

Cardiorespiratory system in female students when adapting to university studies

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Abstract

The article describes the state of the cardiovascular and respiratory systems in female students in the process of their adaptation to educational activities. The process of study of female students at a higher educational institution is accompanied by a decrease in the indicators of the cardiovascular system performance, so that the value of systolic blood pressure in the 2nd year female students is roughly significantly lower than that recorded in the 1st year of their study. The minimum pressure level, 116.8 mm Hg ($P < 0.05$), is detected in the 2nd year female students against 122.88 mm Hg revealed in the first year group of the female students.

In the process of the girls' adaptation to their educational activities, there is a gradual increase in the vital capacity of lungs (VCL) with the maximum level of 3.11 l ($P < 0.02$) in the fourth year of the study, while the lowest value, 2.66, is found in the first-year female students. The value of the inspiratory reserve volume (IRV) significantly increases by the third and fourth year of the study. IRV is recorded to reach 1.47 l ($P < 0.05$) in the 3rd year of study, 1.46 ($P < 0.01$) in the 4th, and 1.24 in the 1st year of the study, respectively. Studying at a university reduces the expiratory reserve volume to 0.76 l by the second year, by the third and fourth years it increases to 0.94 and 1.08 ($P < 0.001$), while in the first year it is reported to be 0.80.

Keywords

Study, Adaptation, Heart rate, Arterial blood pressure, Tidal volume and lung capacity

Imprint

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Introduction

An adaptation is finding a balance between the organism state and the environment, which should allow the body to favorably exist in the environment. Upon matriculation, an adolescent experiences a change in his/her usual living conditions and lifestyle. As a result of the educational activities, a student at a university is forced to accept new forms and methods of teaching, a new mode of work, sleep, rest, nutrition, and, perhaps, climatic conditions.

Going of higher education institutions to applications of more intensive methods and the introduction of innovative technologies into the educational process may produce a rise in stress loading on the mental and physiological systems of the body in the yesterday's schoolchildren and require strengthening of their activity.

Educational activity at the university places heavy demands on the state of the body's systems and on the health of an adolescent, as it is a long-term complex process.

According to T.N. Semenkova et al. [1], the conditions of study determine the state of mental work and the academic performance of a student. It is also found that the functional state of the body's systems depends thereon.

The functional activity of the body's systems provides for its adaptation to the surrounding conditions and the available educational activities. This means that the conditions, under which the training is carried out, have an impact on the performance of the cardiovascular and respiratory systems in the body, which are responsible for oxygen supply to the human organism.

Some indicators like the health status level, the academic performance and the mental performance govern the adaptability of the student's body to learning activities.

An analysis of the data upon completed research study shows that in recent years the students' adaptation to educational activity has resulted in weakening of the state of the body systems in students.

The peculiarities of studying at a university are high workload, increased emotional and mental stress and insufficient physical activity, which not only hinder the adaptation process, but also inhibit the development in general. As a result of the mental work, which

continues for a long time under the conditions of insufficient physical activity, disordering in the body's functions occurs.

In the initial period of study, a high mental load under the influence of a shortage of time makes it necessary to master the culture of the mental work.

The process of an adaptation of a student to studying in each year has its own characteristics. Thus, today 30% of the first-year students have a health disorder: in this case, disorders of the digestive, respiratory and cardiovascular systems are most commonly found in the adolescents who begin studying at a university.

A high training load leads to an increase in the tension of the organism systems that may result in disordering of the functional activity of blood circulation and respiration. In this connection, the study of the state of these systems in the process of the educational activity is of great importance.

Therefore, the purpose of our research is to assess the state of the cardiovascular and respiratory systems in female students in the process of their studying at a higher educational institution.

Materials and methods

To identify the state of the cardiorespiratory system in the female students in the process of studying at the university, we conducted our research study in the laboratory of Human Physiology at the Department of Human and Animal Physiology and Anatomy.

The subject of our study was a cohort of 40 full-time female students who participated in our research work. They were all found to be clinically healthy. Their age ranged from 18 to 21 years. In accordance with the years of study, 4 groups 10 female students each were composed. The collection of experimental data was carried out upon the examination of the female students with the use of the Alton-03 electrocardiograph and the OMRON M3 Expert tonometer.

Metering of the respiratory system parameters was carried out using the Diamant-S spiograph.

For statistical processing of the experimental data obtained, the Biostatistics software was employed.

Results and discussion

The dynamics of the indicators of the performance of the cardiovascular system in the female students during their adaptation to studies at a higher educational institution is shown in Table 1 and Figure 1 given herein.

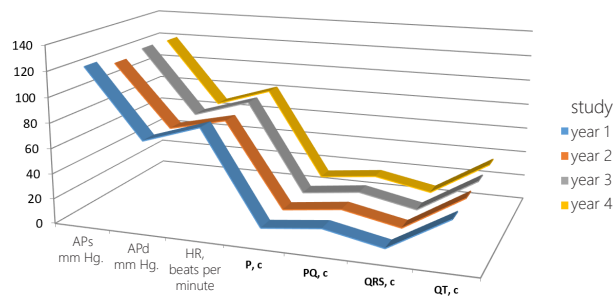


Figure 1. Changes in the cardiovascular system performance in the process of studying at the university

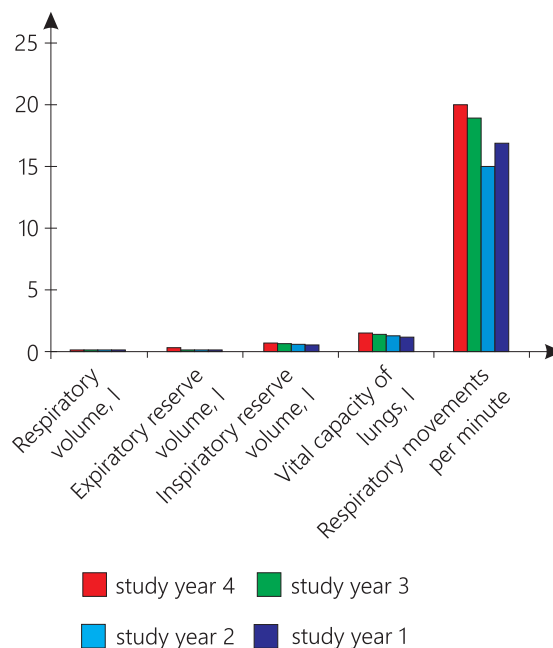


Figure 2. Respiratory system indicators in female students when adapting to university studies

The results of our conducted study show that during the adaptation by the female students to university studies, only systolic blood pressure undergoes considerable changes. Thus, the level of the maximum blood pressure in the second-year girls is 6.0 mmHg lower ($P < 0.05$), and the third and the fourth year female students are recorded to have a decrease in this blood pressure value by 2.2 and 3.1 mmHg, respectively, against that recorded in the group of the first year girls (122.8 mmHg).

The minimum blood pressure in the 2nd, 3rd and 4th year female students are reported to be reduced by 1.4; 0.8 and 1.8 mmHg, respectively, as compared with 69.0 mmHg in the first year girls.

The girls' educational activity leads to slight fluctuations in the heart rate values in both directions, not reaching the values recorded in the first year. Thus, the heart beats less frequently in the second-year female students by 5.7 beats per minute; in those of the

Table 1
Blood picture in female students with different academic performance grades

Indicator	Year in the study			
	1st year	2nd year	3rd year	4th year
APs, mm Hg.	122.8±1.99	116.8±1.63*	120.6±1.70	119.7±1.65
APd, mm Hg.	69.0±2.02	67.6±1.89	68.2±1.71	67.2±1.78
Heart rate, beats per minute	83.4±2.42	77.7±3.07	82.0±1.45	81.6±2.40
P, s	0.112±0.0023	0.107±0.0020	0.105±0.0032	0.108±0.0041
PQ, s	0.165±0.0066	0.163±0.0045	0.160±0.0054	0.159±0.0054
QRS, s	0.072±0.0027	0.070±0.0025	0.066±0.0039	0.070±0.0036
QT, s	0.345±0.0033	0.355±0.0073	0.342±0.0052	0.349±0.0044

Note: **P < 0,05

Table 2
Respiratory system in female students in the process of adaptation to educational activities

Indicator	Year in the study			
	1st year	2nd year	3rd year	4th year
Respiratory movements per minute	17.4±2.02	15.7±0.97	19.4±1.4	20.6±1.96
Vital capacity of lungs, l	2.66±0.086	2.86±0.14	3.03±0.22	3.20 ± 0.12 ***
Inspiratory reserve volume, l	1.24±0.036	1.43±0.082	1.51±0.094*	1.55±0.052 ****
Expiratory reserve volume, l	0.80±0.041	0.76±0.037	0.94±0.118	1.08±0.043****
Respiratory volume, l	0.62±0.059	0,67±0.030	0.58±0.048	0.57±0.052

Notes: *P < 0,05; ***P < 0,01; ****P < 0,001

third year it is reduced by 1.4 and in the fourth year female students by 1.8 beats per minute as against the first year group. Depletion of the adaptive reserves leads to dysfunction of the student's body systems [2, 3]. According to E.S. Gevorkyan et al, [4], an adaptation to the 1st and 2nd year courses is difficult. Disorders in the cardiovascular system performance in young females may be a consequence of tobacco smoking [5].

The average level of systolic pressure in the first and third year female students and the heart rate values in the girl students in the first, third and last years of study exceed the upper limit of the normal value.

In the process of the adaptation of the students, the academic performance load is the main factor affecting the state of the nervous, cardiovascular and respiratory systems, as it is believed in [6, 7].

The student's educational activity is accompanied by a decrease in the performance of the cardiovascular system, according to L.A. Proskuryakova and E.N. Lobykin [8]. In the process of studying at the university, according to A.A. Artemenko [9], in 46.7% of the boys and 41.7% of the girls, the heart rate is found to be above the normal value.

Under the rest conditions, 42.2% of the young males and 69.1% of the young females show high heart rates [10].

The average values of all indicators characterizing the electrocardiogram curves in the female students,

when adapting to the university education, are within the physiological norm.

The time of the atrial contraction in the female students during their educational activities demonstrates minor fluctuations in both directions.

So, the difference between the extreme values of this indicator in the groups is reported to be 0.007 seconds.

The average time of conduction of excitation from the atria to the ventricles in all groups of the female students corresponds to the physiological norm. However, in the process of education, in the females it declines. So, its greatest decline, 0.006 seconds, occurs in the fourth year female students, against 0.165 seconds in the first year girls. During the period of study of the female students at the university, the time of ventricular excitation and contraction coverage recorded remains within the norm.

While the above time is subjected to minor fluctuations in both directions, the range of the QRS time fluctuations between the groups is reported to be from 0.066 to 0.072 seconds.

The range between the extreme average QT values during the study period is recorded to be 0.010 seconds.

The study of the cardiovascular system state in the female students during their adaptation to the university educational conditions shows that the educational activity is accompanied by a significant decrease in their systolic blood pressure and a deviation from the upper normal limit of the maximum blood pressure in

the 1st and 3rd year female students, and a deviation from the normal heart rate value in the 1st, 3rd and 4th years, respectively.

Currently, new non-invasive methods are used to measure the parameters of metabolic processes in the cardiac tissue during the initial ECG processing, which can be employed to detect the degree of the adaptation to the educational process of the university students [11, 12].

The respiratory system state in the female students in the process of their adaptation to training at the higher educational institution is shown in Table 2 and Figure 2 herein.

From the data in the above mentioned Table and Figure, it follows that the adaptation to the university studies among the female students leads to a significant increase in the vital capacity of the lungs, the inspiratory and expiratory reserve volumes, to an insignificant increase in the number of respiratory movements and to a minor fluctuation in of the tidal volume in both directions.

The level of the indicators of the respiratory system in the females in the 1st and 2nd year of study is below the lower limit of their physiological norm. In the process of the educational activity, the respiratory rhythm in the 2nd year students decreases by 1.7 movements per minute, and in the female students of the 3rd and 4th year it increases by 2.0 and 3.2, respectively, against the data recorded in the 1st year female students. The value of the vital capacity of the lungs during the adaptation to learning demonstrates a gradual increase. Thus, the VCL value in the females in the fourth year of study is 0.54 liters higher ($P < 0.01$) than that found among the students in the first year. The adaptation of the female students to the educational process leads to a gradual and significant increase in the inspiratory reserve volume parameters.

It increases by 0.27 l ($P < 0.05$) in the 3rd year students, and by 0.31 ($P < 0.001$) in the 4th female students as compared to the 1st year girls. Learning activity leads to a decrease in the reserve expiratory volume in the 2nd year by 0.04 liters and to an increase in the 3rd and 4th years by 0.14 and 0.28 ($P < 0.001$), respectively, as compared to the 1st year students (0.80 liters).

The tidal volume in the females adapting to the university education is subjected to slight level fluctuations in both directions. So, in females of the 2nd year it is 0.05 liters higher, and it is recorded to be 0.04 and

0.05 lower in the 3rd and 4th year, respectively, than it is the case in the first year (0.62).

Obviously, a gradual increase in the indicators of the respiratory system performance in the process of educational activity should be attributed to a rise in the excitability of the sympathetic part of the autonomic nervous system; it is also an age-related factor. Nifontova O.L. and R.K. Nasrullaev [13] note that in young males aged 20-22, the activity of the parasympathetic nervous system becomes higher in the regulation of body functions, while in young females observed is an elevated activity of the sympathetic part.

Zakharina E.A. [10] believes that students do not complete their adaptation even by their fourth year.

So, it may be concluded that stresses induced by the educational activity lead to significant changes in the indicators of the performance of the respiratory and cardiovascular systems in students [14].

From the results of the conducted research we can arrive to a conclusion that the low level of the physical fitness is the reason for insufficient adaptation of students [15].

Based on the results of their research, I.N. Pushkareva, S.V. Kumskov and S.A. Novoselov [16] state that students have a low level of physical fitness and poor physical health.

Batrymbekova S.A. [17] reports that only 28.1% of the students reach a high level of the adaptation to learning, 52.2% of them demonstrate an average level and 19.75% a low level thereof.

The results of our research show that the adaptation by the female students to study at a higher educational institution leads to a significant increase in the vital capacity of lungs, the reserve volume of inspiration and expiration and to insignificant fluctuations in both directions in the number of respiratory movements per minute and the tidal volume values.

Conclusions

- The mean values of systolic and diastolic pressure between the groups of female students range from 116.8 and 67.2 mm Hg up to 122.8 and 69.0 mm Hg.

- The electrocardiogram indicators in the female students in the process of study are subjected to insignificant fluctuations in both directions.

- The increase in the vital capacity of lungs in the 4th year female students is 0.54 l ($P < 0.01$), in the reserve volume of inspiration 0.31 l ($P < 0.001$) and that

of exhalation 0.28 l ($P < 0.001$), as compared to the respective data obtained in the first year female students.

- The range of fluctuations in the number of respiratory movements between the groups is recorded to be from 15.7 to 20.6 movements per minute, and the tidal volume ranges from 0.57 to 0.67 l.

Statement on ethical issues

Research involving people and/or animals is in full compliance with current national and international ethical standards.

Conflict of interest

None declared.

Author contributions

The authors read the ICMJE criteria for authorship and approved the final manuscript.

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