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## THE CONTENT OF SEROTONIN NEUROMEDIATOR IN MENTALLY RETARDED BOYS OF EARLY SCHOOL AGE

DOI 10.25789/YMJ.2020.69.03

УДК 577.175: 612.085.1: 616.89-008.454-053.2

The article presents the research aimed at the content of serotonin neuro mediator in mentally retarded boys (7 to 11 years). It regulates many physiological functions and also the processes of learning, memory, other cognitive processes, which are very important for early schoolchildren.

In the early schoolchildren with mental retardation from all the groups we determined statistically meaningful ( $p < 0.001$ ) decrease of serotonin content in blood lymphocytes as compared to control groups disregard upbringing conditions and the stage of severity, that can be regarded as typical feature for mentally retarded children.

As a preventive measure, special attention may be recommended to be drawn to making sure that the diets of mentally retarded children are rich in tryptophan-containing food. Besides, as serotonin synthesis is affected by the duration of sunlight exposure, another aspect to care about is proper insolation of children with mental retardation.

**Keywords:** serotonin, mental retardation, early school age, boys, neuromediator.

**Introduction.** The relevance of the mental retardation issue is largely attributed to its high prevalence. Mental retardation in the child population in various countries worldwide is reported to stand at 1-5% [3, 9]. Mental retardation is usually marked by diminished intellectual and cognitive capacities and skills that occur in the process of development (motor, linguistic, social skills, etc.) [19].

Serotonin is a biogenic monoamine that regulates a whole range of reactions and processes in the body (sleeping patterns, appetite, behavior, physical activity, emotional stability, adaptation, etc.). Primary schoolers face difficulties in

the period of adaptation to the beginning of their school education. One of the main functions serotonin has in primary schoolers is its role in the cognitive functions (thought, memory, attention, etc.) [1, 8, 20].

Since due to their pathology mentally retarded children experience difficulties in learning, it appears rather relevant to conduct studies into the serotonin levels prevalent in this group.

The purpose of this study is to research the levels of serotonin neurotransmitter in lymphocytes found in the blood of primary schoolboys (aged 7-11) with mental retardation at the end of the academic year.

**Materials and methods.** The study looked at 119 primary schoolboys (aged 7-11) at the end of the academic year. 46 schoolers had already been diagnosed to have mental retardation and were attending specialized type-8 remedial schools. They were divided into groups according to their family backgrounds. 26 boys with mental retardation came from two parent families (14 were diagnosed with mild mental retardation (F70), 12 were a moderate case (F71)). 20 boys (moderate retardation (F71)) were from an orphanage for mentally retarded children. The control group was made up of 73 mentally healthy boys who studied at a secondary school in Krasnoyarsk and were also divided into groups: 59 came from two parent families, whereas 14 were from an orphanage for physiologically challenged children. The children under study were treated in accordance with the ethical standards imposed by the World Medical Association Declaration of Helsinki (Seoul, 2008). The study was approved by the Committee for Biomedical Ethics

of the Research Institute for Medical Problems in the North.

Mental retardation was diagnosed by a medical commission during a regular medical checkup undertaken by the schoolchildren in compliance with the International Classification of Diseases, 10th Revision (ICD-10).

The content of serotonin in lymphocytes in blood smears was measured using luminescent-histochemical method. This method is based on interaction reaction between serotonin and formaldehyde vapours resulting in luminescent complex formation that glows green. Fluorescent glow was captured using Lumam-I3 microscope («LOMO», Russia) with its signal being transmitted to digital multimeter. The fluorescent signal received at multimeter was measured in  $\mu V$  and then expressed in equivalent units of serotonin content (CU). At present, lymphocytes provide a reasonable and informative model to research levels of serotonin in various cases of neuropsychic diseases [13, 18].

Statistica 6.0 software package was used for statistical data processing (Stat Soft Inc., USA). Normality of distribution was tested using the Kolmogorov-Smirnov test. As these data do not conform to normal distribution, statistical differences of the samplings were checked using non-parametric U-Test Mann-Whitney and median and percentiles were calculated (Me, P25-P75). The statistical hypotheses test showed the significance level of  $p < 0.05$ .

**Results and discussion.** The study into the levels of serotonin at the end of the academic year demonstrated that mentally retarded schoolchildren with family backgrounds are characterized by statistically lower levels of serotonin (23.4

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CU) in comparison to their healthy peers (36.6 CU ( $p=0.00001$ )). No differences were found in the levels of serotonin between children with mild and moderate mental retardation (Fig. 1).

The group of mentally retarded orphans was also reported to reveal lower serotonin levels in comparison to mentally healthy orphans ( $p=0.0003$ ) (Fig. 2).

No significant differences in serotonin levels were found between the groups of the same degree of mental retardation (F71), regardless of their background, however there is a tendency of steadily lower levels of serotonin in mentally retarded orphans, compared to their peers from families.

The conducted study revealed diminished levels of the serotonin neurotransmitter in all groups of boys with mental retardation. However normal learning and memory functions require an optimal level of serotonin [13, 20]. It is well-known that the role of serotonin in the central nervous system is not restricted to cognitive functions only. Serotonin regulates maturation of various structures in the brain [6], has a significant impact on myelination of axons, proliferation of neuroglia, and formation of new fiber connectivity [8]. It was noted that the processes of learning and memory are impacted by a certain number of serotonin-sustained synapses [14].

The revealed marked tendency towards lower levels of serotonin in mentally retarded orphans as compared to their family-raised peers with the same degree of mental retardation (F71) may be attributed to the fact that institutionalized orphans are susceptible to overall deprivation and adverse psychological state caused by the impossibility to satisfy their basic living needs. For a child, it primarily translates into the need for love, tenderness and care from their parents [5]. It is known that deprivation affects their neuropsychic, emotional and physical development [11]. Apparently, the psychological and emotional discomfort caused by a lack of parental care and attention may further have an impact on the level of serotonin in orphaned children with mental retardation. According to Kryzhanovskaya L. I. [2], deprivation is particularly important in mentally retarded children as the combined influence of deprivation and mental retardation is accompanied by graver consequences than those found in the mentally healthy children population.

At the same time our data demonstrate that the bodily functions in primary

schoolers with mental retardation, even those that are raised in their families, and have not only moderate (F71) but also mild forms (F70) of mental retardation, apparently fail to sustain sufficient levels (as those in their mentally healthy peers) of serotonin that influences the processes of learning and affects cognitive function (memory, attention, etc.).

Since the diminished levels of serotonin in primary schoolers with mental retardation are reported regardless of the background they are raised in, or the degree of their mental retardation, the low serotonin levels may apparently be viewed as a peculiarity of primary schoolers with mental retardation that stands in the way of their cognitive activity. Diminished levels of serotonin in mentally retarded children have been reported by other authors as well. For instance, Mulder E. J. et. al. [15] conducted a comparative analysis of serotonin levels in the thrombocytes of 3 groups of children (in the control group, group of autistic children with impaired mental development, and group of mentally retarded children) – the lowest serotonin levels were found in mentally

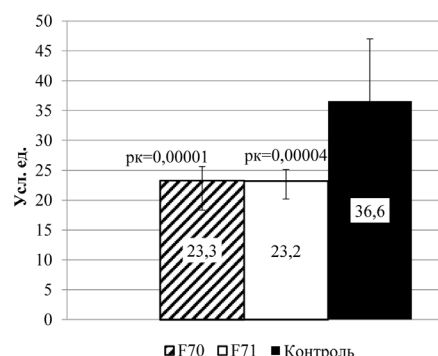
retarded children, even though the statistical significance with the control was not sufficient.

It is worth noting that a number of studies suggested that lymphocytes are reasonable to use as a model of the state of the serotonergic system in the body in the context of neuropsychic disorders [17]. The study conducted by Marazziti D. et. al. [18] claims that lymphocytes that, just as neurons in the central nervous system, serve as transporters of serotonin – SERT – that are a sort of peripheral "mirror" reflecting the activity of serotonergic structures located in the central nervous system. Therefore the study of the levels of serotonin in blood lymphocytes may be considered to be sufficiently relevant for understanding of significance of those levels of this neurotransmitter in primary schoolers with mental retardation.

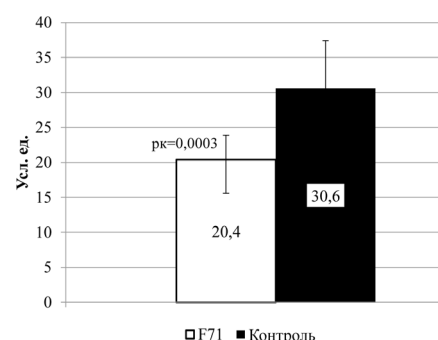
**Conclusion.** Thus, mentally retarded primary schoolers are reported to have diminished levels of serotonin. It is known that serotonin is synthesized from the indispensable tryptophan amino acid [7], that is not generated in the body and is normally introduced with food (nuts, cottage cheese, bananas, chocolate, etc.) [16]. As a preventive measure, special attention may be recommended to be drawn to making sure that the diets of mentally retarded children are rich in tryptophan-containing food. Besides, as serotonin synthesis is affected by the duration of sunlight exposure [12], another aspect to care about is proper insolation of children with mental retardation.

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**Fig. 1.** The content of serotonin in blood lymphocytes (CU) with varying degrees of mental retardation in schoolchildren brought up in the family: F70 - mild severity of mental retardation, F71 - moderate severity of mental retardation



**Fig. 2.** The content of serotonin in blood lymphocytes (CU) in schoolchildren with mental retardation brought up in an orphanage: F71 - moderate severity of mental retardation

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