipping and coiling of the aneurysm, respectively. The overall mortality in World Federation of Neurosurgeon Score (WFNS) grades 1 and 2 SAH was lesser than that in higher grades (28.6% vs 71.4%).

Of 323 patients, 69 died within 1 month post-ictus, accounting for an overall mortality rate of 21.2% in our study.

**Conclusions:** The annual incidence of aneurysmal SAH in Qatar has been increasing. Men had a higher incidence of aSAH. Internal carotid aneurysms have been found to be more common in Qatari women, which may have a genetic basis. Lower WFNS grades of aSAH have been associated with better prognosis. The overall mortality associated with aSAH in Qatar has declined over the last 3 years.

**Keywords:** Subarachnoid hemorrhage, cerebral aneurysm, epidemiology, Qatar

## INTRODUCTION

Spontaneous subarachnoid hemorrhage (SAH) is a life-threatening neurosurgical emergency and accounts for 5% of all cases of stroke, whereas 87% of stroke occurs due to ischemic insult.<sup>1</sup> Aneurysmal subarachnoid Hemorrhage (aSAH) has significant morbidity and mortality, it also increases the burden of disease caused by loss of productivity in terms of life years which is as large as that from cerebral infarction.<sup>2</sup>

Johnson et al.<sup>3</sup> and Ingall et al.<sup>4</sup> found that aSAH has wide variations in epidemiological features in different countries, which is exemplified by an annual incidence rate of 2.0 per 100,000 in the Chinese population compared with 22.5 per 100,000 in the Finnish population.

Epidemiological data on aSAH in Qatar is non-existent in literature. To the best of our knowledge, only one study by Nogueira<sup>5</sup> on the epidemiology of spontaneous SAH published in 1992, which is a limited study of 44 cases, including only 13 aneurysms over 5 years, described the incidence of SAH as ranging from 0.35 to 1.78/100,000 population.

Hamad General Hospital (HGH) is the major academic tertiary care hospital in Doha, Qatar. The Department of Neurosurgery at HGH is unique because it offers neurosurgical services for the entire country. The population of Qatar has rapidly increased over the last decade because of flourishing socio-economics and consequent large influx of expatriates. This has also reflected in a sharp increase in aSAH cases treated at HGH. Therefore, investigating the epidemiological features of aSAH in Qatar is important. The data will help us compare the epidemiology of aSAH with rest

of the world and highlight the evolution of neurosurgical care for patients presenting with aSAH at HGH. The study may also help us identify potential venues of improvement in our management of this life-threatening condition. Our study aimed to describe the epidemiological profile of patients with SAH and aSAH in the State of Qatar.

## PATIENTS AND METHODS

We retrospectively reviewed the medical records of all patients with SAH and/or ruptured aneurysm who were consecutively admitted to HGH (600-bed tertiary care center) from January 1, 2007 to December 31, 2016. The patients were followed up for 3 months after discharge. We retrieved data from the clinical notes available in the patients' medical records and the Cerner Clinical viewer (CCV) database of the hospital. Data included baseline demographics (age, sex, nationality), clinical characteristics at hospital admission, such as headache, dizziness, convulsions, vomiting or nausea, motor deficit, and seizures; clinical diagnosis for SAH with or without other lesions (SAH alone, SAH/intraventricular hemorrhage [IVH], SAH/intracerebral hemorrhage [ICH], and SAH/ICH/IVH), presence or absence of aneurysms, number of aneurysms, location of aneurysms, interventions (clipping, coiling, craniotomy/decompressive craniectomy, external ventricular drain [EVD] insertion, location of aneurysm, grading of SAH by Hent and Hess [H&H], and World Federation of Neurosurgeon Score [WFNS], overall Glasgow coma score [GCS] at admission, on admission, and at transfer from ICU), and overall mortality.

The severity of SAH is assessed using H&H and WFNS scores. H&H describes the severity of SAH from grades 1 to 5 with increasing severity. WFNS uses GCS and neurological deficit to assess the severity of SAH, grading ranges from 1 to 5 with increasing severity.<sup>6</sup>

Criteria for confirmed SAH diagnosis were demonstration of blood in the subarachnoid space on noncontrast computed tomography (CT) with or without intracerebral hematoma or blood in the ventricular system. The clinical diagnosis for aneurysm was considered, if the proportion of dilatation was more than thrice than that of the native vessel diameter on CT angiogram or conventional angiogram. Pediatric population (< 15 years), patients with traumatic SAH and arteriovenous malformations or vascular pathologies other than aneurysms causing

Table 1. Yearly incidence, interventions, and mortality for spontaneous SAH

Year	Number of SAH cases	Population in Qatar	Incidence of SAH per 100,000 population	Clipping n (%)	Coiling n (%)	Mortality n (%)
2007	28	1,218,250	2.3	2 (7.1%)	7 (25.0%)	17 (60.7%)
2008	29	1,448,479	2.0	4 (13.8%)	10 (34.5%)	5 (17.2%)
2009	14	1,638,626	0.9	0 (0.0%)	7 (50.0%)	1 (7.1%)
2010	25	1,715,098	1.5	4 (16.0%)	10 (40.0%)	2 (8.0%)
2011	48	1,732,717	2.8	6 (12.5%)	23 (47.9%)	10 (20.8%)
2012	31	1,832,903	1.7	4 (12.9%)	16 (51.6%)	10 (32.3%)
2013	18	2,003,700	0.9	3 (16.7%)	5 (27.8%)	3 (16.7%)
2014	38	2,216,180	1.7	6 (15.8%)	12 (31.6%)	9 (23.7%)
2015	50	2,437,790	2.1	18 (36.0%)	20 (40.0%)	8 (16.0%)
2016	42	2,617,634	1.6	12 (28.6%)	21 (50.0%)	4 (9.5%)

SAH have been excluded from our cohort. In our study, we have focused on SAH caused by aneurysm rupture and SAH cases with no proven vascular pathology. From here onwards, for purpose of our study and simplification, spontaneous SAH refers to cases that are aneurysmal and non-aneurysmal, unless otherwise specified. Because data were collected retrospectively, a waiver of informed consent was approved by the ethical committee at the Medical Research Center, Hamad Medical Corporation, Qatar with IRB #16387/1.

### Statistical analysis

Data were presented as proportions, median (range), or mean ( $\pm$  standard deviation), as appropriate. Pearson chi-square ( $\chi^2$ ) test was used to compare categorical variables, such as WFNS score with age groups, sex and nationality, aneurysmal localization by sex and nationality, and sex according to presence or

absence of aneurysm and mortality. A two-tailed  $p < 0.05$  was considered significant. Data was analyzed using the Statistical Package for Social Sciences version 18 (SPSS Inc, Chicago, Illinois, USA).

## RESULTS

### Demographic characteristics

According to the statistics obtained with permission from the website of Ministry of planning, development and statistics, the population of Qatar has exponentially increased from 1,218,250 in 2007 to 2,617,634 in 2016, which has also reflected in the incidence of spontaneous SAH due to aneurysm rupture over the last decade (Table 1).<sup>7</sup>

A total of 323 patients with SAH were admitted during the study period. The annual incidence of spontaneous SAH in 2013 was 2.3 per 100,000 inhabitants in Qatar. The number of cases of

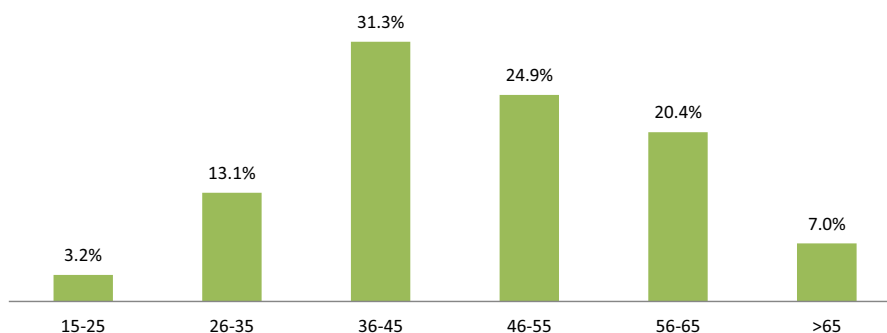


Figure 1. Age distribution in SAH.

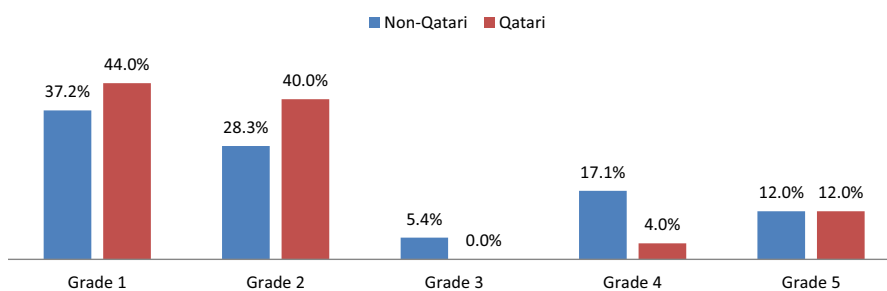


Figure 2. WFNS score by nationality( $p = 0.27$ ).

spontaneous SAH was 50 in 2015, and the annual incidence was 2.1 per 100,000 in the same year. The mean age for spontaneous SAH in our study was  $47.4 \pm 12.2$  years. Nine percent (29) of patients with SAH cases were Qatari nationals, and 91% (294) were non-Qataris. The male-to-female ratio was 2:1 as 68.7% and 31.3% of the patients were men and women, respectively. Approximately 56.2% of the patients presenting with spontaneous SAH were 36 – 55 years (Figure 1).

A comparison between WFNS grades of nationals and non-nationals in the State of Qatar did not reveal a statistically ( $p = 0.27$ ) significant difference (Figure 2).

### Clinical presentation

Acute-onset severe headache accounted for 86.6% of patients. Most patients (64%) presented within 24 hours of the onset of headache, but the range was from 1 to 720 hours. The frequency of other symptoms, including dizziness, convulsions, vomiting, and neurological deficit at presentation was 49.4%, 18.7%, 15.4%, and 10.3%, respectively.

In our study 61.8% and 32.8% presented with WHNS grade 1 or 2 and grade 4 or 5 respectively (Figure 3). 65.3% patients presented with H&H grades 1 and 2

SAH whereas 26.4% presented with grades 4 and 5 SAH (Figure 3).

We could not find a statistically significant ( $p = 0.14$ ) relationship between different age groups and WFNS grades; however WFNS grades 1 and 2 SAH constituted 65% and 50.8% of the cases of SAH in ages 36 – 45 years and 46 – 55 years, respectively, compared with 24.6% and 12.5% in patients aged 26 – 35 years and > 65 years, respectively (Figure 4). Furthermore, we could not find a statistically significant difference ( $p = 0.33$ ) in WFNS grades of spontaneous SAH between men and women (Figure 5).

### CT findings

Initial head CT at presentation revealed SAH without intracerebral and intraventricular hemorrhage in 46.7% of the cases. SAH with intraventricular and intracerebral hemorrhage occurred in 33.4% and 7.4% of patients, respectively. A combination of SAH, intracerebral hemorrhage, and intraventricular hemorrhage occurred in 12.4% of the patients.

All patients presenting with SAH in the emergency department underwent CT angiogram or conventional angiogram. In addition, 217 (77.1%) patients had 1 aneurysm, and 32 (12.8%) patients had multiple

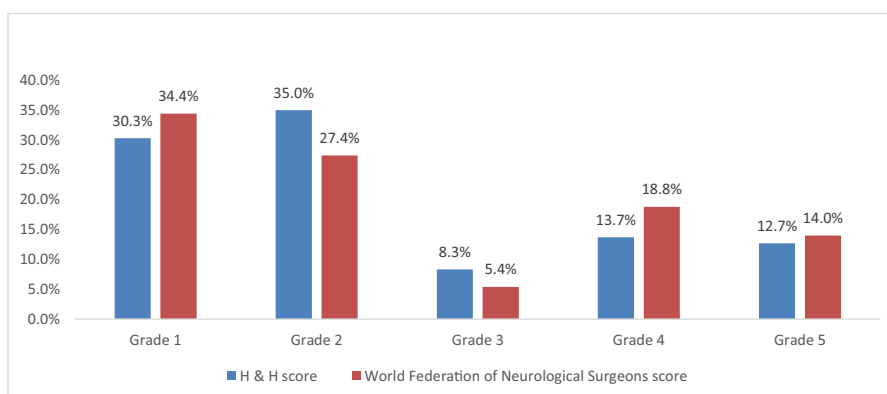


Figure 3. Grading of SAH.

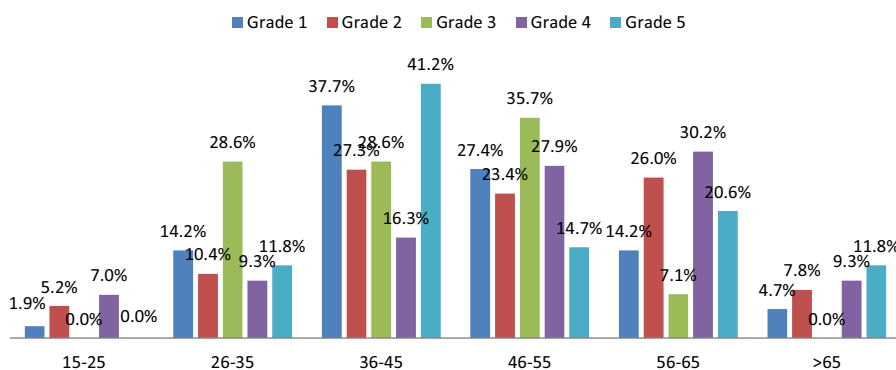


Figure 4. WFNS Scores with age group (p = 0.14).

aneurysms. The most common aneurysm in our study was anterior communicating artery (ACOMA) aneurysm (40%), followed by internal carotid artery (ICA) (14.4%), posterior communicating artery (PCOMA) (8.4%), and anterior cerebral artery (ACA) aneurysms (6.4%). Non-aneurysmal SAH occurred in 74 patients (22.9%) and was more common in men (73%) than women (27%). ICA aneurysms were more common in women (28%) compared with men (7.7%) ( $p = 0.003$ ). Furthermore, we found that ACOMA and ACA aneurysms were the more frequent cause of SAH in men than in women (45.2% vs 29.3% and 7.7% vs 3.7%, respectively). The different types of aneurysms were compared in both sexes (Figure 6). Our study demonstrated that ICA aneurysms more commonly occurs in Qatari nationals (29.4%) compared with non-nationals. ACA, posterior cerebral artery, PCOMA, and posterior inferior cerebellar artery aneurysms occurred in non-nationals, but these aneurysms did not occur in Qatari nationals (Figure 7). No statistically significant difference was found in the aneurysm location and patient nationality ( $p = 0.47$ ).

### Interventions

In our study, 23.7% and 52.6% of patients with aSAH underwent microsurgical clipping and coiling of the aneurysm, respectively (Table 2). Additionally, 19% of the patients underwent craniotomy or decompressive

craniectomy for evacuation of intracranial hematoma or for other reasons. Approximately 44.3% of patients with SAH underwent ventriculostomy (Table 2). A significant number of patients did not receive any treatment because either they were moribund and presented with extremely poor neurological status unlikely to benefit from any intervention or those who were neurologically well and had non-aneurysmal SAH.

### Outcomes

Of 323 patients, 69 died within 1-month post-ictus, accounting for a mortality rate of 21.2%. Because more men were affected by spontaneous SAH than women in our study, the survivors and those who died comprised of twice as many men compared with women, but this result was not statistically significant ( $p = 0.88$ ) (Figure 8). We also found more survivors when patients presented with WFNS grades 1 and 2 than those with WFNS grades 3 and higher. This result was statistically significant ( $p = 0.001$ ) because 44.1% and 32.6% of survivors were WFNS grades 1 and 2, respectively, whereas only 14.5% and 4.4% of survivors were WFNS grades 4 and 5, respectively. Further, 28.6% of the deceased patients had WFNS grades 1 and 2 compared with 64.3% of patients with WFNS grades 4 and 5 combined, which was statistically significant (Figure 9).

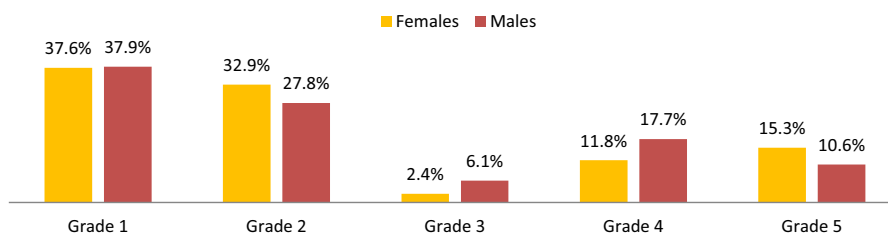


Figure 5. WFNS score by Sex (p = 0.33).

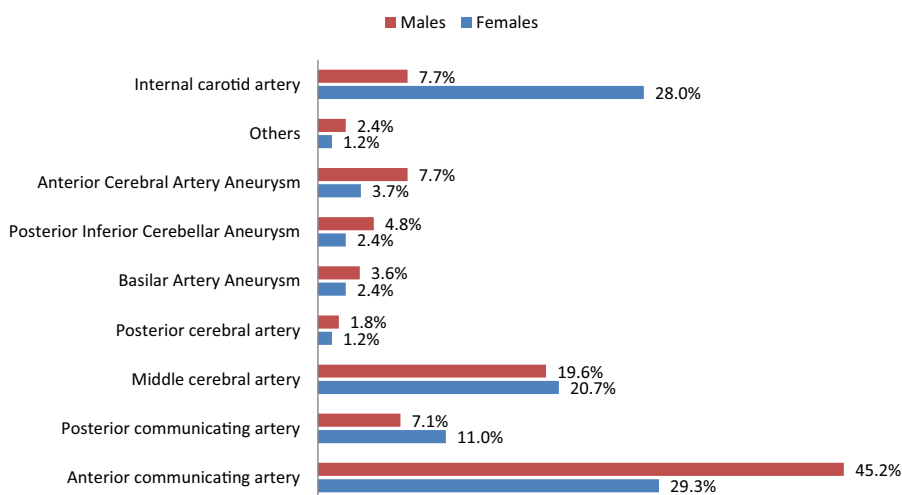


Figure 6. Sex by aneurysm localization (p = 0.003).

### DISCUSSION

Aneurysms are undisputedly the most common cause of SAH.<sup>6</sup> Nogueira<sup>5</sup> has reported only 30 cases of spontaneous SAH from 1983 to 1988 in 1992. To the best of our knowledge, this is the only epidemiological study relevant to spontaneous SAH in Qatar. According to Nogueira,<sup>5</sup> the annual incidence of spontaneous SAH in 1983 was 1.78 per 100,000 inhabitants, and the annual incidence of aneurysmal SAH in the same year was 0.35 per 100,000 inhabitants.<sup>5</sup> In contrast, we found that 28 patients

presented with spontaneous SAH in 2007 alone, and the annual incidence of spontaneous SAH in the same year was 2.3 per 100,000 inhabitants. The number of cases of spontaneous SAH was 50 in 2015 and 2.1 per 100,000 in the same year. The incidence of aSAH has clearly increased because the population evolved over the last decade.

According to the study by Nogueira,<sup>5</sup> the mean age for aSAH was 34 ± 12.8 years. The mean age in our study was 47.4 ± 12.2 years, signifying the recently increased incidence of aSAH in a slightly older population. This is consistent with other studies that

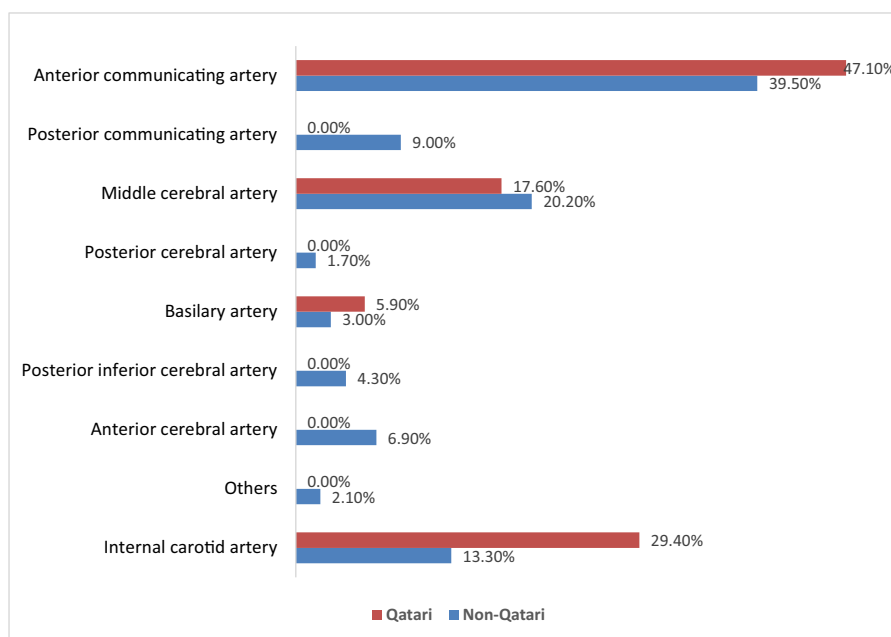


Figure 7. Aneurysm location by nationality (p = 0.47)

**Table 2. Interventions performed for patients with spontaneous subarachnoid haemorrhage**

Clipping	59 (23.7%)
Coiling	131 (52.6%)
Craniotomy for evacuation of hematoma/decompressive craniectomy	19 (6.8%)
EVD (external ventricular drain)	128 (43.4%)
No intervention* (no clipping or coiling)	109 (40.7%)
Mortality	69 (21.2%)

show that the incidence of aSAH increases with age, with typical age of onset at > 50 years.<sup>5,8</sup>

Epidemiological studies in different countries have highlighted considerable variations in the annual incidence of aSAH. The WHO MONICA Stroke study revealed that the age-adjusted annual incidence of aSAH ranged from 2 per 100,000 in China to 22.5 per 100,000 in Finland.<sup>4</sup> Another study describes an annual incidence of aSAH ranging from 2 to 16 per 100,000.<sup>2</sup>

Many studies described a higher incidence of aSAH in women than in men.<sup>8-11</sup> A recent systematic review reported that the incidence of aSAH in women is 1.4 times more than men.<sup>1</sup> In contrast, the male-to-female ratio in our study was 2:1, which may be due to predominant male population in Qatar.

The clinical hallmark of aSAH is "thunderclap" headache described by the patient as "the worst headache of my life" because it is extremely sudden and reaches a maximum intensity immediately. Such headache is reported by 80% of patients with SAH.<sup>12</sup> This is consistent with our cohort as 86.6% of our patients presented with sudden severe headache, most of them presenting to the ED within 24 hours of onset. Less than 1% of patients who present to the ED with headache have aSAH, Therefore, a high index of suspicion is mandatory.<sup>13</sup>

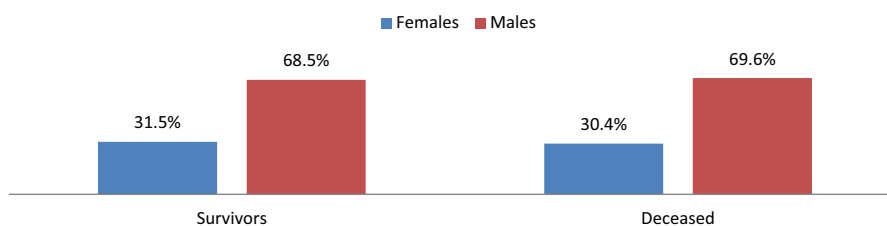
In a retrospective review of 109 patients, Fontanarosa et al.<sup>14</sup> reported that 77% of patients with aSAH had nausea or vomiting. Vomiting was documented at presentation in 49.4% in our cohort. Seizures may occur in up to 20% of patients with aSAH.<sup>15</sup> In our

cohort, 10.3% of the patients had seizures at presentation.

Unenhanced head CT remains the basis of diagnosis for aSAH.<sup>16</sup> The sensitivity of CT in detecting SAH is close to 100%, which it moderately declines over the next few days.<sup>16</sup> SAH was seen on CT in all cases on their first ED admission and was seen in association with IVH, ICH, and both IVH and ICH in 33.4%, 11.4%, and 7.4% of SAH cases, which may have an important bearing on the prognosis of these patients, but this would be a subject of further analysis of our cohort in a future study.

Consistent with other studies<sup>17-20</sup>, the most common aneurysm in our cohort was ACOMA, followed by the middle cerebral artery, ICA, and PCOM aneurysms. Interestingly, the ICA aneurysm was more common in Qatari nationals particularly women compared with non-nationals (Figs. 6 and 8). This finding can ignite further research focusing on genetics and vascular morphology of the ICA in the Qatari population. Non-aneurysmal SAH accounted for 22.9% of the cases in our cohort and was three times more common in men than in women, which was consistent with studies showing male predominance.<sup>21</sup>

According to AHA/ASA guidelines for the management of aSAH (2012), there is level 1b evidence that the initial clinical severity of aSAH is the most important indicator of outcome and must be determined rapidly using a validated scale, such as WFNS and H&H.<sup>6</sup> This was performed for all patients with spontaneous SAH who present to the ED of HGH,

**Figure 8. Outcome by Sex (p = 0.86).**

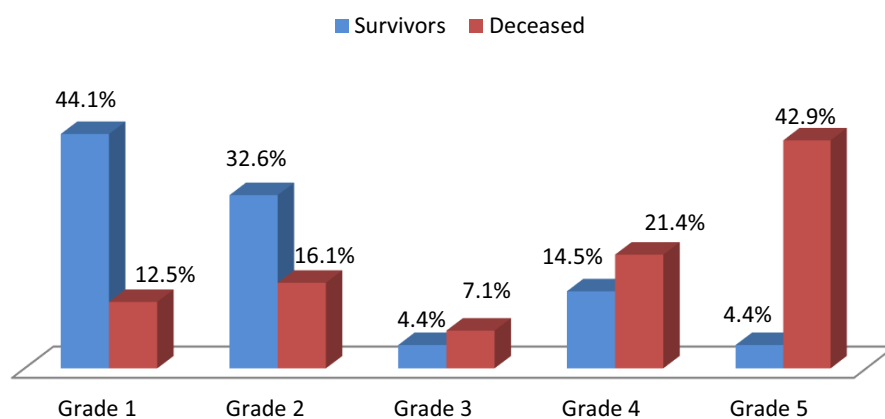


Figure 9. Outcome by WFNS score ( $p = 0.001$ ).

and 67% and 28% of patients in our cohort presented with WFNS grades 1 and 2 and WFNS grades 4 and 5, respectively (Figure 9). This finding had an important bearing on the prognosis of patients in our cohort as 76.7% and 18.9% of the survivors were either WFNS grade 1 or 2 and WFNS grade 4 or 5, respectively, a majority of whom had poor functional status.

Conflicting data exist regarding the prognostic power of the WFNS grades.<sup>22–25</sup> Several studies<sup>22,23</sup> found an increase in the unfavorable outcome with increasing WFNS grade, which was consistent with our results. Zheng K et al. reported that male sex is associated with less favorable outcomes.<sup>25</sup> The ratio of men to women was 2:1 among both survivors and deceased in our cohort, which may be consistent with the annual incidence rate of aSAH in men, which was thrice that for women.

The mortality associated with aSAH has had a declining trend particularly over the last 3 years, even in face of an increased annual incidence of aSAH. Furthermore, the number of aneurysms that underwent coiling or clipping has progressively increased in our hospital over the last 3 years (Table 1). This has undoubtedly resulted from a wide scale acknowledgment of the importance of aSAH as a life-threatening condition and the application of multiple disciplinary measures over the last decade to improve the management of aSAH at our institution

## LIMITATIONS

Retrieval of information particularly those admitted before 2010 proved to be difficult as the method of documentation evolved at our institution, which may have implications on the interpretation of our results. Furthermore, majority of the patients included in the

study were non-nationals, which made follow-up of these patients difficult because most of them traveled back to their home country after treatment. The retrospective nature of the study may also be a limiting factor, and a prospective study in the future would probably assess the epidemiology of aSAH in Qatar even more accurately.

## CONCLUSIONS

This is the first comprehensive epidemiological study of aSAH in Qatar. The annual incidence of aSAH in Qatar is increasing. Male patients have a higher incidence of aSAH in our cohort, which was in contrast with other studies. ACOMA aneurysm is the most common aneurysm in our study. ICA aneurysms were found to be more common in Qatari women, which may have a genetic basis. WFNS grade 1 and 2 aSAH was associated with better prognosis. Non-aneurysmal SAH accounts for 1/4 of the cases in our cohort and was more common in men. Majority of patients with aSAH were treated with endovascular therapy. The mortality associated with aSAH has declined over the last 3 years. This study is an initial detailed epidemiology about spontaneous subarachnoid hemorrhage (SAH) in Qatar highlighting predominant types of cerebral aneurysms, and clinical as well as gender differences, and inform about outcomes of patients with SAH in Qatar. Further large prospective studies will help provide more data about epidemiological, sex, clinical and therapeutic findings in patients with aSAH.

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