

## THE STUDY OF ADAPTIVE REACTIONS OF THE CARDIORESPIRATORY SYSTEM IN CONDITIONS OF PSYCHOEMOTIONAL STRESSES

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It is known that at present time the mechanisms of adaptation to stress influences are mainly related to a narrow circle of experimental conditions, which limits the interpretation of the results and their clinical extrapolation [1,2]. Such thing is usually ignored: the complex nature of the action of circumstantial factors: the social factors that create the nervous-psychic tension (stress), which at present time has acquired a chronic condition and also evolutionarily unusual influences of technogenic origin [3-5].

A promising way of studying the functional state of an organism is the assessment of its integrity, unity and coherence of regulatory mechanisms [6,7]. Physiological basis of an organism unity is an intersystem integration, which causes successful adaptation to the psycho-emotional stress that appears in the conditions of studying in higher educational institutions [8,9].

Previous studies of psychoemotional stress effect on medical students in a state of rest have shown a dynamic and multifactorial nature of adaptation to the training load [10]. But for the purpose of more immersed determination of adaptation patterns that are hidden in a state of rest, this study used a physical load to failure (determination of physical endurance).

**Material and methods.** The subjects of the study were female students of the main group of I-III courses. The research was conducted during the educational process, which simulated the psycho-emotional load of a dynamic nature.

The female students who were enrolled to the 1st year of the medical university made up a control group. The experimental groups included female students of I, II and III courses, whose medical examination was conducted at the end of the school year. The study of the peculiarities of intersystem integration of the cardiorespiratory system of the organism and the integrative activity of the brain was performed during the examination according to the defined scheme. In order to do it, an individual map of the survey was developed that reflected the parameters of the investigated and registered functions, as well as anthropometric data in the initial state and after physical activity.

Physical load was created during work on a bicycle ergometer to failure. The study used a bicycle ergometer ERG-3, constant strength of 200 watts with a rotational pedals speed of 60 Hz.

The hemodynamic indices of students have been studied - pulse rate palpation; arterial pressure (systolic, diastolic, pulse, average) according to N.S. Korotkov's method. In order to study the condition of the respiratory system, respiratory rates, respiratory function tests of Stange's (breath holding at inhalation) and Genci's (breath holding at exhalation) were determined.

For the analysis of intersystem relationships between the cardiovascular and respiratory systems, the "index of the combination" (IC), as the ratio of the heart rate (HR) to the breathing rate (BR), was calculated. Calculation was done in the final state right after the end of physical activity.

The state of intellectual ability and sustainability of attention in the terms of correctional test was studied. Its indicators were the total percentage of completed work, the number of errors for 2 minutes of the test, as well as for each minute. 217 Kharkiv National Medical University students participated in the survey. The survey was conducted at the beginning of the classes (control group), and then at the end of the 1st, 2nd and 3rd year (main group).

**Results and their discussion.** The research was carried out within the scientific comprehensive research work of physiology department of Kharkiv National Medical University "Peculiarities of integrative and autonomic functions in process of adaptation to intellectual, emotional and physical loads" (№ of registration 0115U000239, execution period 2015-2017).

The study of integrative brain functions indicators in a state of rest, conducted before the beginning of classes on the 1st course, showed that the entire contingent of the examined students in the total volume performed in 2 minutes of intellectual work, according to the correctional test, can be divided into three groups. I group - poor performance, the volume of performed work did not exceed 30% (26,48±1,7%). II group - average working capacity, the volume of performed work exceeded 30% (33,4±2,36%) and III group - high efficiency, the volume of performed work exceeded 40% (43,5±3,77%).

In order to identify the patterns of adaptation to the training load, hidden in a state of rest, physical load to failure was implied.

The study of physical endurance during the time of work on a bicycle ergometer before the beginning of studies in high educational institution showed that the most enduring are the female students of I group (167.5 st). In II and III groups there was a decrease of this indicator by 23.2% and 44.5% respectively in comparison with I group. At the end of the 1st year, physical endurance increases in comparison with the final level in all three groups: 15.3% - I group and in II and III groups - by 52.5% and 84.3% respectively.

It is set that by the end of the 2nd year among I and II groups there is a reverse redistribution of physical endurance: in I group, the time of work on bicycle ergometer increases by 34%, and in II group only by 13%. Stable high endurance is shown by the female students of III

group - 215 st., which is 95.5% higher than before the beginning of classes.

By the end of the 3rd year the female students with low intellectual ability (I group) showed again the smallest result among the groups and reduced it by 22% compared with the initial level. Working capacity in II group has been recovered to the initial level, and in III group has been increased by 83.9%. The most enduring are the female students of III group, the female students of I and II groups are observed fluctuations, I group is the least enduring.

From the cardiovascular and respiratory systems, in all groups of students before the beginning of studies in high educational institutions in response to physical activity, an adequate reaction and normative restoration of indicators in the process of rest was noted. The analysis of the reactions of the cardiorespiratory system before the beginning of studies showed that the increase in systolic blood pressure (BP) is noted in the female students of all three groups, but most of all - in I group 41% compared with 33% and 30% respectively in II and III groups. The lowest values of diastolic blood pressure were found in the female students of I and III groups: by 14.7% and 10.2% compared with the female students of II group. The reduction of diastolic blood pressure may be associated with a decrease in the overall peripheral vascular resistance and vasodilatation under conditions of physical activity. The proof of the latter is that the blood pressure pulse increases by an average of 2 - 2.5 times for students of all groups. This provides a compensatory increase in the linear and volume velocity of blood circulation. This change is most pronounced in the female students of extreme groups: 39% and 31% respectively. In the female students of II group, this indicator was increased by 20%.

It is proved that an increase in BR is proportional to the increase in HR in training dynamics. Thus, in the final state, the BR was increased by 39%, 68% and 37.0% in I, II and III groups respectively. At the end of the 1st year, the increase in BR was the lowest, at the end of the 2nd year - by 69%, 87% and 67% more than the final level respectively in the examined groups. At the end of the 3rd year, the BR in response to physical activity increases by 47% in I group, by 67% in II and 66% in III group. That is to say, at the end of the 2nd year this increase is the most pronounced.

It has been set that the corresponding reaction of the cardiorespiratory system to physical activity by studying years in all three groups varies in two variants. The first variant of the reaction is noted in the female students of the 1st group: they have a tendency of gradual decrease of the whole complex of the cardiorespiratory system functional indicators in response to physical activity. This tendency is the most pronounced at the end of the 1st year and the smallest at the end of the 3rd year.

The second variant of the reaction occurs in the female students of the II and III groups. The corresponding reaction in them is two-phase. At the end of the 1st year of studying, an increase in the corresponding response for all indicators compared with the state of rest on average

by 15-20% is noted, followed by a gradual decrease in the severity of all of the cardiorespiratory system indicators on the average by 17-20%.

The proportionality of changes in the functional parameters of the cardiorespiratory system in comparison with the state of rest by years of studying is improving. This is traced to all groups in the dynamics of the first two years of studying. IC is normal in the female students of II and III groups, and in I group it is 25% less than in a state of rest and deviates from the norm. At the end of the 3rd year of physical activity integrated effect isn't marked: IC in all groups decreases again by more than 20% of the normal level.

The study of intellectual ability to work against the background of physical activity in the dynamics of studying proved that the number of errors committed against the background of physical activity decreases, but this reaction arises in the dynamics of training at different times in groups: in I group - at the end of the 2nd year, and in II and III - at the end of the 1st year of studying. But the improvement tendency is continued in the studying dynamics in all groups.

**Conclusions.** Studying the complex of psychophysiological indices in the female students during the three years of studying in higher educational institution has shown that it is accompanied by the formation of chronic emotional stress, the degree of expressiveness of which at the same load depends on the individual characteristics of the students' psychophysiological status, as well as the level of physical activity. The use of physical activity as a provocative factor has made it possible to set that the formation of adaptation to educational stress is of a static nature. The initial period of studying in higher educational institution is accompanied by the activation of nonspecific adaptation mechanisms almost in all of the female students (1st stage).

Starting from the 2nd year, three variants of the adaptation development process were revealed: in the first part of the female students (40%) there is formation of an adequate adaptation to the studying load. This is shown up by an increase in intellectual and physical ability to work, rationalization of vegetative provision of both physical and intellectual work. An objective criterion for the formation of an adaptation optimum is the rapid formation of a stable infrastructure of intersystem connections, which reflects the increase in the organism integrity, and an increase in the strength of positive correlations between functional indicators of the organism (2nd stage).

In the second part of the female students (17%) the activation stage of nonspecific adaptation mechanisms immediately changes their exhaustion (3<sup>rd</sup> stage), which is accompanied by a decrease in intellectual and physical capacity, and the lack of their vegetative provision. These phenomena are manifested in the absence of a stable infrastructure of correlation relations that indicates to the superiority of disintegration phenomena in the organism, a lack of adaptive capacity.

In the third part of the female students (43%), the primary activation of nonspecific adaptation mechanisms (stage 1) in the second year of studying in higher educational institution passes into the stage of a specific adaptation formation (stage 2). However, the severity of changes in psychophysiological indicators has an excessive character. The expense of an excessive amount of organism resources makes the “price” of adaptation very high and naturally leads to the third stage - the exhaustion of adaptation possibilities.

The failure of adaptation in this category of students is accompanied by destabilization of vegetative reactions, decreased physical and intellectual capacity and general neurotization. Infrastructure of intersystem communications, which was formed at the 2nd stage of adaptation to the studying load, is destroyed. The total number of correlations and the number of negative connections grows.

Thus, the formation of adaptive optimum is found only in (40) % of the female students. The large part (60%) of the female students reveals either inherently lack of adaptive capacity or excessive adaptation. As insufficient so excessive adaptation naturally leads to psychological and vegetative violations with the subsequent occurrence of psychosomatic neurotic manifestations.

The prospects for further research, in our opinion, is the further study of the gender peculiarities of adaptive responses development to psychoemotional stress that develops in the conditions of studying in higher educational institutions. This will give an opportunity to identify the features of stability formation mechanisms, depending on the gender.

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## SUMMARY

### THE STUDY OF ADAPTIVE REACTIONS OF THE CARDIORESPIRATORY SYSTEM IN CONDITIONS OF PSYCHOEMOTIONAL STRESSES

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The article presents modern data on the physiological mechanisms study of the stress resistance development, which occurs in medical students in the dynamics of studying in higher educational institution in junior courses (1-3 courses). The adaptive reactions of the cardiorespiratory system in conditions of psychoemotional load were studied.

Results showed that development of adaptation syndrome in those conditions greatly depends on speed of formation and intensity level of intersystem integration in cardiorespiratory system. That relation is revealed most of all on the background of physical activity (load on bicycle ergometer to the full). The variability of stages of adaptation development was found out.

In first group of students the first stage of adaptive syndrome is characterized by activation of non-specific adaptive mechanisms (1<sup>st</sup> year of studies), that is naturally replaced by second stage – specific adaptive reactions, when the intellectual work capacity increases on the background of rationalization of its autonomic supply.

In second group of students the second variant of adaptation development occurs – non-specific adaptive mechanisms (1<sup>st</sup> stage) on the 2nd year of study are changed by the stage of specific adaptation (2<sup>nd</sup> stage), that is accompanied by excessive psychophysiological indexes. On the 3rd year of study it leads to the depletion of adaptive capabilities (3<sup>rd</sup> stage).

In third group of students the stage of activation of non-specific adaptive mechanisms was rapidly changed by their depletion, that was accompanied by decrease of intersystem integration and intellectual workability. Therefore, the formation of adaptive optimum occurs only in 40% of students. The majority (60%) of students-young women show either the initially insufficient adaptive capabilities, or excessive adaptation. Both insufficient and excessive adaptation naturally leads to psychological and autonomic disorders followed by appearance of psychosomatic neurotic manifestations.

The prospects of future research from our point of view should lie in further investigation of gender peculiarities of adaptive reactions development up to psychoemotional stress that develops in conditions of studying in university. That will make an opportunity to reveal the features of mechanisms of resistance formation depending on gender.

**Keywords:** adaptive reactions, cardiorespiratory system, psychoemotional loads, medical students, intellectual performance.

## РЕЗЮМЕ

### ИССЛЕДОВАНИЕ АДАПТИВНЫХ РЕАКЦИЙ КАРДИОРЕСПИРАТОРНОЙ СИСТЕМЫ В УСЛОВИЯХ ПСИХОЭМОЦИОНАЛЬНЫХ НАГРУЗОК

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В статье приведены современные данные об исследовании физиологических механизмов развития устойчивости к стрессу, который возникает у студентов-медиков в динамике обучения в ВУЗе на младших курсах (1-3 курс). Исследованы адаптивные реакции кардиореспираторной системы в условиях психоэмоциональных нагрузок.

Результаты показали, что развитие адаптационного синдрома в этих условиях зависит от скорости формирования и интенсивности уровня межсистемной интеграции в кардиореспираторной системе. Эти отношения проявляются более четко на фоне физической активности (полная нагрузка на велоэргометре). Обнаружена изменчивость этапов развития адаптации.

Формирование адаптивного оптимума происходило только у 40% студентов. Большинство (60%) студентов - молодых женщин показали либо изначально недостаточные адаптивные возможности, либо чрез-

мерную адаптацию. Как недостаточная, так и чрезмерная адаптация приводит к психологическим и вегетативным расстройствам, которые сопровождаются появлением психосоматических невротических проявлений.

Перспективы будущих исследований, с точки зрения авторов, должны заключаться в дальнейшем изучении гендерных особенностей развития адаптивных реакций к психоэмоциональному стрессу, который развивается во время учебы в университете.

## რეზიუმე

კარდიორესპირაციული სისტემის ადაპტაციური რეაქციების კვლევა ფსიქოემოციური დატვირთვის პირობებში

ლ. ჩერნობაი, ო. ვასილიევა, ი. ისაევა,  
ნ. დერევიანჩენკო, ა. ოლეინიკი

ხარკოვის ეროვნული სამედიცინო უნივერსიტეტი, ხარკოვი, უკრაინა

სტატიაში მოყვანილია თანამედროვე მონაცემები სტუდენტ-მედიკოსებში სწავლების საწყის (1-3) კურსებზე სწავლის დინამიკაში განვითარებული სტრესისადმი მდგრადობის განმსაზღვრელი ფიზიოლოგიური მექანიზმების კვლევის შესახებ. შესწავლილია კარდიორესპირაციული სისტემის ადაპტაციური რეაქციები ფსიქოემოციური დატვირთვის პირობებში.

კვლევის შედეგებმა აჩვენა, რომ ადაპტაციური სინდრომის განვითარება ასეთ პირობებში მნიშვნელოვნად არის დამოკიდებული კარდიორესპირაციულ სისტემაში სისტემათშორისი ინტეგრაციის ფორმირების სიჩქარესა და ინტენსივობის ხარისხზე. ეს დამოკიდებულება ყველაზე მეტად ვლინდება ფიზიკური აქტივობის ფონზე (სრული დატვირთვა ველოერგომეტრზე). დადგენილია ადაპტაციის განვითარების ეტაპების ცვალებადობა.

ადაპტაციური ოპტიმუმი განვითარდა მხოლოდ სტუდენტების 40%-ს. სტუდენტი-გოგონების უმეტესობა (60%) ავლენდა იმთავითვე არასაკმარის ადაპტაციურ შესაძლებლობებს, ან ჭარბ ადაპტაციას. როგორც არასაკმარისი, ასევე ჭარბი ადაპტაცია განაპირობებს ფსიქოლოგიური და ვეგეტატიური დარღვევების განვითარებას, თანხვედრილი ფსიქოსომატური ნევროზული გამოვლინებით.

მომავალი კვლევების პერსპექტივა, ავტორების აზრით, მდგომარეობს უნივერსიტეტში სწავლის პირობებში ფსიქოემოციური სტრესისადმი ადაპტაციური რეაქციების გენდერული თავისებურებების კვლევაში.