BJMS
www.batnajms.net

Batna Journal of Medical Sciences 2026;13(8):10
https://doi.org/10.48087/BJMS.2026.130810

ORIGINAL ARTICLE

Prospective population-based study of first-ever stroke in northeastern Algeria: incidence in urban population, Béjaïa municipality, 2018-2019.

Issam MEDKOUR[1], Soumaya AMAROUCHE[1], Rima MOUELLEF[2], Nadir BOUSSOUF[1].

ABSTRACT

Introduction. Stroke is a major public health challenge worldwide, particularly in low- and middle-income countries. Reliable epidemiological data on stroke are essential for guiding prevention strategies, healthcare planning, and clinical management. This study aimed to estimate the incidence of first-ever stroke in the municipality of Bejaia, Algeria, between 2018 and 2019. **Methods.** This prospective descriptive study included all residents of the municipality of Bejaia aged 20 years and older who experienced a first-ever acute stroke between January 1, 2018, and December 31, 2019. Stroke data were collected using a pre-designed questionnaire. Stroke was defined according to the World Health Organization (WHO) criteria, and the diagnosis was confirmed by brain imaging. **Results.** A total of 1,734 patients with suspected stroke were identified, of whom 369 (22.5%) met the eligibility criteria. The crude annual incidence rate of first-ever stroke was 140.4 cases per 100,000 population (95% CI: 126.6–155.3). The incidence rate was significantly lower in males than in females (119.4 vs. 162.5 cases per 100,000 population per year, p = 0.002). The age-standardized incidence rates were 269.9 and 183.6 per 100,000 population using the European and World Standard Populations, respectively. **Conclusion.** The incidence of first-ever stroke observed in this study was higher than that reported in previous studies conducted in Algeria. These findings provide valuable epidemiological evidence to support stroke prevention strategies and inform local healthcare planning and policy development.

Keywords: Incidence, Algeria, population-based study, stroke, surveillance.

1. University Hospital Center/ Department of Medicine/Faculty of Medicine, Salah Boubnider University - Constantine 3, Ali Mendjeli, Constantine, Algeria. 2. Hospital Establishment Didouche Mourad/Department of Medicine/Faculty of Medicine, Salah Boubnider University - Constantine 3, Ali Mendjeli, Constantine, Algeria.

Received: 11 May 2026
Accepted: 22 Jul 2026

Correspondence to: Issam MEDKOUR
E-mail: issam.medkour@univ-constantine3.dz

1. INTRODUCTION

Stroke is one of the most awful public health challenges facing contemporary healthcare systems worldwide, representing one of the leading causes of death and long-term disability [1]. According to the World Health Organization (WHO), approximately 15 million people worldwide suffer a stroke each year, of whom nearly 5 million die and a further 5 million are left with permanent sequelae, making this condition the second leading cause of death and the leading cause of acquired disability in adults [2]. Even more alarmingly, the lifetime risk of having a stroke has increased by 50% over the last two decades, and it is now estimated that one in four adults will be affected. This burden is unevenly distributed: low- and middle-income countries bear more than 80% of the global burden of stroke, often with meagerresources to cope with it [3-5]. The epidemiological, clinical, and economic burden necessitates the optimized organization of healthcare systems, from the acute phase through to rehabilitation and secondary prevention [6]. In this context, population-based studies have emerged as essential tools for measuring incidence, evaluating medical practices, and describing the prognosis of stroke patients, thereby providing the data needed to develop evidence-based health strategies [7–9].

North Africa and the Middle East region (MENA region) are no exception to this widespread trend. High blood pressure, smoking, air pollution, and a sedentary lifestyle are major and increasing risk factors in these regions [10–12]. However, one of the major obstacles to developing effective prevention policies in this region is the acute lack of robust epidemiological data [13]. Unlike Western countries, which have population registries and longitudinal incidence studies, many North African countries, including Algeria, lack precise data on the actual incidence of stroke in the general population [11, 14–16].

In Algeria, except data from the Blida stroke registry (which is based on hospitalized strokes and excludes minor and silent strokes treated outside hospitals) [14], the limited data available mainly comes from retrospective hospital studies or case series, such as the one conducted in Sidi-Bel-Abbes and Setif [17–20], but none has measured the standardized incidence in the general population according to the strict methodological criteria recommended by international studies ('ideal criteria') [8, 21]. This lack of baseline data constitutes a major obstacle to health planning, resource allocation (such as neurovascular units), and the assessment of temporal trends [16]. Although a systematic review of the literature on Arab countries highlighted, as early as 2009, a critical shortage of epidemiological data in Arab countries, this observation remains relevant in Algeria. A systematic review of the literature had already highlighted this gap nearly fifteen years ago, and the situation has changed only partially since then [21].

Whilst high-income countries have access to such data to inform their health policies, a glaring lack of information persists in many resource-limited regions, particularly in Algeria. At the national level, the absence of a national stroke registry results in a lack of robust and representative epidemiological data. This gap is particularly detrimental at the local level, as in the municipality of Bejaia, where decision-makers and clinicians are forced to rely on international data or estimates, which may not reflect the specific demographic, cultural, and organizational characteristics of the local population. Consequently, planning and reorganization, the optimization of care pathways (particularly thrombolysis and thrombectomy), and the allocation of resources take place in the absence of reliable local evidence, potentially compromising the effectiveness and equity of interventions.

In order to address this information gap and provide an evidence-based foundation for the effective reorganization of care, it is imperative to conduct a prospective study on strokes in the municipality of Bejaia, located in northeastern Algeria. Such a study would not only fill a major gap in the national literature but also provide a robust comparative benchmark for the MENA (Middle East & North Africa) region, thereby facilitating analysis of the ongoing epidemiological transition and enabling the generation of accurate population-based data on incidence. This information is an essential prerequisite for identifying the strengths and weaknesses of the local healthcare system, assessing the impact of corrective measures, and, ultimately, improving the quality and efficiency of the overall care of stroke patients at the local level.

The primary objective of this study was to quantify the crude and standardized incidence ¬in accordance with global and European standards¬ of all strokes and their main subtypes (cerebral infarction, intracerebral haemorrhage and subarachnoid haemorrhage) within the urban adult population of the municipality of Bejaia between 2018 and 2019.

2. PATIENTS AND METHODS

Type and period of the study

This was a prospective descriptive study (incidence study). It included all cases of stroke (first stroke episode) occurring among the population of the municipality of Bejaia between 1 January 2018 and 31 December 2019.

Study population

At-risk population: This comprised the population residing in the municipality of Bejaia aged 20 years or older; the size of this population was estimated at 131,035 inhabitants in 2018 and 131,838 in 2019. The data were provided by the Directorate of Health and Population of the Department of Bejaia / National Statistics Office (ONS) according to age, sex, and major and secondary urban areas [22].

Target population: This included all stroke patients aged 20 or over residing in the municipality of Bejaia who had consulted and/or received treatment at healthcare facilities (departments of Bejaia University Hospital, clinics, and private practices) in the municipality of Bejaia, as well as those treated at the El-MATEN Specialist Hospital for Functional Rehabilitation (EHS) and cases residing in the municipality of Bejaia who were treated outside the aforementioned facilities and identified at a later stage.

Definitions and eligibility criteria

Case definitions: A person who has suffered a stroke was defined as "aperson experiencing a cerebrovascular event with rapidly developing clinical signs involving focal [or global] impairment of brain function, lasting more than 24 hours or resulting in death, with no apparent cause other than a vascular one" [23–25] (the former WHO clinical definition, which remains in force; this methodological choice meets a dual requirement: on the one hand, it ensures the strict comparability of our data with major historical and international incidence studies, such as the MONICA project or the European reference registries. On the other hand, the application of the WHO criteria ensures compliance with the methodological standards ("ideal criteria") defined by Sudlow and Warlow for studies in the general population, thereby avoiding overestimation biases associated with the inclusion of routine imaging in contexts where access to MRI may vary [26–28]. This case can be confirmed by medical neuroimaging (radiological confirmation via CT and/or MRI). The diagnosis of stroke was made in the presence of: Persistent neurological deficit beyond 48 hours (clinical confirmation) or A coma with medical imaging showing a cerebral infarction or haemorrhage or A sudden death presumed to be of vascular origin; An autopsy confirming the vascular origin of the death [24, 26, 28, 19]. The opinion of a neurologist was always sought for confirmation (in the absence of neuroimaging) and final classification of the case.

Definition of the first cerebrovascular event: A first cerebrovascular event refers to the first-ever consultation and/or hospital admission for a sudden-onset focal or generalized neurological deficit, presumed to be of vascular origin, whether confirmed by medical imaging [24, 28].

Eligibility criteria:

Inclusion criteria : Cases of stroke diagnosed clinically and/or confirmed by medical imaging, observed in subjects aged 20 years and over of both sexes; Residents of the municipality of Bejaia for at least six months prior to the onset of the stroke; Strokes occurring between 1 January 2018 and 31 December 2019; Cases involving cerebral infarction, haemorrhage or cerebral venous thrombosis.

Non-inclusion criteria: Traumatic cerebral haemorrhage; Transient ischaemic attacks (TIAs); Subdural haemorrhage ; Epidural haemorrhage ; Subdural haematomas; Poisoning; Cases with a history of stroke and hospitalised for another reason, Cases of stroke with motor deficit of another origin (traumatic or metastatic), Coma of systemic vascular origin, such as Shock, Stokes-Adams syndrome and Hypertensive encephalopathy.

Exclusion criteria: Missing data relating to the diagnosis of stroke, the exact address, the date of diagnosis, and data relating to the cerebrovascular event; Lack of documentation confirming the first cerebrovascular event (stroke) for cases identified late and initially treated outside the healthcare facilities targeted by the study.

Data sources: There were two types:

Primary data sources: These comprised all sources used to identify new cases. They included the departments responsible for admitting patients immediately following a stroke, namely the medical and surgical A&E department at Bejaia University Hospital.

Secondary data sources: These were used to identify stroke cases that were not recorded in time or were treated by emergency departments outside the local area. This involves the retrospective identification of stroke cases managed and monitored within healthcare facilities such as inpatient departments (internal medicine, neurosurgery, intensive care, home care, cardiology), follow-up consultations (neurology, cardiology, and internal medicine (public and private), rehabilitation facilities (public and private), death certificates, and health insurance funds (CNAS/CASNOS).

Data Collection and Recording

Two approaches were used: one aimed at recording incident cases and the other aimed at retrospectively recording cases not captured by the primary data sources but identified in secondary data sources.

Capture of incident cases (new cases) : This stems from the definition of an incidence study: a continuous and comprehensive collection of personal data relating to one or more health events (stroke) in a geographically defined population, for research and public health purposes, by a team with the appropriate expertise [31]. We carried out a capture of all (exhaustive) stroke cases residing in the municipality of Bejaia and captured them in a timely manner (capture not exceeding 7 days after the date of stroke onset). We collected the data on a form containing all the necessary variables. This data was collected twice a week at the UMCs of the Bejaia University Hospital. We informed the head physician of the UMCs at the CHU by a personal letter, and we visited them to request that they provide us with a contact person and all the necessary resources to ensure data collection (hospital admission registers, medical records, patient lists from the admissions office).

Identification of stroke cases not captured by the primary data sources : We have listed the secondary data sources: healthcare facilities providing care for stroke patients (treatment, follow-up, and support). The aim was to capture all (exhaustive) stroke cases occurring in the municipality of Bejaia, whether recorded in real time or reported late (with a reporting delay not exceeding six weeks) following the date of the stroke. The case reporting form was the same as that used for stroke cases recorded by the primary sources. We informed all potential sources via a personalized letter addressed to the head physicians of the various departments at the University Hospital, to private practitioners, to the directors of the EHS EL-MATEN and the CNAS/CASNOS insurance funds, and to the managers of medical imaging centers (CT/MRI). We then visited these locations to ask them to appoint a contact person and to raise their awareness of the value and importance of the study and data collection; we explained how to complete the data collection form (a session lasting at least fifteen minutes) and distributed a guide and survey forms. To ensure greater validity, we also utilized all available databases simultaneously (where applicable). For health insurance providers: Given their specific nature, data collection was passive and took place only once a year.

Data checking and verification of duplicates

We checked all the records. The check focused primarily on residential details, the first vascular event, and the diagnostic basis. We used incomplete records to supplement other incomplete records; however, where key data such as address, date of diagnosis, diagnosis, first vascular event, or recurrence were missing, the record was discarded. Given the variety of data sources and in order to check for duplicates, after collecting the records, we checked them to identify any duplicate or redundant entries. To do this, we first carried out a manual sort, arranging all the records in alphabetical order, and identified those that were duplicates or redundant; subsequently, a second check was performed using computer software. A duplicate case: A case recorded by two or more data sources. A redundant case: a duplicate case recorded multiple times by the same source.

Data collected

We have developed a computerized case registration form containing the following details: surname, first name, telephone number, the source reporting the case (the department), date of birth, age, gender, exact address (at least neighbourhood and/or town), first stroke or recurrence, date of diagnosis, basis for diagnosis (suspected, clinical, medical imaging), confirmation by a neurologist, type of stroke (ischemic or haemorrhagic) and investigator.

Identification and definition of variables

We used both qualitative and quantitative variables.

Quantitative variables: We present the quantitative variables and their categories: Age: in years. Breakdown by age group: We selected the age groups used in various registers and stroke incidence studies and recommended by the WHO: 20–24, 25–34, 35–44, 45–54, 55–64, 65–74, 75–84, 85 years and over [28]. Time between first cerebrovascular event and current recurrence: in months. We selected the following time intervals: ≤ 1 month, 2–3 months, 3–6 months, 6–12 months, 1–2 years.

Qualitative variables: Data sources: General Medical Unit (GMU), CT and/or MRI Radiology, Neurologist, Cardiologist, Specialist in Internal Medicine, Specialist in Functional Rehabilitation, Cardiology, Internal Medicine/Medical Neurology, Neurosurgery, Functional Rehabilitation/EHS, Forensic Medicine/Death certificate, Intensive care, Home hospitalization (CNAS/CASNOS). Gender: Male, Female. Date of diagnosis: DD/MM/YYYY. First cerebrovascular event: Yes/No. Recurrence: First/Second. Basis of diagnosis: Clinical/Radiological/Clinical and Radiological. Confirmation by a neurologist: Yes / No. Type of stroke: Cerebral Infarction (ICD-10 code: I63), Intracerebral haemorrhage (ICD-10 code: I61) and Subarachnoid haemorrhage (ICD-10 code: I60).

Data collection

Data were collected prospectively and in real time over a two-year period (2018 and 2019). This study included stroke cases that met the inclusion criteria. The data were validated and coded prior to entry. To this end, and due to the multiple data sources, we ensured that duplicate and redundant cases were eliminated. Suspected cases, for which a definitive diagnosis was subsequently confirmed, were also recorded. Data entry was carried out within the epidemiology department by the registry's coordinating doctor.

Coding

The types of stroke were coded according to the International Classification of Diseases, Tenth Revision (ICD-10).

Analysis plan

Firstly, we analyzed all cases of stroke (first vascular episode), and then we analyzed the different types of stroke separately. We used Epi Info version 3.5.4 (CDC™), Excel and Open-Epi Version 3.01 for data analysis. Statistical analyses, including age-and-sex standardization and 95% confidence interval calculations, were performed using validated epidemiological formulas implemented via Excel and Epi Info software tools and cross-checked for accuracy.

Incidence rates: Three types of incidence rates are to be calculated: crude rates, standardized rates, and age-specific rates.

- Crude incidence rates *:* Annual crude incidence rate (first stroke). This is a ratio with the following components: Numerator: All cases of stroke meeting the case definition (first episode) recorded during the entire study period (2018–2019); Denominator: The population of the municipality of Bejaia aged 20 years and over covered by the registry during the entire study period (2018 and 2019); the two average populations (mid-year figures) were used to calculate this incidence rate ((average population for 2018 + average population for 2019/2)*2). Results: Rate expressed per 100,000 inhabitants per year. This incidence rate was treated as an incidence density.

- Specific incidence rates: This is a ratio with: Numerator: Number of stroke cases recorded in a given category (age group, sex, type of stroke) of the target population during the study period. Denominator: Size of the population in this category (age group, sex, type of stroke) within the at-risk population during the study period. Results: Ratio expressed per 100,000 inhabitants per year for each category (age group, sex, type of stroke).

Standardized incidence rates: These are calculated to ensure comparability with incidence rates from other existing registries around the world. We calculated the age-standardized incidence rate to account for the effect of age across different populations (European and global). To calculate the rates, we used the direct standardization method and applied the crude rates calculated in our study by age group for each of the populations concerned to a reference population (the European standard population 'ESP' and the global standard population 'ASRW'), in order to obtain the total number of expected cases and then calculate the standardized rates. The global population used was that for 2000–2025 proposed by the WHO [31, 32] and the European population proposed by the European Commission responsible for revising the European standard population [33].

Completeness rate : This measures the performance of the register. It is expressed as a percentage, where: Numerator: The number of cases captured by the primary sources. Denominator: The total number of cases captured by both the primary and secondary sources.

Statistical tools

We used those recommended by descriptive statistics: absolute and relative frequencies, cumulative frequencies, ratios, mean, and median. To compare different proportions, in the case of qualitative variables, we used Pearson's chi-square test, Yates' corrected chi-square test, or Fisher's exact test, depending on the requirements (conditions of application). We used the Student's t-test for comparing two means, ANOVA for multiple means, or their non-parametric equivalents as appropriate (depending on the conditions of application). We set a significance level of 5% to conclude that there was a significant difference between the compared parameters.

Feedback

Feedback was provided in the form of an annual report addressed to the healthcare professionals involved in setting up the registry.

Confidentiality

The data recorded in the registry are confidential. The registry coordinator is responsible for ensuring their security and maintaining confidentiality (medical confidentiality) in their use. Data from the registry are only made available to researchers and decision-makers following approval by the registry coordinator and the ethics committee.

3. RESULTS

Between 1 January 2018 and 31 December 2019, the total number of validated stroke cases was 369 (out of a total of 1,734 records collected); the active data collection method was used in 89.43% of cases; the capture ratio was 2.16; the completeness rate of hospital sources was 89.43%; cases of stroke confirmed by a neurologist accounted for 92.41%, by medical neuroimaging (CT/MRI) for 98.37%, and clinically alone (neurologist) for 3.3% of stroke cases. An analysis of death certificates identified three additional suspected cases of stroke; however, these were excluded because they did not meet the strict diagnostic or geographic inclusion criteria (Tables 1 and 2).

The most common type of stroke in both sexes for the first vascular episode was cerebral infarction, accounting for 79.4%, followed by haemorrhagic stroke, accounting for 19.5% (17.3% intracerebral haemorrhage; 2.2% subarachnoid haemorrhage), whilst cerebral venous thrombosis accounted for only 1.1% of all stroke cases. The mean age of stroke patients was 68.6 ± 14.5 years (67.7 ± 15.9 years for men and 69.9 ± 14.8 years for women); the median age was 73 years (59–81) it was 73 years (60–81) and 71 years (57–80) for men and women, respectively (Tables 3 and 4).

Overall, the incidence of stroke increases with age in both sexes, regardless of the type of stroke, except subarachnoid haemorrhages. Overall, the incidence of stroke was higher in women than in men ($p < 0.002$). We recorded 87 cases of recurrence, representing a recurrence rate of 23.8% (87 cases); 78 cases of stroke had a single recurrence, and 9 cases had two or more recurrences. The mean time to the first recurrence within the same year was 43.7 ± 9.4 days, and the mean time to the second recurrence was 6.7 ± 1.9 months.

Table 1. Incidence rates for all types of stroke by age and sex, Municipality of Bejaia, 2018–2019.

Age (Years)	Male				Female				Total				Male vs Female		
	N	P	I	$IC_{95\%}$	N	P	I	$IC_{95\%}$	N	P	I	$IC_{95\%}$	RR F/M	$IC_{95\%}$	*P*
20-24	00	*22023*	00	00-00	00	*21104*	00	00-00	00	*43127*	00	00-00	00	00	00
25-34	02	*37955*	05.3	0.6-19	10	*36225*	27.6	13.2-50.8	12	*74180*	16.2	8.35-28.26	5.21	1.15-23.9	0.01
35-44	09	*29532*	30.5	14-58	09	*28195*	31.9	14.6-60.6	18	*57727*	31.2	1.847-4.928	1.05	0.42-2.6	0.92
45-54	15	*21029*	71.3	39.9-117.7	29	*18794*	154.3	103.3- 221.6	44	*39822*	110.5	80.3-148.3	2.16	1.16-4.04	0.009
55-64	34	*12930*	263	182.1-367.5	37	*11332*	326.5	229.9-450.1	71	*24262*	292.6	228.5-369.1	1.24	0.78-1.98	0.21
65-74	34	*6880*	494.2	342.2-690.6	40	*7401*	540.5	386.1-736	74	*14281*	518.2	406.9-650.5	1.09	0.69-1.72	0.39
75-84	44	*3690*	1192	866.3-1601	52	*4023*	1293	965.3-1695	96	*7713*	1245	1008-1520	1.08	0.73-1.62	0.38
85 & +	23	*801*	2271	1820-4309	31	*960*	3229	2194-4584	54	*1761*	3066	2303-4001	0.70	0.66-1.93	0.38
Total	161	*134839*	119.4	101.7-139.3	208	*128034*	162.5	141.1-186.1	369	*262873*	140.4	126.4-155.4	1.36	1.11-1.7	0.001
ASRW			158.7	158.6-158.8			203.5	203.4-203.6			183.6	183.5-183.7			
ASRE			225.2	225.1–225.3			311.6	311.4-311.7			269.9	269.8-270			

I: Incidence rate p. 100 000 habitants. N: Nember. IC95%: Confidence Interval 95%. P: Population at risk. RR: Relative Risk. ASRE: Age-standardized rate of the European population. ASRW: Age-standardized rate of the World population.

Table 2: Incidence rates of Cerebral Infarction (I63) by age and sex, Municipality of Bejaia, 2018–2019.

Age (Years)	Male				Female				Total				Male vs Female		
	N	P	I	$IC_{95\%}$	N	P	I	$IC_{95\%}$	N	P	I	$IC_{95\%}$	RR F/M	$IC_{95\%}$	*P*
20-24	00	*22023*	00	00-00	00	*21104*	00	00-00	00	*43127*	00	00-00	00	00-00	00-00
25-34	00	*37955*	00	00-00	04	*36225*	11.04	2.9-28.3	04	*74180*	5.39	2.7-25.5	00	00-00	00-00
35-44	04	*29532*	13.5	0.36-34.68	04	*28195*	14.19	3.8-36.3	08	*57727*	13.86	5.9-. 27.3	1.05	0.26-4.2	0.61
45-54	13	*21029*	61.8	23.4-75.3	27	*18794*	143.7	84.6-186.8	40	*39822*	100.4	56.5-107.7	2.32	1.5- 5.7	0.001
55-64	28	*12930*	216.6	143.9-313	31	*11332*	273.6	185.8-388.3	59	*24262*	243.2	185.1-313.7	1.26	0.8-2.1	0.22
65-74	25	*6880*	363.4	235.1-536.4	29	*7401*	391.8	262.4-562.8	54	*14281*	378.1	284-493.4	1.08	0.6-1.8	0.44
75-84	37	*3690*	1003	705.9-138.2	41	*4023*	1019	731.3-1383	78	*7713*	1011	799.4-1262	1.16	0.65-1.58	0.51
85 & +	21	*801*	2622	1622-4008	29	*960*	3021	2023-4338	50	*1761*	2839	2107-3743	1.15	0.66-2.02	0.36
Total	128	*134839*	94.93	83.4-118.9	165	*128034*	128.9	110.3-149.7	293	*262873*	111.5	99.24-124.8	1.36	0.97 - 1.54	0.048
ASRW			114.2	114.1-114.3			163.4	163.3-163.4			147.5	147.4-147.6			
ASRE			169.2	169.1-169.3			243.9	243.8-244			207.8	207.7-207.9			

I: Incidence rate p. 100 000 habitants. N: Nember. IC95%: Confidence Interval 95%. P: Population at risk. RR: Relative Risk. ASRE: Age-standardized rate of the European population. ASRW: Age-standardized rate of the World population.

Table 3: Incidence rates of Intracerebral haemorrhage (I61) by age and sex, Municipality of Bejaia, 2018–2019.

Age (Years)	Male				Female				Total				Male vs Female		
	N	P	I	$IC_{95\%}$	N	P	I	$IC_{95\%}$	N	P	I	$IC_{95\%}$	RR F/M	$IC_{95\%}$	*P*
20-24	00	*22023*	00	00-00	00	*21104*	00	00-00	00	*43127*	00	00-00	00	00-00	00
25-34	00	*37955*	00	00-00	00	*36225*	00	00-00	00	*74180*	00	00-00	00	00-00	00
35-44	04	*29532*	13.54	2.9-28.27	02	*28195*	07.09	5.9-19.02	06	*57727*	10.39	2.95-17.6	0.52	0.26-4.19	0.61
45-54	02	*21029*	9.5	1.06-34.3	02	*18794*	10.64	1.19-38.4	04	*39822*	10.04	2.7-25.7	1.12	1.50-5.65	0.001
55-64	06	*12930*	46.4	19.3-115.2	06	*11332*	52.95	11.7-69.4	12	*24262*	49.46	20.6-69.6	1.14	0.75-2.11	0.22
65-74	09	*6880*	130.8	55.49-230.9	11	*7401*	148.6	79.71-286.1	20	*14281*	140	85.5-216.3	1.3	0.55-3.173	0.35
75-84	07	*3690*	189.7	76.01-390.9	11	*4023*	273.4	136.3-489.3	18	*7713*	233.4	138.2-368.8	1.44	0.42-1.01	0.07
85 & +	02	*801*	249.7	234-752.1	02	*960*	208.3	280.5-901.4	04	*1761*	227.1	61.1-581.5	0.83	0.67-2.02	0.36
Total	30	*134839*	22.25	15.29-31.3	34	*128034*	26.56	18.69- 36.69	64	*262873*	24.35	18.91- 30.89	1.19	1.01-1.54	0.17
ASRW			30.2	29.7 - 30.5			33.9	33.5 - 34.3			34.1	33.5 - 34.7			
ASRE			37.2	36.8 - 37.6			50.1	49.7 - 50.5			43.8	43.3 - 44.3			

I: Incidence rate p. 100 000 habitants. N: Nember. IC95%: Confidence Interval 95%. P: Population at risk. RR: Relative Risk. ASRE: Age-standardized rate of the European population. ASRW: Age-standardized rate of the World population.

Table 4: Incidence rates of Subarachnoid haemorrhage (I60) by age and sex, Municipality of Bejaia, 2018–2019.

Age (Years)	Male				Female				Total				Male vs Female		
	N	P	I	$IC_{95\%}$	N	P	I	$IC_{95\%}$	N	P	I	$IC_{95\%}$	RR F/M	$IC_{95\%}$	*P*
20-24	00	*22023*	00	00-00	00	*21104*	00	00-00	00	*43127*	00	00-00	00	00-00	-
25-34	02	*37955*	5.27	0.6-19.02	04	*36225*	11.04	2.9-28.3	06	*74180*	08.08	2.9-17.6	2.10	0.39-11.4	0.32
35-44	01	*29532*	3.4	0.05-18.8	01	*28195*	3.55	0.05-19.7	02	*57727*	3.46	0.39-12.5	1.05	0.07-16.7	0.73
45-54	00	*21029*	00	00-00	00	*18794*	00	00-00	00	*39822*	00	00-00	00	00-00	00
55-64	00	*12930*	00	00-00	00	*11332*	00	00-00	00	*24262*	00	00-00	00	00-00	00
65-74	00	*6880*	00	00-00	00	*7401*	00	00-00	00	*14281*	00	00-00	00	00-00	00
75-84	00	*3690*	00	00-00	00	*4023*	00	00-00	00	*7713*	00	00-00	00	00-00	00
85 & +	00	*801*	00	00-00	00	*960*	00	00-00	00	*1761*	00	00-00	00	00-00	00
Total	03	*134839*	2.22	0.56-6.1	05	*128034*	3.9	1.4-8.7	08	*262873*	3.04	1.4-5.8	1.76	0.42-7.3	0.33
ASRW			2.1	1.1-3.1			3.4	2.3-4.4			2.6	2.1-3.2			
ASRE			2.5	2.4-2.8			2.2	1.2-3.3			2.4	1.8-3.2			

I: Incidence rate p. 100 000 habitants. N: Nember. IC95%: Confidence Interval 95%**.** P: Population at risk**.** RR: Relative Risk. ASRE: Age-standardized rate of the European population. ASRW: Age-standardized rate of the World population.

4. DISCUSSION

This prospective population-based study provided the first data on the standardised incidence of stroke in northern Algeria, specifically in the urban municipality of Bejaia. Our findings reveal a significant burden of stroke in this region, with notable disparities according to sex, age, and stroke subtype.

The total Age-Standardised Rate of the World population (ASRW) and the of the European population (ASRE) for all strokes was 183.6 vs. 269.9 per 100,000 person-years, respectively (ASRW vs. ASRE), and it was 158.7 vs. 225.2 per 100,000 person-years among men and 203.5 vs. 311.6 per 100,000 person-years among women. The total crude rates were 140.4 per 100,000 person-years; it was 119.4 among men and 162.5 among women, with a relative risk for women compared to men of 1.36 (95% CI: 1.11–1.70). Cerebral infarction (CI) accounted for the majority of cases (79.4% of all strokes), followed by intracerebral haemorrhage (ICH, 17.3%) and subarachnoid haemorrhage (SAH, 2.2%). The incidence of all subtypes increased sharply with age, peaking in the 85+ age group [21, 34].

Our study fills a significant gap in the epidemiological literature on stroke in Algeria. The only Algerian data published to date have come mainly from hospital-based studies, such as the one from Sidi Bel Abbès, which reported a series of 104 hospitalized patients without being able to calculate the population incidence [35]. A systematic review of the literature on Arab countries (covering the period up to 2008) had identified no studies of incidence in the general population in Algeria, Morocco, or Tunisia, reporting only hospital data or estimates.

The few incidence studies available in the MENA region are outdated and often based on inconsistent methodologies. A previous systematic review reported an annual incidence of stroke in Arab countries ranging from 27.5 to 63 per 100,000 inhabitants, figures significantly lower than those we report [21]. This difference is likely due to the non-standardised nature of these older studies, which significantly underestimated the actual burden.

Our study shows that the incidence in Bejaia is in fact comparable to, or even higher than, that reported in recent international studies adhering to strict methodological criteria ('ideal criteria') [36, 38]. A recent analysis by the Global Burden of Disease (GBD) for the MENA region estimated the standardised incidence of stroke at 153.7 per 100,000 in 2019 [13], a figure remarkably close to our ASRW of 158.7 for men. Our data therefore provide field validation of these models for Algeria.

The incidence of stroke reported in Bejaia is generally higher than that observed in most Western countries in recent years. For example, a recent study meeting ideal criteria in France (published in 2022) reported an adjusted incidence of all strokes of 108 per 100 000 among men and 81 among women [36, 37]. In the United Kingdom, the figures are also lower, at around 100–120 per 100 000 [39]. The particularly high incidence among women in Bejaia (ASRW of 225.2) is striking and contrasts with the situation in the West, where the incidence is generally higher among men.

The results show a significantly higher incidence among women (RR = 1.36), a finding that contrasts with many Western cohorts [40]. Since our population-based study does not allow for a detailed analysis of individual metabolic or socioeconomic determinants, this finding underscores the need for future clinical and analytical studies (case-control or cohort). Exploring risk factors specific to women in this region (metabolic profiles, physical inactivity, hormonal factors) will be essential for guiding local prevention strategies.

The profile of stroke subtypes in Bejaia is characterized by a proportion of haemorrhagic strokes (17.3% for ICH + 2.2% for SAH) that is slightly higher than that observed in developed countries (generally 10–15% for ICH). This is consistent with data from the MENA region, where the prevalence of hypertension and its suboptimal control contribute to a higher incidence of cerebral haemorrhages [1, 19, 39]. Several factors may explain the differences in incidence and profile between Bejaia and developed countries:

- Cardiovascular risk factors: The MENA region is undergoing an epidemiological transition characterised by a rapid increase in metabolic risk factors. A 2019 GBD analysis for the region identified high blood pressure (contributing to 53.5% of the burden of stroke), high body mass index (39.4%), and fasting hyperglycaemia as the main attributable risk factors [20]. Increasing urbanisation, the adoption of Westernised diets and a sedentary lifestyle are major drivers of this epidemic of risk factors [41].
- Demographic and epidemiological transition: The very high incidence among older women in Bejaia may reflect inadequate control of cardiovascular risk factors in postmenopausal women, combined with increasing life expectancy. The GBD 2019 study also showed that in the MENA region, the prevalence of stroke was higher among women in all age groups [19].
- Access to care and prevention: Unlike in developed countries, where primary and secondary prevention strategies (treatment of high blood pressure, statins, antiplatelet agents) have significantly reduced the incidence of stroke over recent decades, access to these preventive interventions remains limited in Algeria. The scarcity of neurovascular units and the lack of systematic screening programs for risk factors have been highlighted as major challenges [35].
- Genetic and environmental factors: Although data are limited, some studies suggest that Arab populations may have specific genetic predispositions to stroke, but further research is needed [21, 34]. Ambient air pollution, identified as the third leading risk factor in the MENA region (27.1%), may also play a role in urban areas such as Bejaia [11].

Although death certificates have been analyzed, capturing data on sudden stroke deaths that occur at home remains a challenge.

Strengths and limitations of the study

This study has significant methodological strengths, including its prospective population-based design, the use of standardized diagnostic criteria (brain CT scan), and the standardization of rates according to global and European populations, which allows for robust international comparisons.

Several limitations should be considered: The two-year study period (2018–2019) may not reflect year-to-year variations in stroke incidence. Although the population of Bejaia is representative of an urban population in northern Algeria, it cannot be generalized to the entire country, particularly to rural areas or southern Algeria. Although multiple data sources were cross-referenced to strictly select residents of the Bejaia municipality, a minor bias related to healthcare attraction cannot be entirely excluded due to regional patient mobility and address reporting behaviors. Despite efforts to conduct a comprehensive case-finding survey (using the “hot pursuit” method), minor cases or those who did not seek medical care may have been missed. Data on individual risk factors were not systematically collected, limiting the etiological analysis. The low proportion of usable cases derived from the analysis of death certificates means that a slight underestimation of fatal strokes cannot be entirely ruled out.

Implications for research and clinical practice

Our findings have major implications for health policies in Algeria: Need to strengthen primary prevention: The high burden of stroke, particularly among women, underscores the urgent need for community-based screening and management programs for hypertension, diabetes, and obesity. Development of stroke care pathways: Incidence data can be used to assess the need for neurovascular units, thrombolysis, and post-stroke rehabilitation. From a public health policy perspective, our data quantify the burden of disease at the municipal level. It should be noted, however, that the Bejaia University Hospital serves as the regional referral center for the entire province. The actual volume of hospitalized stroke patients therefore far exceeds the municipal incidence rate. While basic epidemiological standards would generally suggest approximately 1 stroke unit bed per 10,000 to 15,000 inhabitants in high-incidence areas, establishing a Neurovascular Unit (NVU) with at least 20 to 25 beds for this population size will be insufficient. The creation of an NVU with expanded capacity will be essential at the Bejaia University Hospital to accommodate both local residents and the massive influx of patients from the outlying areas of the region. Although a more precise calculation requires additional hospital data (such as average length of stay, bed turnover rate, etc.), this estimate highlights the urgent need to establish specialized facilities to optimize care during the acute phase. Ongoing epidemiological research: The establishment of a national stroke registry, as recommended by international experts, would enable the tracking of trends over time and the evaluation of the impact of interventions [36, 37].

5. CONCLUSION

This study provides the first reliable estimate of stroke incidence in an urban population in Algeria. The observed rates are high, exceeding those of many developed countries and confirming GBD models for the MENA region. The disproportionate burden among women and the significant proportion of hemorrhagic strokes call for targeted prevention strategies. These data will serve as a benchmark for assessing the epidemiological trends of stroke in Algeria in the context of the ongoing health transition.

Competing interests: The authors declare that they have no competing interest.

Funding: This research received no external funding.

REFERENCES

1. GBD 2021 Stroke Risk Factor Collaborators. Global, regional, and national burden of stroke and its risk factors, 1990-2021: a systematic analysis for the Global Burden of Disease Study 2021. Lancet Neurol. 2024;23(10):973-1003. doi:10.1016/S1474-4422(24)00369-7
2. World Health Organization. Global Stroke Factsheet 2022. Geneva: World Health Organization; 2022.
3. Feigin VL, Brainin M, Norrving B, Martins S, Sacco RL, Hacke W, et al. World Stroke Organization (WSO): global stroke fact sheet 2022. Int J Stroke. 2022;17(1):18-29. doi:10.1177/17474930211065917
4. Feigin VL, Owolabi MO; World Stroke Organization–Lancet Neurology Commission Stroke Collaboration Group. Pragmatic solutions to reduce the global burden of stroke: a World Stroke Organization–Lancet Neurology Commission. Lancet Neurol. 2023;22(12):1160-1206. doi:10.1016/S1474-4422(23)00277-6
5. GBD 2019 Stroke Collaborators. Global, regional, and national burden of stroke and its risk factors, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet Neurol. 2021;20(10):795-820. doi:10.1016/S1474-4422(21)00252-0
6. Haute Autorité de Santé (HAS). Évaluation de l'organisation des unités neuro-vasculaires. Saint-Denis La Plaine: HAS; 2012.
7. Béjot Y, et al. Épidémiologie des accidents vasculaires cérébraux. Med Sci (Paris). 2009;25(8-9):727-732. doi:10.1051/medsci/2009258-9727
8. Haute Autorité de Santé (HAS). Accident vasculaire cérébral: méthodes de mesure de l'incidence et de la prévalence. Saint-Denis La Plaine: HAS; 2009.
9. Goueslard K. Intérêt des bases de données médico-administratives pour l'étude de l'épidémiologie et de la prise en charge des accidents vasculaires cérébraux [thèse de doctorat]. Besançon: Université Bourgogne Franche-Comté; 2017.
10. World Bank. The growing burden of non-communicable diseases in the Middle East and North Africa. Washington, DC: World Bank; 2021. doi:10.1596/15312
11. Ali-Ahmed F, et al. The burden of stroke in the Middle East and North Africa (MENA) region. Int J Stroke. 2020;15(3):244-254.
12. GBD 2019 Risk Factors Collaborators. Global burden of 87 risk factors in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet. 2020;396(10258):1223-1249. doi:10.1016/S0140-6736(20)30752-2
13. Owolabi MO, Thrift AG, Mahal A, Ishida M, Martins S, Johnson WD, et al. Primary stroke prevention worldwide: translating evidence into action. Lancet Public Health. 2022;7(1):e74-e85. doi:10.1016/S2468-2667(21)00230-9
14. Lekouaghet A, et al. L'AVC dans la région de Blida (Algérie) en 2018: incidence et mortalité d'après un registre de population. Rev Neurol (Paris). 2022;178:S90. doi:10.1016/j.neurol.2022.02.306
15. Tibiche A. Étude des accidents vasculaires cérébraux au niveau de la wilaya de Tizi Ouzou: incidence, mortalité et fréquence des facteurs de risque [thèse de doctorat]. Tizi-Ouzou: Université Mouloud Mammeri de Tizi-Ouzou; 2012.
16. Institut National de Santé Publique (INSP). Restitution des résultats des registres de l'AVC en Algérie. Alger: INSP; 2024-2026.
17. Messaoudi A, et al. Profil épidémiologique des accidents vasculaires cérébraux au niveau du centre hospitalo-universitaire de Sidi Bel Abbès (Algérie). J Fac Med Oran. 2014.
18. Kesraoui S, et al. Évaluation de la filière neurovasculaire au CHU de Blida (Algérie). Rev Neurol (Paris). 2018;174:S134. doi:10.1016/j.neurol.2018.01.177
19. Bekkai A, Benhaddadi C, Aberkane A, Benbernou S, Abed L. Clinical evaluation and risk factors of stroke hospitalized at the internal medicine department of the University Hospital of Sidi Bel Abbes (Algeria). Ann Cardiol Angeiol (Paris). 2016;65(6):438-439.
20. Bellalem A, et al. G-9 épidémiologie des accidents vasculaires cérébraux ischémiques et classification des sous-types selon les critères TOAST à Sétif en Algérie. Rev Neurol (Paris). 2007;163:18.doi:10.1016/S0035-3787(07)90515-9
21. Benamer HT, Grosset D. Stroke in Arab countries: a systematic literature review. J Neurol Sci. 2009;284(1-2):18-23. doi:10.1016/j.jns.2009.04.029
22. Office National des Statistiques (ONS). Démographie algérienne 2019. Alger: ONS; 2019. Bulletin N°890.
23. World Health Organization. Stroke-1989: recommendations on stroke prevention, diagnosis, and therapy. Report of the WHO Task Force on Stroke and other Cerebrovascular Disorders. Stroke. 1989;20(10):1407-1431. doi:10.1161/01.str.20.10.1407
24. Asplund K, et al. WHO MONICA Project: socioeconomic differences in risk factors for stroke. Stroke. 1988;19(5):555-560.
25. Truelsen T, Begg S, Mathers C. The global burden of cerebrovascular disease. Geneva: World Health Organization; 2003.
26. Sudlow CL, Warlow CP. Comparing stroke incidence worldwide: what do the studies actually show? Stroke. 1996;27(3):550-558. doi:10.1161/01.str.27.3.550

27. Bonita R, Beaglehole R. Modification of Rankin Scale: recovery of motor function after stroke. Stroke. 1988;19(12):1497-1500. doi:10.1161/01.str.19.12.1497
28. World Health Organization. WHO STEPS stroke manual: the WHO STEPwise approach to stroke surveillance. Geneva: World Health Organization; 2005. Available from: https://iris.who.int/handle/10665/43420
29. Sacco RL, Kasner SE, Broderick JP, Caplan LR, Connors JJ, Culebras A, et al. An updated definition of stroke for the 21st century: a statement for healthcare professionals from the American Heart Association/American Stroke Association. Stroke. 2013;44(7):2064-2089. doi:10.1161/STR.0b013e318296aeca
30. World Health Organization. MONICA manual, part IV: event registration. Section 2: stroke event registration data component. Geneva: Office of Cardiovascular Diseases, World Health Organization; 1991 [cited 2026 Mar 29].
31. World Health Organization. World (WHO 2000-2025) standard population. In: WHO discussion paper 31: age standardization of rates: a new WHO standard. Geneva: WHO; 2001.
32. Ahmad OB, Boschi-Pinto C, Lopez AD, Murray CJL, Lozano R, Inoue M. Age standardization of rates: a new WHO standard. Geneva: World Health Organization; 2001. (WHO discussion paper series no. 31).
33. Pace M, Cayotte E, Agafitei L, Zupanic T, Wojtyniak B, Gissler M, et al. Revision of the European standard population: report of Eurostat's task force. 2013 ed. Luxembourg: Publications Office of the European Union; 2013. doi:10.2785/11470
34. Al-Rajeh S, Larbi E, Bademosi O, et al. Stroke register: experience from the eastern province of Saudi Arabia. Cerebrovasc Dis. 1998;8(2):86-89. doi:10.1159/000015823
35. Jaberinezhad M, Farhoudi M, Nejadghaderi SA, Alizadeh M, Sullman MJM, Carson-Chahhoud K, et al. The burden of stroke and its attributable risk factors in the Middle East and North Africa region, 1990-2019. Sci Rep. 2022;12(1):2700. doi:10.1038/s41598-022-06418-x
36. Thayabaranathan T, Kim J, Cadilhac DA, et al. Global stroke statistics 2022. Int J Stroke. 2022;17(9):946-956. doi:10.1177/17474930221123175
37. Fallahtafti P, Habibzadeh A, Ghasemloo N, et al. Stroke burden in North Africa and the Middle East, 1990-2021: an analysis based on the global burden of disease study. BMC Neurol. 2025;25(1):277. doi:10.1186/s12883-025-04298-y
38. Allara E, Shi W, Bolton T, Chalmers F, Brizzi LF, Musto L, et al. Burden of cardiovascular diseases in England (2020-24): a national cohort using electronic health records data. Lancet Public Health. 2025;10(11):e943-e954. doi:10.1016/S2468-2667(25)00163-X
39. Shahbandi A, Shobeiri P, Azadnajafabad S, et al. Burden of stroke in North Africa and Middle East, 1990 to 2019: a systematic analysis for the global burden of disease study 2019. BMC Neurol. 2022;22(1):279. doi:10.1186/s12883-022-02793-0
40. Appelros P, Stegmayr B, Terént A. Sex differences in stroke epidemiology: a systematic review. Stroke. 2009;40(4):1082-1090. doi:10.1161/STROKEAHA.108.540781
41. Feigin VL, Brainin M, Norrving B, Martins S, Sacco RL, Hacke W, et al. World Stroke Organization (WSO): global stroke fact sheet 2022. Int J Stroke. 2022;17(1):18-29. doi:10.1177/17474930211065917