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Assessment of the regulatory systems of the body of children in the early childhood

The assessment of the regulatory systems of the body of children in the early childhood was conducted by using physiological and clinical examination in junior classes of secondary school. Morphological and functional development of children was evaluated in terms of height, body weight, cardiovascular system was assessed by changes in heart rate, SBP, DBP, PP, ECG, systolic blood volume (SV) and blood oxygenation. State of regulatory systems was measured by heart rate variability (HRV), analyzing the common basic parameters of cardiointervalography: M, IC, Mo, Amo, VR and their derivative indicators by R.M.Baevsky: VIR (vegetative index rate), VBI (vegetative balance index), SI (index of regulatory systems stress) ARP (adequacy of regulation processes).

Key words: adaptation, heart rate variability, vegetative parameters rhythm performance, heart rate, parasympathetic mechanisms sympathetic influence.

Adaptation of pupils to the school — a complex dynamic social psychological and physiological process accompanied by a significant stress of the organism and its functional systems against a background of continuous growth processes [1–4].

The study of children's organism adaptation to various environmental influences — is one of the most important directions of physiology. Cardiovascular system determines the success of the adaptive response of the organism to a variety of external influences [5].

The scope of the study of adaptive processes is increasingly includes such areas as «psychological adaptation», «social adaptation», «social and economical adaptation» and even «ideological adaptation». School education traditionally focused on the contingent of healthy children for decades, in recent years has intensified: the programs are getting more complex, new educational technologies and elements of specialization introducing from the first-class. The increase in the total load is carried out without taking into account the recommendations of modern hygiene, exposing up to 80 % of younger schoolchildren undue stress (V.R.Kuchma).

One of the leading problem in the study of the physiologists is adaptation of children and adolescents to educational and physical activities. The main goal of this research is to study the physiological mechanisms of adaptation of the body of children and to be able to influence it by means of pedagogy and hygiene.

The educational system in Kazakhstan over the past decade is in the process of reform. Primary education — is not only one stage of the continuous education system, and also the first stage of school education. It was first touched with all sorts of innovations and changes at almost all levels, at the school, regional and state levels.

Factors adversely affecting the health of schoolchildren are inappropriate methods and technologies of training according to age and functional abilities of the child, irrational organization of educational process, violations of sanitary and hygienic learning environment. The significance of these factors is determined by the duration, regularity and continuity of their impact on the body of child. The widespread adoption of educational technologies is carried out, usually without any preliminary physiological and hygienic studies.

An important role in violation of physiological and hygienic norms plays parents who load their children more information in a variety of developing centers. Almost every parent believes that in addition to nursery school the child should attend developing training classes. The child has no leisure time.

Meanwhile, the processes of adaptation mechanisms of regulation of children under the implementation of innovative learning technologies are not well understood.

The aim of our study is to assess the regulatory systems of the body of children in the early childhood in the conditions of innovative educational technologies of the educational process.

To implement the goals and objectives were carried out physiological and clinical examination in junior classes of secondary school. 50 school children in the age of 8–9 years were examined, including 21 girls and 29 boys. Adaptive response to school stressors of pupils of two groups was studied: group 1 — children

entering first grade after attending kindergarten, group 2 — the children who attended kindergarten in addition with developing centers. Morphological and functional development of children was evaluated in terms of height, body weight, cardiovascular system was assessed by changes in heart rate, SBP, DBP, PP, ECG, systolic blood volume (SV) and blood oxygenation. State of regulatory systems was measured by heart rate variability (HRV), analyzing the common basic parameters of cardiointervalography: M, IC, Mo, Amo, VR and their derivative indicators by R.M.Baevsky: VIR (vegetative index rate), VBI (vegetative balance index), SI (index of regulatory systems stress) ARP (adequacy of regulation processes).

Analyzing the average parameters of morphological and functional development of children, the body weight of boys in this age is lower than body weight of girls (Table 1). The greatest difference in body weight was found between subgroups of girls and boys who attended additionally development centers (31.77 kg — girls in comparison with boys — 29.92 kg). The children who attended kindergarten have small difference (31.29 kg and 30.55 kg, respectively) (Table 1). The height of boys and girls at this age is almost the same (Table 1), but the height of boys attending only kindergarten, taller than girls in the same group on 1.35 cm and the boys from group2 taller than girls of group 1 on 2 cm. Height of boys and the girls of second group is almost the same.

Table 1

Comparative characteristics of anthropometric parameters, blood pressure and oximeter

		Weight, kg	Height, cm	SBP, mmHg	DBP, mmHg	SpO_2, %
G	I	31,29±4,9	128,29±2,8	84,29±7,8	45,71±4,3	95,71±0,8
	II	31,77±1,5	129,69±1,4	89,62±4,2	53,85±2,5	97,08±0,4
B	I	30,55±1,7	129,64±1,3	93,18±4,3	54,55±3,8	96,82±0,6
	II	29,92±1,4	130,15±1,6	89,23±3,3	50,77±3,3	95,31±1,2

Systolic and diastolic blood pressure which is mainly affected by the emotional reaction in this age of boys is higher. The largest difference is noted in the values of blood pressure in boys and girls of1st group (up to 9 mmHg). Systolic pressure between boys and girls of 2nd group is equally, the diastolic pressure of girls is higher (Table 1). Pulse pressure of boys is equally in both groups, the result of girls from 2nd group is lower on 3 mmHg, wherein oxygen saturation of the blood in girls of this group is higher at 97.08 %, while in boys it is 95.31 %. At children who attended only kindergarten oxygen saturation is higher at boys (Table 1).

Analysis of statistical parameters of HRV showed no significant changes in the mean of RR intervals duration and standard deviation characterizing the vagal regulation in boys and girls (Table 2). The difference is clearly seen between girls and boys of 1st and 2nd groups. Despite the fact that the value of M (RRNN), has the lowest volatility among all indicators of heart rhythm, it is lower at girls attending the centers of developing training than at boys of the same group. It is also noted that the value of IC (SDNN) in girls in comparison with boys of the group is lower (Table 2). Among children who attended only kindergarten these indicators higher in girls than in boys of the same group, which indicates to a greater stress resistance of girls.

Variation pulsometry index is higher at boys when compared the groups who attended kindergarten only. As for the second group, the AMO% and VR indexes of girls are higher than indexes of boys, it indicates to an increase in sympathetic activity and regulation systems tension of girls in this group.

As shown in studies of L.A.Dotsoev and N.I.Shlyk in the age between 4–10 years influence of the parasympathetic division of the ANS increases and decreases the activity of the central contour of regulation [6, 7]. The optimal ratio between the nervous and humoral mechanisms of regulation of cardiac activity is formed with age [7–9]. Several authors show sex differences in heart rate regulation, starting from the age of 8 [9–12]. According to some authors [9, 13] 9 years age is characterized by the increasing influence of the parasympathetic division of the ANS and reduce the activity of the central contour of regulation.

The study E.A.Kalyuzhny (2010) in the analysis of vegetative homeostasis of junior classes children by cardiointervalography revealed the predominance of the sympathetic component, statistically different from the benchmarks of cardiointervalography. Examined children at the time of the beginning of the school year had the average value of stress index (SI) that corresponded to the border sympathicotonia andhypersympathicotonia, mainly due to an increase in mode index (Mo), amplitude mode (AMo in%). SI amount varies in dynamics of the academic year, indicating stress response of children to workload. In general determined next trend: the value of SI is rised at the end of a quarter, and reduced after the holidays and the end of the school year [14].

Table 2

Heart rate variability in primary school children

		M, s	IC c∧2, ms	Mo, s	AMo,%	VR, ms	VBI, c.u.	ARP, c.u.	VIR, c.u.	ID, c.u.
G	I	0,73 ±0,03	0,07 ±0,01	0,73 ±0,08	32,80 ±1,2	0,31 ±0,02	111,14 ±12,8	47,19 ±6,5	4,88 ±0,7	82,11 ±13,5
	II	0,64 ±0,02	0,05 ±0,008	0,64 ±0,02	43,68 ±2,4	0,35 ±0,1	204,10 ±34,8	68,55 ±4,6	7,01 ±1,05	173,94 ±19,7
B	I	0,67 ±0,03	0,06 ±0,009	0,66 ±0,02	40,30 ±4,1	0,32 ±0,06	199,42 ±30,9	64,28 ±7,6	6,97 ±1,4	167,44 ±43,3
	II	0,69 ±0,02	0,08 ±0,08	0,68 ±0,03	42,14 ±2,7	0,40 ±0,1	182,16 ±30,9	64,21 ±4,9	6,19 ±1,5	145,05 ±14,5

The increase in the degree of centralization of heart rhythm of girls that attend additional developing centers indicate higher derivative indexes in this group in comparison with boys (Table 2). In group that attended only kindergarten stress of regulatory systems noted in boys.

The evidence of parasympathetic mechanisms activation is a reduction in the activity of autonomic response, adequacy of regulation processes and vegetative index rate [15].

The study of the state of the central contour of heart rate regulation has shown the prevalence of parasympathetic regulation of heart activity in boys, that increases adaptive capacity and effective use of reserve capacity of the cardiovascular system.

According to our findings revealed that boys have dominated parasympathetic regulation, which is reflected in the decrease of the VBI. SI is higher in girls than boys, which is likely due to the fact that the adaptation of the physiological systems of boys in comparison with girls in the training load is given by the stress of the central part of heart rate regulation.

HRV analysis showed that at the age of 8–9 years, the sympathetic influence is stronger in girls, so dominated in comparison with boys that attended only kindergarten, so it is possible to identify the sex differences.

The brightest adaptive response is in subgroups of children that have attended kindergarten. Considering SI as one of the main indicators reflecting the degree of centralization of heart rhythm, the table shows that among the children who attended developing centers, more sympathotonics in comparison with children who attended only kindergarten.

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Төменгі сынып мектеп балалары ағзасының реттеуші жүйелері жағдайын бағалау

Төменгі сынып мектеп балалары ағзасының реттеуші жүйелері жағдайын бағалау, жалпы білім беру мектебінің төменгі сынып оқушыларын физиологиялық-клиникалық зерттеу арқылы жүзеге асырылды. Балалардың морфофункционалды дамуы бойы, дене салмағы арқылы, жүрек-қан тамыр жүйесінің жағдайын ЖЖЖ, САҚ, ДАҚ, ПҚ, ЭКГ және қанның систолалық көлемі (СК) қан оксигенация динамикасы бойынша бағаланды. Реттеуші жүйелердің жағдайын жүрек ырғағының түрленгіштігі (ЖЫТ) әдісімен, көпшілікпен мақұлданған кардиоинтервалографияның негізгі параметрлерін: М, СК, Мо, АМо, ВА және Р.М.Баевскийдің туынды көрсеткіштері: ЫВК (ырғақтың вегетативті көрсеткіші), ВТИ (вегетативті тепе-теңдік индексі), РПБК (реттеуші процестердің баламалылық көрсеткіші) бойынша оларды талдай отырып, анықталды.

Г.К.Рыспаева, Г.М.Тыкежанова

Оценка состояния регуляторных систем организма у детей младшего возраста

Оценка адаптивных системных реакций организма учащихся младших классов проведена с помощью физиолого-клинических обследований учащихся младших классов общеобразовательной школы. Морфофункциональное развитие детей оценивали по показателям роста, массы тела, состояние сердечно-сосудистой системы — по динамике ЧСС, САД, ДАД, ПД, ЭКГ, систолическому объему крови (СО) и оксигенации крови. Состояние регуляторных систем определяли методом вариабельности сердечного ритма (ВСР), анализируя общепринятые основные параметры кардиоинтервалографии: М, СК, Мо, АМо, ВР и их производные показатели — по Р.М.Баевскому: ВПР (вегетативный показатель ритма), ИВР (индекс вегетативного равновесия), ИН (индекс напряжения регуляторных систем), ПАПР (показатель адекватности процессов регуляции).

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