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ABSTRACT

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ANALYSIS OF THE INCIDENCE OF BRAIN TUMORS IN UKRAINE AND THE SUMY REGION IN 2017–2021

Background. Tumours of the brain and other parts of the central nervous system, despite the relatively low incidence, cause significant mortality in all age groups. In addition, these tumours are characterized by great histological diversity, which complicates diagnosis.

Aim. Analysis of statistical indicators of the incidence of brain tumours in the population of Ukraine and the Sumy region in 2017–2021.

Materials and methods. Based on data from the National Cancer Registry of Ukraine, an analysis of the incidence of malignant brain neoplasms in the population of Ukraine and the Sumy region in 2017–2021 was carried out. The histological archives of the Department of Pathology of the Sumy Regional Clinical Hospital and the Department of Pathology of the Sumy State University were also analyzed.

Results. The average incidence of malignant brain neoplasms was 3.5 ± 0.28 cases per 100,000 population of the Sumy region, which was lower than the national level (3.96 ± 0.09 cases per 100,000 population of Ukraine). The average mortality rate for 2017–2021 was 2.3 ± 0.19 deaths per 100,000 population of Sumy Region, which was also lower than the national level (2.58 ± 0.07 deaths per 100,000 population of Ukraine). Morbidity and mortality prevailed among men. Among children, the average incidence rate in 2017–2021 was 2.12 ± 0.11 cases per 100,000 child population of Ukraine, and the average mortality rate was 0.8 ± 0.05 cases per 100,000 child population of Ukraine. During this period, 25 patients were operated on in the Sumy region, of which six men (24%) and 19 women (76%) had the primary diagnosis of meningioma. The average age of the patients was 64.88 ± 2.11 years, and among the histological variants of meningiomas, the following were recorded: 13 meningotheial (52%), eight psammomatous (32%), three mixed meningotheial-psammomatous (12%) and one fibrous meningioma (4%).

Conclusions. Morbidity and mortality due to malignant brain neoplasms in the Sumy region in 2017–2021 were slightly lower than the national indicators, but this may indicate insufficient diagnosis. Among non-malignant tumours, 25 cases of meningiomas were recorded, most of which were characteristic of women aged 65.

Keywords: malignant neoplasms of the brain, tumours, morbidity, meningioma, biomineralization.

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АНАЛІЗ ЗАХВОРЮВАНOSTI НА ПУХЛИНИ ГОЛОВНОГО МОЗКУ В УКРАЇНІ ТА СУМСЬКІЙ ОБЛАСТІ ЗА 2017–2021 РОКИ

Актуальність. Пухлини головного мозку та інших відділів центральної нервової системи, не зважаючи на відносно низьку захворюваність, спричиняють значну смертність у всіх вікових групах. Крім того, для цих пухлин ще характерна велика гістологічна різноманітність, що ускладнює діагностику.

Мета. Аналіз статистичних показників захворюваності населення України та Сумської області на пухлини головного мозку в період 2017–2021 років.

Матеріали та методи. На основі даних Національного канцер-реєстру України проведений аналіз захворюваності на злоякісні новоутворення головного мозку населення України та Сумської області в період 2017–2021 рр. Також були проаналізовані гістологічні архіви патологоанатомічного відділення Сумської обласної клінічної лікарні та кафедри патологічної анатомії Сумського державного університету.

Результати. Середнє значення захворюваності на злоякісні новоутворення головного мозку становило $3,5 \pm 0,28$ випадків на 100 тис. населення Сумської області, що було менше за загальнодержавний рівень ($3,96 \pm 0,09$ випадків на 100 тис. населення України). Середнє значення смертності за 2017–2021 рр. становило $2,3 \pm 0,19$ випадків смерті на 100 тис. населення Сумської області, що також було менше за загальнодержавний рівень ($2,58 \pm 0,07$ випадків смерті на 100 тис. населення України). Захворюваність та смертність переважала серед чоловічої статі. Серед дітей середнє значення захворюваності становило $2,12 \pm 0,11$ випадків на 100 тис. дитячого населення України, а середнє значення смертності становило $0,8 \pm 0,05$ випадків на 100 тис. дитячого населення України. За даний період в Сумській області було прооперовано 25 хворих, з яких 6 чоловіків (24%) та 19 жінок (76%) з первинним діагнозом «менінгіома». Середній вік пацієнтів складав $64,88 \pm 2,11$ роки, а серед гістологічних варіантів менінгіом, то було зафіксовано: 13 менінготеліальних (52%), 8 псаммоматозних (32%), 3 змішаних менінготеліально-псаммоматозних (12%) та 1 фіброзна менінгіома (4%).

Висновки. Захворюваність та смертність від злоякісних новоутворень головного мозку в Сумській області в період 2017–2021 років були незначно меншими за загальнодержавні показники, проте це може свідчити про недостатню діагностику. Серед незлоякісних пухлин було зафіксовано 25 випадків менінгіом, більшість з яких була характерна для жінок віком 65 років.

Ключові слова: злоякісні новоутворення головного мозку, пухлини, захворюваність, менингіома, біомінералізація.

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INTRODUCTION / ВСТУП

Tumors of the brain and other parts of the central nervous system (CNS), despite a relatively low incidence, cause significant mortality in all age groups. A large number of risk factors for the development of tumours of the central nervous system have been studied. However, their etiology is still insufficient because no single risk factor has been established that would cause many cases [1, 2]. So, for example, regarding the etiology of meningiomas, most scientists agree that there is a certain genetic predisposition (specific genes have not been established) and the influence of ionizing radiation [3-5].

In addition to rarity, CNS tumours are also characterized by great histological diversity, which can complicate diagnosis because the World Health Organization (WHO) classification in 2021 includes more than 100 brain tumours [6, 7]. For example, only meningiomas are divided into three groups and 15 histological subtypes, and one tumour can simultaneously observe histological patterns of several subtypes [8].

In addition, tumours of the brain and other parts of the central nervous system are the most common type of oncology in children and the second most common in adolescents. As for risk factors in childhood, the main ones are genetic predisposition and ionizing radiation (it has a more significant impact than in adults) [9-11].

According to the latest report of the Central Registry of Brain Tumors of the United States of America (from October 4, 2023), for the years 2016-2020, the average annual incidence rate of malignant and non-malignant neoplasms of the central nervous system adjusted for age was 24.83 per 100,000 population and for malignant neoplasms 6.94 per 100,000 population. Regarding the distribution by gender, men were sick more often than women (1.28:1). The most frequent nosologies were meningioma (40.8% of all tumours, mainly in women) and glioblastoma (14.2% of all tumours, mainly in men) [12].

The process of pathological biomineralization is characteristic of the central nervous system in general and meningiomas in particular. It can be useful in the differential diagnosis of brain neoplasms, although it needs further definition [13-16].

It is not possible to determine the prevalence of one or another type of CNS tumours on the territory of Ukraine according to the data of the National Cancer Registry due to the combined statistics for all malignant neoplasms of the brain.

Aim. Analysis of statistical indicators of the incidence of brain tumours in the population of Ukraine and the Sumy region in the period 2017-2021.

Materials and methods. Based on the data of the National Cancer Registry of Ukraine, an analysis of the incidence of malignant brain neoplasms in the population of Ukraine and the Sumy region in the period 2017-2021 was carried out [17-21]. We calculated: X_a - the average incidence of malignant brain tumours, σ - the standard deviation, Me - the median and μ - the average error. The histological archives of the Department of Pathology of the Sumy Regional Clinical Hospital and the Department of Pathology of the Sumy State University were also analyzed. The critical level of significance when testing statistical hypotheses in this study was taken as equal to 0.05.

Results and discussion. According to the National Cancer Registry of Ukraine, 9,149 cases of malignant brain neoplasms were registered during 2017-2021 (an average of $1,829.8 \pm 45.19$ cases per year). In general, the average incidence rate for 2017-2021 was 3.96 ± 0.09 cases per 100,000 population of Ukraine. As for the Sumy region, 211 cases of malignant neoplasms of the brain were registered during this period (an average of 42.2 ± 3.12 cases per year). In general, the average incidence rate for 2017-2021 was 3.5 ± 0.28 cases per 100,000 population of the Sumy region (Table 1).

According to the results of the analysis, it was established that the highest incidence rate of malignant brain neoplasms in Ukraine was observed in 2018 and 2019 (4.2 and 4.1 cases per 100 thousand population, respectively) and the lowest in 2021 (3.7 cases per 100,000 population). While in Sumy Region, on the contrary, the highest rate was registered in 2021 (4.1 cases per 100,000 population) and the lowest in 2018 (2.5 cases per 100,000 population) (Fig. 1).

Note that during the current analysis period (2017-2021), the incidence rates of malignant brain neoplasms in the Sumy region were lower than the national rates until 2019; in 2020, they were almost at the same level, and in 2021 they began to prevail.

Table 1 – Incidence of malignant neoplasms of the brain in the population of Ukraine and the Sumy region in 2017–2021

	2017	2018	2019	2020	2021	Xa	σ	Me	μ
Ukraine	4	4,2	4,1	3,8	3,7	3,96	0,21	4	0,09
Ukraine (men)	4,5	5	4,7	4,5	4,2	4,58	0,29	4,5	0,13
Ukraine (women)	3,7	3,6	3,5	3,2	3,2	3,44	0,23	3,5	0,1
Sumy Region	3,3	2,5	3,7	3,9	4,1	3,5	0,63	3,7	0,28
Sumy Region (men)	3,4	2,7	4,3	5	4,3	3,94	0,9	4,3	0,4
Sumy Region (women)	3,1	2,5	3,1	3,1	4	3,16	0,54	3,1	0,24

Notes: Xa - the average incidence of malignant brain tumours, σ - the standard deviation, Me - the median and μ - the average error

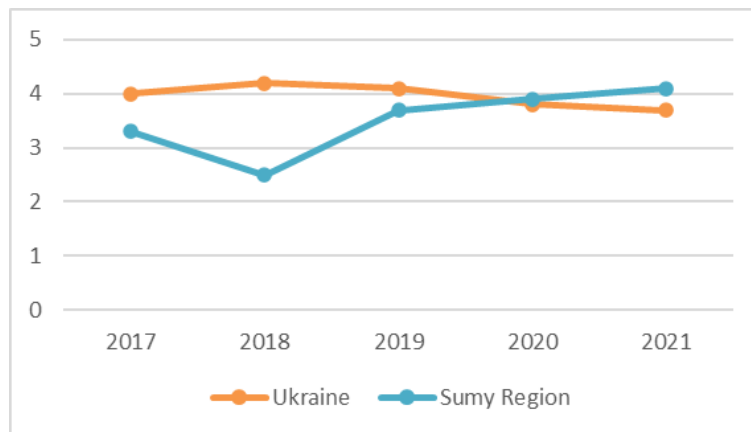


Figure 1 – Comparison of the incidence rates of malignant brain neoplasms in Ukraine and Sumy region during 2017-2021. The ordinate axis is a standardized indicator (world standard) per 100,000 population; the abscissa axis is years

Let's look at the distribution of patients by gender in the current analysis period (2017-2021 years). The nationwide indicators are characterized by a significant difference in morbidity (men:women = 1.33:1, $p <$

0.001) (Fig. 2). In the indicators for the Sumy region, there is also a slightly predominant number of men, but it was not statistically significant (men:women = 1.25:1, $p > 0.05$) (Fig. 3).

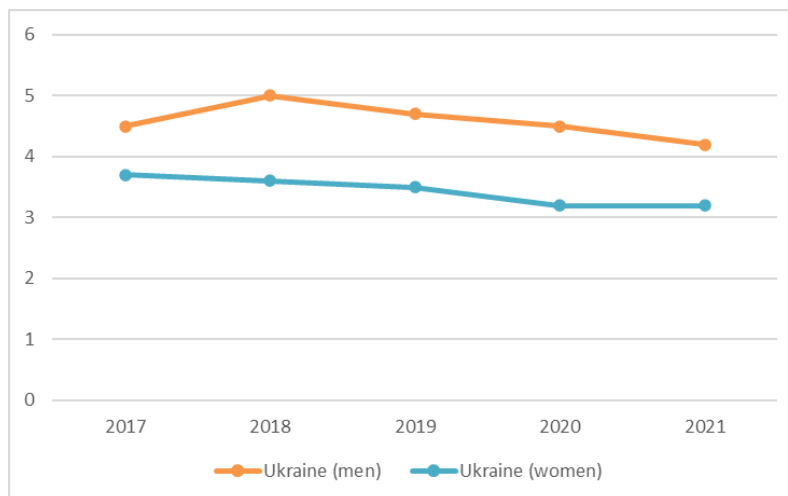


Figure 2 – Comparison of the incidence rates of malignant brain neoplasms in Ukraine among men and women during 2017-2021. The ordinate axis is a standardized indicator (world standard) per 100,000 population; the abscissa axis is years

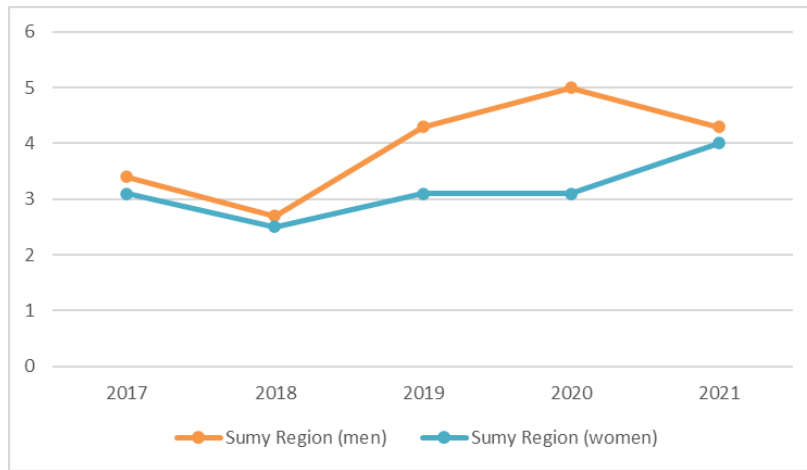


Figure 3 – Comparison of the incidence rates of malignant brain neoplasms in the Sumy region among men and women during 2017-2021. The ordinate axis is a standardized indicator (world standard) per 100,000 population; the abscissa axis is years

According to the National Cancer Registry of Ukraine, 6,491 deaths from malignant brain neoplasms were registered during 2017-2021 (an average of $1,298.2 \pm 27.67$ deaths per year). The average mortality rate for 2017-2021 was 2.58 ± 0.07 deaths per 100,000 population of Ukraine. As for the Sumy region, during

this period, 173 cases of death from malignant neoplasms of the brain were registered (an average of 34.6 ± 2.34 cases per year). In general, the average mortality rate for 2017-2021 was 2.3 ± 0.19 deaths per 100,000 population of the Sumy region (Table 2).

Table 2 – Mortality from malignant neoplasms of the brain of the population of Ukraine and the Sumy region in 2017–2021

	2017	2018	2019	2020	2021	Xa	σ	Me	μ
Ukraine	2,7	2,7	2,7	2,4	2,4	2,58	0,16	2,7	0,07
Ukraine (men)	3,2	3,2	3,2	3	3	3,12	0,11	3,2	0,05
Ukraine (women)	2,3	2,4	2,2	1,9	2	2,16	0,21	2,2	0,09
Sumy Region	2,7	2,2	2,4	1,6	2,6	2,3	0,44	2,4	0,19
Sumy Region (men)	3,7	1,8	2,5	1,4	3,8	2,64	1,09	2,5	0,49
Sumy Region (women)	1,7	2,7	2,3	1,8	1,5	2	0,49	1,8	0,22

Notes: Xa - the average mortality of malignant brain tumours, σ - the standard deviation, Me - the median and μ - the average error

Based on the results of the analysis, the highest mortality rate from malignant brain neoplasms in Ukraine was observed during 2017-2019 (2.7 deaths per 100,000 population) and the lowest in 2020-2021 (2.4 deaths per 100 thousand population). In the Sumy region, the highest rate was also registered in 2017 (2.7 deaths per 100,000 population) and the lowest in 2020 (1.6 deaths per 100,000 population) (Fig. 4).

Note that during the current period of analysis (2017-2021), mortality rates from malignant brain neoplasms in the Sumy region were at the same level as the national rates in 2017; in 2018-2020, they were lower, and in 2021 they began to prevail (as and the uptake rate in 2021).

Let's look at the distribution of the dead by gender in the current analysis period (2017-2021). The national mortality rates are characterized by a predominant number of men (men: women = 1.44: 1, $p < 0.001$) (Fig. 5). There is

also a slight predominance of men in the mortality rates of the Sumy region, but it was not statistically significant (men: women = 1.32:1, $p > 0.05$) (Fig. 6).

As for preventive examinations in 2017-2021, it should be noted that annually in Ukraine, only $1.78 \pm 0.07\%$ of primary patients with malignant brain neoplasms are detected on average, and the situation is even worse in the Sumy region ($1.26 \pm 0.85\%$ of primary patients), and in 2017-2018 and 2021, not a single patient was detected, which may indicate insufficient vigilance among doctors regarding this disease (Fig. 7).

According to the National Cancer Registry of Ukraine, 709 cases of malignant brain neoplasms in children were registered during 2017-2021 (an average of 141.8 ± 7.06 cases per year). The average incidence rate for 2017-2021 was 2.12 ± 0.11 cases per 100,000 children in Ukraine (Table 3).

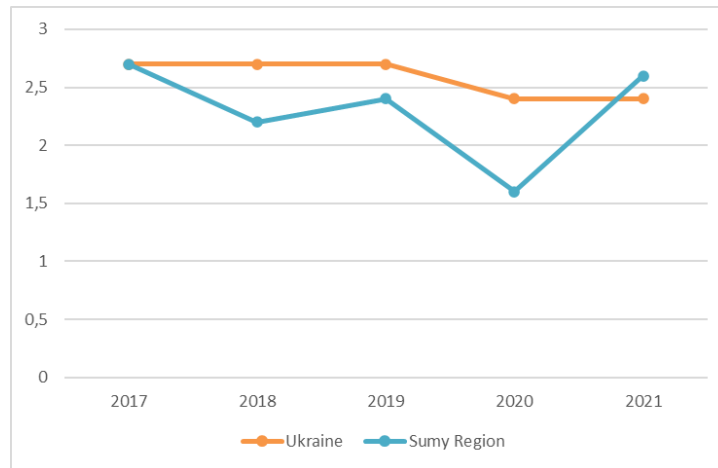


Figure 4 – Comparison of mortality rates from malignant brain neoplasms in Ukraine and Sumy region during 2017-2021. The ordinate axis is a standardized indicator (world standard) per 100,000 population; the abscissa axis is years

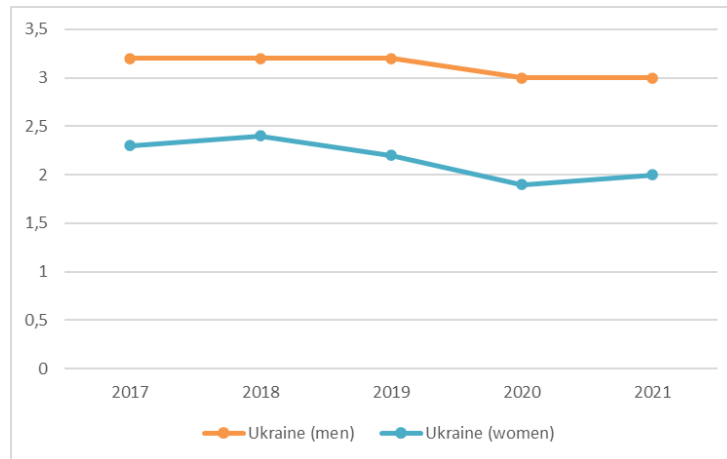


Figure 5 – Comparison of mortality rates from malignant brain neoplasms in Ukraine among men and women during 2017-2021. The ordinate axis is a standardized indicator (world standard) per 100,000 population; the abscissa axis is years

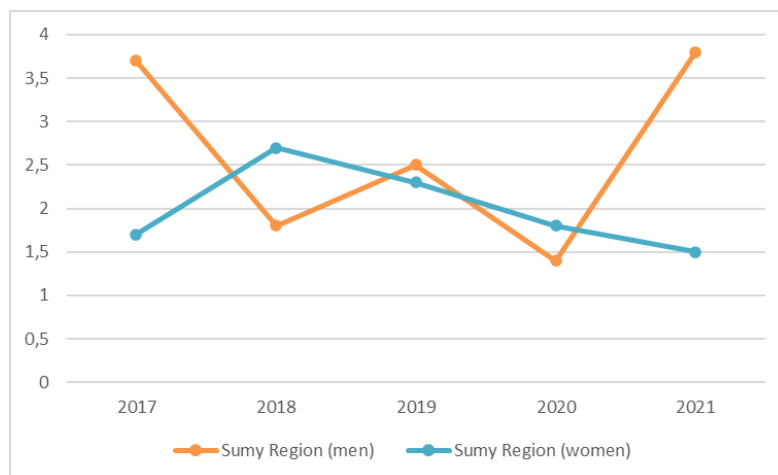


Figure 6 – Comparison of mortality rates from malignant brain neoplasms in Sumy region among men and women during 2017-2021. The ordinate axis is a standardized indicator (world standard) per 100,000 population; the abscissa axis is years

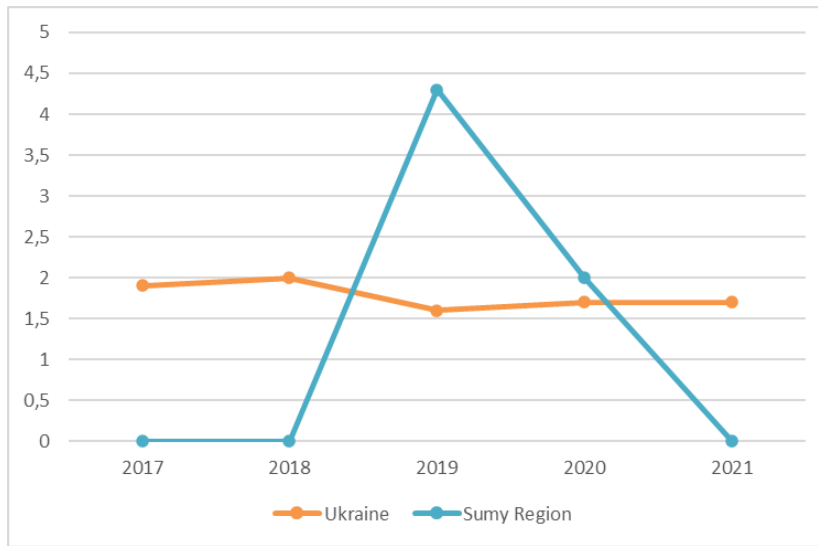


Figure 7 – Comparison of detection rates of patients with malignant brain neoplasms during preventive examinations in Ukraine and Sumy region during 2017-2021. The ordinate axis is % of primary patients; the abscissa axis is years

Based on the results of the analysis, it was established that the highest incidence rate of malignant brain neoplasms in children in Ukraine was observed in 2019 (2.4 cases per 100,000 child population) and the lowest in 2020 (1.8 cases per 100,000 child population).

Let's look at the distribution of patients by gender in the current analysis period (2017-2021). The national indicators are characterized by a significant difference in morbidity (boys:girls = 2.62:1, $p < 0.05$) (Fig. 8).

Table 3 – Incidence of malignant neoplasms of the brain in the children's population of Ukraine in 2017-2021

	2017	2018	2019	2020	2021	Xa	σ	Me	μ
Ukraine	2,1	2,3	2,4	1,8	2	2,12	0,24	2,1	0,11
Ukraine (boys)	2,2	2,8	2,7	2,2	2,1	2,4	0,32	2,2	0,14
Ukraine (girls)	2,1	1,8	2	1,4	1,9	1,84	0,27	1,9	0,12

Notes: Xa - the average incidence of malignant brain tumours, σ - the standard deviation, Me - the median and μ - the average error

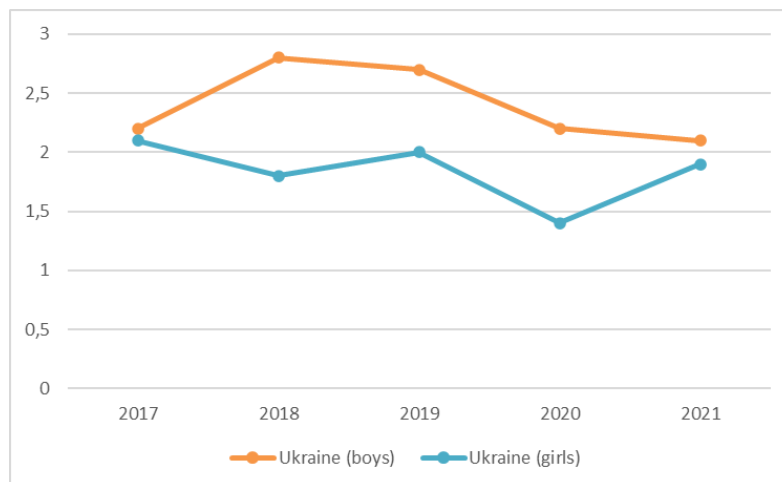


Figure 8 – Comparison of the incidence rates of malignant brain neoplasms in Ukraine among boys and girls during 2017-2021. The ordinate is the rate per 100,000 children; the abscissa is years

According to the National Cancer Registry of Ukraine, during 2017-2021, 274 cases of death of children from malignant neoplasms of the brain were registered (an average of 54.8 ± 3.77 cases per year). The average mortality rate for 2017-2021 was 0.8 ± 0.05 cases per 100,000 children in Ukraine (Table 4).

According to the results of the analysis, it was established that the highest mortality rate of children from malignant brain neoplasms in Ukraine was

observed in 2018-2019 (0.9 deaths per 100,000 child population) and the lowest in 2020 (0.6 deaths per 100,000 children).

If we look at the distribution of patients by gender in the current period of analysis (2017-2021), no significant difference in mortality was found for national indicators (boys:girls = 1.25:1, $p > 0.05$) (Fig. 9).

Table 4 – Mortality from malignant neoplasms of the brain among the children's population of Ukraine in 2017-2021

	2017	2018	2019	2020	2021	Xa	σ	Me	μ
Ukraine	0,8	0,9	0,9	0,6	0,8	0,8	0,12	0,8	0,05
Ukraine (boys)	0,8	0,9	1,1	0,8	0,9	0,9	0,12	0,9	0,05
Ukraine (girls)	0,7	1	0,7	0,5	0,7	0,72	0,18	0,7	0,08

Notes: Xa - the average mortality of malignant brain tumours, σ - the standard deviation, Me - the median and μ - the average error

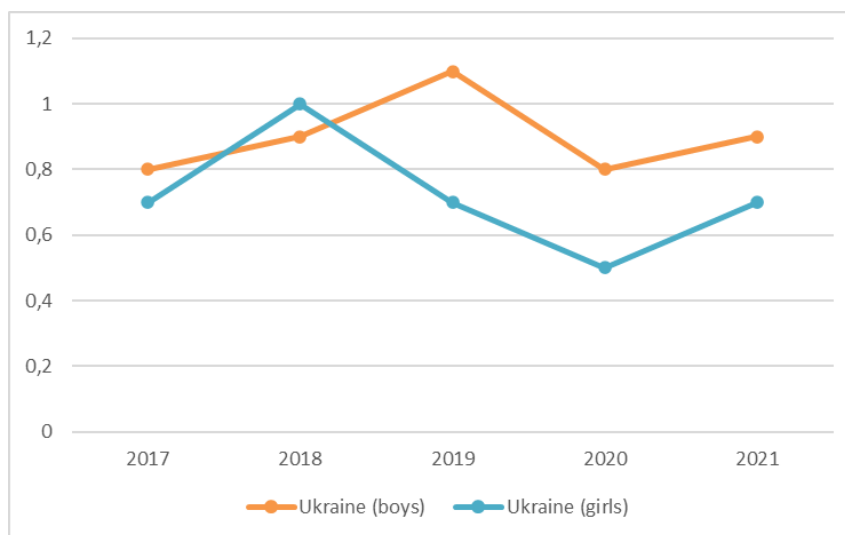


Figure 9 – Comparison of mortality rates from malignant brain tumours in Ukraine among boys and girls during 2017-2021. The ordinate is the rate per 100,000 children; the abscissa is years

Since the National Cancer Registry of Ukraine only includes data on malignant neoplasms of the brain, for the study of other (non-malignant) tumours of the central nervous system, we analyzed the histological archives of the Department of Pathology of Sumy Regional Clinical Hospital and the Department of Pathology of the Sumy State University.

From 2017 to 2021, 25 patients were operated on in the Sumy region based on the neurosurgery departments of the Sumy Regional Clinical Hospital and the Central City Clinical Hospital, including six men (24%) and 19 women (76%) with the primary diagnosis of

"meningioma". The average age of patients was 64.88 ± 2.11 years, women were 63.68 ± 2.05 years, and men were 68.67 ± 6.12 years (Fig. 10).

Regarding the histological variants of meningiomas, the following were recorded: 13 meningothelial (52%), eight psammomatous (32%), three mixed meningothelial-psammomatous (12%) and one fibrous meningioma (4%) (Fig. 11). It should be noted that signs of pathological biomineralization were observed in 16 patients (64%), which once again emphasizes the possibility of their use for diagnostic purposes.

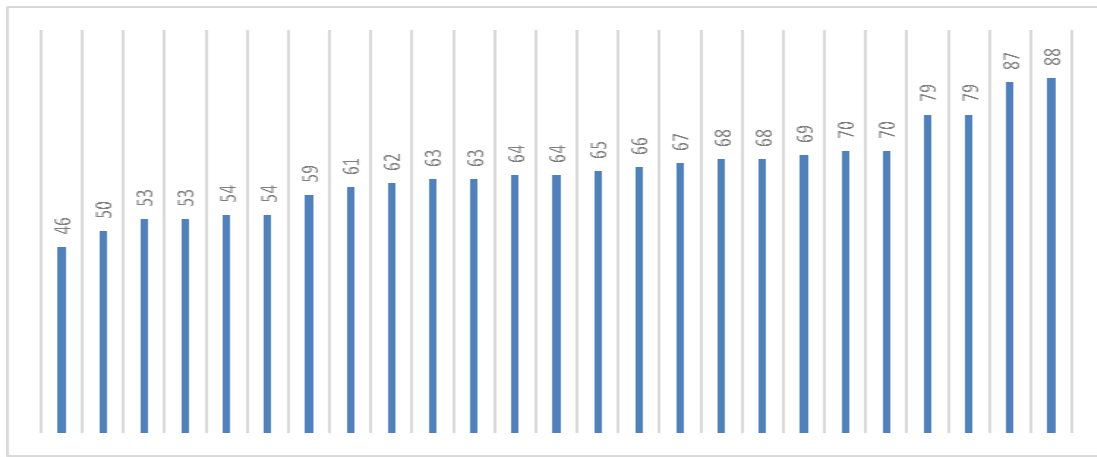


Figure 10 – Analysis by age of patients operated on for non-malignant brain tumors during 2017-2021 in the Sumy region

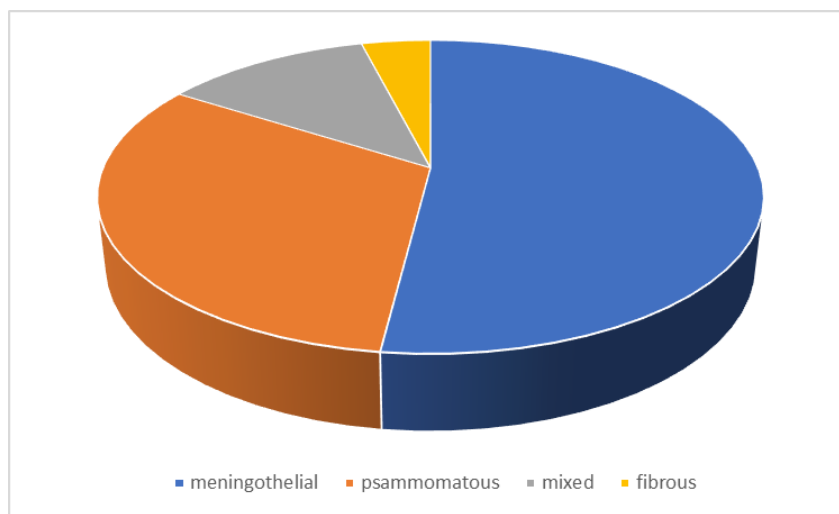


Figure 11 – Analysis of histological subtypes of meningiomas of patients operated on for non-malignant brain tumors during 2017-2021 in the Sumy region

CONCLUSIONS / ВИСНОВКИ

The average incidence of malignant brain neoplasms was 3.5 ± 0.28 cases per 100,000 population of the Sumy region, which was lower than the national level (3.96 ± 0.09 cases per 100,000 population of Ukraine). The average mortality rate for 2017-2021 was 2.3 ± 0.19 deaths per 100,000 population of Sumy Region, which was also lower than the national level (2.58 ± 0.07 deaths per 100,000 population of Ukraine). Morbidity and mortality prevailed among men. Among children, the average incidence rate for 2017-2021 was 2.12 ± 0.11

cases per 100,000 child population of Ukraine, and the average mortality rate was 0.8 ± 0.05 cases per 100,000 child population of Ukraine. During this period, 25 patients were operated on in the Sumy region, of which six men (24%) and 19 women (76%) had the primary diagnosis of "meningioma". The average age of the patients was 64.88 ± 2.11 years, and among the histological variants of meningiomas, the following were recorded: 13 meningotheial (52%), eight psammomatous (32%), three mixed meningotheial-psammomatous (12%) and one fibrous meningioma (4%).

AUTHOR CONTRIBUTIONS / ВКЛАД АВТОРІВ

All authors substantively contributed to the drafting of the initial and revised versions of this paper. They take full responsibility for the integrity of all aspects of the work.

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None.

CONFLICT OF INTEREST / КОНФЛІКТ ІНТЕРЕСІВ

The authors declare no conflict of interest.

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