

Changes In The Parameters Of Systemic Hemodynamics In Adolescents In The Process Of Studying At A Secondary School, Lyceum And College

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ABSTRACT

This article defines the changes in the parameters of systemic hemodynamics in adolescents in the process of studying at a secondary school, lyceum and college. It is known that the cardiovascular system is one of the first to be included in the adaptation process. In healthy schoolchildren, hemodynamic shifts in the process of learning activities may depend on a number of factors, but hygienists consider fatigue from the training load to be the main among them.

KEYWORDS Qualitative and quantitative assessment, hypertonic reactions, hemodynamics, diastolic pressure, cardiovascular system, arterial hypertension.

INTRODUCTION

At present, to determine the adaptive functional capabilities of the body of adolescents, various methods of qualitative and quantitative assessment have been proposed [2, 3] approaches based on the concept of the cardiovascular system as an indicator of the body's general adaptive reactions [7].

It is known that the cardiovascular system is one of the first to be included in the adaptation process. In healthy schoolchildren, hemodynamic shifts in the process of learning activities may depend on a number of factors, but hygienists consider fatigue from the training load to be the main among them. The authors suggest that the development of arterial hypertension begins at school age.

Studies of other works revealed that after a training load that does not cause fatigue, the predominance of hypertonic reactions was not obtained.

On the part of diastolic pressure, which, as you know, with adequate training loads is marked by greater constancy than systolic pressure and heart rate (HR). With a tiring academic load, at the beginning of the school year, the nature of hemodynamics in schoolchildren shows a predominance of a hypertonic reaction on the part of systolic blood pressure. At the end of the academic year, the

authors note the hypertonic nature of the reaction of all indicators characterizing the cardiovascular system [8].

MATERIAL AND METHOD

Studies show that changes in the chronotropic function of the heart of schoolchildren in grades 10-11 of a general education school are a consequence of developing fatigue throughout the school year, in connection with which high school students have a restructuring of the heart rhythm system to a lower level of functioning. This is confirmed by the data of many authors [1, 4, 5, 11, 9]. Fluctuations in the statistical nature of the heart rate, earlier than other functional indicators, signal an excessive training load [6, 9].

It should be noted that it is more difficult for girls to adapt to the educational process in high school, who have a more pronounced reaction of the cardiovascular system to the training load, than for boys, who are trained in high school with less stress on the functional reserves of the heart [5].

In children enrolled in the new programs, differences in the response of the cardiovascular system to the weekly academic load were revealed: in all age groups, the number of adverse shifts in blood pressure from the beginning to the end of the school week in students of new types of schools was significantly greater than in

students involved in according to the usual program [1, 4, 10]. Arterial hypertension was revealed in 22.9% of high school students when studying in schools of a new type. An isolated increase in systolic blood pressure was detected in 54.8 adolescents, an isolated increase in diastolic blood pressure in 16.2% (89).

Literature data indicate that in students of educational and industrial institutions, heart rate and blood pressure, both maximum and minimum, decreased from the beginning to the end of training. The nature of the changes depended on the stage of training. Thus, by the end of the theoretical course of study, the maximum and minimum arterial pressures decreased evenly, the pulse pressure did not change, the pulse value decreased significantly, due to which the systolic and minute blood volumes increased, which are the resulting indicators of the body's blood supply [12].

During practical training, blood pressure, according to literary sources, decreases unevenly: the maximum pressure is greater than the minimum, which caused a drop in pulse pressure and, in turn, in systolic and minute blood volume, which was also facilitated by a decrease in pulse. An analysis of individual students' blood pressure values showed that the number of hypertension fell from 13.7% at the beginning of the school year to 6.2% at the end of it. The number of hypotensions increased from 15.8% to 27.5% [12].

It is known that in healthy adolescents, hemodynamic shifts in the process of educational activity may depend on a number of factors, but hygienists consider fatigue from the training load to be the main among them. To solve the question of how the functional state of the body of adolescents changes in the process of learning in educational institutions of various types, the task was set to investigate in the dynamics of learning (from 15 to 17 years old) the functional state of the most reactive body system - heartily stop the vessels. It is known that age differences in adolescents may not appear in favorable conditions among and be revealed in unfavorable conditions the more clearly, the greater the degree of severity of factors, including educational and training workload. In a state of complete health, hemodynamic parameters such as blood pressure (BP), heart rate (HR), mean pressure (DM), pulse pressure (PP), and production heart rate (HR). mean pressure (BP), systolic (SVK) and minute volumes of blood (MOV) in the same teenager are characterized by relative constancy. Consequently, significant deviations in the level of indicators of the cardiovascular system of

students indicate possible violations in the state of their health.

The conducted studies made it possible to establish the average indicators of systemic hemodynamics of the examined groups of adolescents at the beginning and end of the school year, before and after dosed physical activity.

In the examined students, regardless of the type of educational institution, an increase in mean BP values from 15 to 17 years was noted, but no statistically significant age-related differences in BP levels were found, with the exception of girls studying in a college setting who had systolic BP at the age of 15 was equal to 106 ± 1.7 mm Hg, and at the age of 17 it increased to 111.7 ± 1.1 mm Hg. Art. ($P < 0.05$). Both systolic and diastolic blood pressure indicators among the surveyed boys of all age groups are higher than among girls, but significantly significant differences depending on sex in diastolic blood pressure were established in groups of 16 and 17-year-old adolescents studying in a comprehensive school, and in systolic blood pressure among 106-year-old adolescents of the lyceum ($P < 0.05-0.01$).

Particular attention in the characterization of hemodynamics should be paid to the predominance of hypertonic (maximum blood pressure over 120 and minimum blood pressure over 75 mm Hg) and hypotonic (maximum blood pressure less than 100 mm Hg) types of reaction from blood pressure, to a greater extent expressed in lyceum and college students, among whom vegetovascular dystonia was quite often observed. It is noteworthy that at the beginning of the academic year we did not reveal a single case of hypertonic reaction from blood pressure in secondary school students, while the hypotonic type of reaction was observed in 7.5% of boys and 8.7% of girls.

With an individual assessment of the level of blood pressure in students of the academic lyceum, it was found that the maximum pressure went beyond $+1\delta$ in 3.2% of boys and 3.0% of girls, the minimum in 3.1 and 2.6%, respectively. Outside -1δ systolic pressure was in 9.6% of boys and 10.7% of girls of the lyceum, diastolic - in 6.6 and 8.3%, respectively. An individual assessment of the level of blood pressure in college students showed that the upper limit of the physiological norm of maximum blood pressure was exceeded in 4.6% and minimum blood pressure in 10.6 and 9.6% of cases, respectively.

At the end of the academic year, the number of hypotension in school students increased to 10.2%, in lyceum adolescents - up to

11.4% and in college - up to 12%. The number of hypertension among students of the academic lyceum fell from 3.1% at the beginning of the academic year to 2.3% at the end of the year; in college students from 3.7% to 2.7%, respectively.

It was revealed that the intensity of changes in blood pressure indicators by the end of the academic year is moderate and only in certain groups of students were observed pronounced shifts.

Processing of these indicators of blood pressure, depending on the type of educational institution, revealed that after physical dosed load, both at the beginning and at the end of the school year, the greatest changes were observed in students of a general education school. Thus, systolic blood pressure in young men increased by 18.6%, and diastolic - by 19.7% compared with the young men of the lyceum (11.9 and - 7.9%). A similar trend was found in school girls, in whom BP indicators underwent greater changes than in their lyceum and college peers. So, it was found that the same physical activity at the beginning and end of the academic year was accompanied by large shifts in blood pressure in boys compared to girls and a more pronounced response in adolescents of the school compared with peers of the lyceum and college, which indicates that the boys had better functional abilities than girls, and teenagers of the school, regardless of gender, had higher functional abilities compared to lyceum and college students.

The average values of heart rate in boys of a general education school aged 15-17 years are on average 77.1 at the beginning and 77.6 beats per minute at the end of the academic year; for girls, respectively, 76.9 and 77.7 beats per minute; lyceum boys have 74.7 beats per minute at the beginning and 76.4 beats per minute at the end of the academic year, lyceum girls have 78.0 and 77.8 beats per minute, respectively; college girls have 74.5 at the beginning and 76.4 beats per minute at the end of the school year. So, in the studied age groups, the heart rate only in the boys of the lyceum is somewhat lower than in the girls, but no significant differences by sex were found in any of the age and sex groups of the examined. Thus, the data obtained indicated a certain increase in heart rate under the influence of the training load at the end of the academic year in relation to the initial values. From the materials of appendices 3-5 it can be seen that the heart rate after exercise increased more at the end of the academic year compared to the beginning, and in all cases the differences in the average values are statistically highly significant.

In the process of teaching all the examined groups of students in the nature of hemodynamics, it was revealed that with age, i.e. from 15 to 17 years of age, the heart rate increased slightly, which indicated a more rational way to ensure cardiac output and the efficiency of blood circulation.

The most distinct features of the response of the cardiovascular system were manifested in the analysis of data obtained from adolescents studying in various types of educational institutions. Data processing depending on the type of educational institution revealed some difference in indicators

The heart rate of boys studying at school compared to their peers lyceum students (at 16 years old $P < 0.001$), while in girls at school the heart rate is somewhat lower than that of their peers studying lyceum and higher than that of college peers (at 16 years old $P < 0.01$).

Performing the same physical activity at the beginning of the school year was accompanied by large shifts in boys compared to girls. Thus, physical activity was accompanied by an increase in heart rate in school boys by 47.2%, in lyceum boys by 43.2%, while in girls by 44.1; 35.9 and 37.2% - respectively in school, lyceum and college. The results obtained indicated that the young men had the best mobilization capabilities. Heart rate indicators returned to the initial level in adolescents of both sexes in an average of 2.4-3 minutes. By the end of the academic year, a characteristic adaptive restructuring was noted, expressed in response to physical activity due to a decrease in functional capabilities. So, at the end of the academic year, compared with the beginning, a more pronounced response in terms of heart rate was noted: 51.3% for school boys versus 45.4% for lyceum boys and 52.3 and 46.0%, respectively, for school girls and lyceum versus 42.1% for college girls; and a slower return to rest data was also revealed: on average, after -5.5 minutes after the end of the load, the pulse rate was at the initial level, i.e. the teens of the lyceum, and to a greater extent of the college, reached it in a longer period of time. But it should be noted that with age, i.e., at the age of 16-17, the response of such a hemodynamic indicator as heart rate was higher than at the age of 15. Therefore, in the nature of pulse changes, a certain role belongs to the age factor, i.e. its increase is less frequently noted in the older age group. The difference between the systolic and diastolic pressures represents the pulse pressure (PP). On average, in all the age and sex groups studied by us, PP was at the level of 40 mm Hg. Art. It is known that the magnitude of PP depends

on the contractility of the myocardium, stroke volume, the tone of arterial vessels, and the level of peripheral resistance.

Mean pressure (MP) is half the sum of systolic and diastolic pressure. The observed increase in SD from 7 mm Hg. Art. (normal value) up to 20-30 mm Hg. Art. means its increase, in which blood moves from the periphery to the heart, lungs and increases the reverse venous blood flow and, thus, increases the systolic blood volume (SVC). A number of constants, such as systolic and minute volume, characterize the state of blood circulation. At rest, their indicators are quite constant, and with various kinds of loads they vary widely. The increase in IOC occurs by increasing the SOC or heart rate, or their simultaneous increase. At the same time, the possibilities for increasing the IOC are much greater than the possibilities for increasing the SOC. The dynamics of the circulatory efficiency coefficient (CEC) most clearly demonstrates the degree of influence of parasympathetic innervation on the cardiovascular system.

RESULT

The results of the study showed that the above parameters of systemic hemodynamics, such as PP, SD, COK, MOK and EC in adolescents of the groups studied by us changed in the age period from 15 to 17 years. Both at the beginning and at the end of the academic year before the load, the average values of the listed indicators changed slightly with age, while in the boys of the lyceum, the indicators of SOC and IOC increased by 17 years by 19.6 - 24%, in the girls of the lyceum this increase in the studied age the period was also highly significant ($P < 0.001$), but the change was somewhat lower and ranged from 12.9 to 15.5%. In girls studying in college, the indicators of SOC and IOC from 15 to 17 years old decreased by a significantly significant value ($P < 0.05$), only at the end of the academic year. From the foregoing, it follows that only among students of a general education school do age-related changes in PD indicators occur. SD, SOC, IOC and CEC were insignificant.

It should be noted that hemodynamic parameters at the beginning and end of the academic year are higher in boys than in girls. Physical activity caused unidirectional shifts in adolescents of both sexes: the change in all of the listed indicators was more significant in young men.

Analysis of the data obtained after performing a dosed physical load showed that adolescents studying in different types of

educational institutions cope with the load at different prices.

Thus, among young men in the lyceum, at the beginning of the academic year, after a load, there was a higher increase in PP (by 20.9%) compared with their peers from school (by 15.5%).

The indicators of DM in school boys after dosed physical activity increased by 19.5%, while in lyceum peers only by 10.1%. In terms of other hemodynamic parameters, changes after exercise in young men from school and lyceum were of the same type: the MOC indicators slightly decreased, and the MOC and CEC changed upwards by an average of 41.6 and 66%, respectively.

Girls studying in different types of educational institutions at the beginning of the academic year after physical activity showed the most significant increase in the PD indicator: college by 29.7% versus 7.5 and 6.3%, respectively, in school and lyceum; in terms of DM, the maximum increase was noted in girls from school (19.5%): SOC after exercise decreased in girls from school and lyceum by an equal amount (9%). The rest of the hemodynamic parameters studied by us increased at the beginning of the academic year, most significantly in college girls who responded to a functional test with physical activity to a greater extent than lyceum and school students, which indicated their good functional state at the beginning of the year. At the end of the academic year, tension in the regulation of hemodynamics was revealed in the boys of the lyceum and girls of the college, which was clearly evidenced by a more significant increase in the levels of IOC, CEC by the end of the academic year and the unfavorable nature of the increase in the level of PD. Preferential changes in the IOC index, which is the resulting parameter of the blood supply to the body of adolescents, due to changes in the pulse rate, indicated their insufficient fitness.

The changes observed in adolescents at the end of the school year after exercise were not as pronounced as at the beginning of the year. The nature of the reactions observed at the end of the academic year in adolescents of different types of educational institutions during a test with an additional load indicates a certain deterioration in the functional state of the cardiovascular system, most pronounced in students of a vocational college.

CONCLUSION

Thus, studies have shown that at the end of the academic year, the reaction of the cardiovascular

system to a dosed load in adolescents of a general education school is close to the normotonic type, the restoration of blood pressure and heart rate parameters occurs in 2-3 minutes. This testified to the good adaptive capabilities of the body of schoolchildren and their rapid recovery. The reaction of the body in lyceum and college adolescents at the end of the academic year to a dosed load is close to the hypotonic (asthenic) type and was expressed in a relative increase in heart rate with a slight increase in blood pressure and a slight increase in PP (especially pronounced in college girls). This is an unfavorable type of reaction, indicating that the increase in functional blood circulation due to physical activity does not occur due to an increase in stroke volume, since PP almost does not increase (1.5%), but due to an increase in heart rate (42.1%). Recovery ends in 5-6 minutes. All this testifies to the "physical inferiority" of the cardiovascular system, low adaptation of the body to physical activity at the end of the school year. By the end of the year, the systolic and minute blood volumes of students of the vocational college also decreased, but during practical classes their levels increased, which is probably due to the influence of occupational hazards. From the above material on the change in indicators of the functional state of the cardiovascular system of students depending on gender, age, type of educational institution, time (beginning and end of the school year) conditions (before or after exercise) of the examination, we made the following conclusions:

1. Most of the studied hemodynamic parameters of boys are slightly higher than those of girls, but only in certain groups of students pronounced differences were observed.

2. Age-related changes manifested themselves most clearly in terms of SOC, MOC, CEC in adolescents of both sexes of the academic lyceum ($P=0.05-0.001$): in terms of SOC, IOC and PD ($P<0.05$) in college girls.

3. From the standpoint of adaptation of the body of adolescents to new learning conditions for them, in our case, to the conditions of study in an academic lyceum and college, hemodynamic data indicated that the state of rest for this contingent of students is characterized by lower hemodynamic parameters compared to those of school teenagers. Perhaps these differences are related to the incomplete adaptation of lyceum and college teenagers to new learning conditions.

4. As the analysis of the above data showed, the observed changes in the hemodynamic parameters of adolescents after physical activity at the end of the school year

were the result of developing fatigue, in connection with which the subjects had a restructuring of the cardiovascular system to a lower level of functioning, most pronounced in students of professional technical college.

Thus, the results of studying the functional state of the cardiovascular system showed that it was determined, on the one hand, by the age-related development trend, expressed in an increase in the body's reserve capabilities, and, on the other hand, by the influence of a complex of educational and training -production factors. From what has been said, the need for a hygienically rational organization of the teaching regime in schools, lyceums and colleges becomes obvious.

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