

# PROSPECTIVE ANALYSIS OF THE EPIDEMIOLOGY OF CEREBROVASCULAR DISEASE AND STROKE AMONG THE ADULT POPULATION OF KYIV CITY, UKRAINE

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## ABSTRACT

**The aim:** We aimed to conduct a prospective analysis of the epidemiology of cerebrovascular disease and stroke among the adult population of Kyiv City, Ukraine the last 12 years.

**Materials and methods:** We analyzed sectoral statistical reports of cerebrovascular disease and stroke in Kyiv City for 2009–2020. The statistical method and the method of system approach were used in this study.

**Results:** We established that during the last 12 years there was a decrease in the incidence of cerebrovascular disease and stroke among the adult population of Kyiv (reduction of 1.83 times ( $p < 0.05$ ) with  $t$  reliability criteria 26.89). However, the incidence remains high (476.62 per 100,000 population). At the same time, the prevalence of cerebrovascular disease remains stable, and among the working-age population tends to increase. The incidence of stroke indicates a positive trend (251.3 per 100,000 adult population of Kyiv in 2009 and 95.0 – in 2020, respectively). In particular, the number of primary registered strokes decreased 2.64 times ( $p \leq 0.05$ ) with a reliability criterion of 5.7 which is 1.94 ( $p \leq 0.05$ ) times lower than in Ukraine generally. During the study period, 27,928 people died in Kyiv from a stroke. The mortality rate of stroke among the adult population in the city decreased from 96.14 per 100,000 in 2009 to 57.17 in 2020. This significant decline occurred over the past two years.

**Conclusions:** A significant reduction in the incidence of cerebrovascular disease and stroke in the adult population of Kyiv during the last 12 years has been established. This might be caused by increased stroke prevention work, provided to the city population, and by a higher level of availability and quality of medical care in recent years.

**KEY WORDS:** cerebrovascular disease, CVD, stroke, epidemiology, morbidity, prevalence

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## INTRODUCTION

Cerebrovascular disease (CVD) is the second leading cause of death and the main cause of adult long-term disability in developed countries [1–6]. However, there is a gap of knowledge about trends in CVD incidence and prevalence in adults from middle-income countries.

Little is known about trends in the overall combined burden of CVD in one of the largest middle-income European countries, located in the geographical center of Europe, Ukraine [7–19]. Nevertheless, a detailed analysis of the epidemiology of CVD is an essential tool in creating health programs, aiming to reduce CVD [20–30].

## THE AIM

We aimed to conduct a prospective analysis of the epidemiology of cerebrovascular disease and stroke among the adult population of Kyiv City, Ukraine for the last 12 years.

## MATERIALS AND METHODS

### STUDY SETTING

Data from 2009 to 2020 were prospectively collected from the sectoral statistical reports of CVD and the stroke registry of Kyiv City. The methods of the study, inclusion and exclusion criteria have been reported in detail previously. [31–33] In brief, using multiple overlapping sources, all inpatient and outpatient adults with CVD and stroke were identified. We have prospectively analyzed sectoral statistical reports of CVD and stroke in Kyiv City for 2009–2020. The informational base of the study was data from the information-analytical center of medical statistics, reporting statistical forms: form No. 12 “The report on diseases registered in patients living in the area of service of the hospital and out-hospital facilities”, form No. 20 “The report of the disease treating and preventing institutions”, form No. 14 “The report on the causes of disability and indications for medical, professional, and social rehabili-

tation”, form C-8 “Distribution of deaths by sex, age, and causes”, and analysis of 1575 cases of acute cerebrovascular accident.

In Ukraine, there is no methodology for epidemiological studies on the type of population registers, as recommended by WHO. The analysis of indicators is carried out according to statistics [34-36]. The statistical method and the method of systematic approach were used in this study.

#### DIAGNOSTIC CRITERIA

We defined stroke as the presence of signs of sudden focal or global cerebral dysfunction lasting >24 hours without any apparent nonvascular cause. TIA was defined according to the World Health Organization and American Heart Association criteria [37, 38] as an acute onset of a focal cerebral or ocular functional deficit lasting <24 h. CVD was defined according to WHO and [39] and includes all disorders in which an area of the brain is temporarily or permanently affected by ischemia or bleeding and one or more of the cerebral blood vessels are involved in the pathological process. This includes stroke, TIA, carotid stenosis, vertebral and intracranial stenosis, aneurysms, and vascular malformations. [40] Etiologies of TIA and stroke were classified according to the modified TOAST (Trial of ORG 10172 in Acute Stroke Treatment) criteria [41]. These criteria were the same throughout the period of analysis.

## RESULTS

According to the official statistics of the Ministry of Health of Ukraine, in 2015, 25,51654 patients with various forms of cerebrovascular pathology were registered, which is 7,200.3 cases per 100,000 population [42]. The highest prevalence of CVD was found in Donetsk (12230.2 per 100,000 population), Odessa (10935.8 per 100,000 population), and Zaporizhzhia (11282.8 per 100,000 population) regions. The lowest occurs — in Rivne (2426.0 per 100,000 population), Zakarpattia (2839.3 per 100,000 population), and Lviv (3846.2 per 100,000 population) regions.

At that time, the corresponding prevalence of CVD in Kyiv was 6413.4 per 100,000 population and was lower than the national average. The prevalence of CVD in Kyiv remains stable during the last 12 years with slight tends to increase among the working-age population.

At the same time, the incidence of CVD among the adult population of Kyiv decreased during the last 12 years (reduction of 1.83 times ( $p < 0.05$ ) with t reliability criteria 26.89). However, it still remains high (476.62 per 100,000 population).

The incidence of stroke in Kyiv indicates a positive trend (251.3 per 100,000 adult population of Kyiv in 2009 and 95.0 – in 2020, respectively). In particular, the number of primary registered strokes decreased 2.64 times ( $p \leq 0.05$ ) with a reliability criterion of 5.7 which is 1.94 ( $p \leq 0.05$ ) times lower than in Ukraine generally.

During the study period, 27,928 people died in Kyiv from a stroke. The mortality rate of stroke among the adult population in the city decreased from 96.14 per 100,000

in 2009 to 57.17 in 2020. This significant decline occurred over the past two years.

## DISCUSSION

It should be noted that the dynamics of the prevalence of CVD in Ukraine from 2007 to 2013 had a clear upward trend. Thus, in 2014 – 2015, the prevalence of CVD decreased from 8220 to 7260 cases per 100,000 population, which was due to the territorial changes in the country [43].

In the capital of Ukraine, Kyiv, from 2009 to 2020, the prevalence of CVD among the adult population was almost stable. There were small fluctuations over the years of observation in the range of 6277.8 – 6583.8 per 100,000 adult population and was lower than the average in Ukraine (7967, 2 in 2018). In all years of follow-up in the city, up to 38 (40)% of patients with CVD were patients of working age. The prevalence among this cohort of patients in recent years has had an insignificant tendency to increase and amounted to 2395.9 per 100,000 population in 2018. Analysis of the dynamics of the incidence of CVD among the adult population of Kyiv is presented in Fig. 1.

As can be seen from the figure, over the past 12 years the reduction in the incidence rate occurred 1.83 times ( $p < 0.05$ ) with t reliability criteria of 26.89. This reached the level of 476.62 per 100,000 in 2020.

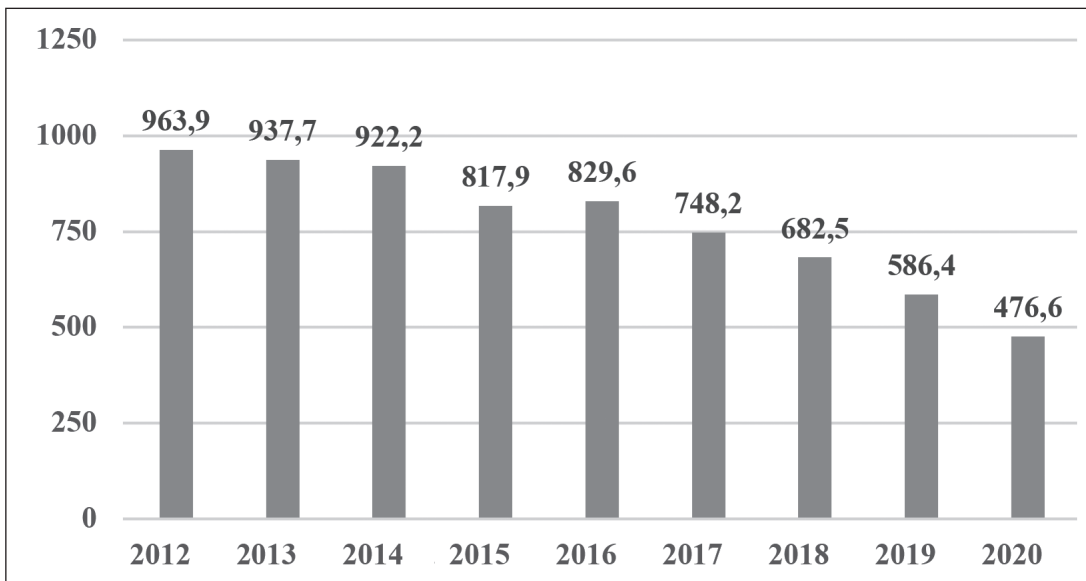
If we compare the last two years, in 2020 the primary incidence decreased by 24,905 cases compared to the previous year. In the structure of morbidity traditionally in all years, women prevailed in a ratio of 1,4-1,5 : 1,0 to men.

Thus, in the course of the analysis of data dynamics, a significant decrease in the incidence of CVD among the adult population of Kyiv City occurred. At the same time, the prevalence of CVD not only remained stable but also tended to increase among the working-age population. This probably characterized the process of the prevalence of “chronic” forms of CVD in the city. The reason for this is the untimely treatment of the population for medical care. To some extent, these results can also be determined by the completeness of the accounting of patients with CVD and, accordingly, the reliability of statistical reporting.

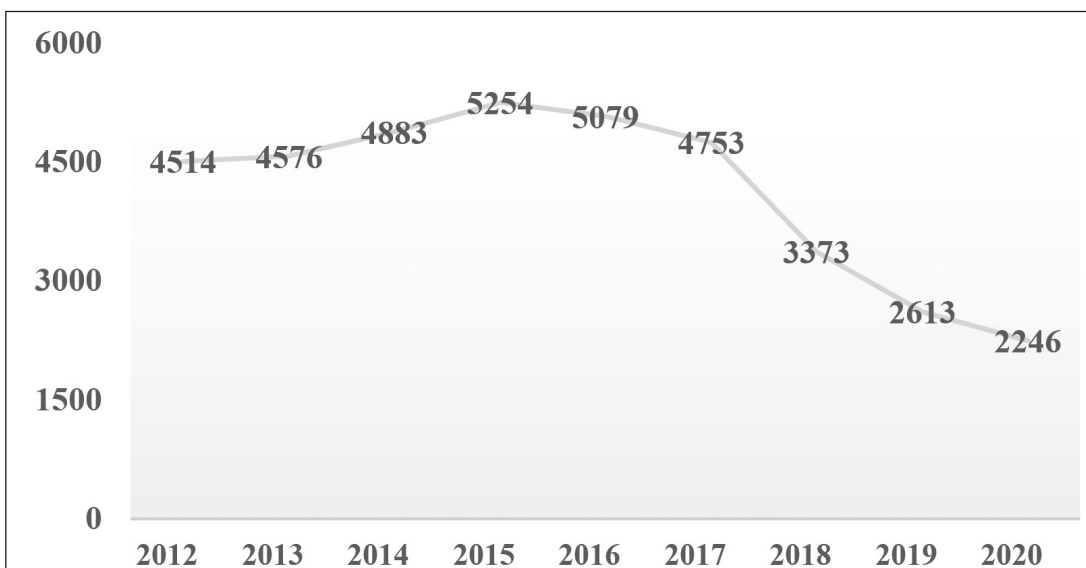
In 2009, 2,109 people with various types of primary stroke were registered in Kyiv, which accounted for 1.46% of the total population. Subsequently (until 2015) the number of stroke incidence increased in the city, but the population increased also. Thus, in the following years, there was a sharp decline in the number of registered strokes and by the end of 2020, there were 2246 people with primary stroke, which amounted to 0.76% of the total population. Traditionally, more than a third of patients were of working age. The rest were people of retirement age.

The dynamics of the detected primary cases of all types of stroke in the city over the years of dynamic observation are presented in Fig. 2.

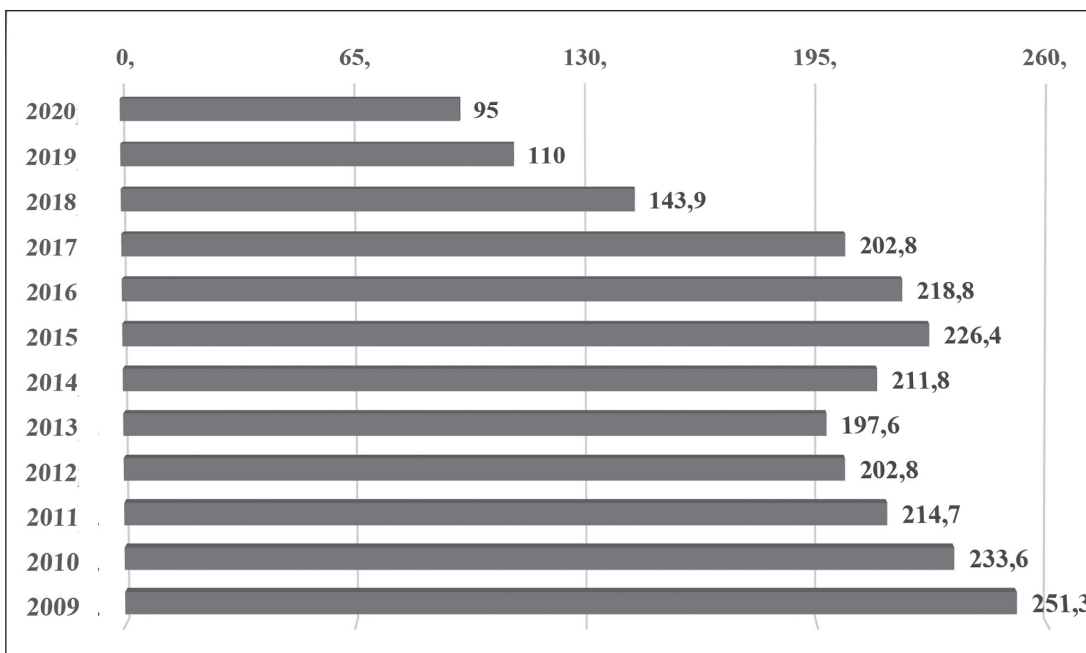
As can be seen from this figure, the number of stroke patients in the city has decreased 2.3 times over the last 5 years and has almost returned to the rate of incidence of ten years ago (2109 cases detected in 2009). The distribution



**Fig.1.** Dynamics of the incidence rate of CVD of the adult population in Kyiv for 2009-2020



**Fig.2.** Dynamics of cases of primary stroke incidence in the Kyiv City during 2012-2020.



**Fig.3.** Dynamics of the incidence of stroke in the adult population of Kyiv, 2009-2020 (per 100,000 of the population).

**Table I.** Mortality of the adult population of Kyiv after stroke, 2009-2020

Year	Number of Death	Mortality Rate (per 100 000 population)
2009	2619	96,14
2010	2487	90,17
2011	2278	82,37
2012	2371	85,02
2013	2381	84,53
2014	2497	86,62
2015	2510	87,85
2016	2476	86,13
2017	2415	83,61
2018	2493	85,93
2019	1743	60,10
2020	1658	57,17

of the incidence of stroke per 100,000 adult population of Kyiv for the last 12 years is presented in Fig. 3

The data represented in Fig. 3 shows a positive trend over the years of observation of the incidence of cerebral stroke in the adult population of Kyiv, in particular, their number decreased by 2.64 times ( $p \leq 0.05$ ) with a T criterion of 5.7.

A significant reduction in the incidence of cerebral stroke in the adult population of Kyiv can be explained by a substantial increase in preventive work among the population. This provided 1.94 ( $p \leq 0.05$ ) times lower than in the capital compared to data for Ukraine as a whole. It should be noted that the highest annual level of reduction in the incidence of stroke was registered in the city in 2017-2020 retrospective observation when in these years the most active preventive work was carried out.

The structure of stroke incidence among the adult population of Kyiv depending on sex was studied separately. Long-term retrospective observation shows that during 2009-2020 the gender structure of stroke patients did not change significantly statistically. In patients with all forms of cerebral stroke. Men predominated (up to 53.2%), while in the structure of CVD by sex women prevailed (up to 61.2%). The findings support the hypothesis that men are less responsible for their health than women and mostly seek help for complications, including stroke.

Given that the available statistics on the type of stroke in the city indicate only its ischemic, hemorrhagic, and unspecified nature, we used the results of our pragmatic observation in 2016 to clarify the information, analyzing 1575 registration cards of acute stroke [44]. The study revealed ischemic stroke in 1328 (86.1%) patients, hemorrhagic – in 121 (7.8%), mixed stroke (presence of ischemic and hemorrhagic stroke at the same time). In 17 (1.1%), hemorrhagic transformation of the site of cerebral stroke infarction – in 19 (1.2%), unspecified nature of stroke – in 57 (3.7%) patients. The share of patients with hemorrhagic stroke was maximum among men of 60-75

yo – 31 (9.8%) patients, decreased in the senile men of 75-90 yo, while in middle-aged, elderly, senile, and long-lived women, with age ranged from 44 yo to over 100 yo, the share of hemorrhagic stroke remained at the same level – 7.6-8.4%. Cases of mixed stroke or hemorrhagic transformation of the ischemic stroke were reported mainly in elderly and senile patients of both sexes.

In Kyiv, as in Ukraine generally, in contrast to the leading countries of the world, including the former Soviet Union, there is no statistical accounting, and accordingly, there is no statistical reporting of CVD in children under 18 years of age. At the same time, children with such pathology are hospitalized in pediatric hospitals. In this regard, we were unable to analyze the incidence of CVD and stroke in the children in Kyiv. According to the statistical reports of the Ministry of Health of Ukraine for 2018, eighteen children under the age of majority with intracranial hemorrhages were treated in hospitals in Kyiv. There is no more information about CVD and stroke in children patients in Kyiv.

The high incidence of stroke in Ukraine is due to several factors. Since stroke is an age-related pathology, the demographic situation that currently exists in the country with registered 12 million pensioners that are counted of 27.9% of the population, has a great influence. [45]. However, the main reason is the growing prevalence of stroke risk factors among the population. Thus, hypertension in Ukraine affects more than 12 million people (28.3% of the population), diabetes – 1.5 million people (3% of the population), and coronary artery disease (CAD) – 18.1% of the population.

A long-term study of the dynamics of the incidence and prevalence of hypertension (HBP) and CAD among the adult population of Kyiv are cited as the main factors in the development of CVD for over 10 years (2009-2018). Thus, the incidence of HBP among the adult population of Kyiv decreased during this period by 1.24 ( $p \leq 0.05$ ) times. In 2018, amounted to 2006.1 per 100,000 adults (compared to 1997.6 per 100,000 adult population in Ukraine). The prev-

alence of CAD in the city is almost stable and was 27241.8 in 2018. The share of women in all years reached 62-64%.

For a more detailed statistical analysis of epidemiology, we considered it appropriate to assess the mortality of the adult population of Kyiv due to a stroke. During the 12-year study period, 27,928 adults died due to a cerebral stroke in the city. Data on this stroke mortality among the adult population of Kyiv for the period 2009-2020 is given in table I.

The statistics shown in Table I represent a steady downward trend in the adult mortality rate of stroke in the city for the period 2009-2020. In particular, during the study period, the adult mortality rate decreased by 38.97 per 100,000 adults (1.7 times,  $p = 0.05$ ), with a particularly significant decrease during the last two years. This situation is primarily due to the higher level of availability and quality of medical care for stroke patients.

## CONCLUSIONS

To summarize, we would like to highlight that a significant reduction in the incidence of CVD and stroke in the adult population of Kyiv may be due to increased preventive work among the city population and a higher level of availability and quality of medical care.

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**Conflict of interest:**

*The Authors declare no conflict of interest.*

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