

ADAPTATION CAPABILITIES OF THE CARDIOVASCULAR SYSTEM OF SCHOOLCHILDREN LIVING NEAR THE CHERNOBYL EXCLUSION ZONE

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The remote humanitarian consequences of the accident at the Chernobyl nuclear power plant in 1986 are of great scientific and practical interest. More than 30 years after this tragedy, in the affected areas, soils and trees growing on them contain significant amounts of radioactive elements, including ¹³⁷Cs, ⁹⁰Sr, ²⁴¹Am [1, p. 10, 16].

Thus, the local population is under constant radiation exposure associated with the penetration of radionuclides into the body. At the same time, vital organs, including the heart and brain, are exposed to the incorporation of radiation agents [2, p. 489]. Under these conditions, it is important to determine the state of the adaptive capabilities of the body's integrative systems, which primarily include the cardiovascular system.

During the implementation in 2015-2022 in Ukraine of the European Commission project «Health and Ecological Programmes around the Chernobyl Exclusion Zone: Development, training and coordination of health-related projects», the adaptive capabilities of the cardiovascular system of 1139 schoolchildren were assessed (579 boys and 560 girls) aged 6-17 years, from rural settlements of Ivankovsky and Polessky districts of the Kyiv region, bordering the Chernobyl Exclusion Zone.

With the consent of the parents, an assessment of the physical development of children was carried out using anthropometric measurement methods unified in Ukraine [3, p. 21–23], while the specific activity of ¹³⁷Cs in their body was recorded.

The Rohrer's index (IR) was used as a criterion for assessing the state of the physical development and the child's metabolism, the value of which allows us to assess the degree of correspondence between a person's weight and his height.

In accordance with the values of IR in the group of schoolchildren, three subgroups were distinguished: "1" – disharmonious (low) physical development, IR index < 10.7 kg/m³; "2" – harmonious physical development, index IR in the range ≤ 13.7 and ≥ 10.7 kg/m³; "3" – disharmonious (high) physical development, IR > 13.7 kg/m³ [3, p. 23].

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To determine the level of adaptive reserves and the functional performance of the cardiovascular system, the Ruffier test was carried out in its classic version using the hardware-software complex «Origins of Health». At the same time, the calculation of the Ruffier's index and its evaluation were performed automatically. The scale for assessing the level of the functional reserve of the cardiovascular system included 5 gradations: < 3.0 – high level, 3.0 – 6.0 – above average, 7.0 – 9.0 – average, 10.0 – 14.0 – below average, ≥ 15.0 – low [4, p. 92, 93].

The adaptive potential (AP) of the circulatory system in schoolchildren was determined by the formula of R. M. Baevsky (1979). The state of AP (conventional units) was assessed on a scale modified by L. V. Kvashnina for children aged 6-17 years, taking into account gender [5, p. 5, 6].

Measurement of the specific activity of ^{137}Cs in the body of children was carried out for 10 minutes using a three-detector human gamma-ray spectrometer (SICH-AKP-3), manufactured by RPE «ATOM KOMPLEX PRYLAD» (Ukraine).

Statistical processing of the material was carried out using the IBM SPSS Statistics 22 package (USA). Statistical analysis included descriptive statistics, correlation and comparative analyses.

The conducted studies revealed that the majority of children had harmonious physical development (70.50 %), the proportion of children with disharmonious low physical development was 9.22 %, the proportion of children with disharmonious high physical development was 20.28 %. At the same time, the proportion of girls with disharmonious high physical development was significantly higher than boys, 23.39 % versus 17.27 % ($t = 2.57$; $p = 0.010795$).

At the same time, the adaptive capabilities of most children were reduced, as evidenced by the results of the evaluation of the Ruffier and AP tests.

Only 9.4 % of children in the general group, 12.44 % in the boys group and 6.25 % in the girls group had a functional reserve of the cardiovascular system above the average ($I_{\text{Ruffier}} \leq 6.0$).

The functional reserve of the cardiovascular system below the average level ($I_{\text{Ruffier}} = 10.0-14.0$) was observed in the general group in 40.30 % of cases, in the group of boys – in 42.49 % of cases, in the group of girls – in 38.94 % of cases. A low level of the functional reserve of the cardiovascular system ($I_{\text{Ruffier}} \geq 15.0$) was determined in the general group in 31.34 % of cases, in the group of boys – in 22.63 % of cases, in the group of girls – in 40.36 % of cases.

Satisfactory adaptive potential (AP) was determined in the general group in 6.41 % of cases, in the group of boys – in 7.08 % of cases, in the group of girls – in 5.71 % of cases.

Tension of adaptation was recorded in the general group in 42.49 % of cases, in the group of boys – in 44.91 % of cases, in the group of girls – in 40.00 % of cases.

Unsatisfactory adaptation was detected in the general group in 33.71 % of cases, in the group of boys – in 34.89 % of cases, in the group of girls – in 32.50 % of cases.

Disruption of adaptation mechanisms was observed in the general group of children in 17.38 % of cases, in the group of boys – in 13.13 % of cases, in the group of girls – in 21.79 % of cases.

Most often, cases of violation of adaptive capabilities were recorded in subgroups of disharmonic high physical development ($IR > 13.7$). At the same time, 38.96 % of children (31.00 % of boys and 45.04 % of girls) had a low level of functional reserve of the cardiovascular system, and 36.80 % of children (33.00 % of boys and 39.70 % of girls) the failure of adaptation mechanisms was stated.

Thus, in the majority of children permanently residing in areas located near the Chernobyl nuclear power plant, reduced adaptive capabilities of the cardiovascular system were recorded. Among the reasons for this phenomenon, first of all, it should be noted the environmental factor, which includes both long-lived radioactive elements, primarily ^{137}Cs and ^{90}Sr , and their decay products, in particular Ba. In addition, social and economic factors should be taken into account.

Attention is drawn to the subgroup of children, primarily girls, with disharmonious high physical development, in which a direct correlation has been established between IR and the Ruffier's index, IR and AP, which indicates the dependence of the occurrence of violations of the adaptive mechanisms of the cardiovascular system on the child's body weight.

At the same time, the specific activity of ^{137}Cs in the body of these children was statistically less than in the body of children with harmonious physical development and disharmonious low physical development.

In the group of girls with disharmonious high physical development, the proportion of cases of homozygous variants of the neutral allele C of the MTHFR:677 polymorphism was significantly more compared to the group of girls with harmonious physical development [6, p. 42].

This genotype has a positive effect on the activity of methylenetetrahydrofolate reductase, which provides the body with the active form of vitamin B₉ – methyltetrahydrofolate.

Thus, the problem of the adaptive capacity of the cardiovascular system in this subgroup of children may be associated, to a greater extent, with overweight.

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