



## Role of Hypertension as a Major Risk Factor of Stroke in Africa; Libya: Community Based Survey

Mohamed Kaled A. Shambesh<sup>1\*</sup>, Taher Mohamed Emahbes<sup>1</sup>,  
Zeinab Elmehdi Saleh<sup>1</sup>, Malik Abdurrazag A. Elosta<sup>2</sup>  
and Iman Mohamed Shambesh<sup>3</sup>

<sup>1</sup>Department of Community Medicine, Faculty of Medicine, University of Tripoli, Libya.

<sup>2</sup>Department of English, Headquartered in Frederick, Maryland University, Maryland, USA.

<sup>3</sup>Department of English, Faculty of Education, University of Tripoli, Libya.

### Authors' contributions

*This work was carried out in collaboration between all authors. Author MKAS designed the study, wrote the protocol. Authors MKAS and ZES wrote the first draft of the manuscript. Author TME managed the literature searches and helped in discussion writing. Author MKAS did the analyses of the study with help of statisticians. Authors MAAE and IMS done the English editing. All authors read and approved the final manuscript.*

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### ABSTRACT

Hypertension is a very common medical disorder and a major health problem in North Africa. Hypertension is associated with an increase in the risk of stroke and hospitalization.

**Objectives:** To estimate the importance of hypertension (HT) as a stroke predisposing risk factor among people living in Libyan community using both CHADS2 and Community Stroke Risk Classification (CSRC).

**Methodology:** Area; North Africa (North of Libya, the capital Tripoli). Time; Five years from 2010-2014.

The study was a community based descriptive cross-section, which screened 7497 individuals living in local communities, looking for risk factors of stroke. Hypertension was one of the factors which was studied in details by community physicians, among this population whom have HT were diagnosed by their past histories, medical reports, hospital discharge letters, whether they were

\*Corresponding author: Email: [mkshambesh@yahoo.com](mailto:mkshambesh@yahoo.com);

taking any treatment or on a diet for hypertension and also medical examinations were conducted to confirm diagnosis by measuring blood pressures.

**Results:** The prevalence of HT among study participants (7497 individuals) was 38% (2850 patients), among males and females was 50.2% and 49.8% respectively ( $P = 0.041$ ). Among different age groups, males had higher rates than females except for age intervals of 50-59 and  $\geq 80$  where females had higher rates. The male to female ratio among the total population screened was almost similar (19%: 18.9%).

HT prevalence rose with the increase of age, with higher rates among age groups of over 40 ( $P < 0.0001$ ).

53% of hypertensive patients had: Diabetes Mellitus (DM) (1538 patients), 27.3% had Congestive Heart Failure (CHF) (778 patients), 15.6% had Atrial Fibrillation (AF) (446 patients), 26.7% had Transient Ischemic attack (TIA) (761 patients), and 14.8% had prior stroke (PS) (423 patients), All these risk factors accompanying hypertension rose with increase of age ( $P < 0.0001$ ).

99.9% of hypertensive patients had risk points of stroke on the CHADS2 scoring system (0.1% had no risk points), from that 53% had intermediate scores (1-2 Risk Points) and 47% had high scores ( $\geq 3$  risk points).

Results of CSRC score showed that 99.9% of hypertensive patients had risk factors of stroke (0.1% had no risk factors), from whom 56% had intermediate scores (1-2 Risk Factors) and 54% had high scores ( $\geq 3$  risk factors).

**Conclusion:** Hypertension is a major risk factor of stroke among the North African Libyan population and many, of whom have HT, had very high risk scores in CHADS2 which mainly concentrates on 1-6 risk points ( $P < 0.0001$ ). Almost all hypertensive patients had risk factors of stroke on CSRC scores which was generally contributed to intermediate and high scores. CHADS2 & CSRC classification scores are very useful tools to be used to classify and describe the risk factors of stroke in a population of a community regardless of having hypertension or not.

*Keywords: Hypertension; stroke; prevalence; risk factors; risk points; classification; community; Africa; Libya.*

## ABBREVIATIONS

*AF: Atrial Fibrillation; HT: Hypertension; DM: Diabetes Mellitus; CHF: Congestive Heart Failure; TIA: Transient Ischemic Attack; PS: Prior Stroke; WHO: World Health Organization; CDC: Centers of Disease Control; CSRC: Community Stroke Risk Classification; RF: Risk Factor; RP: Risk Points.*

## 1. INTRODUCTION

Hypertension is classified as either primary (essential) hypertension or secondary hypertension; about 90–95% of cases are categorized as primary hypertension which means high blood pressure with no obvious underlying medical cause [1]. The remaining 5–10% of cases are categorized as secondary hypertension which is caused by other conditions that affect the kidneys, arteries, heart or endocrine system. Renal disease is the most common [2].

In almost all contemporary societies, blood pressure rises with aging and the risk of becoming hypertensive in later life is considerable [3]. Hypertension results from a complex interaction of genes and environmental factors. Numerous common genetic variants with

small effects on blood pressure have been identified [4] as well as some rare genetic variants with large effects on blood pressure [5] but the genetic basis of hypertension is still poorly understood. Several environmental factors influence blood pressure. Lifestyle factors that lower blood pressure include reduced dietary salt intake [6], increased consumption of fruits and low fat products [7], exercise [8], weight loss [9] and reduced alcohol intake [10]. Stress appears to play a minor role [11] with specific relaxation techniques not supported by evidence [12,13]. The possible role of other factors such as caffeine consumption [14], and vitamin D deficiency [15] are less clear cut. Insulin resistance, which is common in obesity and is a component of syndrome X (also known as the metabolic syndrome), is also thought to contribute to hypertension [16]. Recent studies have also implicated events in early life (for example low birth weight, maternal smoking and

lack of breast feeding) as risk factors for adult essential hypertension [17], although the mechanisms linking these exposures to adult hypertension remain obscure [17].

Hypertension is the most important preventable risk factor for premature death worldwide [18]. It increases the risk of ischemic heart disease [19], strokes [2], peripheral vascular disease [20], and other cardiovascular diseases, including heart failure, aortic aneurysms, diffuse atherosclerosis, and pulmonary embolism [2]. Hypertension is also a risk factor for cognitive impairment and dementia as well as chronic kidney disease [2]. Other complications include hypertensive retinopathy and hypertensive nephropathy [21,22].

According to the World Health Organization (WHO), cardiovascular disease is the number one cause of death globally: more people die annually from cardiovascular disorders than from any other cause [23]. In particular, the Global Burden of Disease study classified ischemic heart disease as the leading cause of global mortality, accounting for 1.4 million deaths in the developed world and 5.7 million deaths in the developing regions [24].

Cardiovascular disease accounts for approximately 30% of all deaths. Of note, deaths caused by stroke and other cerebrovascular disorders are not considered in this count (cerebrovascular disease alone represents roughly 10% of all causes of death) [25].

In 2010, the three leading risk factors for global disease burden were (in this order) arterial hypertension, tobacco smoking (including second-hand smoke), and household air pollution from solid fuels [26]. The reason for the enormous burden of hypertension has been reported in numerous studies, showing that hypertensive disease is strongly associated with overall cardiovascular risk [27]. Increased blood pressure contributes indeed to both cardiovascular and cerebrovascular endpoints, including heart failure, myocardial infarction, and stroke. As reported in 2013 statistics of the American Heart Association (AHA), 33.0% of US adults  $\geq 20$  years of age have hypertension. African American adults have among the highest prevalence of hypertension (44%) in the world [28].

As of 2000, nearly one billion people or ~26% of the adult population of the world have

hypertension [29]. It is common in both developed (333 million) and undeveloped (639 million) countries [29]. However rates vary markedly in different regions with rates as low as 3.4% (men) and 6.8% (women) in rural India and as high as 68.9% (men) and 72.5% (women) in Poland [30]. In Europe, hypertension occurs in about 30-45% of people as of 2013 reports [31].

In 1995 it was estimated that 43 million people in the United States had hypertension or were taking antihypertensive medication, almost 24% of the adult United States population [32]. The prevalence of hypertension in the United States is increasing and reached 29% in 2004 [33,34]. As of 2006, hypertension affected 76 million US adults (34% of the population) and African American adults have among the highest rates of hypertension in the world at 44% [35]. It is more common in blacks, Filipinos, and Native Americans and less in whites and Mexican Americans. Rates increase with age, and is greater in the southeastern United States [1,36]. Hypertension is more common in men (although menopause tends to decrease this difference) and in those of low socioeconomic status [1].

High blood pressure is the most important modifiable risk factor of stroke [37]. It accounts for 35-50% of stroke risk [38]. According to the Libyan research institute report 2001, the percentage of people who have high blood pressure is 21.6% [39]. The report shows that hypertension is more common in males at 22.5% than in females at 21% [33]. Since 2001, the number of hypertensive people has increased to reach 40% in the CDC-WHO report 2009 [40].

This study is done in Libya to find the role of hypertension as one of the most important risk factors associated with cerebrovascular accidents among population living in a Libyan community.

## 1.1 Objectives

To estimate the role of hypertension as a major risk factor of stroke among people living in a community using both CHADS2 Score and the Community Stroke Risk Classification (CSRC) score.

## 2. METHODOLOGY

The study was a community based descriptive, cross-sectional study.

## 2.1 Populations

Individuals who are 16 years old or above.

Score Zero points= No risk = Low Risk Score  
 Score 1 & 2 points = Intermediate Risk Score  
 Score ≥3 points = High Risk Score

## 2.2 Population Sample

Sampling was done from a large cohort of individuals living in a community. 7497 individuals were screened by Shambesh et al. [41]. looking for risk factors of stroke.

**Table 1. Showing CHADS2 score questionnaire used in the study**

Condition	Points
C: Congestive heart failure	1
H: Hypertension	1
A: Age ≥70	1
D: DM	1
S: Prior stroke or TIA	2

## 2.3 Area

North Africa, Mediterranean area of Libya (Tripoli the capital).

## 2.4 Time

Five years from 2010-2015.

### 2.5.2 Community stroke risk classification- CSRC

This classification depends on a calculation on a number of risk factors (RF), each risk factor used in the study (age ≥ 70, DM, Hypertension, CHF, TIA and prior stroke) was given a value (number) for each condition among each individual who participated. The score is a result of summation of those risk factors as shown in Table 2.

## 2.5 Method of Survey

### 2.5.1 Using CHADS2 questionnaire

Individuals were interviewed using CHADS2 Score questionnaire which is usually used to assess stroke risk in patients with atrial fibrillation [42], and was also adapted in this study to be used among a population without AF as it had been used in other studies elsewhere [43]. As well a local Libyan classification of stroke risk factors was used (called Community Stroke Risk Classification-CSRC, which was created to be used for the first time in Libya by Shambesh et al. [41]. CHADS2 score is derived from the sum of point values of individual stroke risk factors {congestive heart failure (CHF), hypertension (HT), age≥ 70, diabetes (DM) (1 point each), and prior stroke or transient ischemic attack (2 points) (Table 1). The CHADS2 scoring table which, shown below, adds together the points that correspond to the condition, representing the result in a CHADS2 score which is used to estimate stroke risk as follows:

## 2.6 Field Survey

Doctors working in the community and family medicine department were trained by professionals to collect data using CHADS2 questionnaires and CSRC scores by interviewing individuals by taking a detailed history (present, past, medical, hospital admission), checking of any available investigations, discharge letters and medical reports and doing medical examinations. Known cases of hypertension, DM, CHF, AF, TIA and prior strokes had been established by previous medical diagnoses by hospital specialists. Hypertension was diagnosed by histories (taking treatment or on diet for hypertension), medical examinations and previous hospital confirmation.

**Table 2. Showing CSRC score used in the study**

Level	Score	No. of risks
Low risk score	score of <b>zero</b>	<b>No</b> risk factors
Intermediate risk score-1	score of <b>one</b>	<b>One</b> risk factor
Intermediate risk score-2	score of <b>two</b>	<b>Two</b> risk factors
<b>High risk with a score 3. Subdivided to</b>		
High risk score-3	score <b>three</b>	<b>Three</b> risk factors
High risk score-4	score <b>four</b>	<b>Four</b> risk factors
High risk score-5	score <b>five</b>	<b>Five</b> risk factors
High risk score-6	score <b>six</b>	<b>Six</b> risk factors

**2.7 Statistical Analysis**

This step was done by statisticians who scored the CHADS2 and CSRC grades by statistical package of social sciences (SPSS) version 19-USA. Data was calculated and described by using mean, mode, standard deviation, cross tabulations and graphical presentations. “T” student test for independent samples of numerical data were used with Chi-square analysis for categorized data.

**3. RESULTS**

**3.1 Hypertension (HT) Prevalence**

The prevalence of HT among our participants (7497 individuals) in the study done by Shambesh et al. [41], was 38% (2850 patients), among males and females was 50.2% and 49.8% respectively (P =0.041). Among different age groups, males had a higher rate than females except for age intervals from 50-59 and ≥80 where females had higher rates as shown in

Table 3 & Fig. 1 .The male to female ratio among the total population screened was almost equal (19%:18.9%, 1431:1419 respectively ).

HT prevalence increases with the increase of age, with higher rates among age groups over 40 (P <0.0001) Fig. 1.

**3.2 Hypertension and Diabetes Mellitus (DM)**

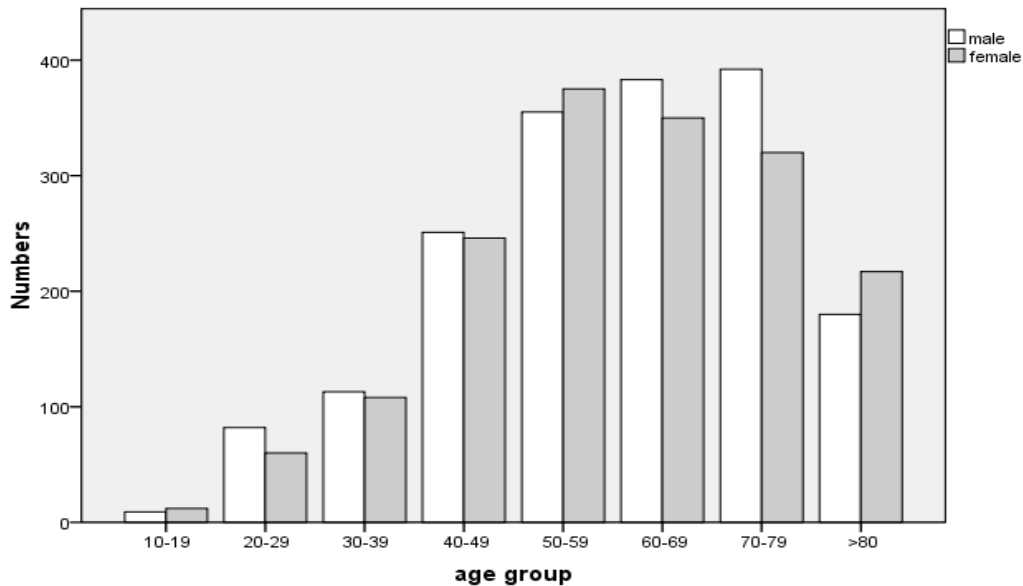
53% of hypertensive patients had DM (1538 patients), with 51% of whom were males and 49% females (P=0.87). Proportion of DM increased with age (P<0.0001).

**3.3 Hypertension and Congestive Heart Failure (CHF)**

27.3% of hypertensive patients had CHF (778 patients), females were slightly higher proportion (51.1%) than males (48.9%)(P=0.87), and CHF increased with age (P<0.0001).

**Table 3. Showing hypertension age structure and sex**

	10-19	20-29	30-39	40-49	50-59	60-69	70-79	>80	Total
Male	1	40	73	179	295	338	345	160	1431
Female	0	32	74	199	316	312	293	193	1419
Total	1 (0.03%)	72 (2.5%)	147 (5.2%)	378 (13.3%)	611 (21.4%)	650 (22.8%)	638 (22.4%)	353 (12.4%)	2850 (38%)



**Fig. 1. Showing hypertension age/sex structure**

### 3.4 Hypertension and Atrial Fibrillation (AF)

15.6% of hypertensive patients had AF (446 patients), females showed a slightly higher proportion (51%) when compared to males (49%) (P=0.87) especially in age groups 50-59 and >80 years, and AF increased with age (P<0.0001).

### 3.5 Hypertension and Transient Ischemic Attack (TIA)

26.7% of hypertensive patients had TIA (761 patients), males were significantly higher (58.7%) than females (41.3%) (P<0.0001), and TIA increased with age (P<0.0001).

### 3.6 Hypertension and Prior Stroke (PS) (Embolic or Hemorrhagic)

8.2% of hypertensive patients had PS (423 patients), males showed significant proportion (51.5%) when compared to females (48.5%) (P<0.0001), and PS increased with age (P<0.0001).

### 3.7 Hypertension and CHADS2 Scores

CHADS2 scores work with points, the higher the points (P) the higher the risk (R) score for stroke. Hypertensive patients showed that 99.9% had

risk points of stroke (0.1% had no risk points), from that 53% of whom had intermediate scores (1-2 Risk Points) and 47% had high scores (≥3 Risk Points) (Table 4 & Fig. 2).

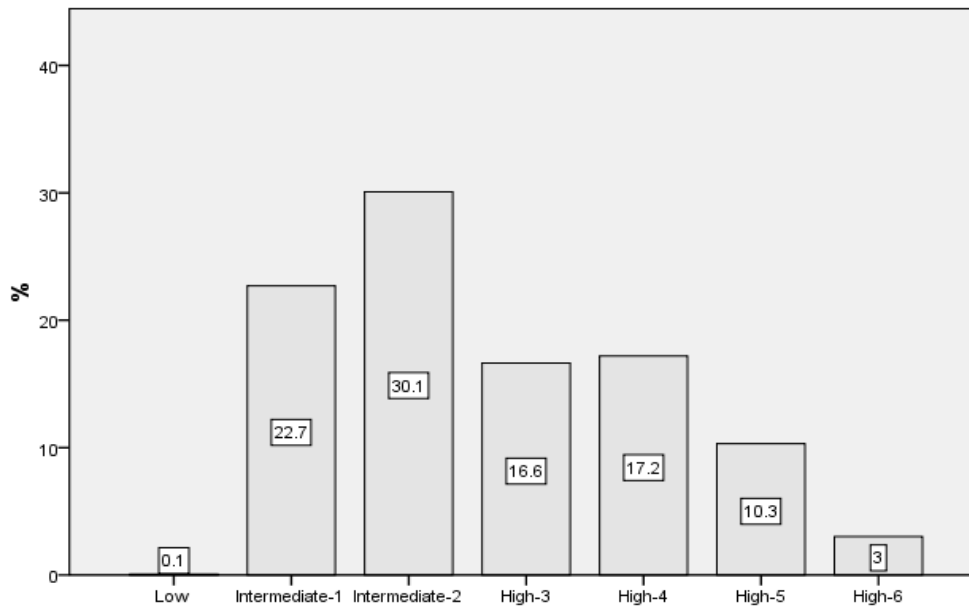
These results found that hypertensive individuals had very high risk scores in CHADS2 which were concentrated in intermediate and high scores (1-6 risk points, (P<0.0001).

**Table 4. Showing CHADS2 score among hypertension patients**

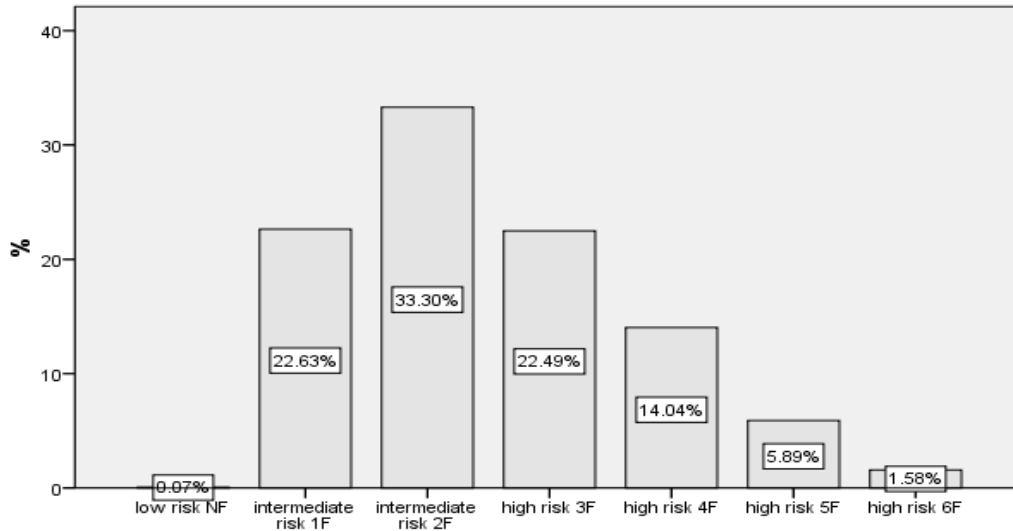
Score	No.	%
Low	2	0.1
Intermediate-1	647	22.7
Intermediate-2	857	30.1
High-3	474	16.6
High-4	490	17.2
High-5	294	10.3
High-6	86	3.0

### 3.8 Hypertension and Community Stroke Risk Classification Score (CSRC)

CSRC works with number of risk factors (RF), the higher the number of risk factors the higher the stroke risk. Hypertensive patients showed that 99.9% had risk factors of stroke (0.1% had no risk factors), from them 56% had intermediate scores (1-2 Risk Factor) and 54% had high scores (≥3 Risk Factors) (Table 5 & Fig. 3).



**Fig. 2. Showing CHADS2 score among hypertension patients**



**Fig. 3. Showing CSRC score among hypertension patients**

This result found that almost all hypertensive patients had risk factors of stroke with a concentration in intermediate and high scores (1-6 risk points, (P<0.0001)).

**Table 5. Showing CSRC score among hypertension patients**

Score	No.	%
low risk No RF	2	0.1
intermediate risk 1 RF	645	22.6
intermediate risk 2 RF	949	33.3
high risk 3 RF	641	22.5
high risk 4 RF	400	14.0
high risk 5 RF	168	5.9
high risk 6 RF	45	1.6

As of 2006, hypertension affected 76 million US adults (34% of the population) and African American adults have among the highest rates of hypertension in the world at 44% [35]. This is confirmed among the African-Arabic population in this study of having a high prevalence of hypertension and this may explain the similarity of the population origins in USA as originally migrants from Africa and other parts of the world.

Hypertension in the USA is more common in blacks, Filipinos, and Native Americans and less in whites and Mexican Americans [35,36]. This was also found to be true in our study of the Libyan population who are considered as African-Arabic origins.

**4. DISCUSSION**

According to reports in 1995 estimated that 43 million people in the United States had hypertension or were taking antihypertensive medication, almost 24% of the adult United States population [32]. The prevalence of hypertension in the United States is increasing and reached 29% in 2004 [33,34], which is less than the prevalence of hypertension in this present study (38%).

The rates in 2005, hypertension was common in both developed (333 million) and undeveloped (639 million) countries [29] and this would include Libya as an undeveloped country.

Several articles reported stroke incidence in Arab and North African countries including Kuwait, Saudi Arabia, Qatar, Libya and Bahrain. The incidence varied from the lowest of 27.5 per 100,000 population per year in Kuwait to the highest of 63 per 100,000 population in Libya [44]. The most frequent stroke type is ischemic. Stroke increased with age affecting old patients, males were more affected than females. Hypertension was the most frequent risk factor, followed by DM, hyperlipidemia, cardiac diseases and cigarettes smoking [44]. Our study results confirmed that all these stroke results reviewed in previous study summaries by Arab countries, especially that of hypertension as a leading factor which shows that Arab countries constitute populations with a similar lifestyle and diet that

may influence stroke risk, type and survival after stroke [44,45].

Hypertension prevalence in this study was high (38%) which agrees with the previous Libyan surveys done among the Libyan population, 21.6% in 2001 [39]. & 40.6% in the 2009 (CDC-WHO) survey [40] and also with the rates in Europe where hypertension occurs in about 30-45% of people as of 2013 [31].

The male: female ratio of hypertension in this study; 19%: 18.9% among the total study population but still agrees with the international rates which vary markedly in different regions with rates as low as 3.4% (men) and 6.8% (women) in rural India and as high as 68.9% (men) and 72.5% (women) in Poland [30].

Hypertension is more common in men in the developed world (although menopause tends to decrease this difference) which increased with age [1,36] and in among those of low socioeconomic status [1,36]. All such factors were confirmed by this study and by Shambesh et al. [41], although these Libyan results showed that the male to female ratio is almost equal and that the socioeconomic factors need further future studies in Libya.

Hypertension, ischemic heart disease, diabetes mellitus, smoking and hypercholesterolemia are well-known risk factors for stroke. The Oxfordshire community stroke project study showed that risk factors for cerebral infarction were present in 80% of cases, hypertension in 52%, ischemic heart disease in 38%, peripheral vascular disease in 25%; cardiac lesions were also a major potential source of emboli to the brain in 20% and diabetes mellitus in 10% [46]. Our study results also confirmed such reports that hypertension is a major risk factor for stroke but stroke prevalence in Libya among hypertension patients (19.8%) was less than that of the United Kingdom which is acceptable as hypertension is less in the developing countries compared to those developed ones according to reports in 2013 [31].

Arterial hypertension is the major cardiovascular risk factor in patients with acute stroke recorded in the different hospital Stroke Data Banks, occurring in 52% of cases of a sample of 1473 patients admitted consecutively at hospital with an acute stroke [47] and the main risk factor in lacunar strokes, with a prevalence of 75% of cases in a recent clinical study of 99 patients with

pure sensory stroke [48] which agrees with our results.

Mortel et al. [49] reported that diabetes is second to hypertension as a risk factor for stroke, followed by heart disease and smoking, which is also shown by this study results and by Shambesh et al. [41], where DM & hypertension are major risk factors followed by CHF.

The high prevalence of hypertension in this study could be related to genetic background in Libya although the genetic basis of hypertension is still poorly understood [4] with no studies done concerning this issue in Africa or in the Arab countries. Hypertension may link with the expression of calcium/calmodulin-dependent kinase IV (CaMKIV) which hitherto thought to be confined to the nervous system and may play a pivotal role in blood pressure regulation through the control of endothelial nitric oxide synthase activity [50]. The heptahelical G-protein-coupled receptors (GPCRs) represent one of the largest classes of cell-surface receptors that partake in the fine-tuning of arterial blood pressure [51]. Some studies explored the possibility that GPIIIa Pl(A1/A2) polymorphism represents a risk factor for stroke in hypertensive patients [52].

This study confirmed that hypertension is the most frequent risk factor of stroke among Libyans and this was also found in other studies in Arab countries [38], in Middle East and North Africa [45].

Finally, this study confirmed that hypertension prevalence was high among Libyans which widely affects large populations and constitutes very important public health problem.

## 5. CONCLUSION

This study concluded that hypertension prevalence was high among Libyan population, Male to female ratio was almost equal. Hypertension is a major risk factor associated with stroke. Moreover, stroke risk factors such as DM, HT, CHF and previous history of stroke or transient ischemic attack are higher among hypertensive patients.

## 6. STRENGTHS AND LIMITATIONS OF THE STUDY

It is the first Libyan community based study to use CHADS2 & CSRC questionnaires to assess stroke risk factors among those who have



hypertension. The limitations of this type of study as a cross-sectional descriptive explore associations, not causation. But as it uses a large enough sample size, thus, the results produced from this study may reflect the real situation in the Libyan community. Also because data was huge and took long time to be collected (more than three years) the study was affected by loss of follow up from physicians working in the field of research and also loss of interests of population in some areas.

## 7. RECOMMENDATIONS

To do other studies in order to measure stroke risk factors by using laboratory investigations, and other medical diagnostic procedures. Consequently, to estimate the most accurate and true rates.

## CONSENT

All authors declare that 'written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images.

## ETHICAL APPROVAL

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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