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DYNAMICS OF INCIDENCE OF MENTAL AND BEHAVIOR DISORDERS IN CHILDREN OF UKRAINE: A 25-YEARS' OBSERVATION EXPERIENCE

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Ключевые слова: *дети, заболеваемость, расстройства психики и поведения, Чернобыльская катастрофа, окружающая среда*

Abstract. Dynamics of incidence of mental and behavior disorders in children of Ukraine: a 25-years' observation experience. Volosovets O.P., Bolbot Y.K., Volosovets A.O., Trachuk L.E., Kryvopustov S.P., Beketova G.V., Kuzmenko A.Ya. *Disorders of psyche and behavior in children is an urgent problem of modern pediatric science and medical practice. The high prevalence of this pathology may be a result of the unfavorable psychological state of society, aggressive effects of the unfiltered information and negative influence of the environment (including radiatioactive factors) on the mind and body of the child. We have studied a 25-years' trends in morbidity of mental illneses and behavior disorders among children of Ukraine in order to determine the impact of environmental factors (in particular - radioactivity after Chernobyl disaster in 1986) on their development. We have performed an analysis of the incidence and prevalence of psychiatric and behavioral disorders (PBD) among children from different regions of Ukraine, including radioactive regions contaminated after Chernobyl disaster. We used methods of statistical evaluation and epidemiological analysis of statistical data about the mental health of children of the country, aquired from the Ministry of Health of Ukraine. Over the past 25 years, we have observed trend of decrease in the incidence of PBD among children of Ukraine to 3.77 cases per 1,000 children ($p<0.01$) with prevalence of this pathology among children from large industrial and agricultural regions of the country. We have connected this trend with significant toxic influence of environmental factors on the child's organism. The incidence of PBD over the last 25 years among children from the regions contaminated by the Chernobyl accident in 1986 (especially in Chernihiv and Zhytomyr regions) has exceeded the national incidence rates of PBD and its incidence among children from regions without territories of radiological control. In early 1990s the incidence of mental and behavioral disorders was high among children affected by Chornobyl accident. But over the last 25 years the incidence of PBD has become lower and now its level is even lower than among children who permanently lived in areas contaminated by radiation after the Chernobyl accident and the national incidence rate of PBD among children. The results of our 25-years' follow-up of PBD morbidity among Ukrainian children have shown that children with prolonged exposure to ecotoxic factors, including radiation, have higher levels of prevalence and incidence of mental and behavioral disorders compared with other children. All this testifies that there is a need of a proper correction programs and special attention to this cohort of children.*

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Реферат. Динамика заболеваемости детей Украины расстройствами психики и поведения: 25-летний опыт наблюдения. Волосовец А.П., Больбот Ю.К., Волосовец А.А., Трачук Л.Е., Кривопустов С.П., Бекетова Г.В., Кузьменко А.Я. *Расстройства психики и поведения у детей являются актуальной проблемой современной педиатрической науки и практики. Высокие уровни распространенности этой патологии – своеобразный маркер неблагоприятного морально-психологического состояния общества и влияния стресса в семье на неустойчивую психику ребенка. Нельзя также исключать и отрицательное влияние информационной среды, а также окружающей среды, в том числе радиационных факторов на организм ребенка. Целью исследования было изучение 25-летних трендов заболеваемости расстройствами психики и поведения детского населения страны Украины с целью определения влияния на их развитие факторов окружающей среды, в частности радиационного фактора, после аварии на ЧАЭС в 1986 году. Проведен анализ заболеваемости и распространенности расстройств психики и поведения (РПП) у детей из разных областей Украины, в том числе загрязненных в результате аварии на ЧАЭС. Применялись методы статистического оценивания, эпидемиологического анализа данных Центра медицинской статистики МЗ Украины по состоянию психического здоровья детского населения страны. Установлено, что в течение последних 25 лет наблюдалась достоверная динамика по уменьшению распространенности и заболеваемости расстройствами психики и поведения у детей Украины до 3,81 случаев на 1000 детей ($p<0,01$) с преимущественным выявлением этой патологии у детей из крупных промышленных и аграрных областей страны, где наблюдается значительное экотоксичное давление факторов внешней среды на детский организм. У детей, постоянно проживающих в областях страны, которые были загрязнены в результате аварии на ЧАЭС в 1986 году, особенно в Черниговской и Житомирской областях, показатели заболеваемости расстройствами психики и поведения в течение последних 25 лет превышали общегосударственные показатели и показатели заболеваемости РПП у детей из областей, не имевших территорий радиологического контроля. У детей, имеющих статус пострадавших вследствие аварии на ЧАЭС, показатель заболеваемости расстройствами психики и поведения был высоким в начале 90-х годов, но в течение последних 25 лет уровень заболеваемости РПП стал снижаться, и сейчас он меньше аналогичного показателя у детей, постоянно проживающих в областях страны, которые были загрязнены в результате аварии на ЧАЭС в 1986 году, и общегосударственного показателя заболеваемости детей РПП. Результаты наших 25-летних наблюдений заболеваемости детей Украины расстройствами психики и поведения свидетельствуют о том, что у детей, которые испытывают удлиненное во времени воздействие экотоксичных факторов, в том числе радиационного, наблюдаются более высокие уровни распространенности и заболеваемости расстройствами психики и поведения по сравнению с общегосударственными показателями, что требует проведения соответствующих психокоррекционных программ и особого внимания к этой категории детей.*

Mental and behavioral disorders in children are an urgent problem of modern pediatric science and practice. At least one out of five children has recurrent mental health problems. 70-75% of mental disorders begin in childhood or adolescence – depression, anxiety disorders, eating disorders, etc. [11, 13, 15]. High levels of prevalence of this pathology are a peculiar indicator of the unfavorable moral and psychological state of society with the corresponding impact on the unstable psyche of a child [9, 10].

It is also impossible to exclude the adverse and aggressive effects of the information environment and the polluted environment, especially of radiation factors, on a child's body [1].

One of the main reasons for the increase in the overall incidence of children in Ukraine, including psycho-somatic pathology, is the negative impact of ecologically polluted environment, in particular the consequences of the Chernobyl accident (hereinafter – Chernobyl) in 1986 [3, 6] .

According to the current legislation of Ukraine, psychic and behavioral disorders were included in the List of diseases and pathological conditions in children approved by the Cabinet of Ministers of Ukraine, the risk of which increases due to exposure to ionizing radiation and other harmful factors related to Chernobyl.

Therefore, the aim of the study was to assess a 25-years' trends in the incidence of mental disorders and behavior of children in Ukraine in order to determine the possible impact of adverse environmental factors, on their development including radiation after the Chernobyl in 1986.

MATERIALS AND METHODS OF RESEARCH

Dynamics of morbidity and prevalence of psychic and behavioral disorders (PBD) in children from different regions of Ukraine, including those contaminated as a result of the Chernobyl accident was analyzed. Methods of statistical assessment and epidemiological analysis of the data of the Center for Medical Statistics of the Ministry of Health of Ukraine on the state of mental health of children in the country were used [2].

Statistical evaluation methods, in particular the W-criterion of signed ranks (Wilcoxon-Mann – Whitney test) to compare the incidence of PBD in children from the same regions of Ukraine at different times and statistical analysis of data from

the Center for Medical Statistics of the Ministry of Health of Ukraine for the last 25 years were used [14]. Cluster assessment of regions of Ukraine in accordance with the levels of PBD morbidity was carried out by the method of K-means due to the ratio of levels of PBD morbidity of children to the national level and the presence of areas of radiological control appeared, in particular, due to the Chernobyl accident [12].

A separate group consisted of children born to participants of the liquidation of the Chernobyl accident and in accordance with current legislation categorized to the victims of the Chernobyl disaster.

The study was conducted in accordance with the basic provisions of the ICH GCP and the Helsinki Declaration on the Ethical Principles of Medical Research Relating to Human Subjects and its Revisions (Seoul, 2008), the Council of Europe Convention on Human Rights and Biomedicine (2007), and Recommendations of Committee on Bioethics at the Presidium of the National Academy of Medical Sciences of Ukraine (2002) and the relevant meeting of the Ethics Committee of the O.O. Bohomolets National Medical University [4, 7, 8].

RESULTS AND DISCUSSION

According to the Center for Medical Statistics of the Ministry of Health of Ukraine, the incidence of psychic and behavioral disorders in children aged 0-14 years (hereinafter – PBD) in 2017 made up 24,626 new cases or 3.81 per 1 thousand of children (of which 1 case of PBD first detected in children of the first year of life). In the list of rankings for the incidence of childhood diseases, PBD ranked 14th place out of 17.

In the age structure of incidence of PBD adolescents dominated, in whom 4382 cases of PBD were detected for the first time, or 40.6 per 1000 of corresponding population. While in children of the first six years of life the incidence of PBD was much lower – 11,920 (3.77 per 1 000 children), and among children aged 6 to 14 years – 12,706 (3.76 per 1 000 children).

In 1993, 58933 cases or 5.41 cases of PBD were detected for the first time. It should be noted that in general for 25 years the incidence rate of PBD in the country has decreased by 29.5%, but unevenly, depending on the area of residence of children. This decrease was primarily due to a decrease in the level of diagnosis of non-psychotic mental disorders in children, as well as due to the shortage of medical staff and unreasonable diagnosis of mental retardation, with increasing levels of diagnosis of psychic disorders, primarily autism spectrum disorders, this testifies to optimizing the structure of psychiatric care and improving its quality [5].

The largest number of PBD in 2017 was detected for the first time in Chernihiv region (8.76 per 1,000 children), Zhytomyr region (8.09), Kherson region (7.27), Kharkiv region (9.95), Poltava region (7.27), Odessa region (5.47), Zaporizhia region (5.23), Lviv region (4.72), Luhansk (4.65) and Donetsk (4.3) regions and Kyiv city (4.37). Of these areas, the first two – Chernihiv and Zhytomyr, are the regions closest to Chernobyl disaster with areas of radiological control (hereinafter – ARC), defined in accordance with applicable law. Other areas with a high incidence of PBD have a developed industrial and agricultural sector with a significant ecotoxic impact on the environment. The lowest incidence rates of PBD were observed in: Volyn (1.87 per 1000 children), Zakarpattia (2.15), Dnipropetrovsk (2.28) and Ivano-Frankivsk (2.54) regions. In general, only in 4 out of 9 regions with ARC the incidence of PBD was higher than the national average.

The proportion of PBD among other diseases of children is 1.46%. According to O. Tolstanov (2013), in the structure of this pathology, as in previous years, non-psychotic mental disorders and disorders of psychological development (speech, motor functions and school skills) dominated – 55.1% of children. Patients with stress-related and somatoform neurotic disorders made up 5.8%, and patients with mental disorders caused by organic brain damage – 11.7% [5].

It is alarming that in the structure of PBD alcohol-related mental disorders were found and were present in 646 children (8.52 per 1,000 of the relevant population), and mental disorders related to drug use – in 176 children (2.32 per 100,000).

It should be noted that up to 8.0% of disability associated with mental disorders account for childhood. In 2017 in Ukraine there were 23,950 (31.4 per 10,000 of relevant population) children with disabilities due to mental disorders. Over the past 10 years, the rate of primary disability due to mental disorders in children in Ukraine has increased by 16.8%. Primary disability due to mental retardation accounts for 49.9% of all primary disability due to mental and behavioral disorders in children. Disabilities due to autism spectrum disorders (ASD) have been on the rise for the past five years. Given the existing trends, it can be predicted that ASD the main will be cause of psychiatric childhood disability in Ukraine in the coming years [5].

In 1993 the following regions were among the leaders in the incidence of PBD in children: Zhytomyr (10.5 per 1000 children), Crimea (9.9), Mykolaiv (9.5), the city of Kyiv (9.48), Chernihiv (7.66), Ternopil (7.08), Sumy (6.98), Luhansk (6.6),

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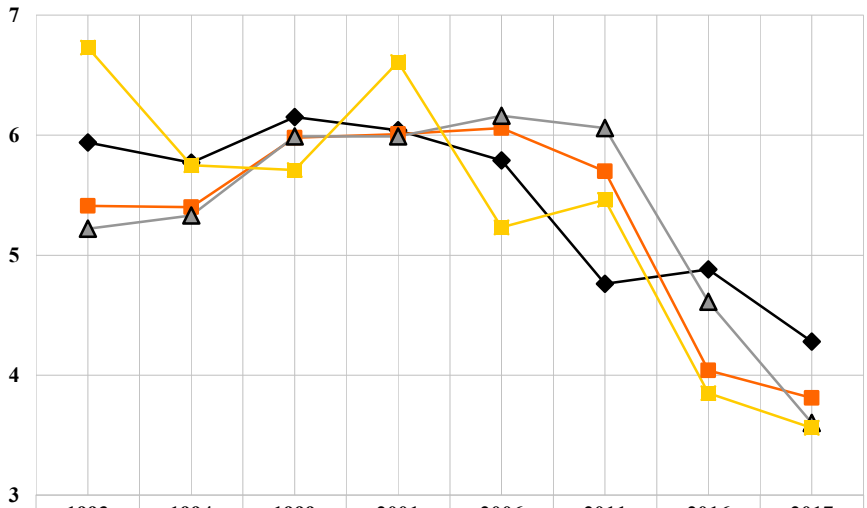
Ivano-Frankivsk (6.2), Lviv (6.3), Poltava 6.16), Kyiv (4.9).

The lowest PBD incidence rates were observed in: Volyn (2.5 per 1000 children), Zakarpattia (3.5) and Dnipropetrovsk (3.6) regions.

In 6 out of 9 regions with ARC, the incidence of PBD was higher than the average nation-wide. That is, 25 years ago numerically among the leading regions in terms of morbidity levels there were more regions with areas of radiological control. In general, the incidence of psychic and behavior disorders of children living in regions with areas of radiological control in the early 90's exceeded the nation-wide rates and incidence of PBD in children in other regions of the country, "uncontaminated" by the Chernobyl (fig.).

The prevalence of mental and behavioral disorders in children of Ukraine in 2017 was 198046 or 26.01 per 1000 children. In 1993, a total of 319781 cases of PBD were detected, or 29.36 per 1,000 children. It should be noted that for 25 years the rate of decrease in the prevalence of PBD in children of Ukraine was 11.4%.



	1993	1994	1999	2001	2006	2011	2016	2017
Children from regions with ARC	5,94	5,77	6,15	6,04	5,79	4,76	4,88	4,28
Ukraine	5,41	5,4	5,98	6,01	6,06	5,7	4,04	3,81
Children from regions without ARC	5,22	5,33	5,99	5,99	6,16	6,06	4,61	3,6
Children suffered	6,73	5,75	5,71	6,61	5,23	5,46	3,85	3,56

Comparative dynamics of incidence rates and psychic and behavior disorders in children of Ukraine suffered from Chernobyl accident, children from regions with ARC, children from regions without ARC (1993-2017)

The highest prevalence of PBD in 2017 was registered again in Zhytomyr, Chernihiv, Cherkasy regions, which are the regions with ARC.

For the first time 1,462 cases of PBD or 3.56 per 1,000 children were detected in children suffered from Chernobyl, which is less than the average incidence of PBD of children of Ukraine.

When conducting a comparative analysis of PBD prevalence in children of Ukraine in terms of data from the regions with ARC and other regions, it was found that in 4 out of 9 regions with ARC it exceeded average nation-wide.

Clustering of regions of Ukraine depending on the incidence rates of PBD and the distribution of regions is presented in the table. The low incidence of children from Volyn and Ivano-Frankivsk regions can be explained by the relatively small area of radiological control areas. Low incidence rates of

PBD in children of Zakarpattia and Chernivtsi regions require additional study in terms of detection of this pathology, staffing of children's psychiatric services and the quality of training of relevant specialists.

Clustering of regions of Ukraine by levels of psychic and behavior disorder incidence rate

Level of PBD incidence rate in children	Regions with territories of radiologic control	Regions without territories of radiologic control
Regions where PBD incidence rate of children is higher than average nation-wide	Chernihiv Zhytomyr Cherkasy	Cherson Poltava Odesa Zaporizhzhia lviv Luhansk city of Kyiv Donetsk Ternopil
Regions where PBD incidence rate of children is approximate to average nation-wide	Kyiv Sumy	Kirovohrad Mykolaiv Chmelnytsk
Regions where PBD incidence rate of children is lower than average nation-wide	Vinnytsia Rivne Volyn Ivano-Frankivsk	Charkiv Chernivtsi Dnipropetrovsk Zakarpattia

As can be seen from the figure, over the last 25 years the incidence of psychic and behavioral disorders in Ukrainian children has significantly decreased ($p<0.01$). Changes in the prevalence of PBD levels over time were unreliably. The same trend was characteristic of the incidence of psychic and behavioral disorders in children from regions with radiological control areas, which decreased by 28% and reached its peak value of 6.15 per 1000 children in 1999. The maximum decrease in the incidence of PBD by 47% was observed in children suffered from the Chernobyl accident. Its peak value of 6.61 per 1000 children was observed in 2001.

It should be noted that for more than 20 years of observation in Kherson, Donetsk and Odessa regions there was the largest increase in the incidence of children with PBD to + 31.3%, + 23.0%, + 22.6% respectively, compared with the incidence of PBD in 1993. While in Chernihiv and Zaporizhzhia regions the increase in incidence was in the range of + 13- + 14%. A negative increase in the incidence of PBD was observed in most regions of the country for the reasons mentioned above. The detection of psychic and behavioral disorders decreased the most in Kyiv (-54%), Mykolaiv (-63.3%), Ivano-Frankivsk (-59.1%), Sumy (-51.3%) and Vinnytsia (-51) 1%) regions.

The incidence of children with psychic and behavioral disorders in the areas with ARC was higher than the nation-wide by 12.3% ($p>0.05$) and the incidence of children in other areas – by 18.9% ($p>0.05$). The incidence of PBD in children suffered from Chernobyl accident was lower by 7.5% of the nation-wide incidence of this pathology and by 16.9% of incidence in children from the regions with ARC (Fig.). Apparently, the children suffered from the Chernobyl accident are most closely approximate to PBD incidence of children from areas without areas of radiological control. This indicates the leveling in time of the primary radiation exposure experienced by their parents and indirectly by their offspring.

Comparing the incidence of PBD between radiation-contaminated areas and other areas with significant development of industry and agriculture, it is necessary to draw a conclusion with the regard of prevalence of the current adverse effects of a set of social, psychological and environmental stressors, including long-term exposure of these children to radionuclides in possible genesis of psycho-somatic pathology development and, accordingly, mental and behavioral disorders. It is worth noting that the overall morbidity rate of children from the regions with ARC now also significantly exceeds the nation-wide rate [1].

The opposite picture regarding the ratio of PBD incidence rates in these contingents of children was observed in 1993, when the rates of children suffered from Chernobyl accident were by 24.3% higher than the average nation-wide and by 13.3% higher of PBD incidence rates of children from radiation-contaminated areas, which in turn exceeded

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the incidence rates of children from "conditionally clean" areas by 13.8%.

Such a difference between the incidence rates of PBD in the early 1990s in favor of the incidence rates of children suffered from Chernobyl accident and children from areas with ARC, compared to other areas, may indicate a cumulative effect of radiation exposure and chronic stress of people permanently living in regions with areas of radiological control after Chernobyl accident.

Over the 25 years of our observation, we have seen a decrease in the growth rate of PBD incidence in children in the regions with ARC and in children suffered from Chernobyl accident. Apparently, it is a consequence of the reduction in the time of chronic stress of families and the impact of the polluted environment as a result of the Chernobyl accident on the child's body.

At the same time, the prolonged impact of the environment polluted by industry and agriculture in combination with the radiation factor on the child's body has now led to a greater detection of PBD in children from regions with ARC compared to the nation-wide incidence of PBD and data from " unpolluted "areas.

CONCLUSIONS

1. Over the past 25 years, there has been a 29.5% decrease in the incidence of mental and behavioral disorders in children of Ukraine with a predominance of detection of this pathology in children from large agricultural and industrial regions of the country with significant ecotoxic pressure on children. The same negative dynamics of changes was characteristic of the prevalence of PBD in children, which decreased over time by 11.4%.
2. In children with the status of victims of the Chernobyl accident, the incidence of mental and behavioral disorders exceeded the nation-wide figures in the early 90's, but over the past 25 years the incidence of PBD in this group of children began to decline and now it is lower than the nation-wide PBD incidence rate and lower than that of children living permanently in regions that were contaminated due to Chernobyl accident of the year 1986.
3. In children living permanently in the regions of the country that were contaminated as a result of the Chernobyl accident in 1986, the incidence of mental and behavioral disorders exceeded the nation-wide figures in the early 90's and during the last 5 years, which needs appropriate correctional and developmental programs and systemic early care.

Conflict of interest. The authors declare no conflict of interest.

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