

## INTERSYSTEM INTEGRATION IN TERMS OF THE EDUCATIONAL PROCESS IN THE INITIAL COURSES OF HIGHER MEDICAL SCHOOL

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Presently the studying in a higher education establishment is considered by physiologists and clinicians as a psychoemotional stress, which can lead to the activation of the sympathetic adrenal system and to the disintegration of intersystem relations in many cases, which provide the body's adaptation to damaging stress factors activation [4,5].

Emotional and stress conditions of the students are common etiologic factor of occurrence of a large group of many visceral systems neurogenic diseases. This ensures the necessity of studying the body's ability to counteract the negative effects of stress. Any stress to our body is a state of disturbed homeostasis and stressors are the factors that cause this violation [1,2].

The body's response to a stress is a stress reaction, i.e., an adaptive process, which is aimed at the homeostasis restoration and preservation of normal life in such conditions. It reveals itself through the complex of behavioral and physiological changes: the mobilization of the circulatory system functions, respiration, energy metabolism, immune system, i.e., those systems which are responsible for adaptation [3]. All of the above mentioned make it necessary to study intersystem relationships that are the basis for the development of the body's resistance to the effects of stress factors, i.e., an adaptation syndrome.

To study the intersystem relationships in medical students of 1-3 courses of Kharkiv National Medical University (KhNMU) and their importance in the development of non-specific resistance to emotional stress tension. The conducted study was as part of research project «Determination of individually typological features of human adaptation to the intellectual and physical activities» of the Physiology Department of KhNMU (state registration number 0115U000239, timeline for compliance 2015-2017).

**Material and methods.** The objects of studying were the female students of 1-3 courses. The study was conducted in the conditions of the educational process that simulated emotional stress of dynamic nature. The features of intersystem integration of the cardiorespiratory system and integrative functions of the brain were studied in a certain pattern, according to which the individual card of the studied has been developed. An intellectual work capacity and attention stability as indicators of the integrative functions of the brain have been studied in terms of correction test, the indicators of which were the total percentage of performed work and the number of mistakes for 2 minutes

of the test. The indicators of autonomic provision were recorded parameters of the circulatory system: heartbeat rate (HR), pulse rate by palpation, blood pressure (systolic, diastolic, pulse and medium dynamic); as well as the respiratory system: respiratory frequency (RF), Stange functional test (breath holding at inhalation) and Ghencea functional test (breath holding at exhalation). In order to analyze intersystem relationships a "conjugation index" (CI) was calculated, as well as the ratio of the heart rate, and respiratory rate. The total number of examined female patients was 217 (aged 18 - 20 years).

**Results and their discussion.** The research of integrative brain functions indicators, carried out before the start of the classes on the 1st course (control group of female students - CG) showed that the entire contingent of the studied according to total amount of performed intellectual work in accordance with correction test is divided into 3 groups: - group 1 (MG1) - low intellectual efficiency, the amount of performed work is below 30% (26,48±1,7%); - group 2 (MG2) - average intellectual efficiency, the amount of performed work is more than 30% (33,4±2,36%); - group 3 (MG3) - high intellectual efficiency, the amount of performed work is more than 40% (43,5±3,77%).

Table 1 represents the groups' quantitative composition (%) by studying years. As it can be seen, the identified groups remain, however, their number is changing: in the control group, students with average intellectual work efficiency level make up a half of the studied at the same low number of MG1 and MG2 groups. In the dynamics of studying the number of groups with average and high intellectual efficiency are increased, with low level are reduced. In this case the amount of performed work is changed in the correction test (Table 2): the total amount of performed work is almost the same for female students of MG1 and MG2 as before the studying so in the dynamics of the three years of studying and for female students of MG3 this index is constantly growing and is maintained till the end of the 3rd year.

An indicator of intellectual efficiency is a quality of performed work, which was estimated by the number of mistakes during intellectual load (Table 3). Thus, qualitatively (the least amount of mistakes in correction test - 4,9±0,6) female students of MG2 work before the start of classes, they make up 54% of the examined at this time. The students with high level of intellectual efficiency (MG3) make up 17%; they work less efficiently apparently due to a large amount of performed work.

Table 1. The dynamics of changes in the number of female students with different degrees of intellectual efficiency according to the years of studying

| Groups of students      | Before classes | At the end of the 1 <sup>st</sup> course | At the end of the 2 <sup>nd</sup> course | At the end of the 3 <sup>rd</sup> course |
|-------------------------|----------------|--|--|--|
| Low efficiency, (%)     | 29             | 26                                       | 11                                       | 16                                       |
| Average efficiency, (%) | 54             | 43                                       | 30                                       | 58                                       |
| High efficiency, (%)    | 17             | 31                                       | 59                                       | 26                                       |

Table 2. The dynamics of changing in quantitative indicators of correction test's performing of female students with different degrees of intellectual efficiency according to the years of studying

| Groups of students      | The amount of performed work (%) |  |  |  |
|-------------------------|----------------------------------|--|--|--|
|                         | Before classes                   | At the end of the 1 <sup>st</sup> course | At the end of the 2 <sup>nd</sup> course | At the end of the 3 <sup>rd</sup> course |
| Low efficiency, (%)     | 26,5±1,76                        | 27,0±0,66                                | 27,1±1,82                                | 23,3±2,45                                |
| Average efficiency, (%) | 33,4±0,41                        | 34,5±0,55                                | 35,3±0,73                                | 33,3±0,42                                |
| High efficiency, (%)    | 43,5±1,26                        | 50,0±3,54                                | 54,6±2,15                                | 47,0±1,89                                |

Table 3. The dynamics of changes in the quality of correction test's performing at rest according to the years of studying

| Groups of students      | The number of mistakes (%) |  |  |  |
|-------------------------|----------------------------|--|--|--|
|                         | Before classes             | At the end of the 1 <sup>st</sup> course | At the end of the 2 <sup>nd</sup> course | At the end of the 3 <sup>rd</sup> course |
| Low efficiency, (%)     | 7,3±2,2                    | 3,5±1,04                                 | 7,1±2,1                                  | 13,3±4,5                                 |
| Average efficiency, (%) | 4,9±0,6                    | 8,7±2,7                                  | 5,9±1,2                                  | 8,9±1,6                                  |
| High efficiency, (%)    | 12,2±5,5                   | 6,6±1,5                                  | 14,4±2,7                                 | 9,7±2,01                                 |

A poor quality and small amount of work is characteristic for female students of MG1. The analysis of this indicator according to the years of studying revealed a clear tendency: in 72.5% of female students the decreasing of the quality of intellectual work is observed (the number of mistakes is increasing, especially marked at the end of the 3rd year in 2 times). In female students of MG3 significant fluctuations in the direction of increasing and decreasing were determined in this index. But by the end of the 3rd year this indicator improves comparing to the beginning of classes.

The studying of autonomic provision of intellectual work has shown that in students of all 3 groups low blood pressure rate is defined in the initial state (BP) – systolic BP, diastolic BP, average BP and pulse BP are low for 4.98% in average compared with standard norm. Herewith the heartbeat rate is not changed. In the dynamics of studying a tendency of further reduction of blood pressure indica-

tors is marked, however, the heart rate remains constant (as compared to the CG).

In complex of studied parameters of the respiratory system at female students of MG1 RF is virtually unchanged from original state, indicating a constant lungs' ventilation (Table 4). The duration of breath delay at inhalation (Stange test) is increased by the end of 1<sup>st</sup> year for 30% compared to the CG and is held at this level until the end of the 3rd year, indicating a speed decrease of oxygen utilization by brain tissue. Breath holding at exhalation (Ghench test) remains practically unchanged, reflecting a stable transferability level of hypoxia by brain that occurs in the conditions of this test.

Disintegration in the cardiorespiratory system is not determined: CI characterizing the intersystem integration of these systems in all the years of studying has normal amount and ranges from the physiological norm from 4.43 at original state to 4.9 at the end of the 3rd year of studying.

Table 4. The dynamics of changes in the degree of functional asymmetry according to the years of studying (%)

| Groups of students      | Before classes | At the end of the 1 <sup>st</sup> course | At the end of the 2 <sup>nd</sup> course | At the end of the 3 <sup>rd</sup> course |
|-------------------------|----------------|--|--|--|
| Low efficiency, (%)     | 10             | 16                                       | 1  | 77                                       |
| Average efficiency, (%) | 13             | 41                                       | 4  | 77                                       |
| High efficiency, (%)    | 2              | 2  | 38                                       | 21                                       |

Table 5. The dynamics of changes of visual memory indicators of female students according to the years of studying (%)

| Groups of students      | Before classes | At the end of the 1 <sup>st</sup> course | At the end of the 2 <sup>nd</sup> course | At the end of the 3 <sup>rd</sup> course |
|-------------------------|----------------|--|--|--|
| Low efficiency, (%)     | 43,1 ± 4,1     | 54,1 ± 3,2                               | 52,6 ± 4,5                               | 52,9 ± 2,1                               |
| Average efficiency, (%) | 50,8 ± 2,2     | 62,0 ± 2,8                               | 60,4 ± 3,2                               | 57,1 ± 2,4                               |
| High efficiency, (%)    | 56,6 ± 4,2     | 63,0 ± 4,1                               | 56,9 ± 2,0                               | 61,1 ± 3,6                               |

Table 6. Dynamics of changes in the complex functional parameters cardiorespiratory system of students with a high capacity for work by years of training

| Functional indicators | Before classes  | At the end of the 1 <sup>st</sup> course |                  | At the end of the 2 <sup>nd</sup> course |                  | At the end of the 3 <sup>rd</sup> course |                  |
|-----------------------|-----------------|--|------------------|--|------------------|--|------------------|
|                       | Absolute number | Absolute number                          | Per-centage, (%) | Absolute number                          | Per-centage, (%) | Absolute number                          | Per-centage, (%) |
| Systolic BP           | 115,0           | 111,8                                    | -2,6             | 112,0                                    | -2,6             | 110,3                                    | -4,1             |
| Diastolic BP          | 71,7            | 74,1                                     | +3,3             | 72,5                                     | +1,95            | 70,0                                     | -2,4             |
| Average BP, mm Hg     | 85,8            | 86,3                                     | +0,58            | 85,3                                     | -0,58            | 83,3                                     | -2,9             |
| Pulse BP, mm Hg       | 43,3            | 40,5                                     | -6,46            | 39,4                                     | -9,0             | 40,3                                     | -6,9             |
| Heartbeat rate        | 75,3            | 76,0                                     | +0,9             | 74,2                                     | -1,5             | 76,8                                     | +1,99            |
| RF                    | 13,8            | 15,6                                     | +13,0            | 18,2                                     | +31,8            | 17,4                                     | +26,0            |
| Stange, seconds       | 40,9            | 51,8                                     | +26,6            | 47,2                                     | +15,4            | 48,3                                     | +18,1            |
| Ghncea, seconds       | 32,3            | 29,4                                     | -8,4             | 30,8                                     | -4,7             | 40,2                                     | +24,5            |
| CI, relative units    | 5,46            | 5,0                                      | --               | 4,08                                     | --               | 4,41                                     | --               |

In female students of MG2 in the dynamics of studying all indicators of respiratory function are changing biphasic (Table 5). So RF is slightly reduced (by 2.48%) in a year of studying and then is continuously reduced at the 2nd course and exceeds the original level in the end of the 3rd year for 6.8%. This is an indication to ventilation increasing, which is accompanied by a deterioration of tests indicators with breath holding: at the end of the 1<sup>st</sup> year the time of Stange test is increased by 23% (the speed of metabolic processes oxygen using decreases), by the end of the 2nd year there is a reduction of test time for 11%, by the end of the 3rd year it is again increased for 9.8%. All above mentioned characterizes an instability of the use of redox processes in metabolic function, but the intersystem relationships of the respiratory and cardiovascular system according CI indicator are stable (4.87) and are not significantly changed during all years of studying.

In female students of MG3 the increasing of RF is marked during the whole period of observation (Table 6), comparing to the original state - for 13% at the end of 1st year, for 31.8% - at the end of the 2nd year, for 23% - at the end of the 3rd year. In this case the increasing of ventilation is accompanied by a dynamic ongoing decrease in metabolic speed: Stange test increased the most at the end of 1st year (26.6%) and remains the same until the end of the 3rd year (15.4% and 18.1% - on the 2nd and the 3rd year respectively). The duration of breath exhalation (Ghncea test,

hypoxia transferability) didn't change during the 2 years of studying, and at the end of the 3rd year increased for 24.5% compared to the CG. CI in this group in the initial state indicates a high degree of the cardiorespiratory system integration, but by the end of the 3rd year of studying at the university, this indicator reduces to 20%.

**Conclusions.** Thus, gained data suggest a dynamic and multifactorial nature of adaptation to the training load: obviously, as a result of the combination of high demands and low efficiency in female students of MG1 and MG2 by the end of the 3rd year of study a phenomena of fatigue, deteriorating processes of analytical activity of the cerebral cortex, difficult decision-making process increase. The high intellectual efficiency in MG3 is the factor that ensures the most effective development of adaptation, but is accompanied by a high waste of resources of the body, makes the "value" of adaptation very high, and naturally can lead to depletion of adaptive capacity.

In our opinion the prospects for further research consist of further study of adaptation to emotional stress, which is developed in conditions of studying in higher education establishment in female students-sportswomen. It will give an opportunity to identify mechanisms of resistance to stress on the background of constant physical exercise comparing to female students of the general group.

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## SUMMARY

### INTERSYSTEM INTEGRATION IN TERMS OF THE EDUCATIONAL PROCESS IN THE INITIAL COURSES OF HIGHER MEDICAL SCHOOL

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The study was conducted as part of research work «Features of integrative and autonomic functions in the process of adaptation to the intellectual, emotional and physical stress» of the Department of Physiology of KhNMU. The aim of this work was to study the intersystem relationships that are the basis for the development of the body's resistance to the effects of stress factors, i.e., the development of adaptation syndrome in medical students. The object of the study were 217 students of 1-3 courses, which were examined in terms of the educational process. The features of intersystem integration the cardiorespiratory system on the basis of conjugation and integration of brain activity indices based on intellectual efficiency in terms of a correction test.

The study of the psychophysiological indicators complex in dynamics (3 years) revealed the formation of chronic

emotional stress in medical students, the severity of which depends on the individual psychophysiological status of students. It was set that the formation of the adaptive optimum with psychoemotional stress occurs in only in 40% of students. Most of the students (60 %) indicate or initially insufficient adaptive capabilities, or an excessive rate, which naturally lead to psychological and autonomic disturbances in the organism.

**Keywords:** medical school, intersystem integration, psychoemotional stress, adaptive capabilities.

## РЕЗЮМЕ

### МЕЖСИСТЕМНАЯ ИНТЕГРАЦИЯ В УСЛОВИЯХ УЧЕБНОГО ПРОЦЕССА НА НАЧАЛЬНЫХ КУРСАХ МЕДИЦИНСКОГО ВУЗА

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Исследование проведено в рамках научно-исследовательской работы «Особенности интегративных и вегетативных функций в процессе адаптации к интеллектуальным, эмоциональным и физическим нагрузкам» кафедры физиологии Харьковского национального медицинского университета. Целью данного исследования явилось изучение межсистемных взаимоотношений, которые являются основой развития устойчивости организма к воздействию стрессовых факторов, т.е. развития адаптационного синдрома у студентов-медиков. Объектом исследования были 217 студентов I-III курсов в возрасте от 18-20 лет, которые были обследованы в условиях учебного процесса. Изучены особенности межсистемной интеграции кардиореспираторной системы посредством определения индекса сопряженности и интеграционной активности мозга на основе интеллектуальной работоспособности в условиях корректурной пробы.

Исследование комплекса психофизиологических показателей в динамике (3 года) выявили формирование хронического эмоционального стресса у студентов-медиков, тяжесть которого зависит от индивидуальных особенностей психофизиологического статуса студентов. Установлено, что формирование адаптивного оптимума при психо-эмоциональном стрессе происходит лишь у 40% студентов. Большинство студентов (60%) показывают либо изначально недостаточные адаптивные возможности, либо их чрезмерную интенсивность, что закономерно приводит к психологическим и вегетативным нарушениям в организме.

## რეზიუმე

სისტემათშორისი ინტეგრაცია სასწავლო პროცესის პირობებში უმაღლესი სამედიცინო სასწავლებლების დაწეებით კურსებზე

დ. მარაკუშინი, ლ. ჩერნობაი, ო. ვასილიევა,  
ი. კარმაზინა

ხარკოვის ეროვნული სამედიცინო უნივერსიტეტი,  
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კვლევა ჩატარდა ხარკოვის ეროვნული სამედიცინო უნივერსიტეტის ფიზიოლოგიის დეპარტამენტის თანამშრომლების მიერ სამეცნიერო კვლევის «ინტეგრაციული და ვეგეტატიური ფუნქციების სპეციფიკა ინტელექტუალური, ემოციური და ფიზიკური დატვირთვისადმი ადაპტაციის პროცესებში» ფარგლებში. კვლევის მიზანს წარმოადგენდა სტუდენტ-მედიკოსებში სისტემათშორისი ურთიერთობების შესწავლა, რომელიც საფუძველია ორგანიზმის მდგრადობისათვის სტრეს-ფაქტორების მიმართ, ანუ ადაპტაციის სინდრომის განვითარებასათვის.

კვლევის ობიექტს წარმოადგენდა სამედიცინო უნივერსიტეტის I-III კურსის 18–20 წლის ასაკის 217 სტუდენტი ქალი. მათი კვლევა ჩატარდა სასწავლო პროცესის პერიოდში. კარდიორესპირაციული სისტემათშორისი ინტეგრაციის თავისებურებები შესწავლილი იყო შეუღლების ინდექსის გამოყენებით, ტვინის ინტეგრაციული აქტივობა კი – ინტელექტუალური შრომისუნარიანობის საფუძველზე კორექტურული სინჯის პირობებში.

ფსიქოფიზიოლოგიური მანევრებლების კვლევამ დინამიკაში (3 წელი) მედიკოს სტუდენტ-ქალთა შორის გამოავლინა ქრონიკული ემოციური სტრესის განვითარება, რომლის სიმძიმე დამოკიდებულია სტუდენტის ინდივიდუალური ფსიქოფიზიოლოგიური სტატუსის მახასიათებლებზე. დადგენილია, რომ ადაპტაციის ოპტიმუმი ფსიქოემოციური სტრესის დროს ფორმირდება მხოლოდ 40%-ში; სტუდენტთა უმრავლესობა (60%) ავლენს ან იმთავითვე არასაკმარის ადაპტაციურ შესაძლებლობებს, ან მათ გადაჭარბებულ ინტენსივობას, რაც კანონზომიერად იწვევს ფსიქოლოგიურ და ვეგეტატიურ დარღვევებს ორგანიზმში.

## РЕЗУЛЬТАТЫ ИЗУЧЕНИЯ ОПАСНОСТИ ЗАГРЯЗНЕНИЯ ПОЧВЫ ГЕРБИЦИДАМИ РАЗНЫХ КЛАССОВ В ПОЧВЕННО-КЛИМАТИЧЕСКИХ УСЛОВИЯХ УКРАИНЫ

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Применение в современном сельском хозяйстве химических средств защиты растений (ХСЗР) является мощным постоянно действующим фактором риска для здоровья населения и природной окружающей среды. Пестициды занимают место в первой десятке приоритетных поллютантов регионального и планетарного масштаба. Потенциальная опасность их использования обусловлена не только токсичностью для млекопитающих, но и тесно связана с особенностями поведения в окружающей среде. Основным и наиболее опасным звеном циркуляции гербицидов в окружающей среде является почва [6,14].

Одним из наиболее широко применяемых классов пестицидов являются гербициды [13]. По состоянию на 2014 г. в Украине их было зарегистрировано 689 препаратов, что составляло 32,1% от общего ассортимента [9]. Гербициды

по сравнению с инсектицидами и фунгицидами более стабильны в объектах окружающей среды, в частности в почве, что обусловлено их назначением и особенностями применения. Гербициды используют перед или после посева, или сразу по всходам, то есть на ранних стадиях вегетации целевых растений, а оказывать защитное действие от сорняков они должны в течение всего вегетационного сезона, который для некоторых культур, в частности яровых зерновых, длится 3-6, а для озимых – 7-9 месяцев. Именно более высокая устойчивость в окружающей среде повышает потенциальный риск их применения для здоровья населения.

В связи с изложенным целью исследования явилась сравнительная гигиеническая оценка опасности загрязнения почвы гербицидами наиболее перспективных химических классов.