Diabetes Mellitus and Cerebrovascular Accident among North African Population (Libya) Community Based Survey

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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. Authors TME and FAK managed the literature searches and helped in discussion writing. Author MKAS did the analyses of the study with help of statisticians. Author IMS done the English editing. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Diabetes mellitus (DM) is a very common medical disorder and a major health problem in North Africa including Libya. DM is associated with an increase in the risk of stroke and hospitalization.
Objectives: To estimate the importance of DM as a stroke risk factor among people living in Libyan community.
Methodology: The study was community based descriptive cross-sectional study used CHADS2 Questionnaire, as well a local Libyan classification of stroke risk factors called Community Stroke Risk Classification (CSRC).

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Area: North Africa (North of Libya, the capital Tripoli).
Time: Five years from 2010-2014.
Population: Sampling was done from a large cohort of individuals living in the community, 7497 individuals were screened looking for risk factors of stroke.
Results: The prevalence of DM among our participants (7497 individuals) was 39% (2908 patients), among males and females was 54.1% and 45.9% respectively (*P* =0.0001). Among different age groups, males have higher rates compared to females except in very young (10-19) and very old (>80) where females dominated. The male to female ratio among total population screened was 21%: 17.8% (1573:1335 respectively).
DM prevalence increased with age, with higher rates among age over 40 (*P* <0.0001).
53% of DM patients had hypertension (1538 patients), 21.3% had Congestive Heart Failure (CHF) (618 patients), 13% had Atrial Fibrillation (AF) (382 patients), 22% had Transient Ischemic Attach (TIA) (643 patients), 12.3% had Prior Stroke (PS) (359 patients), All those risk factors accompanying DM increased with age increase (*P*<0.0001).
100% of DM patients had risk of stroke on CHADS2 and CSRC scores, which mainly concentrated in intermediate and high scores.
Conclusion: DM is a major risk factor of stroke among Libyan population and had very high risk scores in CHADS2 and CSRC.

Keywords: DM; stroke; CHADS2; CSRC.

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

Diabetes mellitus (DM) is characterized by chronic hyperglycemia with disturbances in carbohydrate, lipid and protein metabolism [1]. The worldwide prevalence of DM for all age groups is set to increase from 2.8% in 2000 to 4.4% in 2030 [2].

Diabetes mellitus occurs throughout the world, but is more common (especially type 2) in more developed countries. The greatest increase in rates was expected to occur in Asia and Africa, where most people with diabetes will probably live in 2030 [2]. The increase in rates in developing countries follows the trend of urbanization and lifestyle changes, including a "Western-style" diet. This has suggested an environmental (i.e., dietary) effect, but there is little understanding of the mechanisms at present [2].

As at 2013, 382 million people have diabetes worldwide [3]. Type 2 makes up about 90% of the cases [3,4]. This is equal to 8.3% of the adult population [3] with equal rates in both women and men [4].

In 2014, the International Diabetes Federation (IDF) estimated that diabetes resulted in 4.9 million deaths [5]. The World Health Organization (WHO) estimated that diabetes resulted in 1.5 million deaths in 2012, making it the 8th leading cause of death [6]. The discrepancy between the two estimates is due to the fact that cardiovascular diseases are often the cause of death for individuals with diabetes; the IDF uses modeling to estimate the amount of deaths that could be attributed to diabetes [7]. More than 80% of diabetic deaths occur in low and middle-income countries [8].

Uncontrolled DM may result in several dangerous complications involving most body organs including retinopathy, nephropathy, neuropathy and cardiovascular diseases [9]. Diabetes is now among the leading causes of death due to diseases in most countries of the world [10]. Therefore DM is a growing public health problem all over the world. Epidemiological studies about DM have encouraged governments to initiate or improve local diabetes monitoring and prevention strategies.

Diabetes is a major risk factor for stroke [11]. Patients with diabetes are at 2 to 3 times the risk

of stroke compared with the general population [11]. In Libya DM is common among the population, according to the Libyan research institute report 2001, Diabetes affects 7.9% of the Libyan people [12]. The number of diabetic patients increases over the time, which reaches 23.7% in report by CDC-WHO- 2009 [13].

This study was done in Libya to find the role of DM as one of the most important risk factors associated with Cerebovascular Accidents among population living in a community.

2. OBJECTIVES

To estimate the role of DM 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.

3. METHODOLOGY

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

3.1 Populations

Individuals who are 16 years old or above.

3.2 Population Sample

Sampling was done from a large cohort of individuals living in a community, 7497 individuals were screened by Shambesh et al. 2015 [14]. looking for risk factors of stroke.

3.3 Area

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

3.4 Time

Five years from 2010-2015.

3.5 Method of Survey

3.5.1 Using CHADS2 questionnaire

Individuals were interviewed using CHADS2 Score questionnaire which is usually used to assess stroke risk in patients with atrial fibrillation [15], and was also adapted in this study to be used among a population without AF as it had been used in other studies elsewhere [16]. 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, 2015 [14]. 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:

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

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

3.5.2 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.

3.6 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 DM, hypertension, CHF, AF, TIA and prior strokes had been established by previous medical diagnoses by hospital specialists. DM was diagnosed by histories (taking treatment or on diet for DM), 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 zero	No risk factors
Intermediate risk score-1	score of one	One risk factor
Intermediate risk score-2	score of two	Two risk factors
High risk with a score three subdivided to:		
High risk score-3	score three	Three risk factors
High risk score-4	score four	Four risk factors
High risk score-5	score five	Five risk factors
High risk score-6	score six	Six risk factors

3.7 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. Both descriptive and inferential analyses were conducted. In analysis of continuous variables, means and standard deviations were calculated for uniformly distributed variables and median and range for non-uniformly distributed variables. T student tests for independent samples of numerical data were used with Chi-square analysis for categorized data (Statistical significance level was set at 5%). Cross tabulations and graphical charts was used to present the results.

4. RESULTS

4.1 Diabetes Mellitus (DM) Prevalence

The prevalence of DM among our participants (7497 individuals) in study done by Shambesh et al. [14] was 39% (2908 patients), among males and females was 54.1% and 45.9% respectively (P =0.0001). Among different age groups, males have higher rates compared to females except in very young (10-19) and very old (>80) as shown in Table 3 and Fig. 1.

The prevalence of Males were higher than females among total population screened (21%:17.8%, 1573:1335 respectively).

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

4.2 DM and Hypertension

53% of DM patients had hypertension (1538 patients), with 51% males and 49% females and DM increased among them by age increase (P<0.0001).

4.3 DM and Congestive Heart Failure (CHF)

21.3% of DM patients had CHF (618 patients), males showed slight raise (50.6%) compared to females (49.4%), and CHF increased among them by age increase (P<0.0001).

4.4 DM and Atrial Fibrillation (AF)

13% of DM patients had AF (382 patients), males showed significant raise (54.7%) compared to females (45.3%) (P<0.0001) in all age groups and AF increased among them by age increase (P<0.0001).

4.5 DM and Transient Ischemic Attack (TIA)

22% of DM patients had TIA (643 patients), males showed significant raise (59.3%) compared to females (40.7%) (P<0.0001), and TIA increase among them by age increase (P<0.0001).

4.6 DM and Prior Stroke (PS) (Embolic or Hemorrhagic)

12.3% of DM patients had PS (359 patients), males showed significant raise (53.8%) compared to females (46.2%) (P<0.0001), and PS increased among them by age increase (P<0.0001).

4.7 DM and CHADS2 Score

CHADS2 score works with points, higher the points (P) higher the risk (R) score for stroke. DM patients showed that 100% had risk points of stroke, from that 60% had intermediate score (1-2 Risk Points) and 40% had high score (≥3 Risk Points) (Table 4 and Fig. 2).

Table 3. Showing DM age/sex structure

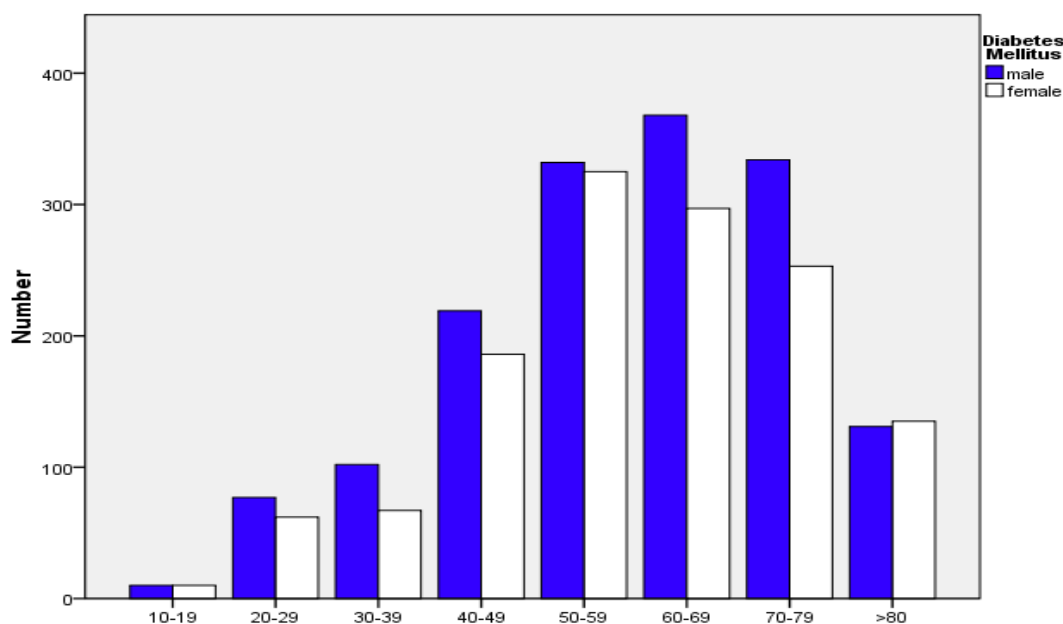| Age	10-19	20-29	30-39	40-49	50-59	60-69	70-79	>80	Total
Male	10	77	102	219	332	368	334	131	1573
Female	10	62	67	186	325	297	253	135	1335

Fig. 1. Showing DM age/sex structure

These results found that DM patients had very high risk scores in CHADS2 which concentrated in intermediate and high scores (1-6 risk points) ($P<0.0001$).

4.8 DM and Community Stroke Risk Classification Score (CSRC)

CSRC works with number of risk factors (RF), higher the number of risk factors higher the stroke risk. DM patients showed that 100% had risk factors of stroke, from that 62.7% had intermediate score (1-2 Risk Factor) and 37.3% had high scores (≥3 Risk Factors) (Table 5 and Fig. 3).

This result founds almost of all DM patients had risk factors of stroke and concentrated in intermediate and high scores (1-6 risk points, ($P<0.0001$).

5. DISCUSSION

Hypertension, ischemic heart disease, diabetes mellitus, smoking and hypercholesterolemia are well-known risk factors for stroke. Oxfordshire community stroke project study in United Kingdom 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 a major potential source of emboli to the brain in 20% and diabetes mellitus in 10% [17]. Our study results also confirmed such reports that DM is a major risk factor for stroke but the stroke prevalence in Libya among Diabetic patients (12.3%) was higher than that in United Kingdom, and this may be explained that the increase in rates of DM in the developing countries in Africa like Libya follows the trend of urbanization and lifestyle changes, including a "Western-style" diet [2].

Table 4. Showing CHADS2 score levels among DM patients

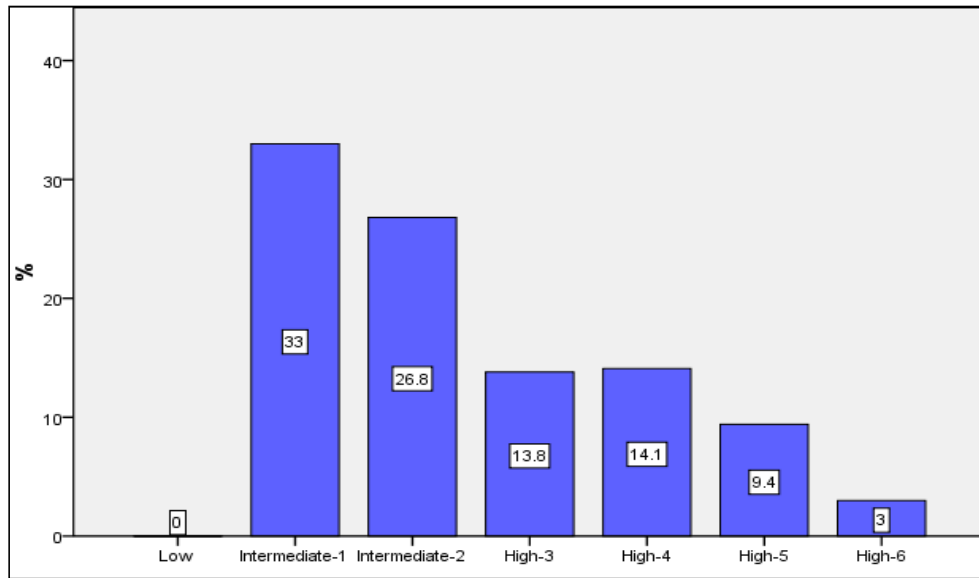| Score level	Number of patients	%
Low	0	0
Intermediate-1	961	33
Intermediate-2	779	26.8
High-3	401	13.8
High-4	409	14
High-5	272	9.4
High-6	86	3

5

Fig. 2. Showing CHADS2 score levels among DM patients

Table 5. Showing CSRC score levels among DM patients

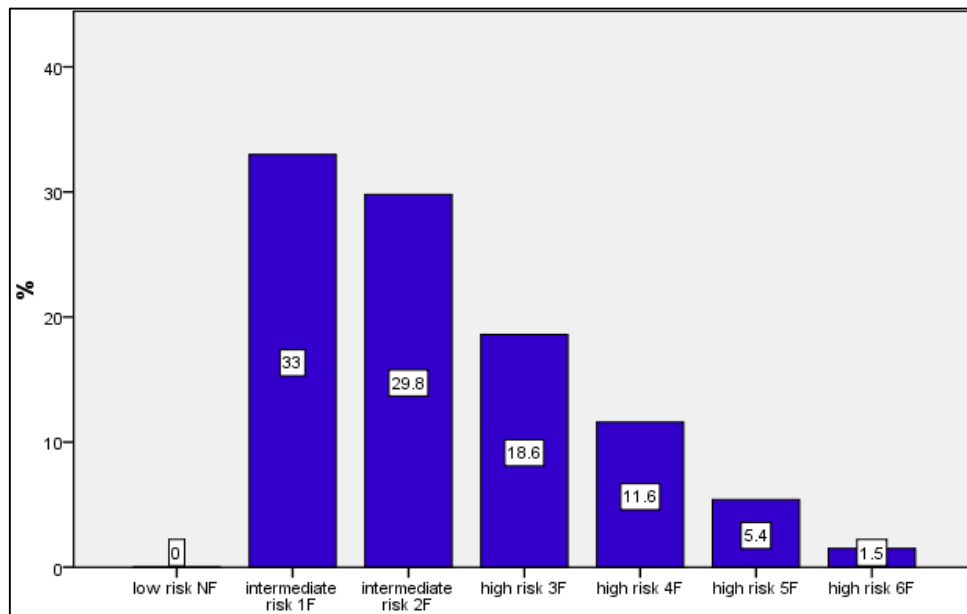| Score level	Number of patients	%
low risk NF	0	0
Intermediate risk 1F	960	33
Intermediate risk 2F	866	30
High risk 3F	541	19
High risk 4F	338	12
High risk 5F	158	5
High risk 6F	45	2

Fig. 3. Showing CSRC score levels among DM patients

6

Several articles reported stroke incidence in Arab and North African countries: 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 highest of 63 per 100,000 population in Libya. 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 with DM, hyperlipidemia, cardiac diseases and cigarettes smoking [18]. Our study results confirm all this stroke results reviewed in the previous Arab countries studies summary specially that DM is a leading factor. This shows that Arab countries constitute populations with a similar lifestyle and diet that may influence DM risk and stroke risk, type and survival after stroke [18,19].

This study confirmed that DM is second to hypertension as the most frequent risk factor of stroke among Libyans and this was also found in other studies in Arab countries [18].

Risk factors of stroke in Libya are multiple and complex, Libyan population surveys done in 2001, showed obesity prevalence of 32.7%, only 18% of study population were performing exercise and 45% were smokers with male of 99.3% [12]. Survey done in 2009 showed that only 12.4% of population study having daily healthy diet, only 22.6% of population having daily exercise, 63.5% were obese, 20% having high cholesterol and 25% were smokers [13]. These reports in Libya showed that such risk factors may play role in the increase of DM prevalence and hence accelerated cerebrovascular accidents rates among Libyan population.

DM prevalence in this study showed unexpected high rate of 39% among total population with male predominance, where in previous study in Tripoli in localized small area in Tagora community showed prevalence of 7.9 in 2001 [12], increased incredibly to 23.7% in 2009 in community survey in Tripoli area done by CDC-WHO [13]. It means that the prevalence is increased 15.8% in eight years from 2001 to 2009, with increase by 2% each year, and this aggress with the prevalence of 39% in this study which was detected in 2014 and goes with the expectation of high prevalence of DM among Libyan population. This expected prevalence is complicated by multiple risk factors but not accounting the severe trauma related to sever stress caused by civil war started in 2011 which

may play a major risk factor of increasing DM and hence storks in Libya and if this will be accounted, the high level of DM in this study will be accepted.

Mortel et al. [20] reported that diabetes is second to hypertension as a risk factor for stroke, followed by heart disease and smoking which also showed by this study results and by Shambesh et al. [14], were DM and hypertension are heading risk factor Followed by CHF.

This study confirmed that DM is the most frequent risk factor of stroke after hypertension among Libyan populations and this was also found in other studies in Arab countries [18] and in the Middle East and North Africa [19].

This study confirmed that DM is a major risk factor associated with stroke among Libyans and its widely affecting large populations constitute very important public health problem.

6. CONCLUSION

This study concluded that stroke is a major important public health problem in Libya in North Africa. DM is suggested as a major risk factor associated with stroke. Moreover, stroke risk factors such as Hypertension, CHF and previous history of stroke or transient ischemic attack are higher among DM patients.

Additionally, both CHADS2 and CSRC classification scores are very useful, easy to use and simple tools which are used to estimate, describe and classify the risk factors of stroke in a population living in a community based on studies of having DM or not.

7. STRENGTHS AND LIMITATIONS OF THE STUDY

It is the first Libyan community based study to use CHADS2 and CSRC questionnaires to assess stroke risk factors among those who have DM. Moreover, it uses a large enough sample size, thus, the results produced from this study may reflects the real situation in the Libyan community. Finally, because, this study is a descriptive cross-sectional study; it therefore explores associations between DM and stroke, not causation. It necessities conduction other types of studies like analytic case control to support and test such hypothesis.

8. RECOMMENDATION

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 patients (or other approved parties) for publication of this paper and accompanying images.

ETHICAL APPROVAL

All authors hereby declare that all research steps 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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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