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### Оригинальные исследования

Взаимосвязь показателей костного метаболизма, фосфорно-кальциевого, липидного обмена с нарушениями метаболизма костной ткани у пациентов с хронической сердечной недостаточностью до и после трансплантации сердца  
*Суджаева О.А., Руденко Э.В., Кошлатая О.В., Спирина О.В., Рачок Л.В.* .....146

Полиморфизм M235T гена ангиотензиногена у белорусских пациентов с эссенциальной артериальной гипертензией  
*Павлова О.С., Огурцова С.Э., Ливенцева М.М., Коробко И.Ю., Мрочек А.Г.* ..... 156

Сравнительный анализ частоты сердечно-сосудистых заболеваний у детей, проживающих в районах, пострадавших от Чернобыльской катастрофы, и других экологически неблагоприятных регионов Украины (результаты 24-летнего мониторинга)  
*Волосовец А.П., Кривоустов С.П., Бекетова Г.В., Волосовец А.А., Савинова Е.Б.* ..... 169

Клиническая и диагностическая значимость уровня биомаркеров атеротромбоза и нестабильности гемостаза у пациентов с нестабильной стенокардией  
*Медведева Е.А., Гелис Л.Г., Полонецкий О.Л., Колядко М.Г., Русак Т.В.* .....178

Влияние показателей дисфункции трансплантата и уровня тревожности реципиентов трансплантата почки на риск возникновения неблагоприятных кардиоваскулярных событий в отдаленном послеоперационном периоде  
*Смолякова М.В.* ..... 196

Новые комплексные подходы к диагностике диастолической дисфункции правого желудочка  
*Жерко О.М.* .....207

Оценка состояния имплантированных стентов методом оптической когерентной томографии через 6 месяцев после имплантации в зоне реканализированных хронических окклюзий коронарных артерий  
*Стельмашок В.И.* .....217

### Обзоры и лекции

Практическое значение результатов исследования COMPASS для сосудистых хирургов  
*Хрыщанович В.Я.* .....233

Проблема кардиотоксичности при лечении пациентов с раком молочной железы  
*Ковш Е.В., Кладченко И.С., Павлова О.С.* .....245

Влияние экзаменационного стресса на развитие стресс-индуцированных заболеваний сердечно-сосудистой системы  
*Авагимян А.А., Хачатрян Р.Х., Оганов Р.Г., Саррафзадеган Н., Чернова А.А., Ивашкина М.Г., Ионов А.Ю.* ..... 253

### Случай из практики

Клинический случай дисфункции протеза митрального клапана вследствие нарушения приема антикоагулянтной терапии у пациента с ИБС высокого риска  
*Гогаева Е.К., Лазоршинцев В.В., Руденко А.В., Дзахоева Л.С., Крикунов А.А.* .....265

### Применение лекарственных средств

Сравнительная эффективность спиронолактона и эплеренона у пациентов с хронической сердечной недостаточностью  
*Нурутдинов Н.А., Хамраев А.А.* .....270

Комбинированный препарат Кратал в терапии сердечно-сосудистых заболеваний  
*Бабушкина А.В.* .....276

### Актуально

Особенности ведения пациентов с болезнями системы кровообращения во время пандемии COVID-19 .....292

**Scientific Publications. Original Researches**

Correlation of Bone Metabolism, Phosphorus-Calcium, Lipid Metabolism with Bone Metabolism Disorders in Patients with Chronic Heart Failure before and after Heart Transplantation  
*Sujayeva V., Rudenko E., Koshlataya O., Spiryna V., Rachok L.* .....146

Polymorphism M235T of the Angiotensinogen Gene in Belarusian Patients with Essential Arterial Hypertension  
*Pavlova O., Ogurtsova S., Liventseva M., Korobko I., Mrochek A.* .....156

Comparison of the Incidence of Cardiovascular Diseases in Children Living in Areas that Were Contaminated by the Chernobyl Disaster and in Other Ecologically Unfavorable Regions of Ukraine (Results of 24-Year Monitoring)  
*Volosovets O., Kryvopustov S., Beketova G., Volosovets A., Savinova K.* .....169

Clinical and Diagnostic Significance of the Level of Biomarkers of Atherothrombosis and Hemostasis Instability in Patients with Unstable Angina  
*Miadzvedzeva A., Gelis L., Polonetsky O., Kaliadka M., Rusak T.* .....178

Influence of Graft Dysfunction Markers and Anxiety Level in Renal Transplant Recipients on the Risk of Cardiovascular Events in the Distant Postoperative Period  
*Smaliakova M.* .....196

New Integrated Approaches to Diagnostics of Diastolic Right Ventricular Dysfunction  
*Zherko O.* .....207

Assessment of the State of the Implanted Stents with the Method of Optical Coherence Tomography in 6 Months after Implantation in the Area of Recanalized Chronic Occlusions of Coronary Arteries  
*Stelmashok V.* .....217

**Reviews and Lectures**

Practical Importance of COMPASS Trial Results for Vascular Surgeons  
*Khryshchanovich V.* .....233

The Problem of Cardiotoxicity in the Treatment of Patients with Breast Cancer  
*Koush E., Kladchenko I., Pavlova O.* .....245

Influence of Exam Stress on the Development of Stress-Induced Diseases of Cardiovascular System among Students  
*Avagimyan A., Khachatryan R., Oganov R., Sarrafzadegan N., Chernova A., Ivashkina M., Ionov A.* .....253

**Case from Practice**

Clinical Case of Mitral Valve Prosthesis Dysfunction Due to Impaired Anticoagulant Therapy in a Patient with High-Risk Coronary Heart Disease  
*Gogayeva O., Lazoryshynets V., Rudenko A., Dzakhoeva L., Krikunov A.* .....265

**Drugs Applying**

Comparative Efficiency of Spyronolactone and Eplerenon in Patients with Chronic Heart Failure  
*Nuritdinov N., Khamraev A.* .....270

Combined Preparation Cratal in Therapy of Cardiovascular Diseases  
*Babushkina A.* .....276

Уважаемые коллеги!

Наступление долгожданной всеми весны совпало с распространением в Беларуси коронавирусной инфекции. Пандемия охватила весь мир, ситуация усугубляется отсутствием специфических методов лечения и профилактики. Интерес медицинской общественности прикован именно к данной проблеме, что нашло отражение в огромном числе публикаций. Информация об особенностях ведения коморбидной патологии в период пандемии COVID-19 практически ежедневно обновляется. Крупнейшие кардиологические сообщества издали рекомендации, касающиеся ведения пациентов с сердечно-сосудистыми заболеваниями в период коронавирусной пандемии. Белорусское научное общество кардиологов не осталось в стороне: ведущими специалистами РНПЦ «Кардиология» подготовлен обзор международных рекомендаций по важнейшим проблемам лечения сердечно-сосудистых заболеваний при широком распространении инфекции COVID-19. В актуальном номере вы найдете особенности лечения острых и хронических коронарных синдромов, нарушений ритма и проводимости, артериальной гипертензии, венозных тромбозов, пациентов после трансплантации сердца, получающих иммуносупрессивную терапию, а также некоторые вопросы взаимодействия основных кардиологических лекарственных средств и препаратов, используемых для лечения коронавирусной инфекции.

Самым остро дискутируемым вопросом, вызывающим интерес не только у врачей-кардиологов, является возможность использования препаратов, влияющих на ренин-ангиотензиновую систему – ингибиторов ангиотензинпревращающего фермента и блокаторов рецепторов ангиотензина II. В доступных информационных ресурсах огромное количество противоречивой информации по данному вопросу, в которой достаточно тяжело ориентироваться. В связи с этим хотелось бы подчеркнуть, что убедительных доказательств относительно вреда данной терапии в период пандемии COVID-19 нет. Согласительное мнение европейского, американского, канадского и российского кардиологических сообществ говорит о необходимости продолжения терапии ингибиторами ангиотензинпревращающего фермента или блокаторами рецепторов ангиотензина II у пациентов, имеющих показания для их назначения (артериальная гипертензия, ИБС, сердечная недостаточность). Если у пациентов диагностируется инфицирование коронавирусом, решение о продолжении терапии принимается индивидуально, исходя из клинического состояния и стабильности гемодинамики.

Помимо информации, касающейся пандемии, в настоящем номере, как всегда, вы найдете обзоры литературы и результаты оригинальных исследований по вопросам кардиологии, кардиохирургии и сосудистой хирургии.

Редколлегия журнала «Кардиология в Беларуси» желает всем крепкого здоровья и выражает надежду, что представленная в номере информация окажется полезной как с научной, так и с практической стороны.

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## Comparison of the Incidence of Cardiovascular Diseases in Children Living in Areas that Were Contaminated by the Chernobyl Disaster and in Other Ecologically Unfavorable Regions of Ukraine (Results of 24-Year Monitoring)

Сравнительный анализ частоты сердечно-сосудистых заболеваний у детей, проживающих в районах, пострадавших от Чернобыльской катастрофы, и других экологически неблагоприятных регионах Украины (результаты 24-летнего мониторинга)

### Abstract

**Introduction.** Ecotoxic factors, particularly emerging from the Chernobyl Nuclear Power Plant (CNPP) accident in 1986 as well as some others, play a significant role in the increasing prevalence of circulatory system diseases in children from environmentally compromised areas in Ukraine.

**Purpose.** Comparative assessment of the incidence and prevalence of circulatory system diseases in children living in regions with territories of radioecological control (TRC) after the Chernobyl accident and in unpolluted areas over the past 24 years in order to identify trends in their health status and to verify the appropriate preventive measures.

**Materials and methods.** In order to assess the dynamics of changes in the incidence and prevalence of circulatory system diseases (CSD) in children from different regions of Ukraine, there was performed statistical analysis based on comprehensive data analysis provided by the Health Statistics Center of the Ministry of Health of Ukraine.

**Results and discussion.** In the last 24 years, the incidence of CDS in Ukrainian children has increased by 65.6% thereby exceeding the growth rate of the overall morbidity of the pediatric population of Ukraine by 2.17 times. The increased incidence of cardiac pathology was mostly observed in children living in radiologically contaminated areas caused by the Chernobyl accident in 1986. In the controlled regions, there were high incidence rates of CDS in children, including nonrheumatic heart, vascular diseases, essential hypertension that were 30.8% higher than in the state and 47.9% higher than in the areas without radioecological control. In children born to parents, who were the victims of the Chernobyl accident or participants of the elimination of its

consequences, the incidence and prevalence rates of CDS also exceeded the corresponding rates in children nationwide.

**Conclusions.** In contrast to previous concepts, the cardiovascular system of children living in the territories contaminated by the Chernobyl disaster proved to be sensitive to the complex and prolonged negative effects of the environmental ecotoxic factors, such as radiation.

**Keywords:** children, circulatory system diseases, morbidity, prevalence, medical consequences of the Chernobyl catastrophe.

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### Резюме

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**Введение.** Экотоксичные факторы, в частности возникшие в результате аварии на Чернобыльской атомной электростанции (ЧАЭС) в 1986 году и другие, вносят весомый вклад в увеличение распространенности болезней системы кровообращения у детей из экологически неблагополучных зон Украины.

**Цель.** Сравнительная оценка заболеваемости и распространенности заболеваний системы кровообращения у детей, которые проживают на территориях радиологического контроля после Чернобыльской катастрофы, и из незагрязненных областей за последние 24 года для установления тенденций в их состоянии здоровья и обоснования соответствующих превентивных мероприятий.

**Материалы и методы.** Для оценки динамики изменений заболеваемости и распространенности болезней системы кровообращения (БСК) у детей из разных областей Украины использовались статистические методы на базе комплексного анализа данных Центра медицинской статистики МЗ Украины.

**Результаты и обсуждение.** Заболеваемость детей БСК в Украине за последние 24 года увеличилась на 65,6% и превышала в 2,17 раза показатель темпа возрастания общей заболеваемости детского населения страны. Преимущественно увеличение кардиологической патологии наблюдалось у детей, которые проживают в областях, загрязненных в результате аварии на ЧАЭС в 1986 году. В контролируемых регионах наблюдались высокие уровни заболеваемости детей БСК: неревматическими поражениями сердца и сосудов, эссенциальной гипертензией, частота которой была на 30,8% выше, чем в стране, и на 47,9% – в областях без территорий радиэкологического контроля. У детей, которые родились от потерпевших в результате аварии на ЧАЭС и участников ликвидации ее последствий, показатели заболеваемости и распространенности заболеваний системы кровообращения также превышали указанные показатели у детей в целом.

**Выводы.** В отличие от предыдущих представлений сердечно-сосудистая система детей, которые проживают на территориях, загрязненных в результате аварии на ЧАЭС, оказалась чувствительной к комплексному и продолжительному негативному влиянию экотоксичных факторов окружающей среды, в частности радиационного.

**Ключевые слова:** дети, болезни системы кровообращения, заболеваемость, распространенность, медицинские последствия Чернобыльской катастрофы.

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## ■ INTRODUCTION

One of the most dangerous trends of recent decades is the negative impact of the polluted environment, resulting from human activity on a child's organism. Due to environmental pollution, up to 3 million children die every year in the world [1].



It is well known that anthropogenic and technogenic loads on the environment in Ukraine are several times higher than in the developed countries of the world. That is why, at the Conference of European Environment Ministers, held in Budapest in 2004 under the auspices of the World Health Organization, Ukraine was mentioned among the countries with environmental depopulation.

Ukraine has not been an exception to global trends in the spread of non-communicable diseases among adults and children, including, above all, circulatory system diseases (CSD), neoplasms, diabetes mellitus, and chronic obstructive pulmonary pathology.

According to Academician Y.G. Antipkin, at the present time, special attention should be paid to the health problems of children and adolescents living in the regions of Ukraine contaminated by the Chernobyl nuclear power plant accident in 1986. It is also necessary to conduct long-term studies in order to assess the health status of children born to victims and participants of elimination of the consequences of the Chernobyl disaster [2, 4, 8].

A well-known Ukrainian researcher of the health status of children affected by the consequences of the Chernobyl accident, Professor E.I. Stepanova believes that there is no evidence of new disease manifestations in children from the controlled territories. There is an increase in the morbidity rates and prevalence of already known diseases in these children, due to the long-lasting impact of medium and long term decay radionuclides on the background of the long-term negative influence of an unstable socio-economic situation [5].

In the large-scale study conducted by the O.O. Bogomolets National Medical University (Kyiv, Ukraine), the P.L. Shupyk National Medical Academy of Postgraduate Education (Kyiv, Ukraine) together with State Institution "Institute of Pediatrics, Obstetrics, and Gynecology named after acad. O.M. Lukyanova of the NAMS of Ukraine" (Kyiv, Ukraine), and other medical universities and academies of the country it was proved that only in the last 22 years in Ukraine the child morbidity increased by 36%, the prevalence – by 41%, and CSD – by 116.3% [6, 7].

The assessment of radiation risk in children living in contaminated territories revealed that 92.8% of radiation effects could be related to thyroid gland irradiation capacity; 4.8% – to external gamma irradiation; 2.3% – to internal radiation due to  $^{137}\text{Cs}$  and 0.1% – due to  $^{90}\text{Sr}$  [2, 3]. Thus, in our study back in 1998, it was found that the total contribution of these factors to the development of secondary cardiomyopathy in children evacuated from Pripjat was 15.46%.

In the study of Professor Y.I. Bandazhevsky (Belarus) and G.V. Beketova (Ukraine) it was shown that the accumulation of one of the major gamma-ray emitters,  $\text{Cz-137}$  radionuclide, in myocardial tissue, which is competing and replacing potassium, leads to the effect of "energy starvation" in cardiomyocytes [9].

## ■ PURPOSE OF THE STUDY

Comparative assessment of the incidence and prevalence of circulatory system diseases in children living in territories with radiological control (TRC) after the Chernobyl disaster and in unpolluted areas over the past 24 years



in order to identify changes in their health status and to verify appropriate preventive measures.

## ■ MATERIALS AND METHODS

Methods of statistical evaluation and epidemiological analysis were used, based on the materials of the Center of Medical Statistics of the Ministry of Health of Ukraine for the last 24 years. The incidence and prevalence of circulatory system diseases in children living in 9 regions of Ukraine (Vinnytsia, Volyn, Ivano-Frankivsk, Kyiv, Rivne, Sumy, Chernihiv, and Cherkasy, which were determined as radio-ecologically controlled territories, according to the legislation of Ukraine) were evaluated and compared to radiologically uncontaminated areas.

## ■ RESULTS AND DISCUSSION

In the past 24 years, the incidence of CSD among Ukrainian children increased by 65.6%, both inside and outside the areas of radioecological control (Table 1). At the same time, the prevalence of the circulatory system diseases (CSD) in children during this period increased by 116.3%. It should be noted that the rate of increase in the incidence of CSD exceeded 2.17 times the overall morbidity rate of children in Ukraine. Furthermore, despite the fact that in the overall structure of the child morbidity in Ukraine, circulatory system diseases make up only 2.01%, in the last 24 years, CSD has been ranked 5th among other childhood diseases in growth rate and 3rd in prevalence.

This is primarily due to the increase in the detection of non-rheumatic heart lesions in children, namely vegetative dysfunctions, primary and secondary cardiomyopathies, non-rheumatic valve lesions (6.93 per 1000 children), arrhythmias, essential hypertension (0.36 per 100 children). At the same time, the incidence of acute rheumatic fever and chronic rheumatic disease has decreased to a minimum over the years, namely 1 case per 100 000 children.

Child mortality from CSD in 2017 was 0.14 per 10,000 children. The highest rates of child mortality due to circulatory diseases were observed in the regions having radiological control territories that emerged from the Chernobyl accident: Zhytomyr, Rivne, Chernihiv, Ivano-Frankivsk, Vinnytsia, Volyn, and Kiev regions. High levels of infant mortality from diseases of the circulatory system in the Transcarpathian, Luhansk and Kirovograd regions were isolated from unpolluted areas.

The main causes of death of children from CSD were: primary cardiomyopathies, endocardial fibroelastosis, acute disorders of the cerebral circulation, which are most often manifested in the form of hemorrhagic and ischemic strokes against the background of abnormal development of cerebral vessels, non-rheumatic carditis, malignant arrhythmias and other causes.

Comparative analysis of the incidence rates of circulatory system diseases in Ukrainian children residing in TRCs and other regions showed that in 2017 in 5 out of 9 regions with TRC it exceeded the national incidence rate (Table). In Sumy, Kyiv, Chernihiv and Volyn regions, the corresponding rates were slightly lower than the national rate. However, in 1994, the incidence of CSD in children from the regions with TRC was higher than the

**Incidence of the circulatory system diseases in Ukrainian children in 1994 and 2017 in different regions, ranked in decreasing order according to indices recorded in 1994 (data of the Health Statistics Center of the Ministry of Health of Ukraine, 2017)**

Name	Child morbidity in 1994 *		Child morbidity in 2017		Rate of change of the indices (in %) from 1994 to 2017
	Absolute numbers	Per 1000 children	Absolute numbers	Per 1000 children	
Ukraine	46893.0	4.4	55458	7.29	+65.6%
Rivne reg.**	4885.0	16.7	3711.0	13.33	-20.2%
Zhytomyr reg.**	3220.0	10.2	2637.0	10.91	+08.01%
Chernihiv reg.*	2103.0	8.2	1096.0	6.66	-18.8%
Cherkasy reg.**	2353.0	7.8	2033.0	10.01	+28.3%
Sumy reg.**	1835.0	6.6	1227.0	7.07	+07.1%
Zakarpattia reg.	1819.0	5.6	1334.0	4.56	-18.6%
Volyn reg.**	1358.0	5.3	1159.0	4.84	-08.7%
Kirovohrad reg.	1330.0	5.3	759.0	4.45	-16.1%
Mykolaiv reg.	1526.0	5.1	2156.0	10.34	+101.9%
Vinnytsia reg.**	1874.0	5.0	2145.0	7.37	+47.4%
Zaporizhzhia reg.	2089.0	4.9	2265.0	7.69	+56.9%
Kyiv reg.**	1932.0	4.8	2189.0	6.66	+38.7%
Poltava reg.	1524.0	4.5	2306.0	9.83	+118.4%
Dnipropetrovsk reg.	3313.0	4.2	4631.0	8.05	+91.7%
Khmelnyskyi reg.	1216.0	3.9	1822.0	7.64	+95.6%
Kharkiv reg.	2273.0	3.8	6913.0	16.20	+326.3%
Chernivtsi reg.	758.0	3.5	1324.0	7.17	+104.9%
Ivano-Frankivsk reg.**	1121.0	3.3	3242.0	11.62	+252.2%
Ternopil reg.	843.0	3.3	1641.0	8.22	+149.1%
Luhansk reg.	1681.0	2.9	1216.0	11.20	+286.2%
Kyiv city	1418.0	2.7	2545.0	4.84	+79.2%
Donetsk reg.	2538.0	2.5	2463.0	8.02	+220.8%
Odesa reg.	1224.0	2.3	2397.0	10.22	+344.3%
AR of Crimea*	1097.0	2.3	0	0	0
Lviv reg.	1262.0	2.1	1449.0	2.99	+42.3%
Sevastopol city*	146.0	1.8	0	0	0
Kherson reg.	251.0	0.9	798.0	4.03	+347.7%

Notes: \* information is missing, \*\* territories with radioecological control.

analogous national incidence rate in 8 out of 9 cases. Moreover, in terms of the incidence of CSD in children, Rivne, Zhytomyr, Chernihiv, Cherkasy and Sumy regions occupied the first place in the country. And, in 1994, the top ten regions with increased incidence rates of CSD included 7 regions with TRC. Nowadays, Rivne, Cherkasy, Ivano-Frankivsk and Vinnytsia admirative districts remain leaders among all others.

In general, the highest incidence rates of CSD were observed in Kharkiv (16.20 per 1 thousand child population), Rivne (13.33), Ivano-Frankivsk (11.62), Lugansk (11.2), Zhytomyr (10.91), Mykolaiv (10.34), Cherkasy (10.11), Poltava (9.83) regions. It should be noted that among the top-ten regions with a high incidence of CSD in children, in 4 regions with TRC, these numbers exceeded the national indices. In Sumy, Kyiv, Chernihiv and Volyn regions,

with TRC, the incidence rate of CSD in children was lower than the national incidence rate. The leaders in the incidence of circulatory system diseases in children were also Kharkiv, Lugansk and Mykolaiv regions, which are large agro-industrial regions and, accordingly, had polluted environment.

It is significant that the morbidity rates in children from Ivano-Frankivsk, Zhytomyr and Cherkasy regions exceed those of children from Luhansk, Mykolaiv, Poltava, Dnipropetrovsk, Donetsk and Zaporizhzhia regions, which always had polluted environment.

The main environmental problems of recent years are an excessive technogenic load on natural systems, the formation, and accumulation of industrial and household waste, large areas of destroyed lands and significant pollution of air and water basins as well as soils (more than 20% of the total volume in Ukraine). All these in the complex cannot but affect the functional activity of the cardiovascular system in children from the aforementioned regions, resulting in the highest incidence rates of CSD in the country together with radio-ecologically controlled areas due to the Chernobyl disaster.

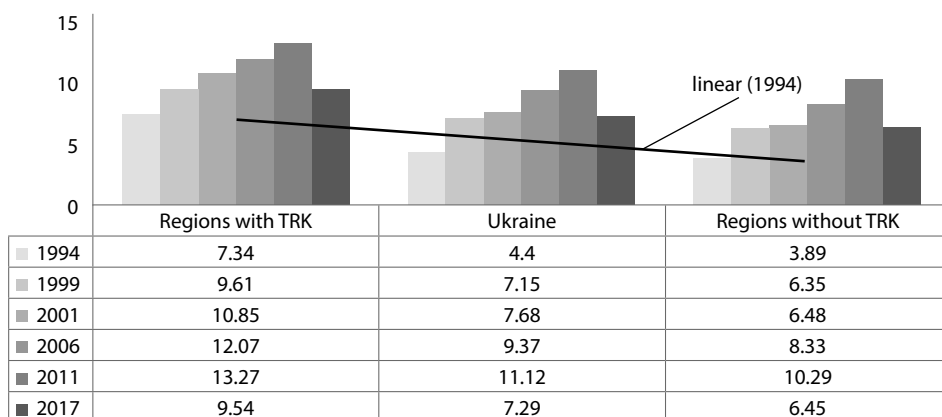
According to the Health Statistics Center of the Ministry of Health of Ukraine (2017), the incidence of CSD in 2017 was 55 458 new cases or 7.29 per 1 thousand children. At the same time, more than 2.2 thousand cases of CSD were registered in children of the first year of life. The prevalence of CSD among children of 0–17 years in 2017 amounted to 247.9 thousand cases or in other words 32.56 per 10 thousand children.

According to the State Register of Ukraine, in 2017, there were 369 896 children born to persons who were victims of the Chernobyl accident and to participants of its liquidation. Among the child population that was directly or indirectly affected by the accident, the percentage of children that were recognized as sick was 74.7%. The lowest percentage of healthy children in this category was observed in Chernihiv and Rivne regions. In 2017, 4050 of such children got sick with circulatory system diseases for the first time, and the relative incidence rate per 1,000 children was estimated as 10.91 (in 2015, 11.54), which exceeded both the national rate and similar rates in children permanently residing in regions with TRC.

The prevalence of CSD in registered children was 64.88 (in 2015 – 60.51) per 1,000 children or 24,000 reported cases, which was almost double as compared to the overall national rate and revealed a need to consider parental exposure as a risk factor for the development of cardiovascular pathology in their offspring.

As can be seen from Figure in 2017, the incidence rates of circulatory system diseases among children from the regions with TRC exceeded the corresponding national incidence rate by 30.8% and incidence rates of CSD in children from other regions – by 47.9%.

Approximately the same was the dynamics of the incidence of nervous system disorders in children, which were closely related to the heart and cardiocerebrovascular system disorders, and to this day were considered radioresistant. The highest morbidity rates were observed in children from the regions with TRC, which exceeded national indices among the child population and were attributed to the diseases of the endocrine system and blood, digestive organs and neoplasms, thus, indicating their high dependence on the complex influence of ecotoxic factors.



**Comparative dynamics of changes in the incidence of cardiocirculatory diseases of pediatric population from 1994 to 2017 in regions with territories of radioecological control (TRC) and without TRC per 1000 children**

High variations between in the incidence rates of the circulatory system diseases in children from regions with TRC as compared to other areas were observed in 1994, they were higher (by 88.7%) as compared to other regions and to corresponding national incidence rate (by 66.8%) during the same time period.

That is, in the last 24 years the difference between child morbidity in the regions with the TRC and other regions decreased by 40.8%, and by 36.0% as compared to the corresponding indices nationwide.

It is important to mention that in the last 24 years there was a general trend that the incidence of CSD in children from the regions with TRC has always exceeded the relevant indices nationwide and incidence rates in other regions (Figure).

In general, in the last 24 years, the increase of the incidence rate of circulatory system diseases in children from the regions with TRC was 29.9%, and was lower than in non-TRC regions (65.8%), and nationwide (65.6%) (Figure).

It is noteworthy that the rates of CSD in children from other areas are rapidly approaching the incidence rates among children in areas with TRC. It should be noted as well that the determined dynamics correspond to the increasing ecotoxic pressure of the environment on the child organism across the country. This dangerous trend will likely continue in the future.

At present, there is an increase in the incidence of neoplasms and respiratory diseases among the pediatric population, and mainly among children from the TRC regions. The highest incidence rates of CSD in children from all the studied territories, as can be seen from Figure, was observed in 2011, however, in the regions with TRC, the incidence rates of CSD in children still remain high, and exceed the corresponding indices nationwide and in other regions.

Apparently, there is a clear time-dependent negative shift in the environment in the regions with TRC and other regions of Ukraine with

an increase in the incidence of CSD among the child population, while a certain convergence of these indicators among children from different regions can be also detected. This data indicate the accumulation of chronic pathology in Ukrainian children on the background of complex negative impact of radiation on the child's organism, together with other factors of a polluted environment, such as heavy metals (primarily cadmium and lead), electromagnetic radiation, pesticides, hydrogen sulfide, carbon dioxide, nitrogen dioxide, etc.

This issue requires the attention of health professionals and the continued long-term monitoring of the health of children living in a polluted environment, in order to develop the necessary therapeutic and diagnostic and preventive measures to strengthen the child's organism to counteract the adverse effects of 1986.

## ■ CONCLUSIONS

1. The incidence of circulatory system diseases in Ukrainian children has increased by 65.6% over the last 24 years, particularly in the areas with radiological control.
2. The incidence of diseases of the circulatory system in children from regions without territories of radiological control amounted to +65.8% and more than doubled the growth rate in the regions having radiological control territories of the regions, amounting to 29.9%. This indicates that the disease incidence of circulatory system in children in Ukraine is affected by a number of socio-economic and other adverse factors, especially environmental ones. After all, the largest increase was observed in the regions of the country, which have strong industrial and agro-industrial potential and have polluted the environment due to the large amount of xenobiotics emissions into the environment.
3. Comprehensive analysis of the health status of children of 9 regions with radioecological control, showed a high incidence of circulatory system diseases (non-rheumatic heart lesions, vegetative dysfunctions, essential hypertension, and chronic rheumatic diseases) which maintained over the last 24 years. These indices exceed the corresponding numbers nationwide by 30.8% and by 47.98% the incidence rates of CSD in the pediatric population from unpolluted areas.
4. In children born to persons affected by the Chernobyl accident and participants in the elimination of its consequences, data on the incidence and prevalence of circulatory system diseases exceed the corresponding indices among children of the country, regardless of the place of residence, which indicates the need to consider parental exposure as a risk factor for cardiovascular pathology in their offspring.
5. In contrast to previous ideas, the cardiovascular system of children living in the territories contaminated by the Chernobyl disaster appeared to be susceptible to the complex and prolonged negative effects of ecotoxic environmental factors, including radiation. In our opinion, this fact should be taken into account in the development and implementation of therapeutic and preventive measures.

**The authors declare no conflict of interests.**



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