

ГОМОЦИСТЕЇН, ГОРМОНИ ГІПОФІЗА ТА ЩИТОПОДІБНОЇ ЗАЛОЗИ У ДІТЕЙ З РІЗНИМ РІВНЕМ ФІЗИЧНОГО РОЗВИТКУ ПІСЛЯ ЛІСОВИХ ПОЖЕЖ У ЧОРНОБИЛЬСЬКІЙ ЗОНІ ВІДЧУЖЕННЯ

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HOMOCYSTEINE, PITUITARY AND THYROID HORMONES IN CHILDREN WITH DIFFERENT PHYSICAL GROWTH LEVELS AFTER FOREST FIRES I N THE CHORNOBYL EXCLUSION ZONE

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uring the implementation of projects of the European Commission and Regional Council of Rhône-Alpes (France) in 2013-2017 in Ukraine, the majority of the examined adolescent children living in settlements of Kyiv region near the Chernobyl exclusion zone (ChEZ) were found to have increased blood levels of homocysteine – a metabolic product of the essential amino acid methionine [1].

It is necessary to look for reasons for this phenomenon, since hyperhomocysteinemia in the adult population is associated with the development of a number of serious diseases [2, 3]. In this regard, attention should be paid to fires of forests, which occupy 62.8% of the territory of the ChEZ.

At the same time, a huge amount of wood combustion

lived radionuclides are released into the environment [4, 5].

Considering that the number of forest fires in the ChEZ has increased significantly in recent years, one can assume their negative impact on processes of metabolism, including that of amino acids methionine and homocysteine in children and adults.

In this regard, one of the important sources of information may be the results of laboratory examination of children with different physical growth levels living near the ChEZ.

The purpose of this paper is a comparative assessment of blood levels of homocysteine, pituitary and thyroid hormones in children with different levels of physical growth before and after forest fires in the ChEZ in 2015.

Material and methods. The research was carried out as

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Мета дослідження: порівняльна оцінка рівня гомоцистеїну, гормонів гіпофіза і щитоподібної залози у крові дітей з різними рівнями фізичного розвитку до і після лісових пожеж у Чорнобильській зоні відчуження (ЧЗВ) у 2015 році.

Методи дослідження: імунохімічний, інструментальний, математико-статистичний.

Результати. Аналіз динаміки показників проведено у 336 підлітків Поліського та

Іванківського районів Київської області. Виявлено зв'язок між гомоцистеїном (H_{cy}), гормонами гіпофізарно-тиреоїдної осі і фізичним розвитком дітей. У підлітків Іванківського району встановлено достовірно більш високий рівень H_{cy} порівняно з дітьми із Поліського району. Основною причиною підвищення H_{cy} у крові підлітків слід вважати лісові пожежі навесні та влітку 2015 року у ЧЗВ. Підвищений рівень T_3 у периферичних тканинах, індукований H_{cy} і ТТГ, сприяв зменшенню значень індексу фізичного розвитку. У групі дітей дисгармонійно та високого фізичного розвитку реєструвалася недостатнє утворення T_3 у периферичних тканинах у зв'язку зі зниженням інтенсивності процесу дейодування T_4 .

Ключові слова: гомоцистеїн, гормони гіпофіза і щитоподібної залози, фізичний розвиток, підлітки, лісові пожежі, Чорнобильська зона відчуження.

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projects of the European Commission «Health and Ecological Programmes around the Chernobyl Exclusion Zone: Development, training and coordination of health-related projects» and the Regional Council of the Rhône-Alpes region (France) in Ukraine. 158 children from Poliskyi district and 178 children from Ivankivskiyi district of Kyiv region underwent laboratory and instrumen-

tal examination. The territories of these districts have remained radioactively contaminated many years after the accident at the Chernobyl nuclear power plant in 1986 (a ^{137}Cs soil contamination density is 0.17-1.9 Ci/sq.km) [6]. The research carried out within the framework of the European Union project in 2014 confirmed the high density of contamination of the territory of

Ivankivskiyi district with ^{137}Cs and ^{90}Sr radionuclides [4].

All the children who attended school had blood drawn from the ulnar vein after fasting in the morning. Blood was drawn in the children from Poliskyi district on 02.04.2015, and in children from Ivankivskiyi on 18.12.2015. At the time of examination, the average age of the children from Poliskyi district was (14.8 ± 0.1) years old (95% CI 14.7-15.0 years old), and that of the children from Ivankivskiyi district was (13.6 ± 0.1) years old (95% CI 13.4-13.8 years old).

The blood samples were analysed at a laboratory certified under quality standards and we received consent of the parents to do those blood tests. Thus, we assessed blood levels of pituitary thyroid-stimulating hormone (TSH), free triiodothyronine (T_3), free thyroxine (T_4), homocysteine (H_{cy}) and determined the T_3/T_4 index.

TSH, T_3 and T_4 were determined using an electrochemiluminescent immunoassay (ECLIA) method. Analyzer and test kit: Cobas 6000; Roche Diagnostics (Switzerland).

Plasma H_{cy} was measured using a chemiluminescent immunoassay (CLIA) method. Analyzer and test kit: Architect 1000 (ABBOT Diagnostics (USA)). Plasma homocysteine levels in the children of over $10 \mu\text{mol/L}$ were defined as hyperhomocysteinemia.

Physical growth (PG) in children was assessed with the help of anthropometric measuring techniques standardized in Ukraine [7] in compliance with the rules of bioethics and with the signature of protocols of informed parental consent for each subject.

The Rohrer's weight/height index (RI) independent of age and sex, the quotient obtained when weight in kilograms is divided by the cubic of height in meters, was chosen as a criterion for assessment of PG and metabolism in a child [8, 9].

RI allows to assess the degree of conformity of one's weight to height. Normal PG is defined at RI range of 10.7 to

Table 1
Number of children from Poliskyi and Ivankivskiyi districts in physical growth groups

District	Total number of children	Group 1		Group 2		Group 3	
		Abs.	%	Abs.	%	Abs.	%
Poliskyi	158	17	10.76	103	65.19	38	24.05
Ivankivskiyi	178	19	10.67	127	71.35	32	17.98

Table 2
Statistical variables in children from Poliskyi district with different physical growth levels

Variables	Group 1		Group 2		Group 3	
	Me	IQR	Me	IQR	Me	IQR
H_{cy}	10.14	7.92-13.30	10.16	8.67-13.23	10.26	8.46-12.62
TSH	2.08	1.57-2.84	1.79	1.36-2.39	1.92	1.37-2.59
T_3	4.52	3.94-4.80	4.14	3.80-4.60	3.99	3.68-4.461
T_4	1.21	1.12-1.28	1.18	1.09-1.29	1.13	1.03-1.28
T_3/T_4	3.67	3.25-4.37	3.51	3.12-4.06	3.50	3.03-3.95

Note: 1 – Statistical differences in T_3 values between groups 1 (RI < 10.7) and 3 (RI > 13.7). U Mann-Whitney test – 194.500; $p = 0.019$.

Table 3
Statistical variables in children from Ivankivskiyi district with different physical growth levels

Variables	Group 1		Group 2		Group 3	
	Me	IQR	Me	IQR	Me	IQR
H_{cy}	12.61	11.57-17.32	11.41	9.46-13.28 ¹	11.87	10.91-13.76
TSH	1.94	1.47-2.47	1.77	1.29-2.37	1.93	1.29-2.70
T_3	4.32	3.88-4.88	4.44	4.00-4.81	4.40	3.99-4.64
T_4	1.21	1.10-1.28	1.22	1.12-1.30 ³	1.30	1.20-1.34 ²
T_3/T_4	3.48	3.19-4.27	3.63	3.20-4.01	3.26	2.94-3.79 ⁴

Note: 1 – statistical differences in H_{cy} values between groups 1 (RI < 10.7) and 2 (RI = 10.7-13.7). U Mann-Whitney test 819.500; $p = 0.024$.

2 – statistical differences in T_4 values between groups 1 (RI < 10.7) and 3 (RI > 13.7). U Mann-Whitney test 183.50; $p = 0.019$.

3 – statistical differences in T_4 values between groups 2 (RI = 10.7-13.7) and 3 (RI > 13.7). U Mann-Whitney test 1417.500; $p = 0.008$.

4 – statistical differences in T_3/T_4 index values between groups 2 (RI = 10.7-13.7) and 3 (RI > 13.7). U Mann-Whitney test 1441.500; $p = 0.011$.

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Objective: We performed a comparative assessment of the blood levels of homocysteine, pituitary and thyroid hormones in children with different levels of physical development before and after forest fires in the Chernobyl exclusion zone (ChEZ) in 2015.

Methods: We used immunochemical, instrumental, mathematical and statistical methods.

Results: The analysis of variable dynamics was performed in 336 adolescents of the Poliskiyi and the Ivankivskiyi districts of Kyiv region. An association was found between

homocysteine (H_{cy}), hormones of the pituitary-thyroid axis and physical development of children. A statistically significantly higher level of H_{cy} was observed in the adolescents from the Ivankivskiyi district in comparison with the children from the Poliskiyi district. Forest fires in the spring and summer of 2015 in the ChEZ should be considered the main cause for the increase in H_{cy} in the blood of the adolescents. The increased level of T_3 in the peripheral tissues induced by H_{cy} and TSH contributed to a decrease in the physical development index values. Due to a decrease in the intensity of the T_4 deiodination process, the insufficient formation of T_3 in the peripheral tissues was recorded in the group of children with a disharmonious high physical development.

Keywords: homocysteine, hypophysis and thyroid gland hormones, physical development, adolescents, forest fires, Chernobyl exclusion zone.

13.7 kg/m³, abnormal PG of children with insufficient body weight is identified at the RI value of less than 10.7 kg/m³, abnormal PG of children with excess body weight – at the RI value of more than 13.7 kg/m³.

Three groups were identified during the examination of children from Poliskiyi and Ivankivskiyi districts according to RI values:

1 – abnormal (low) PG, RI is <10.7;

2 – normal PG, RI is in the range of 13.7 and 10.7;

3 – abnormal (high) PG, RI is >13.7.

The statistical processing of the findings was performed using the IBM SPSS Statistics 22 software (USA). The arithmetic mean (M), standard error of mean (m), confidence interval for the mean value (95% CI), median (Me), interquartile range (IQR), minimum and maximum parameter values and percentiles were calculated for the variables analysed. The distribution hypothesis was tested (a Kolmogorov-Smirnov test). All the studied parameters did not conform to the normal distribution law, thus, a non-parametric Mann-Whitney U test was used to compare values. Associations between H_{cy} , TSH, T_3 and T_3 levels were iden-

tified with the help of the Spearman's rank correlation coefficient (r_{xy}). The statistical significance of variables was assessed by determining a significance level for p with the help of the statistical software programme.

The Student's t-test was used to compare variables. The critical level of significance for the null hypothesis (p) was set at 0.05.

The strength of an association was assessed according to a typical scale: weak – 0 to 0.299; moderate – 0.3 to 0.699; strong – 0.7 to 1.0.

Results and their discussion. The similar groups of children from Poliskiyi and Ivankivskiyi districts with normal, abnormal low and abnormal high physical growth levels had no significant differences in quantitative terms.

The largest number of children was registered in the group with a normal level of physical growth, the smallest number of children was in the group of children with an abnormal low level of physical growth (Table 1).

The groups of children from Poliskiyi district had no statistical differences among themselves in blood H_{cy} levels (Table 2), while in the children from Ivankivskiyi district the level of

this metabolite was statistically significantly higher in the Group 1 than in the Group 2 (Table 3).

The blood H_{cy} level in all 3 groups of children from Ivankivskiyi district had significantly higher values than in the similar groups of children from Poliskiyi district (Tables 2-6). The proportion of cases of exceeding the physiological level of this metabolite for adolescent children ($H_{cy}>10.0 \mu\text{mol/l}$) was higher in the groups from Ivankivskiyi district than in that from Poliskiyi district (Table 7).

TSH values had no statistical differences in the groups of children from the both districts (Tables 2-6).

The T_3 level was higher in the children from Poliskiyi district in the Group 1 than in the Group 3 (Table 2). There were no differences between the groups in relation to this hormone among the children from Ivankivskiyi district (Table 3). However, the T_3 level was statistically higher in the Groups 2 and 3 of children from Ivankivskiyi district than in the similar groups of children from Poliskiyi district (Tables 2, 3, 5, 6).

The T_4 level did not differ statistically in the groups of children from Poliskiyi district (Table 2). Among the children from Ivankivskiyi district, statis-

tically significantly higher values of this hormone were determined in the Group 3 compared to the Groups 1 and 2. At the same time, the values of the T_3/T_4 index in Group 2 were higher than in the Group 3 (Table 3). The T_4 level was statistically higher in the Group 3 in the children from Ivankivskiy district than in the same group from Poliskiy district (Table 6).

A direct association was determined between H_{cy} and T_3 in the Group 2 of children from Poliskiy district (Table 8).

In the Groups 1 and 2 of the children from Ivankivskiy district, a direct association was found between H_{cy} and TSH, while it was absent in the similar groups of children from Poliskiy district (Tables 8, 9). The association strength was more pronounced in the Group 1.

No association was observed between H_{cy} and T_4 in the groups of children from Poliskiy and Ivankivskiy districts (Tables 8, 9).

The research carried out enabled to characterize the groups of PG of children permanently residing near the ChEZ, taking into account the relationship between H_{cy} and hormones of the pituitary-thyroid axis.

Large-scale radiometric studies carried out in 2014-2016 during the project of the European Commission in Ivankivskiy and Poliskiy districts of Kyiv region of Ukraine showed an inverse association between RI and ^{137}Cs specific activity in children aged 12-17 years old (Table 10), while no association was recorded between RI and age. The highest level of ^{137}Cs

radionuclides was registered in the children from the group of abnormal low PG [10].

Based on this, it can be assumed that the constant presence of ^{137}Cs , and accordingly, their decay products (Ba), in the body of children affects their PG.

Children with insufficient body weight are characterized by increased production of H_{cy} , which stimulates the production of TSH by the adenohypophysis. This is evidenced by a direct association between H_{cy} and TSH. In turn, TSH enhances the 5'-deiodinase activity, resulting in an increase in T_3 levels and a proportional decrease in T_4 levels in peripheral tissues [11]. This is proved by a direct association between TSH and the T_3/T_4 index, and an inverse one between TSH and T_4 .

It was found that the process of T_3 formation in peripheral tissues is associated with the G risk allele of the MTR:A2756G genetic polymorphism, which is responsible for the synthesis of the B_{12} -dependent methionine synthase enzyme. Impaired H_{cy} methylation activates its utilization through a complex of transsulfuration reactions. At the same time, an increased amount of T_3 is formed [12], which negatively affects the metabolism in a cell, as proved by a decrease in RI values [13].

The blood H_{cy} level also decreases with a lower specific activity of ^{137}Cs in the body of children. In the group of abnormal high PG of children from Ivankivskiy district (RI>13.7), the association between H_{cy} and TSH disappeared, while the T_4 level was higher than that in the children from the other two analyzed groups. T_3 production was less than in the group of children with a normal level of PG, as evidenced by the values of the T_3/T_4 index. A decrease in the intensity of the process of the deiodination of T_4 , and, in this regard, a decrease in the formation of T_3 in peripheral tissues, contributes to an increase in the child's body weight, since T_3 stimulates the

Table 4
Statistical criteria when comparing metabolic variables of Group 1 (RI <10.7) of children from Poliskiy and Ivankivskiy districts

Variables	H_{cy}	TSH	T_3	T_4	T_3/T_4
Average rank Poliskiy district	13.59	19.62	19.26	18.62	19.21
Average rank Ivankivskiy district	22.89	17.50	17.82	18.39	17.87
U Mann-Whitney test	78.00	142.50	148.50	159.500	149.50
Asymptotic significance (2-tailed), p	0.008	0.547	0.680	0.949	0.704

Table 5
Statistical criteria when comparing metabolic variables of Group 2 (RI 10.7-13.7) of children from Poliskiy and Ivankivskiy districts

Variables	H_{cy}	TSH	T_3	T_4	T_3/T_4
Average rank Poliskiy district	103.39	118.10	101.61	106.98	112.64
Average rank Ivankivskiy district	125.32	113.39	126.77	122.41	117.82
U Mann-Whitney test	5293.50	6273.00	5109.50	5663.00	6246.00
Asymptotic significance (2-tailed), p	0.013	0.594	0.004	0.080	0.557

Table 6
Statistical criteria when comparing metabolic variables of Group 3 (RI >10.7) of children from Poliskiy and Ivankivskiy districts

Variables	H_{cy}	TSH	T_3	T_4	T_3/T_4
Average rank Poliskiy district	29.70	36.14	30.61	28.07	38.04
Average rank Ivankivskiy district	42.39	34.73	41.31	44.33	32.48
U Mann-Whitney test	387.50	583.50	422.00	325.50	511.50
Asymptotic significance (2-tailed), p	0.009	0.773	0.028	0.001	0.255

ГОМОЦИСТЕИН, ГОРМОНЫ ГИПОФИЗА И ЩИТОВИДНОЙ ЖЕЛЕЗЫ У ДЕТЕЙ С РАЗНЫМИ УРОВНЯМИ ФИЗИЧЕСКОГО РАЗВИТИЯ ПОСЛЕ ЛЕСНЫХ ПОЖАРОВ В ЧЕРНОБЫЛЬСКОЙ ЗОНЕ ОТЧУЖДЕНИЯ
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Цель исследования: сравнительная оценка уровня гомоцистеина, гормонов гипофиза и щитовидной железы в крови у детей с разными уровнями физического развития до и после лесных пожаров в Чернобыльской зоне отчуждения (ЧЗО) в 2015 году.

Методы исследования.

Иммунохимический, инструментальный, математико-статистический.

Результаты. Анализ динамики показателей проведен у 336 подростков Полесского и Иванковского районов

Киевской области. Выявлена связь между гомоцистеином (H_{cy}), гормонами гипофизарно-тиреоидной оси и физическим развитием детей. У подростков Иванковского района установлен достоверно более высокий уровень H_{cy} по сравнению с детьми из Полесского района. Основной причиной повышения H_{cy} в крови подростков следует считать лесные пожары весной и летом 2015 года в ЧЗО. Повышенный уровень T_3 в периферических тканях, индуцированный H_{cy} и ТТГ, способствовал уменьшению значений индекса физического развития. В группе детей дисгармоничного высокого физического развития регистрировалось недостаточное образование T_3 в периферических тканях, в связи со снижением интенсивности процесса дейодирования T_4 .

Ключевые слова: гомоцистеин, гормоны гипофиза и щитовидной железы, физическое развитие, подростки, лесные пожары, Чернобыльская зона отчуждения.

processes of lipolysis in adipose tissue and the oxidation of fatty acids in the liver.

The occurrence of this physiological effect may be associated with an insufficient level of H_{cy} in the blood to stimulate the adenohypophysis to produce TSH, or activate the complex of transsulfuration reactions, and, consequently, increased production of T_3 in peripheral tissues.

In this case, one should also not exclude a congenital disorder of the central mechanisms of endocrine regulation in the hypothalamic-pituitary system [14].

Taking into account the dates of the laboratory examination of children from the both districts, it can be reasonably stated that higher blood H_{cy} levels in the children from Ivankivskiyi district in comparison with the children of Poliskiyi district are associated with forest fires in the ChEZ in the spring and summer of 2015.

The area of the largest of these fires was 10,127 ha. At the same time, the maximum density of the territory contamination in some quarters of the Lubyansk's forestry was 1040 kBq/m² for ¹³⁷Cs; 368 kBq/m² for ⁹⁰Sr; 11.4 kBq/m² for ²³⁸⁻²⁴⁰Pu and 14.4 kBq/m² for ²⁴¹Am [5].

In addition to these radionuclides, the burning of forest trees in the ChEZ is accompanied by the release of black and organic carbon into the environment.

The negative influence of these agents on H_{cy} metabolism in elderly men has been known [15].

Experimental studies have shown a decrease in the level of methionine, an essential sulfur-containing amino acid closely related to H_{cy} in the blood of laboratory animals fed by oat grains containing ¹³⁷Cs and ⁹⁰Sr radionuclides [16].

Thus, the children from Ivankivskiyi district, living near the ChEZ, were exposed to radioactive and chemical agents formed as a result of the burning of forest trees in 2015. In previous publications, we have shown the effect of a forest fire factor on the metabolism of children in Poliskiyi district, who also live near the ChEZ [17].

The findings show that there is a negative effect of products of combustion of wood from the ChEZ and the radionuclides contained in it on the metabolism of sulfur-containing amino acids methionine and H_{cy} in adolescent children.

Increased formation of H_{cy} stimulates the synthesis of TSH, which in turn affects the synthesis of hormones in the thyroid gland and in peripheral tissues, which is reflected in the child's PG.

Conclusions

1. The blood H_{cy} level was statistically significantly higher in the groups of adolescent children from Ivankivskiyi district, formed taking into account the values of the physical growth index (Rohrer's index), than in similar groups of children from Poliskiyi district.

2. Taking into account the dates of the laboratory examination of children in both districts, forest fires in the spring and summer of 2015 in the ChEZ should be considered as the main reason for a higher blood level of H_{cy} in the children from Ivankivskiyi district in comparison with those from Poliskiyi district.

3. Direct associations were observed between H_{cy} and T_3 , TSH and T_3 in the group of children with a normal level of physical growth from Poliskiyi district living near the ChEZ.

4. A direct moderate association was recorded between H_{cy} and TSH in the groups of chil-

dren with abnormal low physical growth from Ivankivskiy district after the forest fires in the ChEZ.

5. The increased T_3 level in peripheral tissues, induced by H_{cy} and TSH, contributed to a decrease in values of the physical growth index.

6. In the group of children with abnormal high physical growth, the insufficient formation T_3 in peripheral tissues was recorded. It was due to a decrease in the intensity of the process of deiodination of T_4 .

7. The conducted studies have found an association between H_{cy} , hormones of the pituitary-thyroid axis and the physical growth of children living near the ChEZ.

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Proportion of cases of hyperhomocysteinemia ($H_{cy} > 10 \mu\text{mol/L}$) in groups of children of Poliskyi and Ivankivskiy districts

Table 7

Districts	Group 1		Group 2		Group 3	
	Abs.	%	Abs.	%	Abs.	%
Poliskyi	9	52.941	55	53.402	20	52.633
Ivankivskiy	16	84.21	86	67.72	28	87.504

Note: 1 – statistical differences between groups 1 of children of Poliskyi and Ivankivskiy districts ($t=2.13$, $p=0.045027$).

2 – statistical differences between groups 2 of children of Poliskyi and Ivankivskiy districts ($t=2.22$, $p=0.0281828$).

3 – statistical differences between groups 3 of children of Poliskyi and Ivankivskiy districts ($t=3.49$, $p=0.001093$).

4 – statistical differences between groups 2 and 3 of children of Ivankivskiy district ($t=2.75$, $p=0.007027$).

Table 8

Results of correlation analysis of metabolic variables in children from Poliskyi district

Parameters	Correlation coefficient	Group 1	Group 2	Group 3
H_{cy} and T_3	Spearman's	-0.261	0.205*	0.004
	Significance, p	0.311	0.037	0.983
	N	17	103	38
H_{cy} and TSH	Spearman's	-0.034	0.003	-0.009
	Significance, p	0.896	0.978	0.958
	N	17	103	38
H_{cy} and T_4	Spearman's	0.175	0.015	-0.134
	Significance, p	0.503	0.879	0.422
	N	17	103	38
TSH and T_3	Spearman's	0.094	0.203*	0.218
	Significance, p	0.719	0.039	0.189
	N	17	103	38
TSH and T_4	Spearman's	-0.680**	-0.181	-0.238
	Significance, p	0.003	0.068	0.150
	N	17	103	38
TSH and T_3/T_4	Spearman's	0.547*	0.280**	0.427**
	Significance, p	0.023	0.004	0.008
	N	17	103	38

Note: * – correlation is significant at the 0.05 level (2-tailed),

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Table 9

Results of correlation analysis of metabolic variables in children from Ivankivskiy district

Parameters	Correlation coefficient	Group 1	Group 2	Group 3
H _{cy} and T ₃	Spearman's	0.361	0.163	0.072
	Significance, p	0.128	0.067	0.697
	N	19	127	32
H _{cy} and TSH	Spearman's	0.502*	0.224*	-0.119
	Significance, p	0.029	0.011	0.517
	N	19	127	32
H _{cy} and T ₄	Spearman's	0.119	0.108	0.016
	Significance, p	0.629	0.226	0.929
	N	19	127	32
TSH and T ₃	Spearman's	0.154	0.211*	0.382*
	Significance, p	0.528	0.017	0.031
	N	19	127	32
TSH and T ₄	Spearman's	-0.084	-0.134	-0.317
	Significance, p	0.733	0.132	0.077
	N	19	127	32
TSH and T ₃ /T ₄	Spearman's	0.097	0.247**	0.526**
	Significance, p	0.694	0.005	0.002
	N	19	127	32

Note: * – correlation is significant at the 0.05 level (2-tailed).

** – correlation is significant at the 0.01 level (2-tailed).

Table 10

Results of correlation analysis between RI and ¹³⁷Cs specific activity in examined children [11]

Groups of children	Correlation coefficient	Parameters	
		RI	¹³⁷ Cs specific activity, Bq/kg
Total group	Spearman's		0.070**
	Sign. (2-tailed), p		0.005
	N		1656
Younger group	Spearman's		0.120
	Sign. (2-tailed), p		0.144
	N		150
Middle group	Spearman's		-0.094*
	Sign. (2-tailed), p		0.009
	N		782
Older group	Spearman's		-0.326**
	Sign. (2-tailed), p		0.0001
	N		724

Note: * – correlation is significant at the 0.05 level (2-tailed),

** – correlation is significant at the 0.01 level (2-tailed).

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