



AN EPIDEMIOLOGICAL PERSPECTIVE ON STROKE IN RURAL CROATIA: INSIGHTS FROM OGULIN

EPIDEMIOLOŠKI PRIKAZ MOŽDANOG UDARA U RURALNOJ HRVATSKOJ: ISKUSTVA IZ OGULINA

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ABSTRACT

Aim: This study aimed to determine the basic epidemiological characteristics of patients with stroke who were hospitalised at the General Hospital and the Hospital for Homeland War Veterans in Ogulin over a ten-year period.

Materials and methods: A retrospective analysis of data from the hospital information system was conducted, encompassing all patients diagnosed with stroke at Ogulin General Hospital between January 1, 2014, and December 31, 2023.

Results: A total of 1521 patients were diagnosed with a stroke. Of these, 81.7% were diagnosed with an ischaemic stroke. No statistically significant difference was found in the frequency of strokes between men and women ($p = 0.233$). The highest proportion of patients, 39.7%, was in the 70- to 80-year age group. Most strokes were recorded in January (147), while the fewest occurred in April (107). A total of 13.7% of patients diagnosed with a stroke were transferred to another hospital facility.

Discussion: The study highlights stroke as a significant problem in the rural region of Ogulin, primarily due to limited resources. Early interventions, improved infrastructure, and standardised protocols are needed to reduce mortality and disability.

Keywords: rural area; stroke; epidemiology

SAŽETAK

Cilj: Ovo je istraživanje imalo za cilj utvrditi osnovne epidemiološke značajke bolesnika s moždanim udarom koji su bili hospitalizirani u Općoj bolnici i bolnici branitelja Domovinskog rata u Ogulinu tijekom desetogodišnjeg razdoblja.

Materijali i metode: Provedena je retrospektivna analiza podataka iz bolničkog informacijskog sustava koja je obuhvatila sve bolesnike s dijagnozom moždanog udara u Općoj bolnici Ogulin u razdoblju od 1. siječnja 2014. do 31. prosinca 2023.

Rezultati: Ukupno je 1521 bolesniku dijagnosticiran moždani udar. Od toga je 81,7 % imalo ishemijski moždani udar. Nije utvrđena statistički značajna razlika u učestalosti moždanog udara između muškaraca i žena ($p = 2,33$). Najveći udio bolesnika (39,7 %) bio je u dobnoj skupini od 70 do 80 godina. Najviše moždanih udara zabilježeno je u siječnju (147), dok je najmanje bilo u travnju (107). Ukupno je 13,7 % bolesnika s dijagnozom moždanog udara premješteno u drugu bolničku ustanovu.

Rasprava: Istraživanje naglašava moždani udar kao značajan problem u ruralnom području Ogulina, ponajprije zbog ograničenih medicinskih resursa. Rane intervencije, poboljšana infrastruktura i standardizirani protokoli mogu smanjiti smrtnost i invaliditet bolesnika.

Ključne riječi: ruralno područje; moždani udar; epidemiologija

INTRODUCTION

A stroke is a sudden, usually localised disturbance of brain function that lasts longer than 24 hours and is caused by an interruption of the blood supply to the brain (1). Depending on the mechanism of origin, stroke is classified into two types: ischemic stroke, which is caused by a thrombosis, and haemorrhagic stroke, which is caused by a haemorrhage (2). Stroke is the second most common cause of death in Europe and worldwide (3,4). The World Stroke Organisation warns of a dramatic increase in strokes of up to 70% between 1990 and 2019. This increase will inevitably be accompanied by a higher number of deaths, which will increase by 43% despite improved healthcare. The World Health Organisation points out that every year around 13.7 million people experience a stroke, and around 5.5 million die from it or its consequences, particularly in low- and middle-income countries (5,6,7). Stroke primarily affects the elderly population. It is a generally recognised fact that the incidence of stroke increases with age, especially after the age of 55 (8). This is related to the increasing prevalence of risk factors in old age, including high blood pressure, diabetes, smoking, obesity, or lack of exercise (9). However, atrial fibrillation, the most common arrhythmia in older adults, is one of the most important causes of stroke (10). Unfortunately, epidemiological observations show a worrying trend of increasing stroke incidence in younger people, further increasing the socioeconomic burden and public health importance of this disease in the next 20 years (11,12). Global studies show that the risk of stroke has increased to 24.9% in people over the age of 25 (13). In younger age groups, stroke is more common in women, while in older populations, it is more common in men (14). In addition to the high mortality rate, stroke is one of the most common causes of acquired disability. It is estimated that only around half of all stroke survivors return to work in some form, while around 20–30% are no longer able to work unaided (15–17). In 2019, a large epidemiological study conducted in 32 European countries showed that the total cost of stroke in Europe in 2017 was €60 billion—more than double the 2015 estimate (18). It is predicted that the cost of treating stroke will increase by 44% by 2040, and in some countries by almost 100% (19). According to the Croatian Institute of Public Health, stroke was the fourth leading cause of death in Croatia in 2023, with a total of 3,255 deaths, which accounted for 6.35% of all deaths that year (20,21). Every year, more than 15,000 Croatian citizens suffer a stroke, and around 80,000 people live with its consequences (22). The geographical distribution of stroke shows a 1.45 times higher incidence in the continental part of Croatia compared to the coastal part, indicating a probable influence of lifestyle and environmental factors on disease prevalence (23). However, stroke research in Croatia is still insufficient and not de-

tailed enough, which makes a comprehensive understanding of the specificities of the disease in different regions and population groups difficult. Studies on the specifics of stroke occurrence in rural areas compared to urban areas are very rare. Therefore, this study focused on the epidemiological profile of stroke in the central rural region of Karlovac County (located in central Croatia, covering 3,622 km² and 112,195 inhabitants). Hospital care is provided by two hospitals, Karlovac and Ogulin General Hospital (24).

This study aimed to determine the basic epidemiological characteristics of patients with stroke treated at Ogulin General Hospital, Croatia. In particular, the aim was to determine the incidence of stroke as an indication for hospital treatment and to investigate the occurrence of different types of strokes. The frequency of stroke types was to be determined as a function of gender, age, and season. In addition, the frequency of stroke as an indication for urgent transfer to another healthcare facility was determined. These findings could enable more precise planning of organisational improvements and contribute to improved healthcare, better treatment outcomes, and a more favourable prognosis for stroke patients in the region.

MATERIALS AND METHODS

Patients

This study included 1,521 patients who were treated at Ogulin General Hospital between 1 January 2014 and 31 December 2023 with a diagnosis of stroke (I60–I64 according to the International Classification of Diseases). All included patients were over 18 years of age and had complete medical documentation. Patients with incomplete documentation, those under the age of 18, and those admitted for re-evaluation of a previously diagnosed stroke without acute symptoms were excluded from the study.

Procedure

The study analysed basic demographic data (age and gender of patients), type of stroke, the month in which patients were treated, and the number of transfers to other medical facilities. Data were collected retrospectively from the hospital information system of the General Hospital and the Ogulin Home War Veterans Hospital and entered into a database created using MS Excel.

Statistical analysis

The sociodemographic characteristics of the participants were assessed through descriptive analysis of response frequencies. Frequencies were analysed utilising the chi-square test. The Cochran-Armitage test for trend was employed to evaluate the trend in stroke diagnoses

over the course of the year. To assess whether there were statistically significant differences in the distribution of stroke patients across various age groups, the Kruskal-Wallis ANOVA test was performed. A post-hoc analysis was conducted to identify which specific age group exhibited the most variation. A p-value of less than 0.05 was established as the threshold for statistical significance. The data collected were analysed using TIBCO Statistica 13.3.

Ethical aspects

The study was conducted following the ethical guidelines of the Faculty of Health Studies in Rijeka and with the approval of the Ethics Committee of the General Hospital and the Hospital for Homeland War Veterans Ogulin (reference no. 01-2/17-1 of 15 May 2024).

The rights and personal data of the participants were protected following the regulations of the Republic of Croatia and the principles of the Declaration of Helsinki. All data was entered into the database confidentially and under encrypted identifiers.

RESULTS

During the ten-year study period (2014–2023), a total of 1,521 patients were treated for stroke at the Ogulin General Hospital and Hospital for Veterans of the Homeland War, representing 4.5% of all hospital admissions during the observed period (33,811 patients).

Men and women were almost equally represented in the analysed sample – 775 men (50.8%) and 746 women (49.2%) (Table 1). The results obtained using the chi-square test showed no statistically significant difference in stroke incidence between men and women ($P = 0.233$).

Among the total participants, a substantial 1,242 individuals were diagnosed with ischaemic stroke, representing a striking 81.7% of the cohort. This finding is reinforced by the results of the chi-square test, which revealed a statistically significant difference in stroke occurrence related to the participants' diagnoses ($P = 0.002$), highlighting the urgent need for further investigation into this critical health issue.

Table 1. Characteristics of patients with stroke

Variable	n (%)
admissions	1521 (4.5)
Sex	
Male	775 (51)
female	746 (49)
Age	
<18 y	1 (0.1)
20-29 y	4 (0.3)
30-39 y	0 (0)
40-49 y	27 (1.8)
50-59 y	75 (4.9)
60-69 y	235 (15.4)
70-79 y	604 (39.7)
80-89 y	539 (35.4)
>90 y	36 (2.4)
Diagnosis	
I60 Subarachnoid haemorrhage	44 (2.9)
I61 Intracerebral haemorrhage	107 (7.0)
I62 Other nontraumatic intracranial haemorrhage	1242 (81.7)
I63 Cerebral infarction	26 (1.7)
I64 Stroke, not specified as haemorrhage or infarction	

The analysis of the age distribution of the participants showed that stroke occurred most frequently in patients aged 70 to 79 years, corresponding to 39.7% of all participants in the total sample. The youngest patient was 18 years old, while the oldest was 102.

The Kruskal-Wallis ANOVA test reveals a statistically significant difference in the distribution of stroke patients across various age groups ($p < 0.001$). Notably, the post-hoc analysis highlights the most pronounced disparity between participants in the youngest age categories (under 20 and 30–39) and those in the 80–89 age bracket ($P = 0.011$). In examining the seasonal distribution of stroke occurrences, it was observed that January reported the highest number of stroke diagnoses, totalling 147 cases, while April exhibited the lowest count, with only 107 cases (Table 1).

Moreover, during the colder months of November through February, a total of 529 patients with the specified diagnosis were treated, representing 34.7% of all participants. However, the trend in the incidence of stroke diagnoses shows a relatively consistent distribution throughout the year (Figure 1). This observation is supported by the results of the chi-square test for trend, known as the Cochran-Armitage test, which was used to assess the trend in stroke diagnoses over the year. The results indicated that no linear trend was established, as there were no significant differences in the number of cases across the various months ($P = 0.244$).



Figure 1. Ten-year trend in the number of patients diagnosed with stroke by month of the year

Of the 1,521 patients diagnosed with a stroke, 209 patients (13.7%) were transferred to another hospital, 155 (74.2%) of whom had a diagnosis of ischaemic stroke.

DISCUSSION

This retrospective ten-year study included a total of 1,521 patients who were treated at the Ogulin General Hospital and Hospital for Veterans of the Homeland War with a diagnosis of stroke. This represents 4.5% of all patients treated at this facility during the study period, indicating a significant presence and, consequently, considerable importance of this clinical entity for public health in the Ogulin region. Although a 4.5% share of overall morbidity may not seem particularly high at first glance, it should be noted that the Ogulin General Hospital primarily serves a rural area, which inevitably poses organisational challenges and makes access to healthcare services, especially diagnostics and emergency interventions, more difficult. In general, the health profile of rural areas is characterised by inadequate education, lower levels of health literacy, geographical distance from hospital centres, and often a shortage of healthcare professionals (25). This further worsens the treatment results, making the recorded number of 1,521 patients quickly significant. Numerous epidemiological studies, such as the one by Georgakakos et al. (2020, US, 1,865,310 participants), emphasise that poorer access to healthcare in rural areas is directly linked to poorer treatment outcomes, higher mortality, and more disability (26).

In the sample observed in this study, the ratio of men to women was approximately equal. In contrast to these results, worldwide research shows clear gender-specific differences in the incidence, prevalence, and mortality of strokes (27–29). These data apply to both forms of stroke—*ischaemic stroke* (stroke incidence in men vs. women: 132.77 vs. 98.85 per 100,000) and *haemorrhagic stroke* (incidence of 64.89 in men vs. 45.48 in women) (30). However, women are more likely to die from a stroke and suffer more severe consequences. It is hy-

pothesised that a combination and interaction of various biological, social, and health-related factors contribute to this outcome. On average, women suffer strokes at an older age, which is associated with a greater number of comorbidities and risk factors such as high blood pressure, diabetes, and atrial fibrillation (31,32). Diseases in women often present with atypical symptoms, leading many women to underestimate these symptoms and delay seeking medical attention. Combined with poorer access to emergency care in rural areas, this results in an irreversible loss of valuable time, leading to treatment delays of several hours (33–34). Hormonal changes, pregnancy, and postmenopause also increase the risk of stroke in older age, as emphasised in the study by Yoon et al. (35). Nevertheless, Lackland et al. (2014) emphasise that there has been a decline in stroke mortality in recent decades, which is related to improved living conditions and health services (36).

Of the total of 1,521 patients in our sample, 1,242 (81.7%) had an *ischaemic stroke*. Global epidemiological studies also report a high proportion of *ischaemic strokes* among all strokes, which is up to 87% (37). These risk factors can be influenced by lifestyle changes (38–39). Therefore, early detection and treatment of risk factors is a fundamental goal in strengthening public health interventions. One of the key elements in the stroke care chain in rural areas, such as the Ogulin region, is transport to secondary centres with better therapeutic options. Unfortunately, the results of our study show that only 13.7% patients were transferred to another hospital, even though three-quarters of the transferred patients had an *ischaemic stroke*. The reasons for this are certainly complex. In remote rural areas, the number of emergency medical teams is limited, which can hinder timely transport to a larger facility. Major hospitals are often located far away, and the transportation itself may take too long, preventing the patient from receiving the necessary treatment in a timely manner. Some patients are not candidates for transport due to the severity of their clinical condition. Finally, personal or family reasons may also influence the decision to refuse a transfer. All of these factors highlight the need to introduce clearly defined protocols, known as ‘stroke pathways’, that enable quick and efficient decision-making while reducing reliance on subjective clinical judgement. Furthermore, the study results underline the need to introduce new therapeutic methods for stroke treatment in low-level health centres in order to bring medical care closer to the patient and ensure adequate and equitable healthcare for all.

The data analysis in this study showed that stroke was most prevalent among patients aged 70 to 80 years (39.7%). And this confirms the widely accepted view that stroke is primarily a disease of older age (40). Age-

ing is the most robust non-modifiable risk factor for incident stroke, with the risk doubling every 10 years after the age of 55. Approximately three-quarters of all strokes occur in individuals aged ≥ 65 years (41). However, numerous studies—such as those by Sultan et al. and Zhang et al.—have highlighted the rising incidence of stroke among younger individuals, particularly in the 15 to 49 age group (42-43). This increase may be linked to the growing prevalence of traditional cardiovascular risk factors among younger people, combined with high-stress lifestyles and increasing personal and societal expectations (12,44).

According to the data analysed, the highest number of patients diagnosed with a stroke was recorded in January and the lowest in April. Furthermore, in the colder months of the year—January, February, November, and December—a total of 529 (34.7%) patients with this diagnosis were treated with no trend differences. In contrast, international studies report a significant seasonality in the occurrence of strokes, especially ischaemic strokes (45,46). Cold months are associated with an increased risk of high blood pressure and a greater tendency to form blood clots. This is also supported by a predominantly sedentary lifestyle and reduced physical activity in winter, as well as a higher incidence of infection, factors that contribute to an increased risk of stroke (47).

The results of this study—some of which are consistent with and some of which differ from global research—show the importance of recognising the specific characteristics of each region, taking into account geographical, socio-economic, cultural, and other local factors. Nevertheless, it is undeniable that stroke is a serious public health problem in the rural region served by Ogulin General Hospital, with potential implications for other rural regions. These findings highlight the urgent need to intensify public health initiatives aimed at the earliest possible detection of stroke symptoms, such as the FAST (Face, Arms, Speech, Time) initiative, which is also known in Croatia under the acronym GROM (48). It is crucial to strengthen the capacity of healthcare facilities to provide adequate stroke treatment, reorganise medical transport, and establish clear protocols to improve prevention, speed up diagnosis, and increase the effectiveness of treatment, ultimately reducing mortality and disability rates.

Limitations of the study

This study has certain limitations. The retrospective design carries the risk of incomplete or inaccurate data. The study was conducted in a single institution, which limits the generalisability of the results to other regions. Diagnostic and treatment methods have changed over the ten-year period, which may affect the comparability of the data over time. The organisational characteristics of the studied region were interpreted based on observations.

This ten-year study shows that stroke is a major public health problem in the rural region of Ogulin. The primary issue is the shortage of medical resources, which significantly hinders timely diagnosis and treatment. The ischaemic form of stroke predominates, which is in line with the global trend, but the even distribution between genders and the lack of seasonality are particular characteristics of the region studied. The results underline the importance of early detection and management of risk factors, the need to improve health infrastructure, and the implementation of standardised protocols to reduce mortality, disability, and long-term socioeconomic burden.

Competing interests: Bojan Miletic is a member of the International Editorial Board of the European Journal of Health Studies.

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