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Original article

Stroke Incidence and Risk Profile in Misrata City: A Retrospective Cross-Sectional Hospital-Based Study from Emergency Medical Records

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Abstract
A stroke significantly affects both individuals and their communities. Understanding the epidemiology and occurrence of strokes within a community can enhance awareness and guide treatment strategies to reduce their immediate and long-lasting effects. Our objective is to identify the epidemiological factors and accompanying comorbid conditions linked to stroke among patients visiting the Emergency Department at Misrata Medical Centre MED. This is a hospital-based retrospective cross-sectional design study that includes patients of any sex presenting with an acute cerebral vascular accident (CVA) at the medical emergency department (MED) at Misrata Medical Center (MMC) during the period from January 1, 2019, to December 31, 2020. All medical records with a diagnosis of stroke were identified based on the definitions provided by the International Classification of Diseases. Among 837 stroke patients seen at Misurata MED (2019–2020), 440 had acute strokes and 397 had old strokes, with an average annual incidence of 461.95 per 100,000 MED patients and 33.14 per 100,000 city population. Males accounted for 61.05% of cases ($p < 0.0001$). Stroke incidence peaked at age 70–79 (22.6%) and showed a significant age-sex association ($p < 0.0001$). Polynomial regression ($R^2 \approx 0.878$) indicated a strong non-linear relationship with age. Ischemic strokes dominated (90.45%). Risk factors were present in 76% of cases; hypertension was most common (59.1%), often combined with diabetes (25.9%). Stroke risk was significantly higher in patients with multiple risk factors ($p < 0.0001$), and hypertension increased stroke risk by 3.5 times compared to other risk profiles. Stroke incidence at Misrata Medical Centre is notably high, particularly among older males, with ischemic stroke being the predominant type. The findings highlight hypertension and diabetes as the most prevalent and impactful risk factors, especially when combined. The significant association between multiple risk factors and increased stroke likelihood underscores the urgent need for targeted prevention, early screening, and comprehensive management strategies, particularly in high-risk populations. These insights can guide local health policies to reduce stroke burden and improve patient outcomes.
Keywords. *Stroke Epidemiology, Misrata, Ischaemic Stroke, Hypertension, Diabetes Mellitus, Risk Factors.*

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Introduction

Cerebrovascular accidents, commonly known as strokes, are among the leading causes of death and long-term disability worldwide, posing a major challenge to global health systems [1]. They are increasingly recognized as a significant category of non-communicable diseases in both high- and low-income countries, prompting growing research interest into their epidemiology, risk factors, and strategies for prevention and treatment [2, 3]. In addition, there is heightened focus on managing post-stroke complications, particularly the persistent disabilities that result in substantial personal and healthcare burdens [4]. While extensive studies have explored stroke patterns globally and regionally [5], Libya has witnessed limited investigations into stroke epidemiology since the 1980s. However, more recent hospital-based studies from cities like Tripoli and Benghazi suggest that the incidence and characteristics of stroke in Libya are broadly aligned with international observations [6-8].

Despite these efforts, no prior research has specifically addressed stroke patterns in Misrata City. Therefore, this study aims to assess the frequency and associated risk factors of stroke in Misrata in order to generate evidence that can enhance local healthcare delivery, identify prevalent risk profiles, and support the development of effective prevention strategies. The rising number of stroke diagnoses in Libya is likely linked to improved diagnostic capabilities, growing public awareness, and increased access to emergency medical services [11, 12]. Additionally, advances such as thrombolytic therapy and endovascular procedures have significantly transformed acute stroke management, enabling better outcomes for selected patients [1, 2]. Evaluating the stroke burden in Misrata can thus help determine the availability and utilization of these advanced interventions while also identifying gaps in current care systems.

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Globally, an estimated 15 million new strokes occur annually, with nearly two-thirds affecting individuals in low- and middle-income regions [1, 2]. According to data from the Global Burden of Disease study, approximately 11 million ischemic strokes were recorded in 2010, with 63% occurring in developing countries [2]. Ischemic stroke is the most common subtype, accounting for about 87% of all cases, whereas hemorrhagic strokes represent the remaining 13% [13, 3]. Stroke risk factors are commonly categorized into modifiable and non-modifiable factors. The most notable include advancing age, prior cerebrovascular events, hypertension, diabetes mellitus, smoking, alcohol use, dyslipidemia, obesity, sedentary lifestyle, cardiovascular disease, and genetic predisposition [3, 9].
Understanding the prevalence of these risk factors is essential for designing effective prevention and public health strategies [10, 4]. Recent evidence suggests that stroke is a growing cause of hospitalization in Libya, indicating an urgent public health issue [7, 14]. This study, therefore, aims to investigate the incidence and determinants of stroke among patients admitted to Misrata Medical Centre. Through this research, we seek to highlight key gaps in service provision, improve stroke care pathways, and ultimately contribute to better health outcomes in the local population.

Methods

Study setting, design, and study population

The study was conducted at Misrata Medical Centre, the main public hospital in Misratah City, where most patients with acute neurological deficits come for medical care. However, it is not the sole center in the city; there are a number of big private hospitals with advanced medical care wards that have been developed in the last decades inside the city zone. Therefore, some stroke patients seek medical care at these hospitals, but they are inadvertently missed and not counted in the study.
The Libyan nationwide official census provided the population data for 2020. The center is serving more than 663853 people in the city and nearby zones. The population of the city in 2020 was taken as a source reference apart from the total number, according to age and sex. The Medical Emergency Department (MED) is the main entrance for all acute medical cases in the hospital, and it includes both the emergency ward and observation ward. It represents the filtering point for medical case admissions, where the main history and examination, initial investigation, imaging, and initial management take place. All adult patients with medical conditions who were presented to the MED were the target population of the study. A cross-sectional retrospective study design was conducted on the stroke cases presented to MED during the period from 1st of January 2019 until 31st December 2020.

Data collection and assessments

The patients were identified from medical records. The records involve demographic information, main keys in history and examination, management, diagnosis of the case, and cause of admission or discharge. The data collected using a structured checklist included age, sex, presenting complaint, type of stroke, and comorbidities; hypertension, diabetes mellitus, cardiac disease, and previous cerebrovascular accident. Other risk factors for cerebrovascular accident were inaccessible because of limitations to access.

Inclusion and exclusion criteria

Inclusion criteria are set to include all patients presenting to MED from 1st of January 2019 until 31st December 2020, who have an acute neurological deficit, are aged more than 18 years old, and have a confirmed diagnosis of stroke before shifting from MED as recorded by final clinical assessment and initial computed tomography (CT) imaging scan. Also, patients who have a previous history of stroke and come to MED because of other medical conditions not related to their stroke. All patients should have a documented comorbidity assessment and complete their workup before the final diagnosis of stroke. The two types of strokes were involved, either hemorrhagic or ischemic, in both groups of patients. The exclusion criteria are set to exclude Patients who presented with transient ischemic attack, traumatic brain hemorrhage, hypertensive emergency with rapidly improving neurological deficit, venous infarctions with venous sinus thrombosis, and posterior reversible encephalopathy syndrome. Patients with a suspicious diagnosis of stroke and stroke mimics were excluded from the study.

Ethical consideration

An appropriate consent for accessing medical records was obtained. The study protocol was approved by the institutional review. All recorded data were confidentially handled. Patients were coded, and data were not shared or circulated.

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Data analysis

The Stroke Database was created using Microsoft Excel. The data were coded and then entered into the appropriate statistical package for analysis. SPSS and MedCalc were both used for analyzing data. Descriptive statistics were used to summarize the demographic features and related parameters of stroke patients. Categorical data were summarized using frequencies and percentages. The chi-square test and Mann–Whitney U test were used to analyze the categorical and continuous data, respectively. The relationship between risk factors and stroke was examined by logistic regression and chi-square test. All p-values presented were two-tailed, and values < 0.0001 were considered statistically significant. Because no control group of non-stroke cases was used in this study, both the odds ratios and relative risks were calculated by comparing the frequencies within the stroke-affected groups. ChatGPT was used for Language Editing work.

Results

A total of 837 cases of stroke patients were seen at the Medical Emergency Department (MED) from 1st January 2019 until 31st December 2020. The cohort included both cases presented with a history of old stroke (n=397) and those presented with acute stroke (n=440) cases over the two years. The average annual incidence rate was 461.95 per 100,000 MED patients per year, while the average annual incidence rate is 33.14 per 100,000 city population per year. The prevalence rate was 1747.2 per 100,000 within the MED population over the two-year study duration. Out of 837 total stroke cases, males accounted for a higher number (n= 511 cases at 61.05%) compared to females (n= 326 cases at 38.95%), with a male-to-female ratio of approximately 1.57:1. A chi-square test was performed and indicated that the difference in stroke incidence between sexes is statistically significant (P-value = 0.00000678).

Stroke prevalence increases with age, peaking between 70 and 79 years (Figure 1), the most affected age group, accounting for 22.60% of all stroke cases, and then shows a slight decline in the >80 years age group. The youngest (<39) and oldest (>90) groups have the lowest proportions (3.0% and 4.7%), suggesting a bimodal risk pattern with middle and older ages most affected. The linear regression analysis shows a positive trend between age and the number of stroke cases, indicating that stroke prevalence tends to increase with age. However, the R-squared value is approximately 0.076, meaning that only about 7.6% of the variation in stroke cases is explained by age alone using this linear model. While visually there is an increasing trend up to the 70–79 group, the low R-squared suggests that the relationship is not strongly linear across all age groups.

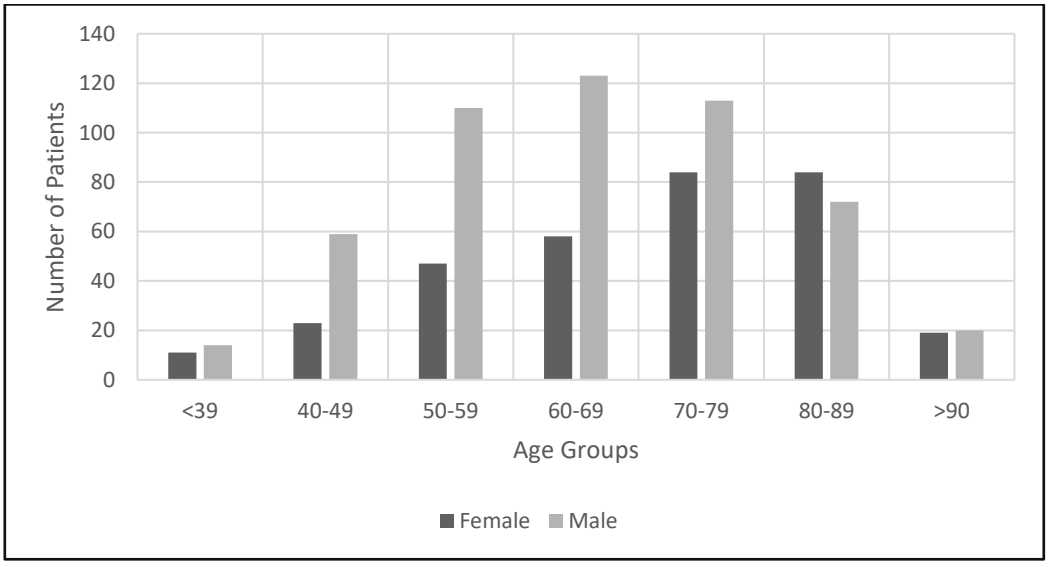

Figure 1. Distribution Of Patients According to Age and Sex

When stroke cases are stratified by age group and sex (Female vs. Male), Table 1, the mean age for female stroke patients is 69.21 years (SD = 14.59, n = 326), while the mean age for male patients is 64.49 years (SD = 14.04, n = 511). The overall mean age for all patients is 66.33 years (SD = 14.43, n = 837). Chi-Square Test shows a statistically significant association between age group and sex in the distribution of stroke cases ($p < 0.0001$). The polynomial regression (degree 2) provides a much better fit for the age-related stroke data, with an R-squared value of approximately 0.878. This indicates that

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87.8% of the variation in stroke case numbers across age groups is explained by this model. The curve illustrates a non-linear relationship where stroke prevalence increases significantly with age up to around 70–79 years. Beyond this peak, a decline is observed. Illustrated in Figure 2**.** Out of a total of 440 documented acute stroke cases, 398 (90.45%) were ischaemic strokes, while only 42 cases (9.55%) were haemorrhagic strokes.

Table 1. Stroke Patients Distribution in Relation to Age Groups and Sex

Age Group	Female Cases	Male Cases	Total Cases	% of Total Cases	Male-to-Female Ratio
<39	11	14	25	3.0%	1.27
40–49	23	59	82	9.8%	2.57
50–59	47	110	157	18.8%	2.34
60–69	58	123	181	21.6%	2.12
70–79	84	113	197	23.5%	1.35
80–89	84	72	156	18.6%	0.86
>90	19	20	39	4.7%	1.05
Total	326	511	837	100%	1.57 (Overall Ratio)

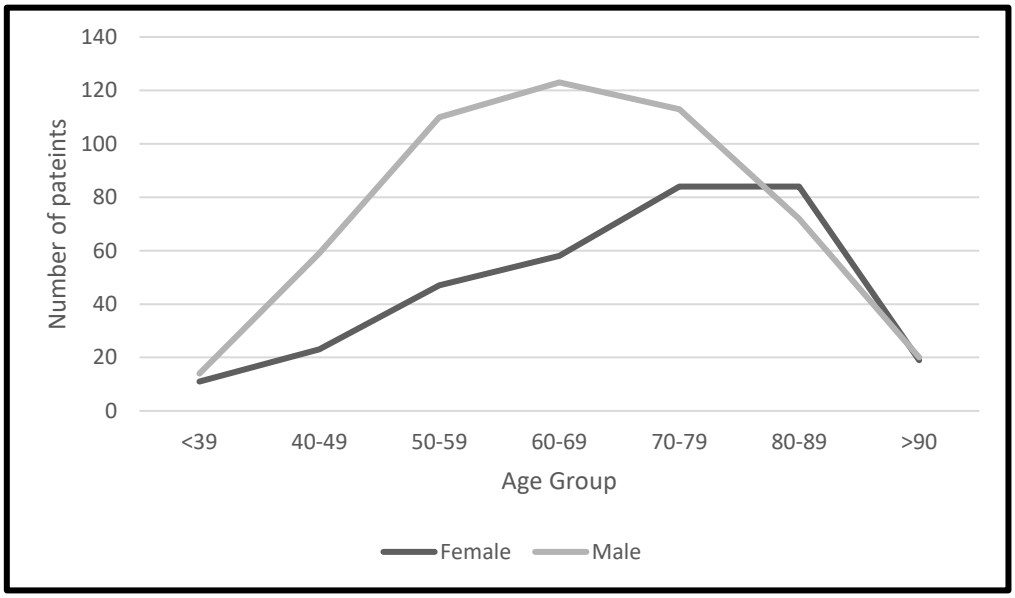

Figure 2. The Nonlinear Model of Stroke Incidences According to Age in Relation to Sex

The majority of cases (76%) had one or more documented risk factors. 202 patients (24.0%) had no previous risk factor, indicating that nearly a quarter of stroke presentations occurred without prior known comorbidities. Among this subgroup of cases, a small proportion (7.1%) had no identifiable risk factors. In 17.2% of cases, the stroke itself was the first presentation that led to the identification of a risk factor. when analyzing the difference in likelihood of stroke occurrence between those with a single risk factor vs. those with combinations of risk factors. The chi-square value of 42.4 with $p < 0.00001$ indicates a highly statistically significant difference, indicating Stroke patients are significantly more likely to present with multiple risk factors than a single one. Compared to patients with a single risk factor, those with multiple risk factors have a relative risk of about 1.5 of getting a stroke. Table 2 summarizes the risk factor categories.

Table 2. The Number and Percent of Stroke Cases Across Various Categories of Risk Factors.

Risk Group / Category	No. of Stroke Cases	% of Total (n = 837)
Risk Group		
Single Risk Factor	251	30.0%
Multiple Risk Factors	381	45.5%
Subtotal (Known Risk Groups)	632	75.5%

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Overall Risk Factors		
Hypertension (HTN)	492	58.8%
Diabetes Mellitus (DM)	425	50.8%
Cardiac Disease	115	13.7%
Old Stroke	112	13.4%
Single Risk Factor Categories		
No previous risk factor	200	23.9%
HTN (alone)	124	14.8%
DM (alone)	76	9.1%
Old Stroke (alone)	26	3.1%
Cardiac Disease (alone)	27	3.2%
Combinations of Risk Factors		
DM + HTN	219	26.2%
HTN + Old Stroke	20	2.4%
HTN + Cardiac Disease	12	1.4%
DM + Cardiac Disease	8	1.0%
DM + Old Stroke	3	0.4%
DM + HTN + Cardiac Disease	59	7.0%
HTN + DM + Old Stroke	54	6.5%
DM + HTN + Cardiac Disease + Old Stroke	9	1.1%
Total Stroke Cases (from all sources)	837	100%

The most prevalent single risk factor was hypertension (HTN), seen alone in 14.7% of cases, and was associated with an estimated 41% increase in stroke odds compared to individuals with no history of HTN or DM (OR ≈ 1.41). Diabetes mellitus (DM) alone accounted for 9.1%, was linked to a 25% increase in stroke odds (OR ≈ 1.25). Cardiac disease and old stroke as individual risks were relatively uncommon (3.2% and 3.1%, respectively). Hypertension (HTN) appeared in 59.1% of all cases. It was more common than diabetes (51.0%), and significantly more common than cardiac disease (13.8%) and old stroke (13.5%). Notably, the majority of HTN cases occurred in combination with other risk factors — only 122 cases (24.8%) of the 492 HTN-associated strokes had HTN as the sole factor. The co-occurrence of HTN and DM (216 cases) accounted for more strokes than HTN or DM individually, and was associated with a striking 150% increase in stroke odds (OR ≈ 2.50). Combined risk factors were more common than single ones. The most frequent combination was DM/HTN, representing 25.9% of all cases—more than any single factor alone. Complex combinations such as DM/HTN/CAD (7.1%) and HTN/DM/old stroke (6.5%) were also notable.

The proportion of stroke patients who had diabetes (DM) or hypertension (HTN), separated by sex, showed that more females with stroke had diabetes (52.4%) than males (48.9%), and more females with stroke had hypertension (62.6%) than males (56.4%). A statistical test with chi-square shows that these differences are not statistically significant. In this study, both males and females were similarly affected by diabetes and hypertension. The slightly higher proportions in females could be due to random variation, not a real sex-specific difference. Stroke patients with HTN as a risk factor make up ~77.8% of all cases with known risk factors, compared to those with non-HTN risk factors, which make up only ~22.2%. The relative likelihood of stroke in the presence of hypertension is about 3 times higher compared to having other risk factors without HTN.

Discussion

This study offers a comprehensive view of stroke epidemiology in Misrata, Libya, emphasizing prevalence trends, age-sex distribution, and associated risk factors, with findings that both reflect and diverge from earlier studies conducted in other Libyan cities such as Tripoli, Benghazi, and Sabha. The observed total of 837 stroke cases over a two-year period, with an annual incidence rate of 33.14 per 100,000 population, is notably lower than the 52.6 per 100,000 reported in Benghazi by El Zunni et al. [6], and significantly below the global average incidence of 81.0–91.0 per 100,000 as estimated

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by Feigin et al. [2]. This discrepancy may be attributed to the study's reliance on data from a single public hospital, which resulted in the exclusion of cases managed in private healthcare facilities. This limitation likely led to an underestimation of the true burden on the community. Additionally, the use of population figures from only one year of the study period—rather than the average over the two years—and the reliance on total population counts instead of the adult population specifically, may have further contributed to the underestimation of the actual stroke burden in the community.

Ischemic stroke was predominant, constituting 90.45% of all acute cases, aligning with national and international patterns. This proportion closely mirrors the findings from Benghazi (88.5%) [14] and Tripoli (85.6%) [7], confirming that ischemic events vastly outnumber hemorrhagic ones in Libya. These findings support the INTERSTROKE study's conclusion that ischemic stroke is globally the most common subtype, particularly in low- and middle-income countries [3]. The high proportion of ischaemic cases underscores the critical role of vascular risk management, particularly with a focus on hypertension and diabetes.

A striking sex disparity was noted, with males comprising 61.05% of cases, with a male-to-female ratio of 1.57:1, echoing results from Benghazi (63%) [6], Tripoli (62.8%) [7], and Sabha (60%) [11], indicating a consistent male predominance across Libyan cities. This sex-based variation has been widely reported in both Arab and Western populations [8,10,4,16]. Biological differences in vascular structure, hormonal protection in premenopausal women, and variations in healthcare-seeking behavior may contribute to these differences [4]. Additionally, men in Libya may be more exposed to behavioral risk factors such as smoking and sedentary lifestyles, as highlighted in national surveys of non-communicable disease (NCD) risk [12].

Age was a major non-modifiable factor associated with stroke. It was a strong predictor of stroke, with prevalence increasing markedly in the 60–79-year range and peaking at 70–79 years. Although linear regression showed only modest correlation ($R^2 = 0.076$), a polynomial model offered a better fit ($R^2 = 0.878$), indicating a non-linear relationship where stroke prevalence rises with age until late elderly years, then slightly declines. This age distribution is consistent with both regional and global epidemiological studies [3,5,16], reflecting the age-associated rise in comorbidities such as hypertension and diabetes mellitus. The peak incidence in the 70–79-year age group and a mean age of 66.3 years for all patients are consistent with previous Libyan studies, which reported mean stroke onset ages ranging from 63 to 68 years [6,7,14]. However, in comparison to international cohorts where stroke onset may occur later (e.g., >70 years in high-income countries) [2], Libyan patients tend to present with stroke at relatively younger ages. This earlier onset may reflect a high burden of undiagnosed or poorly managed risk factors such as hypertension and diabetes, as well as limited access to preventive services.

The burden of comorbidities was high, with about 76% of stroke patients having at least one risk factor and nearly 59% having hypertension. Hypertension, alone or in combination, was the most dominant risk factor (seen in 492 cases), and it was present in approximately 77.8% of all cases with any risk factor, underscoring its primacy in stroke pathogenesis in the region [7, 15, 3]. This prevalence exceeds earlier Libyan reports [11,12,14] and is consistent with findings from global studies like INTERSTROKE [3] and GBD 2019 [2], which identified hypertension as the single most significant modifiable risk factor. This is consistent with findings from Tripoli, where HTN was reported in 57.4% of stroke patients [4], and higher than the 51.3% reported in Benghazi [7]. Community-based surveys across Libya also identify hypertension as the leading risk contributor to stroke [5]. The relative risk of stroke in hypertensive patients was 3.5 times higher than in those with non-HTN risk factors alone, reinforcing conclusions from Shambesh et al.'s national data [5]. This strong correlation supports the prioritization of hypertension screening and management as a central pillar of stroke prevention in Libya.

Diabetes mellitus was the second most common risk factor (51.0%), with a significant overlap with hypertension—DM/HTN combination alone accounted for 26% of cases. This comorbidity pattern was similarly observed in Alkhadra Hospital (Tripoli), where the HTN/DM combination was prevalent in 28% of stroke patients [14]. The clustering of cardiovascular risks in stroke patients reflects the findings of O'Donnell et al. in the INTERSTROKE study [3], which identified hypertension and diabetes as the most powerful modifiable contributors to stroke worldwide. When considering isolated risk factors. The estimated odds ratio for stroke in the presence of HTN alone was 1.41, and for DM alone, it was 1.25, indicating a moderately increased risk. However, when both HTN and DM were present, the odds ratio rose to 2.50, suggesting a synergistic effect—a combined impact greater than the sum of each factor individually. This aligns with international literature showing that comorbid metabolic and vascular conditions substantially magnify stroke risk due to cumulative endothelial damage, accelerated atherosclerosis, and impaired cerebral autoregulation.

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An important observation in this study is that about 24% of patients had no prior diagnosis of stroke-related risk factors, and for 17.2%, the stroke was the first clinical manifestation of an underlying disease. Comparable results were reported in Benghazi and Sabha, where undiagnosed comorbidities were discovered in over 20% of stroke admissions [6,11]. This suggests systemic gaps in primary care screening and follow-up, particularly for chronic NCDs. The findings indicate an urgent need to strengthen community-based screening programs, especially in primary healthcare settings, to detect hypertension, diabetes, and cardiac diseases before complications like stroke occur.

Moreover, patients with multiple comorbidities had significantly higher stroke occurrence than those with single risk factors ($p < 0.00001$), with a relative risk of 1.5. This dose-response relationship supports evidence from the Framingham Study and global research [16], emphasizing the additive risk posed by multimorbidity. Libyan studies have rarely quantified this relationship, making this analysis a valuable contribution to local data.

In comparison to older Libyan reports, such as the 2009 review by Benamer and Grosset [8], which criticized the lack of comprehensive national stroke registries and standardization in reporting, this Misrata-based study provides a relatively structured and statistically robust approach. It highlights progress in hospital data use but also underscores the persistent limitation of non-integrated health information systems, especially with stroke cases managed in the private sector, not captured in public databases.

Strengths and limitations of the study

This study, the first of its kind conducted in Misrata, reveals patterns broadly consistent with those observed in other Libyan cities in terms of age distribution, sex, risk factors, and stroke subtypes. However, it offers a more precise estimation and robust statistical analysis. When compared with previous regional research, these results strengthen the existing evidence base and highlight the need for coordinated national strategies to address undiagnosed chronic conditions and the growing burden of stroke in Libya. Nevertheless, the study's reliance only on patients presenting to MED and the inability to access data from private healthcare centres limit the generalisability of its findings in estimating incidence rates across the central region. Moreover, the absence of complete data on all potential risk factors constrained the analysis to a limited range of determinants.

Conclusion

This hospital-based study highlights the substantial and growing burden of stroke in Misrata City, Libya, revealing patterns consistent with global trends but intensified by regional risk factor prevalence and healthcare limitations. Stroke incidence was highest among older adults, particularly males, with ischemic strokes dominating clinical presentations. A significant proportion of patients had multiple modifiable risk factors—most notably hypertension and diabetes—which substantially increased the likelihood of stroke. Alarmingly, a quarter of cases occurred in individuals without known prior comorbidities, and in many, stroke was the first indication of an underlying condition. These findings emphasize a critical gap in preventive care and underscore the urgent need for targeted public health strategies, including early screening, hypertension and diabetes control, and improved stroke awareness. Investing in community-based prevention, structured outpatient follow-up, and stroke-specific infrastructure such as registries and rehabilitation units is essential to curb the rising stroke burden and improve outcomes in Libya.

Conflict of interest. Nil

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