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Influence of the examination on the functional state of the organism of schoolboys

The work is devoted to an estimation of influence of the adverse ecological factors on a functional pressure of schoolboys CNS of the at passing an examination. Object of research the pupils of average comprehensive schools of. Karaganda city living in various on an ecological situation areas. Is revealed, that negative ecological conditions of a residence have on different influence on a functional condition and serviceability CNS and intimately — vascular of systems in time of stress situation (passing an examination). There are distinctions to a sexual attribute. High nervous and emotional state, which occurs under the influence of stress factors in extreme conditions can lead to disruption of the mechanisms of homeostasis, and if its effect on the body is high in intensity, there may be a depletion of reserve capabilities organism. The revealed differences in the response of the cardiovascular and central nervous systems in boys and girls suggest a higher «mobilization readiness» of the male body for the effects of stress. The female organism reacts to the exam less pronounced, but more prolonged arousal, which may indicate the involvement of the hormonal system in the body's response to a stressful situation.

Keywords: of influence, ecologia, examination, reaction, organism, process, central nervous system, cardiovascular system, adaptation.

The state of health of the child population, its protection and strengthening are a central problem at all stages of society's transformation, because the health of the young generation is at the basis of the nation's long-term development.The quality of the environment has a pronounced effect on the formation of indicators of the state of health of the child's body. The state of children's health as an ecopathological problem in the last decade is the most studied, as there is a tendency to increase the incidence and severity of diseases [1, 2].

The study of stress and its consequences is one of the pressing problems of our time. Not only massive extreme situations are significant stressors, but, at times, quite ordinary phenomena and situations, such as exams. The busy schedule of the day, a significant amount of training programs, a chronic and prolonged time deficit necessary for mastering the vast amount of information characteristic of students in modern society, act as stressors and can lead to various nervous breakdowns and adaptation disorders [3].

In the situation of the exam, as in any situation that requires the restructuring of the adaptive mechanisms of the organism, the whole gamma of physiological, vegetative, somatic and psychological manifestations of stress is observed.

Researches to assess the impact of the environment on health, especially children, should primarily focus not so much on the study of morbidity as on the identification of initial adverse pre-pathological changes that will fully meet the principles of prevention and will ensure the preservation of health in the conduct of recreational activities [4].

The purpose of the work: to assess the influence of environmental factors on the functional stress of the schoolchildren's body under emotional stress.

Materials and methods of the research

Object of the study: students of secondary comprehensive schools in Karaganda. The age of the examined was 14–15 years. A methodical «copy-pair» approach was used, in which for each unit of observation in the experimental group, similar units of observation in the control group (by age, social and household indicators) are selected so that the only distinctive feature of the two groups being compared is the zone of residence. The main group of children lived in the area — Maikuduk, where there is a whole complex of industrial enterprises (school № 61), control — the area of the South-East, where there is no prom-enterprises (school № 16). Physiological studies included: 1) measurement of cardiovascular system parameters — systolic (SAP) and diastolic (DAP) arterial pressure, pulse rate (PR); 2) measurement of the CNS indices — the critical fusion frequency of light flashes (CFFLF), the time of a simple visual and auditory response (SVR and SAR). Studies were conducted before and after the exam, as well as during the training period (initial state).

Statistical processing of data was carried out using standard and modified packages of statistical programs [5].

Results and discussion

High nervous and emotional state, which occurs under the influence of stress factors in extreme conditions, as in our example, passing the exam, can lead to disruption of the mechanisms of homeostasis, and if its effect on the body is high in intensity, there may be a depletion of reserve capabilities organism.

From the analysis of the dynamics of psycho-physiological indicators, it can be seen that in general, all systems adequately responded to emotional stress. But despite this, different systems have their own peculiarities. One such system was the central nervous system. As the analysis of the results showed, the severity of CNS response to exam stress directly depended on the environmental situation at the place of residence of schoolchildren, however, this did not everywhere have significant differences.

One of the criteria for the effectiveness of the CNS was the magnitude of the critical frequency of fusion of light flashes. As can be seen from Figure 1, the ecological situation at the place of residence was reflected in the dynamics of CFFLF during the exam, and these differences did not have a negative color. In schoolchildren living in the main district, the values of CFFLF were higher than in control.

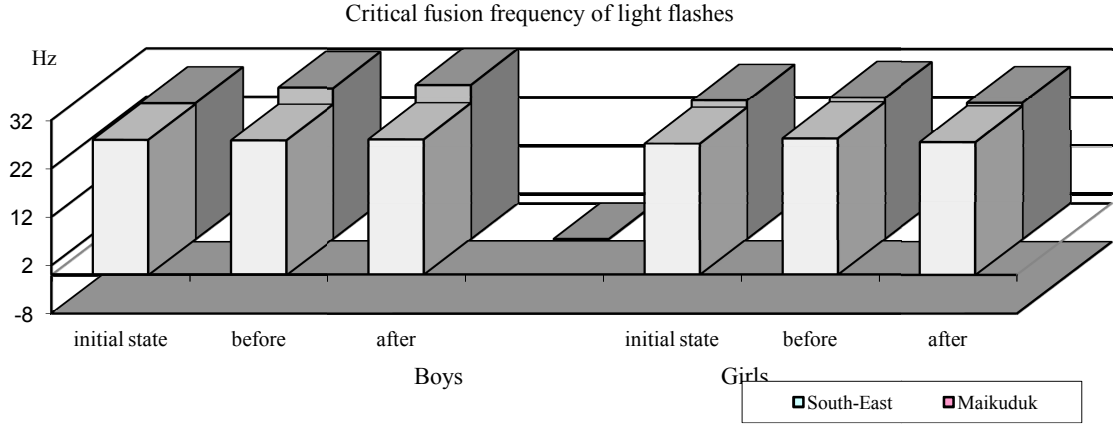

Figure 1. Dynamics of CFFLF in schoolchildren with emotional stress depending on the place of residence

From the analysis of the dynamics of psycho-physiological indicators, it can be seen that in general, all systems adequately responded to emotional stress. But despite this, different systems have their own peculiarities. One such system was the central nervous system. As the analysis of the results showed, the severity of CNS response to exam stress directly depended on the environmental situation at the place of residence of schoolchildren, however, this did not everywhere have significant.

The boys had significant differences and the degree of expression of changes in emotional stress was greater. So, if the boys of the control group did not show significant dynamics, then in the main group these changes had a pronounced character. At the initial value of CFFLF 28.1±0.5 Hz, the average value before the exam increased to 31.3±0.84 Hz ($p < 0.05$), reaching a maximum value after the exam — 32.1±1.34 Hz ($p < 0.05$). And if we take into account that CFFLF is a characteristic of the functional state of the central nervous system, it turns out that in schoolchildren living in the main region, the functional activity of the cortical part of the visual analyzer is much higher than in the control group. CFFLF is a very labile indicator that varies with mental and physical loads, therefore, the adaptive ability to influence stress factors in the schoolboys of the main group is higher. Girls have significant differences both in the dynamics of passing the exam, so, depending on the place of residence, it is not revealed.

Several excellent results were obtained using reflex responses to sound and light stimuli, and if in the previous case there was a positive dynamics in the schoolchildren of the main group, then with MWR and CMR the result was the opposite. And besides, the dynamics in the process of passing the exam had similar tendencies on the basis of gender and differences in indicators.

So in boys there were significant differences in SVR and SAR between the main and control groups, i.e. on an ecological basis. The exception was the postexamendation stage at the time of the SVR. In girls, significant differences were noted only in the initial values (Figs. 2 and 3). On the part of SVR (Fig. 2), the

schoolchildren of the main group showed an increase in the reaction time in boys in the postexamination period, whereas in girls high values occurred already in the pre- and postexecutions periods, although these differences did not have statistical validity.

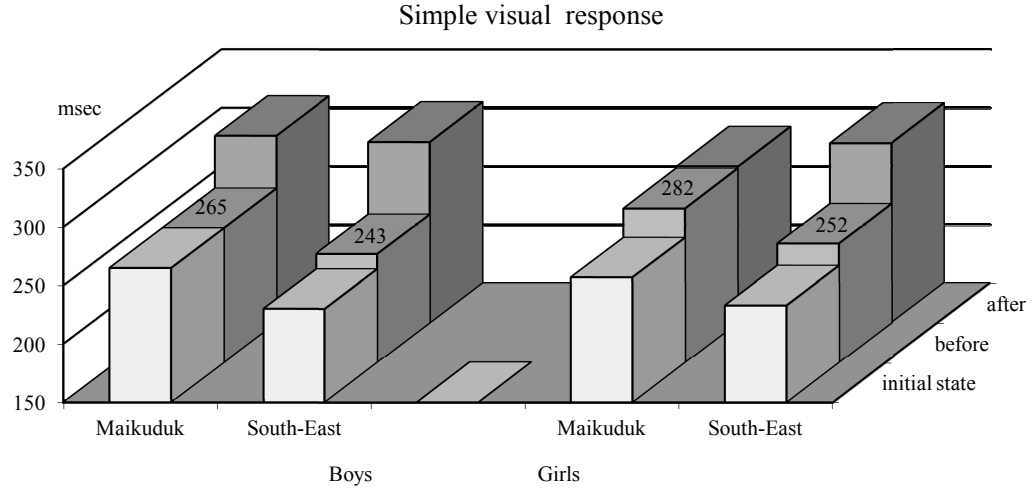

Figure 2. Dynamics of SVR in schoolchildren with emotional stress depending on the place of residence

So, if the boys had a 265.2±8.7 msec initial SVR level, before the exam it remained at the same level — 265.1±14.1 msec, then after the exam it increased to 309.6±20.0 msec ($p < 0.05$). In the control group, both in girls and boys, there was a gradual increase in SVR time, which reached statistical certainty in the postexamination period. At the initial level of SVR in boys, 229.7±10.6 msec (233.1±9.89 msec in girls), before the examination there was a slight increase — 242.5±5.39 (252.5 ±14.7), which reached the maximum peak after the exam — 304.9±17.6 msec (304.0±17.6, $p < 0.05$).

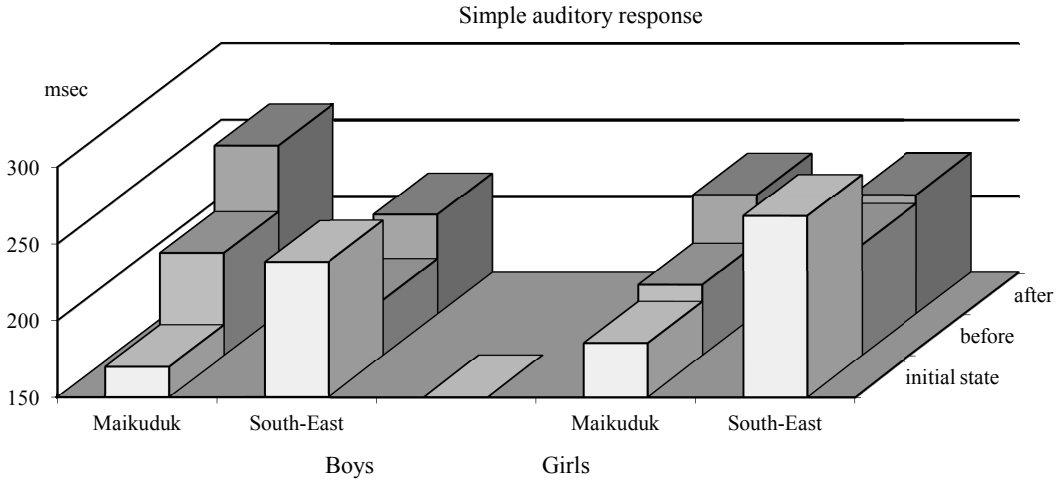

Figure 3. Dynamics of SAR in schoolchildren with emotional stress depending on the place of residence

At the time of the latent period of SAR (Fig. 3), the dynamics, depending on the place of residence, had a slightly different directionality than in the SVR. If at the first there was an increasing increase in the mean in the dynamics of passing the examination process in both groups studied, then the second indicator (SMR) had significant distinctive features. Thus, in the schoolboys of the main group, there was a growing increase in the time of SAR, with minimal values in the initial state (170.0±10.1 msec in boys, 185.4±10.2 in girls) and maximum in the postexamination period (259.6±18.5 and 228.1±11.1, respectively, $p < 0.05$). In the school children of the control group, the maximum values of the SAR time were recorded in the initial state (in boys — 238.2±12.1 and in girls — 267.8±15.2 msec), the minimum for the pre-examination period (186.8±11.9 and 221.5±15.9 msec, $p < 0.05$).

The time of the reflex to light and sound depends not only on the speed of passage of excitation through the central formations, but also on the physiological performance of the analyzer itself, its properties. Therefore, probably, schoolchildren living in the zone of environmental stress, where the largest number of industrial enterprises, vehicles, there is a decrease in the threshold of auditory sensitivity, which was reflected in the time of SAR.

In this way the unfavorable ecological situation at the place of residence has different effects on the functional state and efficiency of the central nervous system during the stressful situation (passing the exam). The schoolchildren in the main district have higher lability of the visual and auditory analyzer, however, the reflex reactions are much lower, especially manifested when exposed to stress factors. In girls, these manifestations are less pronounced than in boys. An additional criterion confirming this assumption can be the number of reliable shifts observed in schoolchildren during the research. Thus, the total number of reliable shifts in girls corresponded to 4, while to boys — 7. The number of significant differences between the groups studied, separated by the ecological sign, also differs significantly — in girls there were only two significant differences, while in males -customers — 6.

The level of arterial pressure is one of the leading indicators of hemodynamic adaptation to various conditions of life. The level of blood pressure is determined mainly by two factors — the amount of blood injected by the heart into the arterial system per unit time and the resistance that meets the blood flow in the vessels. Due to the fact that these factors are interrelated and subject to the influence of complex regulatory mechanisms, the pulse and blood pressure indicators can give the most general impression of the functional state of the circulatory system. Especially if this factor is emotional stress, to which the cardiovascular reacts one of the first.

On the part of SAP and DAP, the boys did not experience significant dynamics under the influence of examination stress. The exception is the boys living in the control area, who had an increase in diastolic pressure in the postexamination period to 82.7±2.83 mm Hg (at the initial level of 76.7±1.57, $p < 0.05$). Girls had a gradual increase in the systolic level and a decrease in diastolic blood pressure during the postexamination period. And if the decrease in DAP was noted only in the control group, the increase in SAP was noted in both groups. Significant differences depending on the zone of residence were noted only in the SAP in the initial state and after the examination. At the same time, the schoolchildren of the main district had higher blood pressure values than in the control, with the exception of DAP in boys after the examination, where its level in the control group was higher than in the main group by 5.2 mm Hg ($p < 0.05$).

Examination stress causes an increase in the tone of the sympathetic nervous system, as evidenced by an increase in heart rate. In the dynamics of the examination, there are significant differences in the analysis of their schoolchildren both in terms of gender and in the area of residence. In boys, as such, there was no significant dynamics in passing the exam, except for a significant difference in the initial PR, in boys in the main rayon it averaged 81.7±2.9 beats per minute, while in control it was 72.5±2.74 ($p < 0.05$) beats per minute (Fig. 4). This difference explains the presence of reliable shifts in this group when passing the exam. The girls had a significant increase in PR both before and after the exam. In the main group, the average PR values were higher than in the control group by an average of 7.2±8.1 bp/min ($p < 0.05$).

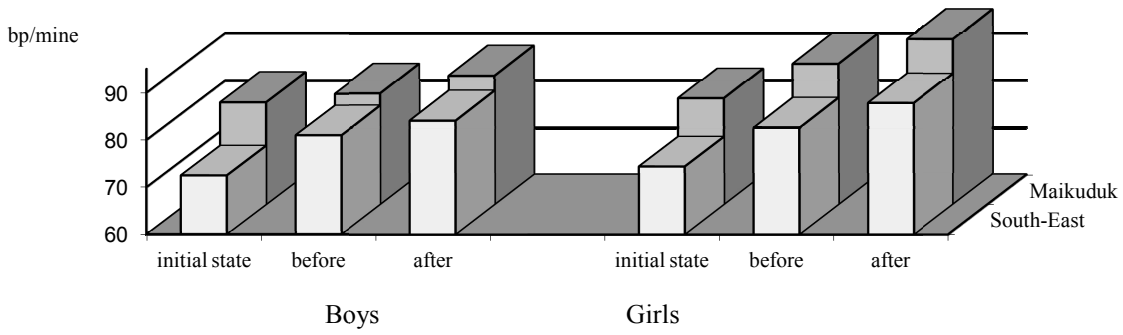

Figure 4. Dynamics of PR in schoolchildren with emotional stress depending on the place of residence

The studies conducted in the groups formed on the principle of copy-pair, indicate that girls are more sensitive to the effects of environmental pollution than boys [2].

In the process of passing the exams, various levels of functional stress of the schoolchildren's organism were noted. At the same time, more pronounced changes in the direction of increase in the functional strain of the organism were noted in schoolchildren living in the zone of ecological stress. Sexual characteristics were also noted — the girls' organism responded more expressively to examination stress, which was characterized by higher values of physiological indicators reflecting the level of functional strain of the organism in the process of vital activity.

The adaptive-adaptive activity of the whole organism of schoolchildren under the influence of stress-strain was evaluated, as in the previous chapter, in terms of the mathematical analysis of the heart rhythm. To assess the state of the body's regulatory systems, in particular, the activity of the sympathetic and parasympathetic parts of the autonomic nervous system, a method of mathematical analysis of the heart rhythm was widely used. Most authors emphasize the high enough informativeness of the methodology in assessing the functional state of schoolchildren. Changes in the pulse rate is a universal reaction of the body in response to any load. And, if the average heart rate reflects the final result of numerous regulatory influences on the circulatory system, then the structure of the heart rhythm, encoded in the sequence of cardiointervals, shows how this homeostasis was formed, what is the «price» of this adaptation.

Since the value of expectation is a derivative of the pulse rate (PR — 60 mm/sec), the description of its dynamics is omitted (Table).

T a b l e

Parameters of *Regulatory System Activity Index* (RSAI) in schoolchildren with exam stress

Parameter	Initial	Before the exam	After the exam
Boys — Maikuduk	5.8 ± 0.59	6.12 ± 0.43	6.78 ± 0.62
Boys — South-East	4.82 ± 0.39	5.78 ± 0.47	5.96 ± 0.52*
Girls — Maikuduk	5.87 ± 0.45	6.53 ± 0.51	7.13 ± 0.63*
Girls — South-East	4.37 ± 0.43	4.95 ± 0.34	5.4 ± 0.48*

Note: * — $p < 0.05$.

Under the influence of pre- and postexamination stress, the schoolchildren have an increase in the amplitude of the mode amplitude (AMo). Moreover, it is more pronounced in the post-examination period for girls living in the zone of ecological stress. Thus, if they had an initial AMo of 46.0±2.24 % (40.4±2.24 % in the «clean» one), in the pre-examination period there was an insignificant increase to 50.7±2.1 % (48.8±3.69 %, $p < 0.05$), after the examination the average value was 65.7±2.27 % ($p < 0.05$) (in the «clean» — 50.0± 3.64 %) (Fig. 5). In boys, large AMo values were observed in a «clean» area. And since AMO reflects the mobilizing effect of centralizing cardiac rhythm management, consequently, in the girls of the Maikuduk, the examination process was accompanied by an increase in the influence of the sympathetic department of the autonomic nervous system. A similar dynamics was observed in the coefficient of variation (Table).

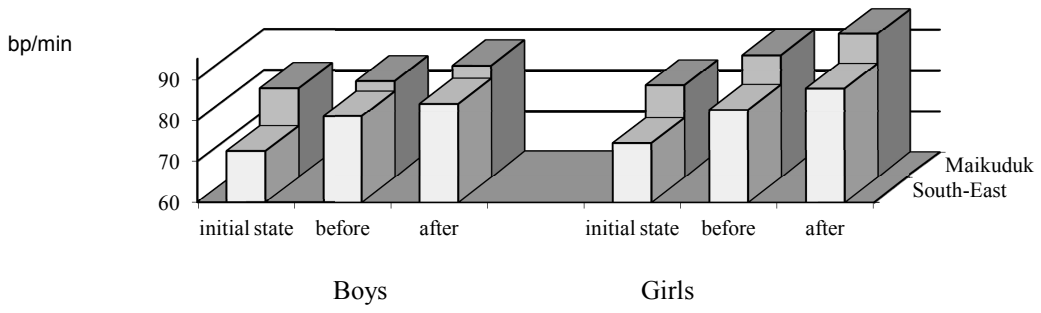

Figure 5. Dynamics of AMo in schoolchildren with exam stress

Examination stress causes the stress of regulatory systems, by activating central regulatory mechanisms. This is evidenced by the dynamics of the stress index (SI), where its phased increase is noted, with the maximum values in the post-examination period (Fig. 6). In this case, unlike the previous indices (AMo and CV),

in this case, high values of SI were for schoolchildren living in the zone of ecological disadvantage, and also high values of SI were observed in girls.

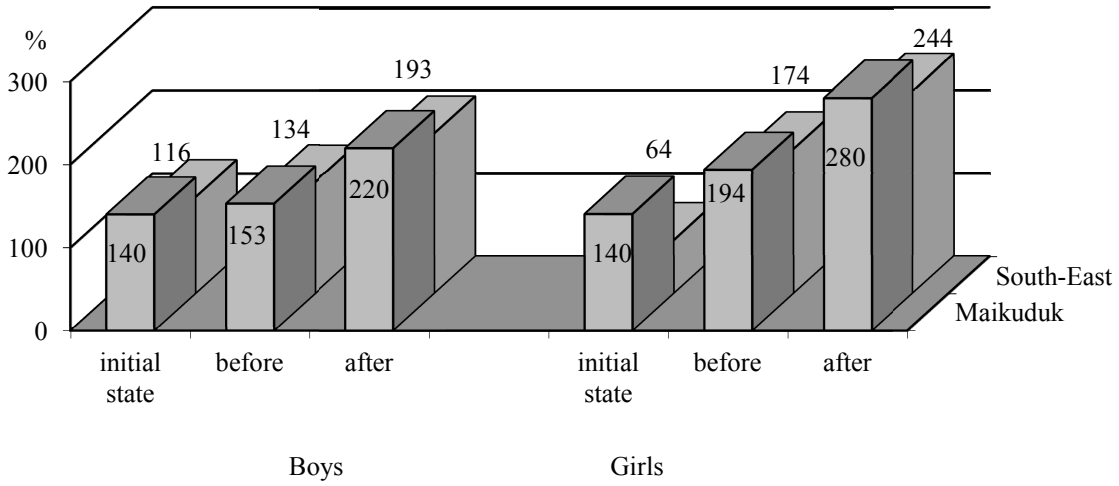

Figure 6. Dynamics of SI in school children in exam stress

So, if the boys in the Maikuduk, the value of the IN after the exam averaged 220.1±32.4 units. (193.1 ± 34.4 in «clean»), then for girls for this period the average value of IN was 280.3±44.2 units (244.1 ± 28.1). A similar dynamics was noted in the centralization index, which reflects the degree of centralization of cardiac rhythm management (Table).

In accordance with the evaluation scale of the RSAI, the level of functional stress was estimated:

For boys of the Maikuduk:

– before the exam — the state of overstraining of regulatory systems;

– after the exam — the state of a pronounced overvoltage of regulatory systems.

For boys in the South-East:

– before the exam — the state of overstraining regulatory regulators;

– after the exam — the state of expressed overvoltage of regulatory systems.

For girls of the Maikuduk:

– before the exam — the state of overstraining regulatory regulators;

– after the exam — the state of a pronounced overvoltage of regulatory sytems.

For girls in the South-East:

– before the exam — the state of sharply expressed tension of regulatory systems.

Thus, based on the foregoing, we can draw the following conclusions.

1. The unfavorable environmental situation at the place of residence differently affects the functional state and performance of the CNS during a stressful situation (passing the exam). The dynamics of systolic and diastolic pressures, as well as an increase in PR during the exam, reflects a certain degree of mobilization of the cardiovascular system to ensure high mental tension.

2. The revealed differences in the response of the cardiovascular and central nervous systems in boys and girls suggest, apparently, a higher «mobilization readiness» of the male body for the effects of stress. The female organism reacts to the exam less pronounced, but more prolonged arousal, which may indicate the involvement of the hormonal system (pituitary-adrenal) in the body's response to a stressful situation — the exam.

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Ш.М. Нугуманова

Оқушылар ағзасының функционалдық жағдайына емтиханның әсерін бағалау

Мақала емтихан тапсыру кезіндегі оқушылардың функционалдық ауыртпалығына жағымсыз экологиялық факторлардың әсерін бағалауға арналған. Зерттеу нысаны ретінде Қарағанды қаласының экологиялық жағдайы әртүрлі аудандарында тұратын жалпы білім беретін орта мектеп оқушылары алынды. Стресс кезінде (емтихан) тұрғылықты жеріне байланысты жағымсыз экологиялық жағдай орталық жүйке жүйесінің функционалдық жағдайы мен жұмысқа қабілеттілігіне және жүрек-тамыр жүйесіне әртүрлі әсер ететіндігі байқалды. Сонымен қатар жыныстық белгілері бойынша айырмашылықтар байқалды. Төтенше жағдайларда стресс-факторлар әсерінен туындайтын жоғары жүйкелік-эмоционалдық ширығу жағдайлар гомеостаз механизмдердің зақымдануына әкеледі. Осындай әсер ағзаға қарқынды болса, ағзаның қосымша қолайлы жағдайлардың сарқылуы орын алады. Ұлдар мен қыздарда қан-тамыр және орталық жүйке жүйесінің реакция корында анықталған айырмашылықтар күйзеліс әсеріне ұлдар ағзасында «ұтқыр дайындыққа» бейімділігін көрсетті. Қыздар ағзасы емтихан жағдайларына әлсіз, бірақ қызумен көрініс табады, оның себебі — күйзеліс әрекетіне ағза реакциясының гормоналдық жүйесінің қатысуы.

Кілт сөздер: бағалау, экология, емтихан, реакция, ағза, орталық жүйке жүйесі, қан-тамыр жүйесі, бейімделу.

Ш.М. Нугуманова

Оценка влияния экзамена на функциональное состояние организма школьников

Работа посвящена оценке влияния негативных экологических факторов на функциональное состояние организма школьников во время экзамена. Объектом исследования явились школьники, проживающие в различных по степени экологического загрязнения районах города Караганды. Выявлено влияние неблагоприятной экологической ситуации при стрессе (экзамена) со стороны ЦНС и сердечно-сосудистой системы у учащихся по месту жительства. Также наблюдались различия по половому признаку. Высокое нервно-эмоциональное состояние, возникающее под воздействием стресс-факторов в экстремальных условиях, может привести к нарушению механизмов гомеостаза, а если при этом воздействие его на организм будет высоким по интенсивности, то может возникнуть истощение резервных возможностей организма. Выявленные различия в реакции сердечно-сосудистой и центральной нервной систем у мальчиков и девочек свидетельствуют о более высокой «мобилизационной готовности» мужского организма на воздействие стресса. Женский организм реагирует на экзамен менее выраженным, но зато более длительным возбуждением, что может указывать на вовлечение гормональной системы в реакцию организма на стрессорную ситуацию.

Ключевые слова: оценка, экология, экзамен, возраст, реакция, организм, процесс, центральная нервная система, сердечно-сосудистая система, адаптация.

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