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CONTENTS

Chernobay L., Vasylieva O., Lenska O., Morozov O., Terentyev V.
TO THE ISSUE OF THE MECHANISM OF ADAPTATION DEVELOPMENT TO THE PSYCHOEMOTIONAL STRESS OF TRAINING IN FEMALE MEDICAL STUDENTS OF GENERAL AND SPORTS GROUPS.......................................................................................... 5

Goncharova A. V., Pavlov S. B., Pavlova O. S., Razumovskyi A. N., Kaur A.
ADAPTABILITY OF CARDIORESPIRATORY SYSTEM IN NORMOTENSIVE AND HYPOTENSIVE FEMALE STUDENTS WITH DIFFERENT IMPACT OF THE AUTONOMIC NERVOUS SYSTEM SUBDIVISIONS................................................................. 8

Nataliia S. Hloba, Inna M. Isaieva, Irina S. Karmazina, Dmytro I. Marakushin, Oleksandr A. Hloba
THE INTERCONNECTION BETWEEN INDIVIDUAL CIRCADIAN RHYTHMS AND EATING BEHAVIOR AS ONE OF MAIN REASONS OF OVERWEIGHT AND OBESITY IN YOUNG PEOPLE ........................................................................................................... 12

Maslova N., Maslova Y.
RESEARCH OF THE DENTAL STATUS OF MEDICAL UNIVERSITY STUDENTS............ 16

Pandikidis N. I., Stoyan A. O.
INFLUENCE OF THE ENVIRONMENTAL FACTORS ON THE HUMAN DIABETES.......... 18

Alekseeenko R. V., Rysovana L. M.
THE INFLUENCE OF NATURAL AND SOCIAL FACTORS ON THE VITAL ACTIVITY OF THE ORGANISM IN MODERN CONDITIONS.................................................................................................................. 21

Bulynina Oksana, Voytenko Taisya
THE EMPATHIC ABILITY OF KHARKIV NATIONAL MEDICAL UNIVERSITY STUDENTS WITH THE FUNCTIONAL ASYMMETRY OF A DIFFERENT TYPE...................................................... 24

Nadiia V. Hryhorenko, Marina S. Zimina, Stanislav M. Zimin, Maryna N. Kucher
PHYSICAL AND CHEMICAL PROPERTIES OF BILE IN DIABETIC PATIENTS........... 28

Dunaeva O. V., Korovina L. D.
THE DEPENDENCE OF THE DEGREE OF METEOSENSITIVITY ON THE STATE OF THE CARDIORESPIRATORY SYSTEM AND THE PRESENCE OF PREPATHOLOGICAL CHANGES IN THE BODY IN MEN AND WOMEN............................................................ 32

Dmytro I. Marakushyn, Inna M. Isaieva, Iryna S. Karmazina, Natalia S. Hloba,
Elijah Adetunji Oluwasegun, Kateryna M. Makarova
FEMALE VS. MALE: DIFFERENCE IN IMMUNE RESPONSE........................................ 35

Kyrychenko M. P., Marakashin D. I., Shenher S. V., Dunaeva O. V., Bondar O. O.
SOME FEATURES OF THE EYE TEST IN PERSONS WHO ARE SYSTEMATICALLY INVOLVED IN SPORTS.......................................................................................................................... 38

CORRELATES OF AUTONOMOUS NERVOUS AND IMMUNE SYSTEMS AT INTELLECTUAL EXERTION OF MEDICAL STUDENTS IN CONDITIONS OF COMBINED ACTION OF ENVIRONMENTAL STRESSORS........................................... 40

Hanna M. Zelinskaya, Katerina A. Zelenskaya, Sukhachova I. A., Kovalenko A. A.,
Yuliya G. Bazyleva
FEATURES OF ADAPTATION REACTIONS OF ORGANISM OF STUDENTS, WHICH DEPEND ON THE PRESENCE OF CHRONIC DISEASES IN ANAMNESIS........................................ 43

Tishchenko A. N., Listina A. V., Yurkova O. V., Tishchenko M. O.
CERTAIN ASPECTS OF ADAPTOLOGICAL INFLUENCES ON THE DEVELOPMENT OF PSYCHOPHYSIOLOGICAL ADDICTION........................................................................................................ 47

Shtrakh Kateryna Vasylivna, Rak Larisa Ivanivna, Mulenga Natasha,
Samuel Arko Addo, Okoronkwo Ugochukwu, Innocentia Awuzie
CORRELATION OF STRESS-PROVIDING AND RENIN-ANGIOTENSIN-ALDOSTERONE SYSTEMS AND NT-PROBNP IN ADOLESCENTS WITH RHYTHM DISORDERS.......................................... 49
Маракушин Д. І., Ісаєва І. М., Кармазіна І. С., Глоба Н. С.
Вплив оксиетильованих нонілфенолів та їх похідних на стан неспецифічної імунної резистентності щурів................................. 54

Л. М. Дяченко
Відповідь клітин лейкоцитарного ряду на вплив стрес-факторів та можливість її кореляції природними антиоксидантами.......................... 60

Vaschuk Mykola A., Sokol Olena M., Khorshunova Anastasiy M., Chernysh Hanna O., Yacenko Alina Yu.
ADAPTATION INDEX AND FUNCTIONAL STATE OF CENTRAL NERVOUS SYSTEM IN MEDICAL STUDENTS DURING THE PERIOD OF INTENSIVE LEARNING ACTIVITY........ 67

Ковальов М. М., Чеботенко О. Р.
Явлення емпатії як спосіб адаптації та взаємодії в соціальній сфері........ 70
ADAPTABILITY OF CARDIORESPIRATORY SYSTEM IN NORMOTENSIVE AND HYPOTENSIVE FEMALE STUDENTS WITH DIFFERENT IMPACT OF THE AUTONOMIC NERVOUS SYSTEM SUBDIVISIONS

PhD Goncharova A. V., PhD, DSc in Biology Pavlov S. B., MD Pavlova O. S., MD Razumovskiy A. N., Kaur A.

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ABSTRACT
It was carried out the analysis of the body adaptability in the situation of training loads stress in students with normotension and hypotension and predominance of different types of autonomic nervous system regulatory influence on the cardiorespiratory system. In 103 second-year female students of KNMU systolic, diastolic blood pressure, pulse pressure, heart rate were measured, the Kerdo index and the Robinson index were determined. Functional breathing tests with breathing delay on the inhalation (Stange) and on the exhalation (Genchi) were conducted. They are the indicators of the cardiorespiratory system functional state and sensitivity to a decrease of oxygen saturation in arterial blood (hypoxemia) and carbon dioxide increase in blood (hypercapnia). Psycho-emotional stress in second-year female students causes a deficiency in the body adaptation reserves. Formation of adapting to learning stress is carried out at the limit of the functional capabilities of the body and may lead to a breakdown of adaptation

KEYWORDS
adaptability, autonomic regulation, blood pressure, cardiorespiratory system, hypotension.


Recently, the attention of researchers is once again attracted by the role of autonomic regulation providing the adaptive capabilities of the cardiorespiratory system, and especially among young people [1-3].

The period of studying at university is indicative in the regard of regulatory mechanisms reserves functioning, since studying workloads are turning out to be a factor of adaptation mechanisms stress. The second year of studying characterizes the period when the process of formation of adaptation to academic loads went through the stage of activation of nonspecific adaptation mechanisms and was replaced by the stage of activation of specific ones. The basic system for ensuring adaptation processes is the cardiorespiratory functional system, the regulatory element of which is the autonomic nervous system. The latter coordinates the adaptation reactions of the body. But the result of compensatory-adaptive reactions also depends on the initial functional state of the organism. One of its indicators is blood pressure and the type of autonomic regulatory influence.
It is interesting to analyze the adaptability of the organism in a studying workloads stress situation in students with hypotension and predominance of different subdivisions of autonomic nervous system in cardiovascular system regulation.

The aim of the study was to investigate autonomic regulation of the body with normal and decreased blood pressure and different values of the vegetative index.

Materials and methods.

103 female students of the second year studying of the Kharkov National Medical University were examined. Structural-temporal parameters of the circulatory system were measured at rest — systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse pressure (PP), heart rate (HR). Determination of vegetative Kerdo index (VKI) was carried out. Its calculation is as follows: \(1 - \text{DBP} / \text{HR} \times 100\). In the Kerdo-index, positive values indicate the predominance of sympathetic subdivision of autonomic nervous system (sympathicotonia), and negative values indicate the increase of parasympathetic tone (parasympathicotonia). In full autonomic equilibrium (eutonia) in the cardiovascular system, VKI = 0. Also the level of metabolic and energy processes in the myocardium determination was carried out according to the Robinson Index (IR), which was calculated using the formula IR = \(\frac{\text{HR} \times \text{SBP}}{100}\). An IR of 69 or less indicates a high level of functional reserves of the cardiovascular system, 70-84 - a physiologically normal level, 85-94 - a low level of functional capabilities, 95-110 - an insufficient level and signs of cardiovascular system dysregulation, 111 and more - violation of regulation. Functional breathing tests with breathing delay on the inhalation (Stange) and on the exhalation (Genchi) were conducted. They are the indicators of the cardiorespiratory system functional state and sensitivity to a decrease in oxygen saturation of arterial blood (hypoxemia) and increase of carbon dioxide in blood (hypercapnia). Normally, the duration of the Stange test is 40-60 s, the Genchi test is 20-40 s.

According to the study of all indicators of blood pressure, the students were divided into two groups: normotensive (40 stud.) and hypotensive (63 stud.). In each group, on the basis of the VKI, students were identified as students with parasympathicotonia (28 and 24 students, respectively), students with sympathicotonia (8 and 13 students, respectively) and students with eutonia (26 and 4 students, respectively). Thus, in order to identify various adaptive abilities in these groups, a comparative analysis of all studied parameters was carried out.

Statistical significance was assessed using parametric and non-parametric criteria. A critical level of significance was taken 0.05.

Results and Discussion.

An investigation of circulatory system parameters showed the following. In students of normotensive type with parasympathicotonia, a higher HR was observed in comparison with students of hypotensive type \((p < 0.05)\) (Table 1). In the latter, the duration of the Stange test and the Genchi test was lower than the normal values - 40-60 s and 20-40 s, respectively, which indicates the organism instability to hypoxemia and hypercapnia. Although at the same time, in students of normotensive type, the average duration of breath holding during inhalation (Stange test) 37.96 ± 2.89 was close to the lower limit of normal range.

Statistical significance was assessed using parametric and non-parametric criteria. A critical level of significance was taken 0.05.

Table 1. Parameters of the cardiorespiratory system in students with parasympathicotonia

<table>
<thead>
<tr>
<th>Groups</th>
<th>HR, 1/min</th>
<th>SBP, mm Hg</th>
<th>DBP, mm Hg</th>
<th>PP, mm Hg</th>
<th>Stange, s</th>
<th>Genchi, s</th>
<th>IR</th>
<th>VKI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normotensive type</td>
<td>67.89± 0.73*</td>
<td>119.11± 0.63</td>
<td>77.32± 0.83</td>
<td>42.14± 1.10</td>
<td>37.96± 2.89</td>
<td>23.36± 1.42</td>
<td>80.88± 1.61</td>
<td>-14.76± 2.13</td>
</tr>
<tr>
<td>Hypotensive type</td>
<td>62.58± 0.96</td>
<td>96.25± 0.77</td>
<td>66.04± 0.60</td>
<td>30.21± 0.77</td>
<td>23.71± 1.24</td>
<td>19.29± 0.58</td>
<td>60.35± 1.18</td>
<td>-5.69± 0.95*</td>
</tr>
</tbody>
</table>

* - \(p < 0.05\) - in comparison with students of normotensive type

Also in the students of normotensive type the level of metabolic processes of providing myocardium with oxygen which is characterized with IR was 80.88 ± 1.61. This is a low level of functioning of the cardiovascular system. And in students of hypotensive type, the IR was lower than 69, which characterizes a high level of functional reserves of the cardiovascular system. In this group,
students of normotensive type PP was higher in comparison with students of hypotensive type (p <0.01), 10 of the 28 students of normotensive type had PP 45 mm Hg and higher.

In the group of hypotensive type students with eutonia a decrease in the duration of breath-holding on inspiration (Stange test) has been revealed (p <0.05 compared to the group with normotensive) (Table 2). IR in students of normotensive type was increased in comparison with hypotensive. The values of IR in normotensive type students represented a low level of functional reserves of the cardiovascular system regulation, and the values of IR in students with hypotension showed a high level (p<0.01). PP among normotensive students was higher than 40 mm Hg and higher compared to hypotensive ones. (p<0.01).

Table 2. Parameters of the cardiorespiratory system in students with eutonia

<table>
<thead>
<tr>
<th>Groups</th>
<th>HR, 1/min</th>
<th>SBP, mm Hg</th>
<th>DBP, mm Hg</th>
<th>PP, mm Hg</th>
<th>Stange, s</th>
<th>Genchi, s</th>
<th>IR</th>
<th>VKI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normotensive type</td>
<td>75±2,89</td>
<td>117,5±2,5</td>
<td>75±2,89</td>
<td>42,50±4,79</td>
<td>42±4,24</td>
<td>26,25±6,79</td>
<td>88±2,83</td>
<td>0</td>
</tr>
<tr>
<td>Hypotensive type</td>
<td>66,54±0,67</td>
<td>100±0*</td>
<td>66,54±0,67</td>
<td>33,46±0,67</td>
<td>24,23±0,85*</td>
<td>19,38±1,11</td>
<td>66,54±0,67*</td>
<td>0</td>
</tr>
</tbody>
</table>

* - p<0.05 - in comparison with students of normotensive type

Hypotensive students with sympathicotonia also had a low inspiratory breath hold time (Stange test) (p <0.05 compared to the group with normotension), while such parameters of normotensive students were in the normal range (Table 3). In normotensive students the IR values were in the range of insufficient level of functional reserves of cardiovascular system regulation and demonstrated the signs of dysregulation. The IR values of hypotensive type students were of the high level range. The PP of normotensive students with sympathicotonia was higher than 40 mm Hg and higher compared with hypotensive students (p <0.05).

Thus, according to the data presented in the study, regardless of the sympathetic-parasympathetic relationships, the hypotensive students showed a high level of myocardial metabolic processes, which was provided by a high sensitivity of the body tissues to hypoxia and hypercapnia.

In normotensive students in the group with eutonia, adequate sensitivity to hypoxia and hypercapnia is determined. The normotensive students of the other two groups — with sympathicotonia and parasympathicotonia — have a high sensitivity. Level of metabolic processes in the myocardium in the students with eutonia was low, in the group with sympathicotonia - insufficient, and the normal level of functional reserves of regulation of cardiac activity has been revealed only in the group with parasympathicotonia.

Table 3 Parameters of the cardiorespiratory system in students with sympathicotonia

<table>
<thead>
<tr>
<th>Groups</th>
<th>HR, 1/min</th>
<th>SBP, mm Hg</th>
<th>DBP, mm Hg</th>
<th>PP, mm Hg</th>
<th>Stange, s</th>
<th>Genchi, s</th>
<th>IR</th>
<th>VKI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normotensive type</td>
<td>80,5±1,56</td>
<td>120±1,34</td>
<td>73,13±1,62</td>
<td>48,13±1,88</td>
<td>43,81±6,62</td>
<td>22,43±2,15</td>
<td>96,68±2,61</td>
<td>9,05±1,86</td>
</tr>
<tr>
<td>Hypotensive type</td>
<td>67,38±0,49</td>
<td>93,08±0,92</td>
<td>61,54±0,61</td>
<td>31,54±0,82</td>
<td>27,15±1,21*</td>
<td>18,77±0,79</td>
<td>62,75±0,87</td>
<td>8,62±0,85</td>
</tr>
</tbody>
</table>

* - p<0.05 - in comparison with students of normotensive type

It follows that the students of the normotensive type with different types of autonomic regulation demonstrated the different nature of the adaptive regulatory reactions providing. Thus, in students with parasympathicotonia with a physiologically normal myocardium oxygen supply level adaptation reactions are carried out due to the high tension of the functional oxygen transport system capabilities. This was reflected in high sensitivity to hypoxia, as well as high pulse pressure, which in turn may be a factor in the development of heart failure [4-5]. In students with eutonia and sympathicotonia, the sensitivity to hypoxia was adequate, however, the reduced functional reserves of the cardiovascular system were at the limit of physiological capabilities and could not provide a sufficient level of myocardial metabolic processes.
According to the IR data, the hypotensive type students with different activity of the autonomic nervous system subdivisions were characterized by a high level of reserve abilities of the cardiovascular system, which correlates with a high sensitivity of tissues to hypoxia and low pulse pressure, which, in our opinion, reflects the high tension of adaptation mechanisms. Therefore, the body adaptabilities of students are insufficient.

**Conclusions.** Psycho-emotional stress in a second year studying at the university causes a deficit of adaptive reserves of the body in students. Formation of adapting to learning stress is carried out at the limit of the functional capabilities of the organism and is body resource-intensive. This is a risk factor for the development of failure of adaptation and psychosomatic diseases in the dynamics of educational process.

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