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CEREBRAL ENERGY METABOLISM IN CHILDREN WITH HIGH LEVEL OF ANXIETY

People living in the conditions of the Arctic latitudes become the cause of more intensive use of the body's adaptation reserves. The children's body reacts heavily to the effects of climatic factors because it has the immaturity of the functional systems. Currently, it is important to study the specifics of the functional state of the central nervous system in children living in the Arctic region. Chronic psycho-emotional stress is a significant characteristic of distress in the Arctic region. This is one of the manifestations of readiness to respond in an alarming manner. A child with high anxiety will be at high risk of sensitivity to the action of adverse environmental factors. The body requires the use of more effort to process incoming information and the formation of responses. The purpose of this study is to determine the characteristics of the distribution of the level of DC potential of the brain in children with a high level of anxiety living in the Arctic region. We conducted a cross-sectional study with the participation of 105 children aged 9-10 years. The level of personal anxiety in children was assessed using the "Multidimensional Evaluation of Child Anxiety" test. A DC potential was recorded using a 5-channel hardware-software complex for topographic mapping of brain electrical activity, NEURO-KM (Russia). We have revealed an increase in the absolute values of the constant DC potential of high-anxious children living in the Arctic region. The absolute values of the DC potential show an increase in all leads, the shift in the distribution of DC potentials is changed to the occipital region of the brain. The results of the study indicate a higher energy consumption of the brain in children living in the Arctic region. An increase in total DC potentials indicators was recorded. In children with high anxiety, these indicators show even greater DC potentials. The reduction of energy consumption in the frontal regions relative to other brain areas in children of the North can be regarded as a manifestation of the functional tension of the central nervous system when living in the Arctic region.

Keywords: children, anxiety, DC potential, North, Arctic region.

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Introduction. It is known that living in the Northern latitudes has a negative impact on human health and causes more intensive use and rapid depletion of adaptive reserves of the body [4, 7]. Children react more intensively to external influences, because they are in the process of forming functional systems. Therefore, the study of the specifics of the functional state of the Central nervous system in children living in the Arctic region is very important. The age of 9-10 years is a period of structural and functional rearrangements of the Central nervous system, which requires large energy expenditure and is characterized by high sensitivity to external influences, including adverse climatic factors of high latitudes [1, 11]. In this regard, the study of brain energy exchange, as an indicator of the functional co-existence of the Central nervous system, using the method of recording the level of constant potential is important [2, 3]. The registration is based on the assessment of the intensity of cerebral metabolism and is a method of its biochemical neuroimaging. High readiness to react according to the alarm type is one of the significant characteristics of distress in the North [8]. A child with high anxiety will be at increased risk of vulnerability to adverse environmental factors, due to the need for the body to spend more effort on processing incoming information and responses [5, 10, 12]. At the same time, studies of the relationship of children's anxiety with the peculiarities of the functional state of the Central nervous

system of northerners are not numerous, and the study of the peculiarities of cerebral energy processes with high anxiety in children is not given due attention. the purpose of our study is to determine the features of the distribution of the level of permanent brain potential in children with high anxiety levels living in the Arctic region.

Materials and methods of research.

The cross-sectional study involved 105 children aged 9-10 years. All children were trained in the third classes of comprehensive schools of the city of Arkhangelsk. The study was carried out in accordance with the standards of good Clinical Practice (Good Clinical Practice) and the principles of the Helsinki Declaration. The study was approved by the Ethical Committee of the Northern Arctic Federal University named after M. V. Lomonosov. The examination of children was carried out with the written informed consent of the parents. The level of personal anxiety in children was assessed using the test "Multivariate assessment of children's anxiety (MACA)."

We used a 5-channel hardware-software complex "NEURO-KM" (Russia) to record and analyze the intensity of cerebral energy metabolism. The level of permanent potential was recorded monopolarly in the frontal (Fz), Central (Cz), occipital (Oz), right temporal (Td) and left temporal (Ts) leads according to the international scheme 10-20. The values of the constant potential were recorded 5-6 minutes after the electrodes were

applied to the lead points and then the recording was carried out continuously. Analysis of constant potential was done by mapping the unipolar values and calculate the Transconductance of the difference. Local values of the constant potential in each of the departments were measured, excluding the influence of the reference electrode. Deviations of the constant potential level from the average in each of the leads were calculated for all areas of the cerebral cortex. The obtained characteristics of the distribution of the level of constant potential were compared with the average normative values allocated for the corresponding age groups of the middle latitudes of Russia.

There were no statistically significant differences between the groups of boys and girls according to the studied indicators. schoolchildren living in the Arctic region were divided into two groups: with a high level of personal anxiety (40 people) and with a normal level of anxiety (65 people). The control group included the results of mapping children from Central Russia, built into the software hardware and software complex "NEURO-KM".

Data processing was carried out using the statistical software package "SPSS 17 for Windows". The distribution of signs to normality was evaluated using the criteria of Shapiro-Wilk and Kolmogorov-Smirnov. student's t-test was used to identify differences between the compared groups. The critical level of significance (p) when testing statistical hypotheses was taken to be 0.05.

Results and discussion. We obtained results that characterize the flow of cerebral energy metabolism in children-northerners. The results indicate that for the inhabitants of the Far North there is a tension of physiological systems of the body. At the same time, we recorded a change in brain energy consumption in northerners with high levels of anxiety (Fig.).

We have shown that the intensity of cerebral metabolism in children decreases after the age of 9 [2]. However, our results also indicate that in children living in the Arctic region, indicators of the intensity of cerebral energy exchange have increased values. Thus, the total cerebral energy consumption of children from the North, both in the group with a normal level of anxiety and in the group of children with high anxiety exceeds the normative values by 37% and 85%, respectively. The absolute values of the constant potential of the children of the North of both groups exceed the

indicators of the control group for all leads. The exception is the indicators of frontal abduction in the group of children of the North. In the group of children of the North with a normal level of anxiety – they are identical to the indicators of children of Central Russia (Fz 8.1 mV and 8.5 mV, respectively), while in high-anxiety children of the North it is increased twice compared to the other two groups.

The relative values of the constant potential of the children of the North have confirmed the assumption of a slower rate of maturation of some structures and functions of the brain in children of the Arctic region compared to their peers from Central Russia. The decrease in energy consumption in the frontal lobes relative to other parts of the brain in children of the North of 9-10 years speaks of the relative immaturity of the frontal structures of the brain. According to the normative values of this difference is -2,4 mV, and in the group of children of the North of 5.7 mV in children with normal levels of anxiety and 4.2 mV in children with a high level of anxiety.

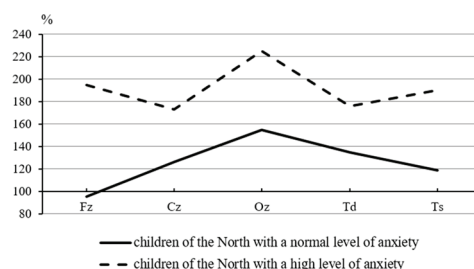
The high value of the index characterizing the energy consumption in the left temporal region (Ts 20.1 mV; $p \leq 0.001$) is recorded in the group of highly anxious children of the North, which is almost twice the same value in the other two groups. In addition, the absolute values of the constant potential in this group are significantly higher than the other two groups in all leads almost twice. The cortex of the human brain can inhibit the underlying centers, which allows the body to mitigate the manifestations or regulate the intensity of anxiety in normal conditions [6]. This type of control is possible at the optimal level only with the functional maturity of the neocortex. Functional systems of the brain are actively maturing and improving throughout the period of primary school age [3, 9]. Probably, high anxiety aged 9-10 years, actively affects the dynamics of these processes, which is confirmed by the highest increase in the level of

constant potential in children with anxiety in the frontal and left temporal regions of the brain.

The values of constant potential in Northern children in the Central parts of the brain exceed the values in other leads. However, the relative distribution of their constant potential does not correspond to the dome-shaped distribution: there is practically no difference in energy consumption between the Central and occipital parts of the brain (0.8 mV), while in children of the middle band when comparing the indicators for these leads it is the maximum (3.1 mV). At the same time, in terms of deviation from the average level of constant potential in the Central parts of the brain, groups of children do not have statistically significant differences ($p = 0.616$), and in terms of deviation from the average value of the constant potential in the occipital sections, the difference between children of the North and their peers from the Central strip of Russia is significant ($p = 0.014$).

In children of the North with high anxiety, the maximum values of constant potential in the occipital lead were registered. There is no difference in energy consumption between the Central and occipital parts of the brain. At the same time, according to the indicators of deviation from the average value of constant potentials in the occipital sections, the difference is established between highly anxious younger students and their peers with a normal level of anxiety ($p = 0.034$). Therefore, a violation of the principle of Cuprobaze distribution neuroenergetic in the group of children of the North with a high level of anxiety due to the increase of constant potential in the occipital parts of the brain. It is known that the local constant potential in the occipital region reflects changes in energy metabolism in the stem structures involved in the regulation of emotions. At the same time, it was found that the structures of the hypothalamic-pituitary system and the stem reticular formation are activated under stress. Obviously, the shift in the distribution of constant potential in the occipital region of the brain in anxious children may also be associated with increased functional activity of non-specific reticular-limbic-cortical neural connections with high anxiety.

Thus, the violation of the principle of dome-like distribution of neuro-energy in the group of children living in the Far North is due to a significant increase in the constant potential in



Distribution of constant potential indicators.
Comment. normative values of the control group are accepted for 100%

the occipital parts of the brain. In this case, a high level of anxiety affects the increase in energy exchange in the occipital areas of the brain.

Conclusion. We have shown that children living in the Arctic region have increased the total indicators of the level of permanent potential. Potential values in each area of the brain are increasing in children of the North and, also, indicators of constant potential with a high level of anxiety in children of the North are increased. The principle of "dome-shaped" distribution of neuroenergosatrats is broken, which is due to the shift of the distribution of constant potential in the occipital region of the brain, and may be associated with both the impact of adverse climatic and environmental living conditions, and with increased functional activity of non-specific reticulo-limbic-cortical neural connections with high anxiety. Energy consumption in the frontal lobes relative to other parts of the brain are reduced in children of the North compared to their peers from the Central regions of Russia, which can be regarded as a manifestation of the functional tension of the Central nervous system when living in the Arctic region.

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