

Optimization of Cardiovascular System of Teenagers Aged 12–14 Years at Medium Intensity Aerobic Physical Load

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ABSTRACT

The paper considers peculiarities of aerobic physical exercises for 12–14-year old teenagers suffering from arterial hypertension. Cardiovascular diseases in teenagers affect the development of the body and its functional stability. In this regard, this paper discusses the peculiarities of CVS optimization of teenagers after aerobic physical exercises accompanied by the normalization of a vascular tone and improvement of heart functions. SDS of teenagers is better adapted to physical activity thus improving their physical fitness and functional class, endurance, stabilizing heart rate and normalizing blood pressure indicators.

Keywords: *arterial hypertension, physical activity, teenagers, aerobic load*

1. INTRODUCTION

Adolescence is characterized by marked changes in blood vessels, since the growth rate of blood vessels is lagging behind the growth rate of heart volume, which leads to relatively narrow blood vessels after 12 years [1, 2]. Faster increase in the heart volume compared to the increase in the capacity of the vascular network gives reasons for the increase of the vascular tone thus creating anatomical conditions for the increase of blood pressure [2]. Significant changes in neuroendocrine regulations accompanied by the beginning of the incremental function of genital glands and marked activation of hypothalamo-pituitary-adrenal axis also contribute to this. Increased influence of sympathetic outflow to the heart and associated lability of nervous processes, reduced excitability threshold of vegetative nervous system typical for adolescent age also reflect upon the regulation of blood circulation of a teenager. Various adverse factors play a critical role: defatigation, persistent infection sites, hypokinesia and physical overwork [3, 4]. Differences in cardiovascular system (CVS) of teenagers shall be taken into account during adaptive physical training and sports. [5].

Despite this, it shall be noted that against the background of morpho-functional immaturity of heart and vascular elements, as well as continued development of the central nervous system, teenagers are characterized by incomplete formation of mechanisms regulating and coordinating the functions of heart and vessels both within the circulatory system and ensuring the blood flow of organs and systems of the body [6, 7]. That is why the adaptive capabilities of the circulatory system of teenagers during muscle activity are much less than those for young

men and much less for adults. The circulatory system in a teenage period responds to loads with less efficiency and comes to a state of considerable tension at relatively small physical loads [8–10]. Therefore, we used the **average intensity load** to prevent negative consequences of CVS.

In the age interval from 12–13 to 18 years there is the greatest increase and the highest growth rate of systolic and diastolic blood pressure. The risk of arterial hypertension in adulthood is 2.3 times higher for teenage boys with elevated blood pressure and 2.9 times higher for teenage girls compared to boys and girls with normal blood pressure. If elevated blood pressure is combined with overweight, the risk of arterial hypertension in adulthood increases 7.5 times for boys and 5 times for girls compared to their peers without this risk factor. The overweight of teenage boys is an independent predictor of arterial hypertension and atherogenic dyslipidemia in adulthood [11–13].

Arterial hypertension occurs in 40 % cases among adult population. At the same time, 18.5 % men and 30.4 % women suffering from arterial hypertension showed elevated blood pressure in childhood or adolescence. The risk of arterial hypertension increases 2–3 times if high blood pressure is detected at this age and 5–7 times when high blood pressure is combined with overweight.

The **purpose of the study** is to analyze the effect of medium-intensity physical exercises on students' CVS.

Research objectives:

- 1) To identify students with arterial hypertension in the examined groups.
- 2) To develop a set of exercises to optimize students' CVS.
- 3) To determine the functional class in the examined groups.

3) To conduct a pilot study in order to identify the efficiency of the developed set of exercises.

Aerobic physical activity is a type of physical activity characterized by long rhythmic contraction of muscles accompanied by reinforced metabolism and considerable heart acceleration. Running, dancing, jumping rope, swimming, cycling are all examples of aerobic physical activity. Regular aerobic physical activity has a training effect on CVS and respiratory system.

Therefore, this problem is relevant for the younger generation.

2. METHODS AND MATERIALS

The study was conducted at the State Budgetary General Educational Institution of Samara Region – Boarding School No. 5 for physically disabled students of Togliatti city district.

The study covered by 30 boys aged 12–14 with arterial hypertension. Two groups of 15 persons each were formed, and adolescents of both groups did not differ in their physiological indicators, age and physical development. Teenagers of the main group (MG) studied

Table 1 Norms and deviations of arterial blood pressure and heart rate in boys aged 12–14 with arterial hypertension at the beginning of the study

| Indicator | Systolic blood pressure (Torr) | Diastolic blood pressure (Torr) | HR (BPM) |
|-----------------------|--------------------------------|---------------------------------|----------|
| Norm | 103–107 | 61–64 | 80–84 |
| Arterial hypertension | 118–125 | 70–85 | 85–90 |

The target HR that we used to moderate the intensity of physical activity for teenagers aged 12–14 ranged from 130 to 156 beats per minute.

The **Varikard 2.51** hardware and software complex was used for heart rate variability analysis [14].

Let us give the norms and deviations of blood pressure and heart rate for this group of persons aged 12–14 years old.

Description of tests.

2.1. Running at a pace of 130–140 steps per minute, arms bent halfway and relaxed

The running length in the first week made 30 seconds. With good health, running time can be increase by 1–2 minutes per week and gradually increased up to 5–10 minutes. After running – walking for 1–3 minutes combined with proper breathing (pay attention to full exhalation). Aerobic running improves CVS and normalizes arterial blood pressure.

2.2. Medium intensity 1000-meters running

Such running contributes to the expansion of blood vessels, reduces peripheral vascular resistance, improves

according to the school program of physical education and performed a medium intensity set of aerobic physical exercises twice a week during out-of-lesson time. The experimental group (EG) was studied according to a standard curriculum. Classes in MG on optimization of CVS indicators were conducted using a set of aerobic exercises, which included a 30-second running with further increase to 5–10 minutes; a 1-km low intensity running; 10-minute indoor cycling and 10-minute treadmill classes.

Not all physical activity is equally useful for health: those activities give the best results where the pulse is in the so-called target zone (target range). The target heart rate (HR) is the amount of HR during training that helps maintaining the level of physical intensity between the upper and lower boundaries of the HR. The Karvonen method, a method to determine the HR reserve that is equal to the difference between the maximum HR and the resting heart rate, is used to establish the target HR. The method takes into account individual differences in the physical condition of a teenager since it is based on resting HR indicators. This indicator depends not only on age, but also on physical fitness [3].

Table 1 Norms and deviations of arterial blood pressure and heart rate in boys aged 12–14 with arterial hypertension at the beginning of the study

heart function and increases body endurance. Running shall be alternate with fast and slow walking to avoid CVS overloading.

2.3. 10-minutes treadmill

This type of physical activity provides perfect training of CVS, as systematic exercises normalize arterial blood pressure and body weight, increase immunity and resistance of the body to stresses. Correct performance of treadmill exercises is important. Keep your body straight as balanced as possible in relation to hips. You can hold the handrails. The muscles of the neck and shoulder strength shall not be too tense. In case of arterial hypertension, it is recommended to train on a treadmill 2 times a week for 10 minutes with alternation of aerobic loads in the open air.

2.4. 10-minutes cycling

A teenager shall not feel discomfort, and the pace of cycling shall be calm and moderate. It is allowed to drive at the minimum speed, the first trainings finish in 5 minutes. During the first week, the load and rest are alternated for one minute. Every two weeks, the time of

the exercise is increased by 1–2 minutes, bringing it to 10 minutes of cycling.

2.5. Mathematical statistics

The results of the studies were processed using mathematical statistics via the Student’s t-test and Excel Windows application package.

Table 2 Physical fitness of teenagers aged 12–14 at the beginning of the study

| n/n | Indicator | MG (M±m) | EG (M±m) |
|-----|---|-----------|-----------|
| 1 | Running at a pace of 130–140 steps per minute, 5 minutes (km) | 0.77±0.20 | 0.78±0.16 |
| 2 | Medium intensity 1000-meters running (min) | 4.47±0.15 | 4.54±0.12 |
| 3 | 10-minutes treadmill (km/h) | 1.11±0.18 | 1.09±0.24 |
| 4 | 10-minutes cycling (km/h) | 3.7±1.04 | 3.5±1.06 |

Table 3 Physical fitness of teenagers aged 12–14 at the end of the study

| n/n | Indicator | MG (M±m) | EG (M±m) |
|-----|---|-----------|-------------|
| 1 | Running at a pace of 130–140 steps per minute, 5 minutes (km) | 0.80±0.17 | 0.92±0.17* |
| 2 | Medium intensity 1000-meters running (min) | 4.49±0.07 | 3.35±0.21* |
| 3 | 10-minutes treadmill (km/h) | 1.09±0.21 | 1.58±0.16** |
| 4 | 10-minutes cycling (km/h) | 3.0±0.99 | 4.2±0.84* |

* – p<0.05; ** – p<0.01 – reliability of differences relative to EG.

Table 3 shows indicators of physical fitness of 12–14-years old teenagers with arterial hypertension at the end of the study, which indicate that all used indicators of the MG were improved.

The results of five-minute running at the rate of 130–140 steps per minute in teenagers of the MG significantly (p<0.05) increased compared to the EG.

At the end of the study, the medium intensity 1000-meters running time in the MG significantly decreased (p<0.05) compared to the to the EG.

The average speed of ten-minute running on a treadmill in the MG increased reliably (p<0.01) compared to the EG.

At the end of the study, the speed of 10-minutes cycling of students of the MG significantly increased (p<0.05) compared to the EG.

The improvement of physical fitness of MG teenagers after the proposed set of physical exercises was combined

Table 4 Norms and blood pressure of 12–14-years old boys with arterial hypertension at the end of the study

| Indicator | Systolic blood pressure (Torr) | Diastolic blood pressure (Torr) | HR (BPM) |
|-----------|--------------------------------|---------------------------------|----------|
| Norm | 103–107 | 61–64 | 70–84 |
| MG | 107 | 63 | 80 |
| EG | 123 | 79 | 86 |

3. RESULTS

Table 2 shows indicators of physical fitness of 12–14-years old boys with arterial hypertension, no reliable differences were revealed in their knowledge, therefore, hence the level of physical fitness of the groups was correctly selected.

with the positive dynamics of CVS indicators used in the pedagogical process of general education institutions (Table 4).

It is known that in addition to arterial hypertension, low physical activity – hypodynamia – is considered a “large” risk factor of cardiovascular diseases [1].

Although the terms “physical activity” and “exercise” are used as synonyms, there are differences between them. The term “physical activity” refers to any work done by skeletal muscles resulting in energy consumption beyond the level typical for the state of rest. The term “physical exercises” (physical education) refer to a subcategory of physical activity and is defined as planned, structured and repetitive body movements that are performed to improve or maintain physical fitness and health. These differences are important because only a small percentage of children and teenagers do physical exercises solely to improve their physical fitness [1].

It shall be noted that after physical exercises the CVS indicators of the 12–14-years old teenagers with arterial hypertension were improved.

Consequently, the CVS of teenagers is better adapted to physical activity (as also evidenced by the results of improving their physical fitness), their endurance is increased, and the HR and blood pressure normalize.

The functional class at the end of the study in the MG regarding the atypicality index consistent with its gender

and age group began to correspond to the first class and to the physiological norm, while in the EG – to the sixth functional class regarding the atypicality index, which corresponds to premorbid state, i.e. the pre-existing disease state (Figures 1 and 2).

This, in turn, confirms the need to do aerobic physical exercises for teenagers with arterial hypertension, which leads to CVS optimization.

Section containing the results of the study.

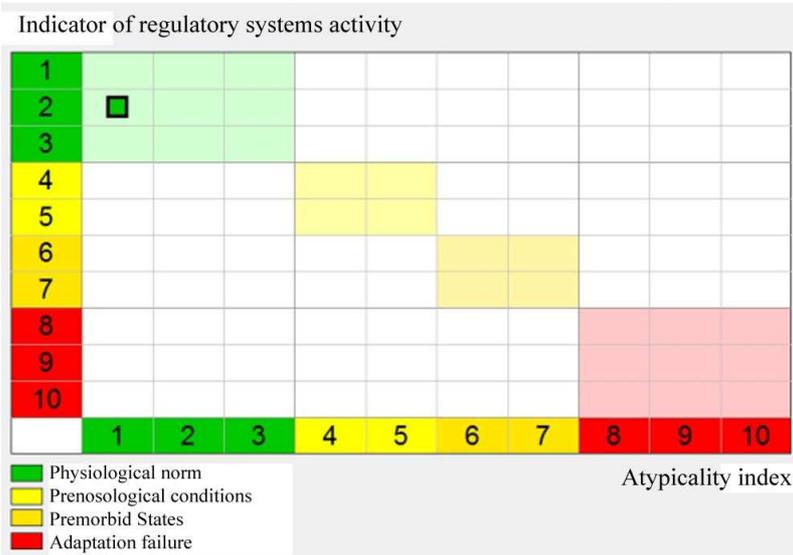


Figure 1 Functional class indicators of the MG at the end of the study

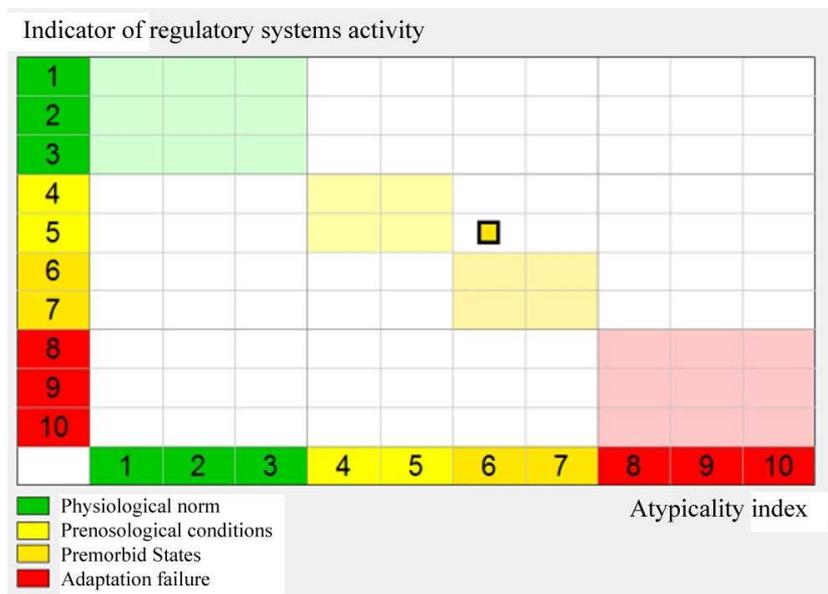


Figure 2 Functional class indicators of the EG at the end of the study

4. CONCLUSION

When choosing physical exercises for teenagers with arterial hypertension, great attention shall be paid to their aerobic orientation. Systematic physical exercises of medium intensity contribute to CVS training and its better

adaptation to physical loads. It is necessary to detect blood hypertension at a school age in a timely manner and to select the appropriate aerobic physical activity for them.

1. The use of medium-intensity aerobic physical exercises is a promising direction in adaptive physical education.

2. Our study found that CVS at arterial hypertension in the MG were significantly improved compared to the EG due to the fact that the corresponding set of physical exercises was used in the MG.

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