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The influence of the war events on the epidemiology of cerebrovascular diseases and strokes among residents of Kyiv, Ukraine

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Abstract. ***Background.*** *In Ukraine, mortality rates from cerebrovascular diseases (CVD) are 10–17 % higher than in Europe. The number of registered cases of strokes is increasing in the world and this tendency is expected to continue in the coming years. One of the factors affecting epidemiological indicators is military conflicts. This mostly applies to low- and middle-income countries due to the complexity of providing medical care. Large studies testify to the negative impact of military actions on the morbidity and mortality from CVD, a change in the structure of strokes due to an increase in the proportion of intracerebral hemorrhages, and an increase in the number of young and middle-aged patients. People who live in war zones have a higher risk of heart disease and stroke, even years after the war ends. This is due to an increase in the share of both medical and non-medical risk factors. Considering world tendency, the study of epidemiological indicators regarding the prevalence, morbidity, and mortality of both cardiovascular disease in general and cerebral strokes in particular and the comparison of these data in the pre-war and war periods is relevant not only for Ukraine. The purpose was to provide an epidemiology of CVD and cerebral stroke among the adult population of Kyiv in the prewar and wartime periods.* ***Materials and methods.*** *The data from the statistical reports of CVD and stroke in Kyiv from 2007 to 2023 were analyzed using statistical methods and the systematic approach.* ***Results.*** *There was a decrease in the prevalence and morbidity of cerebrovascular diseases and cerebral stroke among adult residents of Kyiv in the pre-war period. These epidemiological findings were comparable to the general level in Ukraine but remained higher than in Western Europe. The most common risk factors were hypertension (28 % of the population), coronary heart disease (18.1 %), diabetes (1.3 %) as well as a high percentage of bad habits. In the first year of the war, the incidence rate of CVD and stroke in Ukraine decreased, and in the second year, it increased by 15 and 22 %, respectively. The incidence of cerebral strokes was the lowest in 2022 and amounted to 82.1 per 100,000 adult population, increasing in 2023 by 22.4 % to 100.5 per 100,000 population. The number of stroke patients in the city during 2022–2023 increased by 26.6 % compared to 2016. An increase in stroke hospitalizations was due to repeated strokes. The ratio of stroke types had also changed: in prewar times, it was 8.4 cases of ischemic strokes to 1 case of hemorrhagic stroke, during the war — 12.7 : 1. In 2022–2023, the mortality from CVD and all forms of cerebral strokes increased in Kyiv.* ***Conclusions.*** *The results of the study prove the negative impact of war on the epidemiology of CVD and stroke. An increase in the number of patients with CVD and cerebral strokes as well as a change in the ratio of stroke types and an increase in hospital mortality were noted.*

Keywords: *war; Kyiv; cerebrovascular diseases; stroke; morbidity; mortality; adults*

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Introduction

Worldwide, stroke is the leading cause of disability and the second leading cause of death [1]. Globally, the lifetime risk of stroke, its incidence, prevalence, disability, and mortality has increased by 50, 70, 143, 102, and 42 %, respectively, for the last ten years [2]. The number of strokes is disproportionately increasing in lower- and lower-middle-income countries (86 % of deaths due to stroke and 89 % of disability) compared to the high-income countries and this trend is expected to continue in the coming years, posing an unprecedented problem to families with less resources [3]. According to the World Health Organization, cardiovascular diseases take an estimated 17 million lives annually in the world, which is 30 % of all deaths [4, 5]. The lifetime risk of stroke and rates of mortality from cerebrovascular diseases (CVD) are 10–17 % higher in Ukraine compared to Western European countries [6–8]. The most important factor, contributing to the higher rates of CVD and stroke in Ukraine, is the war. Not only does war cause direct damage to people's health, safety, and property, but it also increases stress levels dramatically, causing severe social and economic insecurity.

The negative impact of military operations on morbidity and mortality from cerebrovascular diseases is proven scientifically [9, 10]. The increased number of intracranial hemorrhages, especially in young and middle-aged patients, is typical of the war. People who live in war zones have a higher risk of heart disease and stroke even years after the war ends. This is due to an increase in the share of both medical and non-medical risk factors.

War contributes to speedy aging, increased health issues, and mortality rates among people with cardiovascular disease and cerebrovascular pathology [11]. In early studies of the Lebanon war's impact on CVD, Sibai (1989) noted that there is a connection between the influx of acute and chronic stress factors along the rise of CVD among civilians during the war conflict [12]. During and after the war in Iraq, a significant increase (from 1.19/1,000 in 2003 up to 2.42/1,000 in 2014) in the incidence of stroke was reported [13].

A systematic analysis of the global war burden was carried out in 195 countries over ten years (2007–2017), showing that the mortality rate due to violent conflicts and terrorism increased by 118.0 % [14]. The impact of war on CVD morbidity and mortality was also confirmed by the analysis of 6,255 types of cerebral strokes in Sarajevo (Bosnia and Herzegovina), which revealed a 48% increase in stroke mortality during the war compared to the pre-war period. The structure of strokes changed, and the incidence of intracerebral hemorrhage has increased in patients with atherothrombotic cerebral infarction; the number of patients aged 51–60 years increased significantly [15]. The results of current studies proved that people living near combat zones are at greater risk for CVD and stroke compared to those living further away. A systematic review by Mahase (2019) revealed that these conditions are associated with an increased risk of developing heart attack, stroke, high blood pressure, and high cholesterol as well as increased consumption of alcohol and recreational drugs [16].

As with every war, the military campaign in Ukraine can't help but affect the prevalence, morbidity, and mortality of CVD and cerebral stroke. However, there is a lack of scientific reports on the epidemiology of CVD and stroke in Ukraine during the war [17]. According to statistical data from the Ministry of Health of Ukraine, the number of strokes in the country increased by 16 %.

The purpose is to provide an epidemiology of CVD and cerebral stroke among the adult population of Kyiv in the pre-war and wartime periods.

Materials and methods

The data from the statistical reports of CVD and stroke in Kyiv from 2007 to 2023 were analyzed using statistical methods and the systematic approach. To exclude the influence of the COVID-19 pandemic and therefore analyze the impact of the war solely on the epidemiology of CVD and stroke in Ukraine, 2019–2021 were not considered in this study.

Results and discussion

The prevalence of CVD in Ukraine increased starting from 2009, stabilized in 2012, decreased in 2014 and 2015 (from 8,220 to 7,260 per 100 thousand), and remained stable in 2016–2021 [18]. The prevalence of risk factors among the Ukrainians was as follows: hypertension (28 % of the population), ischemic heart disease (18.1 %), cardiovascular diabetes (1.3 %), poor eating habits, smoking, and increased intake of alcohol [19, 20].

The rate of CVD in Ukraine reached 868.1 in 2009, subsequently increased to 937.7 in 2013, and then began to gradually decrease, reaching 682.5 in 2018 ($p < 0.05$). We also note that the number of patients who seek medical care due to various neurological conditions has changed significantly. The number of patients with CVD was traditionally the highest, but never exceeded 74 %, except for 2022–2023 when it rose to 75.5 %.

In the pre-war period, there was a positive trend in the rate of CVD with a tendency to decrease. However, due to the rise in the war-related death toll and migration (of the population to the Kyiv from the active war zone as well as out of the Kyiv and country for safety), the number of Kyiv residents has changed significantly. Immigrants temporarily resettled in Kyiv were not registered in the medical system and sought medical help only in emergencies.

War events reduced the number of visits to doctors and sometimes made it impossible to record all cases of illness. However, practically all stroke patients turned to the emergency department and were hospitalized in neurological departments and received free examination and treatment.

The fact that the number of CVD is growing in hypertensive patients registered in the city is important: for example, in 2023, the percentage of such patients was 93 %, while in 2016, it reached 78 %. This is confirmed by the observations in other countries where military operations took place.

Stroke incidence among the urban adult population has a positive trend in 2009–2018. In 2009, it was 251.3 per 100,000, gradually decreasing by 1.7 times to 143.9 in 2018 ($p \leq 0.05$). Stroke incidence in Kyiv was almost half as much as in Ukraine.

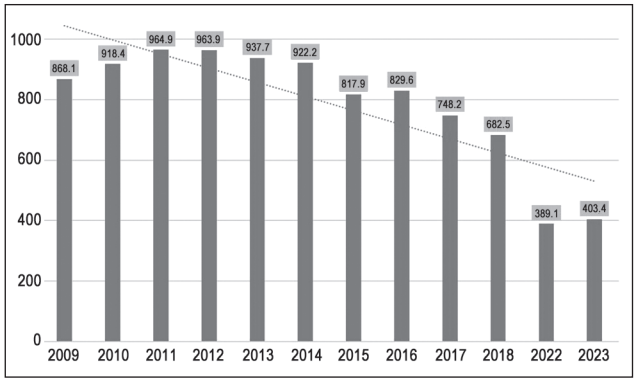

Figure 1. Dynamics of the rate of cerebrovascular diseases in adults of Kyiv during 2009–2018 and 2022–2023

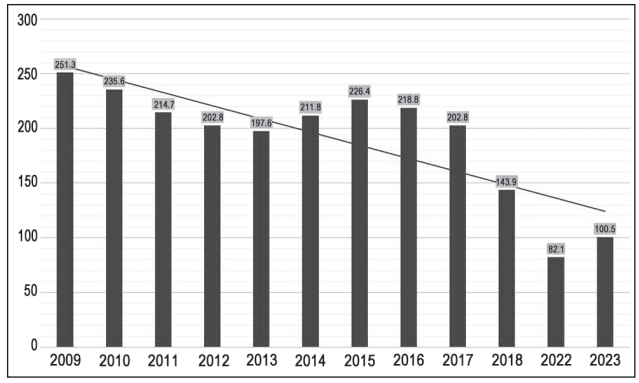

Figure 2. Dynamics of the cerebral stroke incidence in the adult population of Kyiv in 2009–2018 and 2022–2023

At the beginning of the war, the stroke incidence was the lowest and amounted to 82.1 per 100,000 adult population. During the second year of the war, it increased by 22.4 % and was 100.5 per 100,000 population. If we translate this indicator into the number of registered new stroke cases, the data will be as follows: in 2018, 3,373 new cases were registered; in 2019 — 2,613; in 2020 — 2,246.

At the same time, the total number of patients treated in the city's hospitals for stroke did not decrease during the war years and remained at the level of 6–6.5 thousand (data refer to public hospitals and do not include private hospitals). Consistently, the number of stroke cases remained high due to the occurrence of repeated strokes.

However, the situation in the city changed during the war. In 2022, the total number of stroke patients treated in the hospitals was 7,744. Compared to 2016, this number has increased by 26.6 %. In 2016, the ratio of primary to recurrent strokes was 48.7 to 51.3 %, while in 2022, it was 25.0 to 75.0 %.

In 2023, more stroke patients were treated in hospitals of Kyiv — 9,666. This number is the highest in all years of our observation (the second highest was 7,559 in 2018). In 2023, the ratio of primary strokes to recurrent ones was 1 : 4. The number of stroke hospitalizations in Kyiv during the first two years of the war increased significantly due to repeated stroke. This is caused by patients' non-adherence to measures preventing the recurrences. The growth of risk factors like hypertension, cardiovascular diseases, and diabetes is associated with increased stress levels due to the war. Such a phenomenon as wartime hypertension is observed during the war and is a variant of stress-induced hypertension.

The ratio of ischemic and hemorrhagic strokes in the pre-war period was 8.4 : 1, in 2022 — 12.6 : 1, and in 2023 — 12.7 : 1. Consequently, the number of ischemic strokes during the military operations increased significantly.

The in-hospital mortality from CVD during the pre-war period was relatively low and amounted to 6.85 % (2015), 7.32 % (2016), 6.72 % (2017), and 6.78 % (2018). In 2022, it increased sharply to 12.77 %, and then decreased to 10.92 % in the following year. Mortality varied based on the stroke type and was as follows: in all pre-war years (2014–2018), it fluctuated from 14.73 to 15.99 % in case of ischemic stroke, and from 37.93 to 41.83 % in intracerebral hemorrhage. During the first year of the war, these indicators increased sharply and amounted to 19.31 and 44.13 % (2022), respectively, and slightly decreased (16.79 and 41.13 %) in 2023. This dynamics might be explained by the stabilization of the war situation in Kyiv and the improvement of health care care availability.

In-hospital mortality from CVD was the lowest in 2011 amounting to 113.68 cases per 100 thousand population

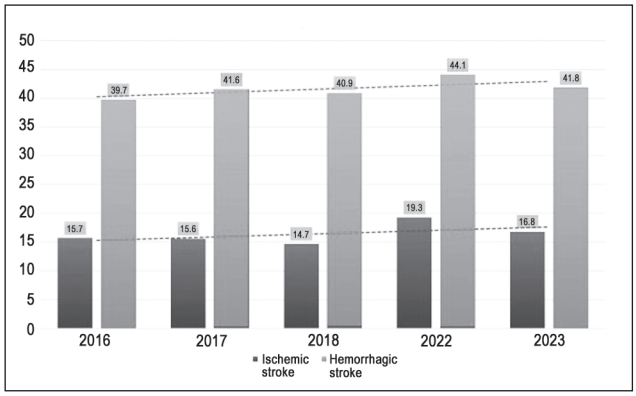

Figure 3. Dynamics of in-hospital mortality of stroke patients in Kyiv in 2016–2018 and 2022–2023

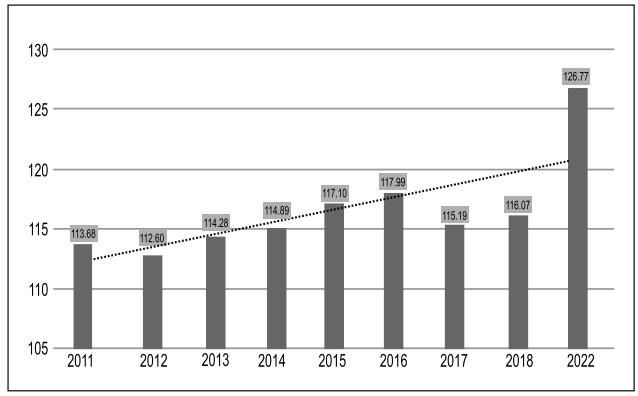

Figure 4. Dynamics of CVD mortality of the adult population of Kyiv in 2011–2018 and 2022

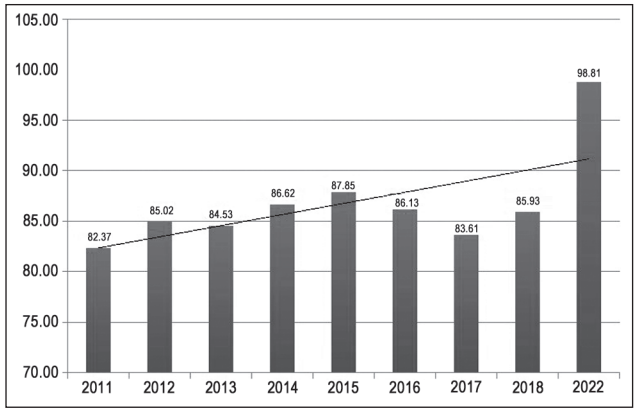

Figure 5. Dynamics of mortality due to cerebral stroke among the adult population of Kyiv (2011–2018 and 2022)

compared to the pre-war years. It was the highest in 2016 — 117.99 cases per 100 thousand population, while in 2018 — 116.07 cases per 100 thousand population. However, these differences were statistically insignificant ($p \geq 0.06$). During the first year of the war, CVD mortality increased sharply: by 10.7 cases per 100 thousand population and amounted to 126.77 or increased by 1.09 times ($p < 0.05$). Even though the incidence of CVD decreased in Kyiv during the war, the mortality from this pathology has increased.

Stroke mortality did not undergo significant fluctuations in the pre-war years. Its lowest rate was in 2011 (82.37 cases per 100 thousand population), and the highest — in 2015 (87.85 cases per 100 thousand population) (Fig. 5). If we compare the indicator of 2022 (98.81 cases per 100 thousand population) with that in 2018 (85.93 cases per 100 thousand population), then its growth by 1.15 times is noted ($p < 0.05$).

Consequently, we have found an increase in mortality among the adult population of the city both from CVD in general and from cerebral strokes. At the same time, the rate of increase in mortality from strokes was higher, which gives reason to think that strokes were the main cause of death among all forms of CVD.

Conclusions

1. The incidence of CVD and cerebral strokes in the adult population of Kyiv in the pre-war period (2018) decreased by 1.3 times ($p < 0.05$) compared to 2009 with t reliability criteria of 26.89. It decreased further during the first year of the war in 2022 to 389.1 cases per 100 thousand population, but in 2023, it slightly increased to 403.4 cases per 100 thousand population.

2. In the pre-war period, the number of patients with cerebral strokes receiving treatment in communal hospitals of Kyiv was 7.2–7.5 thousand annually; in the first year of the war, it increased by 2.4 % and in the following year — by 27.9 %.

3. An increase in the number of patients with stroke during the war occurred due to an increase in the number of ischemic strokes: in the pre-war period, the ratio between ischemic and hemorrhagic strokes was 7.9–8.4 : 1, and during the war, it became 12.6–12.7 : 1.

4. Retrospective analysis revealed a change in the ratio of primary to recurrent strokes: before the war, primary strokes predominated by a ratio of 1.9 : 1, and during the war, by a ratio of 3 : 1.

5. During the first year of the war, 2022, there was a ra-ther sharp increase in the hospital mortality rate: up to 19.3 % in cases of ischemic stroke and 44.1 % in hemorrhagic strokes. The next year, in 2023, these numbers decreased to 16.8 and 41.8 %, respectively.

6. In 2022–2023, an increase in mortality among the adult population of Kyiv was noted both from CVD in general and from the cerebral strokes by 1.15 times ($p < 0.05$).

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Authors' contribution. Prokopiv M.M. — research concept and design, data analysis, writing manuscript, supervision throughout the research, final editing; Okuneva S.-M.S. — collection of the data, data analysis, writing manuscript; Heletiuk Yu.L. — data analysis, writing manuscript, technical editing; Fartushna O.Y. — design, data analysis, writing manuscript; Symonenko G.G. — data analysis, writing manuscript, technical editing.

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Вплив воєнних подій на епідеміологію цереброваскулярних хвороб та мозкових інсультів серед жителів м. Києва (Україна)

Резюме. ***Актуальність.*** В Україні показники смертності від цереброваскулярних хвороб (ЦВХ) на 10–17 % вищі, ніж у Європі. У світі зростає кількість зареєстрованих випадків інсультів, і в найближчі роки, за прогнозами, ця тенденція буде утримуватися. Одним із факторів, що впливає на епідеміологічні показники, є воєнні події. Найбільше це стосується країн із низьким та середнім рівнем доходу через ускладнення надання медичної допомоги. Великі дослідження засвідчують негативний вплив воєнних дій на захворюваність і смертність від ЦВХ, зміну структури інсультів через зростання частки внутрішньомозкових крововиливів та збільшення кількості хворих молодого й середнього віку. Люди, які живуть у зонах бойових дій, мають вищий ризик розвитку серцево-судинних захворювань та інсульту навіть через роки після їх закінчення. Це зумовлено збільшенням частки факторів ризику як медичного, так і немедичного характеру. Зважаючи на світові тенденції, вивчення епідеміологічних показників поширеності, захворюваності, смертності від ЦВХ загалом та мозкових інсультів зокрема й порівняння цих даних у довоєнний і воєнний періоди є актуальними не лише для України. ***Мета:*** дослідити епідеміологію цереброваскулярних хвороб і мозкових інсультів серед дорослого населення м. Києва у довоєнний та воєнний періоди. ***Матеріали та методи.*** При проведенні цієї роботи використано статистичний метод і системний підхід. Матеріалами дослідження слугували

дані галузевої статистичної звітності по м. Києву упродовж 2007–2023 рр. ***Результати.*** Встановлено тенденцію до зниження захворюваності й поширеності ЦВХ та мозкових інсультів серед дорослих жителів Києва у довоєнний період. Рівень вказаних показників був порівнянний із загальним по Україні, але вищий за такий у країнах Західної Європи. Найбільш поширеними факторами ризику є артеріальна гіпертензія (28 % населення), ішемічна хвороба серця (18,1 %), цукровий діабет (1,3 %), а також шкідливі звички. У перший рік війни частота ЦВХ і мозкових інсультів в Україні знизилася, а на другий рік зросла відповідно на 15 та 22 %. Захворюваність на мозкові інсульти була найнижчою у 2022 році (82,1 на 100 тис. дорослого населення), у 2023-му зросла на 22,4 %, дорівнюючи 100,5 на 100 тис. населення. Кількість пацієнтів з усіма формами інсультів у місті впродовж 2022–2023 рр. підвищилася на 26,6 % порівняно з 2016 р. Збільшення кількості госпіталізованих хворих зумовлено виникненням повторних інсультів. Співвідношення типів інсультів також змінилось: у довоєнний час воно становило 8,4 випадку ішемічних інсультів до 1 випадку геморагічного інсульту, під час війни — 12,7 : 1. У 2022–2023 рр. у Києві зросла лікарняна летальність від ЦВХ та всіх форм мозкових інсультів. ***Висновки.*** Результати дослідження підтверджують негативний вплив воєнних подій на епідеміологічні показники цереброваскулярних хвороб та мозкових інсультів. Відмічено збільшення кількості пацієнтів із ЦВХ і мозковими інсультами, а також зміну співвідношення типів інсультів та підвищення госпітальної смертності.

Ключові слова: війна; Київ; цереброваскулярні хвороби; інсульт; захворюваність; смертність; доросле населення