Epidemiology and Risk Factors of Stroke

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Abstract

Background: Stroke is a deficit death without clear causes. **Objective:** This study is aimed at investigating the epidemiology of stroke, and its prevalence and risk factors in order to increase the awareness of people towards this problem. **Methods:** Search was done using different database as Medline, PubMed, and Science Direct with different keywords to identify the relevant articles published. Also, the search was conducted using the electronic library of Taibahu University for Health Sciences. **Conclusion:** The second leading cause of mortality worldwide is stroke and it represents the third leading cause of morbidity globally. The stroke risk factors are divided into non-modifiable and modifiable factors. The common non-modifiable factors which cannot be changed or controlled are transient ischemic attack and family history. Furthermore, the most prevalent modifiable risk factors are uncontrolled hypertension followed by uncontrolled diabetes. Moreover, physical inactivity, cigarette smoking, excessive alcohol intake and obesity are considered as stroke modifiable risk factors. The alarming stroke can be decreased or even prevented by controlling or avoiding these modifiable risk factors.

Keywords: Epidemiology, prevalence, risk, factors, modifiable, non-modifiable, stroke

INTRODUCTION

"Stroke is defined as a rapidly developing global or focal neurological deficit maintaining more than 24 h or causing death without clear causes other than vascular origin"[1]. Also, stroke can be defined as a rapid damage in brain function caused by brain arteries decrease or stop [2]. It is divided into three types; most commonly hemorrhagic, ischemic, and Transient Ischemic Attacks (TIA).

Stroke is the most common cause of serious, functional disability and long-term neurologic impairment globally [3-6]. The common clinical manifestations of stroke are slurred speech, sudden weakness of one side (arm, face, or leg), blurred vision in one or both eyes, sudden troubled walking, and sudden severe headache[7]

In 2010, the prevalence of stroke worldwide was 33 million, and the first stroke happened in 16.9 million people. The second-leading global cause of death behind heart disease was stroke, accounting for around 11.13% [8].

A recent systematic review reported that the incidence of stroke has been increased in low-to-middle income countries and in high-income countries the stroke incidence has been decreased in the last four decades [9]. On the contrary, the severity of stroke has not been changed in this period.

Now, there are many factors well established as stroke risk factors. These factors are divided into non-modifiable and modifiable factors. They have been identified as risk factors for ischemic stroke such as: diabetes mellitus, asymptomatic carotid stenosis, hypertension (HTN), age, dyslipidemia, smoking, and non-valvular atrial fibrillation[10, 11]. The most factors linked to intracerebral hemorrhage are HTN and oral anticoagulation therapy [12]; while, smoking, alcohol consumption, and HTN have been reported as risk factors to subarachnoid hemorrhage [13]

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Prevention plays a decisive role in avoiding mortality and morbidity linked to stroke. Around 50% of stroke can be prevented by changing lifestyle factors and controlling modifiable risk factors [14].

Rationale/ justification:

In our country (Saudi Arabia), stroke is observed as a rapidly growing problem and cause of disability and death[15]. Although many risk factors are preventable, high prevalence of consequences in survivors such as post-stroke depression, physical disability, and dementia is probable [16, 17]

Objectives

Ppeople have to know how can they avoid stroke and decrease its risk factors especially the ones that can be controlled. Thus, the purpose of this review is to insight on stroke epidemiology, prevalence, and risk factors, in order to increase the awareness of people toward this problem.

METHODS:

For doing this review, Medline, PubMed, and Science Direct Databases were used to identify relevant articles published until the 3rd of January 2015 (date of search).

The search was conducted using the electronic library of Taibahu University for Health Sciences, Madinah, Saudi Arabia. Search was done using following descriptors (keywords: stroke, and cerebrovascular accident); epidemiological terms (keywords: epidemiology, risk, incidence, and prevalence) and geographical location (keywords: worldwide, and Saudi Arabia). The final list consisted of 25 articles either abstract or full text.

Literature of review:
I. History of stroke:

"The word stroke was likely first introduced into medicine by William Cole in 1689 in a physico-medical article concerning the late frequencies of apoplexies"[18]. Before Cole, the most popular word used to describe acute non-traumatic brain damage was apoplexy. It was used by Hippocrates circa 400 BC for more than 2000 years [19]

II. Definition of stroke:

Stroke is "rapidly developing clinical signs of focal (or global) disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than that of vascular origin"[1].

III. Epidemiology of stroke:
III-A. Prevalence of stroke:

A previous research done by Awada et al. (1999) reported that 76% of cases were ischemic stroke, of which one-third were lacunar infarcts. Intra-Cerebral Hemorrhages (ICHs) were the most of the hemorrhagic strokes [20]. Similar results from other studies assured the higher percentage of occurrence of ischemic stroke[21].

Akala FA, and El-Saharty S. (2006) reported that the North Africa and Middle East regions face a high burden of the disease because of increasing of non-communicable disease and decreasing of communicable diseases [22].

III-B. Incidence of stroke:
1. Incidence worldwide:
According to stroke statistics (2005) and American Heart Association Heart Disease, it was reported that the majority (88%) of strokes are ischemic in origin; and approximately 12% of strokes are hemorrhagic. Hemorrhagic strokes are more likely than ischemic strokes to result in death within 30 days (Fig.1)[23].

The study conducted by Carandang et al., (2006) reported that the stroke incidence is decreasing over time. Particularly, the incidence of age-adjusted of first stroke per 1000 person-years has decreased from 6.2 for women and 7.6 for men between1950–1977 to 5.1 for women and 6.2 for men between1990–2004[24].

Nevertheless, a systematic review found an increase in the stroke incidence in low-to-middle income countries more than 100% and decrease in incidence of stroke in the last four decades in high-income countries about 42% which was documented by Feigin et al. (2009) [25].

Another study conducted by Roger et al. (2012) estimated that, every year in the USA about 530,000 people experience ischemic stroke (IS) [26].

2. Stroke as a cause of mortality:
According to the World Health Organization, the second cause of death over the past 2002-2012 has been stroke. Also, it has estimated that in 2004 about 5.7 million deaths happened because of stroke which accounted for 9.7% of deaths [27]; more than 85% of these deaths occurred in middle-income and low income countries [28]. The reasons for this trend are not clear, but it can be attributed to getting more information about the risk factors of stroke (Fig. 2) [29]

Stroke Statistics update (2015) and Heart Disease reported that the fifth death cause in the USA is stroke, killing about 129,000 People per year[30].

3. Incidence in Arab countries:
In a systemic review conducted by Jackie Tran et al. (2010), it was reported that seventeen papers were conducted on the stroke incidence in the North Africa and Middle East. A study from Qatar showed only subarachnoid hemorrhage and another study from KSA documented incidence of non-traumatic cases of hemorrhagic. Two studies from Iran examined ischemic stroke cases[31] (Fig.3).

The rate of incidence for stroke was at the maximum level in Libya accounting for 63 per 100,000 and minimum in Qatar accounting for 11.7 per 100,000. In Iran, hemorrhagic stroke rate was 10.4 per 100 000, 1.9 per100 000 in KSA, and 2.7 per 100,000 in Qatar [31].

The two incidence rates for ischemic stroke in Iran were vastly different. One was reported for the young at 8 per 100 000 and the other included all ages, finding an incidence rate of 43.2 per 100 000 [31].

4. The incidence in KSA:
In comparison to the Western countries, in Saudi Arabia, the incidence and prevalence of strokes were low that the younger age groups predominance in this region might be the reason for such a result[32-34].

Thus far, no nationwide has been conducted recently on the prevalence and incidence of strokes in Saudi Arabia. However, it was reported in a study that the rate of stroke in Saudi Arabia was 29.8/100,000[35]. They also reported that ischemic strokes (69%) predominated and Sub-Arachnoid Hemorrhage (SAH) accounting only for 1.4%[36].

In a study by Al Rajeh et al. (1993) the incidence rate of stroke was 43.8 per 100,000 [33]. The most frequent stroke was ischemic infarcts (79%), of which 46% were lacunar infarcts, followed by intracerebral hemorrhage (18.8%), and SAH (2.2%) [36].

IV. Risk factors of stroke:
 "A risk factor is any characteristic, attribute or exposure that increases the likelihood of having an injury or disease"[37].
 The Risk factors of stoke are divided into non-Modifiable and modifiable factors[38].

Non-modifiable risk factors cannot be modified by lifestyle changes or medical treatment such as gender, race and ethnicity, family history, previous stroke, sex, and Transient Ischemic Attack (TIA)[39].

Modifiable risk factors can be modified by lifestyle changes or medical treatment. It is divided into Medical Conditions and Lifestyle Factors. Medical conditions include heart disease (myocardial infarction, and atrial fibrillation), hypertension, carotid stenosis (asymptomatic) and diabetes mellitus, and hyperlipidemia. Lifestyles include obesity, excessive alcohol use, physical inactivity and cigarette smoking[40].

IV-A. Non- modifiable risk factors of stroke:

1. Age:
A Research done by *Al-Rajeh et al. (1989)* reported that in KSA the frequency of stroke showed a constant increase with age until the 7th decade [41].

Also there was a study from KSA (2009) that noted that stroke happened mostly between 60-72 age groups, while those between 32-40 age group were least affected [42]. *Al-Jadid (2010)* reported that the percentage of occurrence of stroke in the 60-72 age group was higher than in the 22-30 and 31-40 age groups [43]. In addition, a study done by *Orzuza*

and Zurru (2011) reported that age has been identified as a significance risk for stroke [44].

2. Gender:
A study done by *Haberman et al. (1981)* reported that for cerebral infarction, there was a very little difference between the males and females. A study on the stroke gender differences in KSA (1991) reported there were more males with regard to all types of strokes than females [45].

In addition, a study done in 1993 on 500 Saudi patients with stroke indicated 31.6% were females and 68.4% were males [34]. In a systemic review conducted by *Appelros (2009),* it was documented that compared with female; the rate of incidence in male is 30% higher [46]. Moreover, a study done in Saudi Arabia (2010) also reported that the group of men patients had the higher risk when compared with the group of women [43].

3. Race and ethnicity:
There is a higher rate of stroke if people come from certain ethnic groups. For African Americans, stroke is of higher incidence and more common– even in middle-aged adults and young– than for any ethnic or other racial group in the US. Studies show that the incidence of the age-adjusted of stroke is about twice as high in Hispanic Americans and African Americans as in Caucasians[38].

There was a study by *Ralph L. et al. (1995)* which reported that African-Americans have an unknown increased mortality and incidence from stroke compared with whites, and little is known about stroke in Hispanics[47].

Also *Hayes DK et al. (2003)* reported that "the prevalence of two or more stroke risk factors was the highest between American Indians/Alaska Natives and blacks and lowest among Asians" [48].

Another recent study conducted by *Tefera et al. (2014)* reported that stroke is a major health issue, particularly among ethnic sub-groups and minority. [49].

4. Family history:
Stroke looks common in certain families. There are some factors can lead to familial stroke. Those families might have a genetic tendency for risk factors of stroke, such as an inherited predisposition for diabetes or hypertension[38].

5. Previous stroke and Transient ischemic attack:
When a person has symptoms or signs of stroke and last for a short time, is called transient ischemic attack (TIA). It is often labeled mini-stroke[50]. *Karen and Hakan (2014)* reported that TIA is an alarming sign that a person is at the risk of stroke.

IV- B. Modifiable Risk Factors:
IV-B-A. Medical conditions

1. Uncontrolled Diabetes Mellitus:

A research done by *Sacco et al. (1989-1991)* reported that diabetic patients have severe disability, higher mortality and slower recovery after a stroke, as well as higher rates of recurrence of stroke at 1 month (4.9% versus 2.6%) and at 2.6 years (15.2% versus 11.4%) compared to non-diabetic stroke patients [51, 52].

Also there are two studies conducted by *Furie et al. (2008, 2011)* reported that the first ischemic stroke risk factor is diabetes mellitus; while, data on stroke recurrence are more sparse [53, 54].

2. Uncontrolled Hypertension and Hyperlipidemia:

One of the risk factors of both types of stroke (ischemic & hemorrhagic) is uncontrolled hypertension. Hypertension can cause ischemic stroke by narrowing or clogging blood vessels in the brain that cause cutting off the blood that go to supply brain cells. Also it can damage the arteries and form weak places that rupture easily (aneurysm) which lead to hemorrhagic stroke[55].

There were several studies which confirm this relationship. One of them conducted in Saudi Arabian in (1993) reported hypertension as one of the most serious stroke risk factors between the Saudi populations [34].

Also in a meta-analysis conducted by *He J et al. (1995)* reported that hypertension is an important risk factor for stroke [56].

Curb et al. (2004) reported that the low concentrations of HDL cholesterol can lead to increased risk of stroke[57].

There was a review article conducted by *Silvia Di et al. (2012) which* reported that the single most important modifiable risk factor for stroke is arterial hypertension, it plays the role of 60% of all strokes (by the following mechanisms: atheroma in aortic arch carotids, and vertebral arteries; friability of small cerebral arteries; atrial fibrillation and left ventricular dysfunction)[58].

Another study conducted by *Zhang et al (2012)* reported that, relation of stroke with total and high-density lipoprotein cholesterol (HDL-C) risk is unclear. Low levels of HDL-C and high total/HDL cholesterol ratio were associated with increased risks of ischemic stroke in both sexes. These associations attenuated after adjustment for body mass index, history of diabetes, and blood pressure[59].

3. Atrial Fibrillation (AF):

An abnormal heartbeat called atrial fibrillation can breakdown blood clots in the heart and escape from the heart to the blood vessels supplying the brain .This will lead to block these blood vessels of brain[60]. *Wolf et al. (1991)* reported that, atrial fibrillation, undetected and asymptomatic, is a risk factor, by 5-fold increasing stroke risk throughout all ages [61].

Also there was a study conducted by *Avenue et al. (2008)* that the thromboembolism and stroke are increased in AF, but this risk is not the same in all patients[5] and is dependent on the presence of various stroke risk factors in the individual patient [62].

Other recent studies done in (2009) reported that the patients with non-valvular atrial fibrillation (AF) are at higher risk of having stroke [63].

4. Carotid stenosis (asymptomatic):

Carotid stenosis is a constriction of the lumen of the carotid arteries, the two major arteries that carry oxygenated blood from the heart to the brain. It is an important risk factor for stroke and can lead to brain damage [64].

There was a study done by *Rothwell et al.* (*2000)* showed that the ischemic stroke increases with the degree of stenosis of carotid artery [65].

IV-B-B. Lifestyle Factors

1. Excessive alcohol drinking:

Alcohol drinking has been linked to stroke in many studies. Drinking a lot of alcohol will lead to increased blood pressure and stroke risk [66]. *Sundell et al. (2008)* showed that the ischemic stroke risk is associated with alcohol consumption regardless of the amount of daily alcohol intake [67].

2. Cigarette smoking:

One of main risk factors of cardiovascular diseases including stroke and heart attacks is Smoking. Smokers are up to three times higher to have stroke than non-smokers[68]. Stroke leads to increased triglycerides, reduced HDL cholesterol, blood viscid and more likely to clot, which lead to block flowing of blood to the brain, increase the buildup of plaque (calcium, cholesterol, fat, and other substances) in blood vessels, and cause narrowing and thickening of blood vessels[68].

There are some studies which confirm smoke as the risk factor of stroke. One of them conducted by *Wolf et al. (1988)* showed that the risk of stroke is directly proportional with the number of cigarettes smoked. In heavy smokers (40 cigarettes a day or more) stroke risk was twice that of light smokers (10 cigarettes a day or less) [69].

Another study conducted by *Lin Xu et al. (2013)* reported that smoking is strongly associated with hemorrhagic stroke mortality, particularly for subarachnoid hemorrhage by increasing blood pressure which is the biggest risk factor for hemorrhage stroke[70].

3. Physical inactivity:

Physical inactivity appears to raise the risk of stroke according to several studies.

In a meta-analysis conducted by *Chong Do et al. (2003)*, it was reported that "the stroke incidence or mortality is less in

those who are active moderately or highly active compared to low-active individuals"[71].

McDonnell et al. (2013) reported that the physical inactivity is associated with increased risk of incident stroke. The traditional risk factors of stroke can decrease by any effect of physical activity[72].

4. Obesity:

Daniels et al. (2009) reported that obesity can lead to increased stroke risk because of inflammation which is caused by excess fatty tissue. This will lead to increased difficulty in blood flow and increased risk of blockage, both of which can cause strokes[73]

III-C. Other modifiable risk factors:

In a systemic review conducted by *Ajay Gupta et al. (2016),* it was reported that "silent brain infarction (SBI) on magnetic resonance imaging has been proposed as a subclinical risk marker for future symptomatic stroke"[74].

CONCLUSIONS:

The second cause of mortality worldwide which is also the 3rd leading cause of morbidity globally is stroke. The global burden of stroke is high, inclusive of increasing incidence, mortality, and economic impact particularly in low- and middle-income countries.

The stroke risk factors are divided into non-modifiable and modifiable factors. The common non-modifiable factors which cannot be changed or controlled are previous stroke, family history, and Transient Ischemic Attack (TIA) .On the other hand, most modifiable factors are uncontrolled hypertension followed by uncontrolled diabetes and then other cardiac factors. Moreover, physical inactivity, cigarette smoking, obesity and excessive alcohol use are considered as stroke modifiable risk factors. The alarming stroke can be decreased or even prevented by controlling or avoiding these modifiable risk factors.
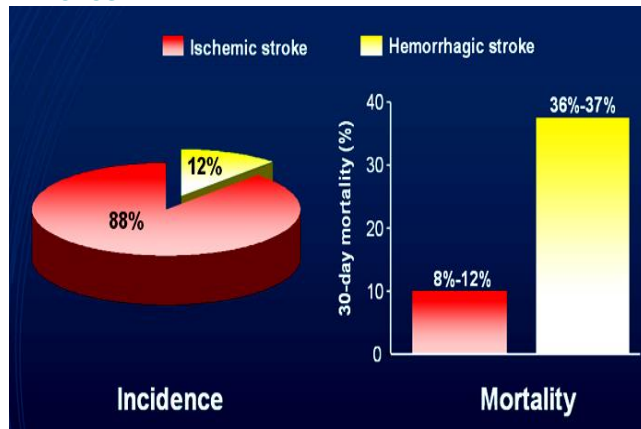
Annexes:

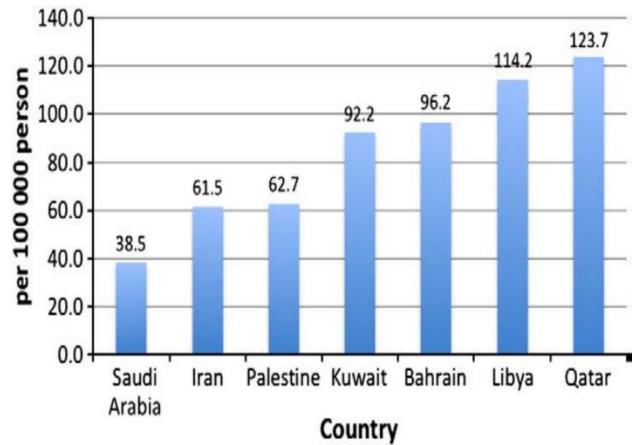**Figure 1.** American Heart Association Heart Disease and Stroke Statistics 2005 [23]

Figure 2. World Health Organization [27]

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