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**VARIATION OF THE CHARACTERISTICS
OF THE CARDIORESPIRATORY SYSTEM AND BIOIMPEDANCE
ANALYSIS OF THE PERSONS WITH ELEVATED
AND NORMAL BLOOD PRESSURE UNDER THE INFLUENCE
OF MODERATE PHYSICAL ACTIVITY**

ABSTRACT. The aim of this study was to investigate the dynamics of the cardiorespiratory system and bioimpedance analysis of patients with normal and elevated blood pressure under the influence of power and aerobic exercise of moderate intensity. The study involved 111 people. There were 63 men and 48 women. We have found that among people with normal and high blood pressure there are no significant differences in the indicators under study in response to physical stress; but people with normal blood pressure had a higher rate of change of the indicators of bioimpedance analysis, which is associated with a better adaptation capacity of their cardiorespiratory system. Analysis of the effects of physical exercises revealed an increase in the body mass index due to increase in the muscle mass. This leads to increase in the cardio-vascular risk. Aerobic exercises contributed to the growth of muscle tone without its hypertrophy and a faster cardio adaptation. Thus, any physical activity helps to improve health and reduce the risk of cardiovascular diseases, but for those with elevated blood pressure aerobic exercise is preferable.

KEY WORDS. Physical activity, cardiorespiratory system, bioimpedance analysis.

Different categories of people do physical exercises for various purposes. Sportsmen aim at achievement of high sports results; people involved in exercise nonprofessionally wish to increase their functional capabilities; people with health problems concentrate on therapeutic effects in order to restore their life quality [1] through risk factors definition and their elimination. Feedback is very important for the effective training or treatment process: what impact and to what extent this or that physical load produces on the person's body. Thanks to such information we can control the course of treatment or training and correct the amount and intensity of the used exercises as well as monitor the dynamics of the functional state of the patient's body. Various objective and subjective methods are employed in order to receive feedback on the influence of the physical exercise on the human body. Development of the appropriate methodologies of prevention and rehabilitation is possible only with the introduction of the method of assessment [2]. In our case we used: measurement of blood pressure on the brachial artery by Korotkov's method, manual (palpatory) check of the heart rate on the radial artery, anthropometry, spirometry and bioelectrical impedance analysis of the body composition.

Arterial pressure is one of the most important parameters characterizing work of the blood circulatory system. Pressure increase by each 10 mm of mercury raises the risk of cardio-vascular diseases by 30%. People with increased pressure develop cerebral circulation disorders 7 times as more often as other people which can lead to vascular catastrophes; ischemic heart disease 4 times as often, blood circulation in the lower limbs twice as often which is especially dangerous for the people little involved in physical activity [3].

Heart rate is a dynamically changing indicator which reflects the organism's capacity to respond to various influencing factors. The adaptation of the organism to physical activity is mainly defined by the boosting cardiovascular system which involves increased heart rate, increased myocardial contractility and increased stroke and minute blood volume [4-5]. The data on the heart rate change during exercise are necessary for the analysis and assessment of the bodily functions, calculation of the training zones boundaries as well as design and realization of training programs [6-7]. The standards for the general physical activity have been developed according to the interrelation of the heart rate and specific sports activity [8-9].

Anthropometry is one of the main methods of an anthropometric examination consisting of the measurement of the human body and its parts for the purpose of defining its age, gender and other physical peculiarities which can help provide a qualitative characteristic of their variability. Waist circumference is used as a valid indicator of the presence or absence of abdominal adiposity which according to the criteria of risk stratification concerning cardio-vascular complications together with increased arterial pressure belongs to the modifiable factors.

The bioelectrical impedance analysis is the most modern, safest and noninvasive method for estimating body composition based on the differences in the electrical conductivity of its component tissues due to the different content of liquid and electrolytes. About 90% of all the measurements made with the method of bioelectrical impedance analysis in the world use single-frequency integral episodic measurements placing the electrodes on the ankle and wrist with sensing current at a frequency of 50 kHz [10].

111 persons have been examined: 63 (56.7%) males and 48 (43.2%) females.

64 (57.6%) persons out of 111 have high arterial pressure at rest and 47 (42.4%) persons have a normal level of blood pressure: 8 (17.02%) males and 39 (82.98%) females.

Among the people with high blood pressure there are 54 (84%) males and 10 (16%) females. 82.98% females and 17.02% males have normal arterial pressure.

The males with high blood pressure are characterized by:

1. Lower vital capacity (according to the data obtained with the help of a portable spirometer); 24 persons (44.4%).

44.4% of the examined males with high blood pressure have a low vital lung capacity, whereas 55.6% males from this group have VC within normal limits.

2. 59.3% males from this group have a body mass ratio above the norm; 40.7% have it within normal limits.

3. Fat weight is above the norm for 70.4% males; within normal limits for 29.6%.

4. 57.4% have low active cell mass.

5. 75.9% have a low musculoskeletal weight; 24% have it within normal limits.

6. The total amount of liquid in the body is low for 16.7% males; 83.3% have it within normal limits.

We cannot have valid data on the source norm deviations for the males with normal arterial pressure due to the small number of the examined persons.

Among the females with high arterial pressure:

Lower vital capacity is revealed for 70% females; 30% females from this group have VC within normal limits.

60% females from this group have a body mass ratio above the norm.

Fat weight is above the norm for 70% females with high arterial blood pressure.

90% females with high arterial blood pressure demonstrate low active cell mass.

80% have a low musculoskeletal weight.

The total amount of liquid in the body is low for 40% females in the group with high arterial blood pressure; 60% have it within normal limits.

As for the deviations from the norm for the females with normal level of arterial pressure:

1) Low VC according to the portable spirometer is found for 17 persons (43.6%);

2) Increased body mass ratio is found for 5 persons (12.8%);

3) Increased body fat is found for 10 persons (25.6%);

4) Decreased active cell mass is found for 19 persons (48.7%);

5) Decreased musculoskeletal weight is found for 24 (61.5%).

Thus, the persons with normal values of arterial pressure, as opposed to the persons with high blood pressure, have a lower body mass ratio (never over 30kg/m²) and smaller amount of fat in the body. The values for VC, active cell mass and musculoskeletal weight are more or less the same for the people with various levels of arterial pressure (normal and high).

According to the data of dynamics control we have the following information.

Under the influence of aerobic training the males display a decrease in the body mass ratio and amount of body fat; an increase in the active cell mass, VC and musculoskeletal weight. 25%-85% have noted a feeling of well-being, more social activity and arterial pressure stabilization. The best results for the dynamics control are obtained for the period 16-24 weeks from the beginning of the training process.

The persons with normal arterial pressure have a similar dynamics to the persons with high blood pressure; however the speed of the data change is more expressed which is connected with better adaptation capabilities of the healthy organism.

Under the influence of weight lifting exercises there is a slower decrease in the body mass ratio than under the influence of aerobic exercises. In 12.3% cases we registered increase in the body mass ratio due to the growth and hypertrophy of muscle

tissues [11], which can cause an increase in the cardiovascular risk. Fluctuation of the indicators is less stable and dynamics is more expressed only at the end of 24th week.

Dynamics of the values depending on the level of arterial blood pressure has a similar tendency; but the people with high blood pressure demonstrate a lower speed of changes concerning the parameters in question and the character of the changes was unstable and labile.

The group of females involved in aerobic exercises display a positive dynamics regarding the values of the body mass ratio, VC, fat and musculoskeletal weight. The level of the active cell mass has an unstable dynamics which is connected with the socially active lifestyle and psycho-emotional load at work and at home.

The women with a normal level of arterial pressure have a similar dynamics of the studied parameters to the group of females with high arterial pressure. However the qualitative level of the values is higher which is connected with their better discipline. The females with high blood pressure have a slower speed of change which is linked to the decreased adaptation capabilities of their cardiovascular system.

Power lifting exercises have led to the growth of the musculoskeletal weight in 100% cases, decrease in the fat weight and increase in the active cell mass and vital lung capacity. The most expressed values of the dynamics are registered in the period of 16-24 weeks after the beginning of the regular training process.

Regardless the gender, aerobic exercises lead to the decrease in the body mass ratio, fatty tissue; increase in the lean body mass, active cell mass and musculoskeletal weight. 85.7% persons with high blood pressure have noted stabilization of the level of arterial pressure and general well-being. In 23.5% cases we have registered an increase in VC.

In general weight lifting produces positive effects regarding cardio-respiratory parameters; but in a number of cases there was an increase in the musculoskeletal weight which led to an increase in the body mass ratio and as a result an increase in the cardiovascular risk.

Thus, all kinds of physical exercise, both for men and women, bring a tendency of arterial pressure stabilization and growing stamina. However, when doing mainly power physical exercises there is an increase in the body mass ratio due to the significant increase in the musculoskeletal weight; and in 30% cases we register an increase in the fatty tissues which raises the cardiovascular risk. Aerobic exercises mainly train the cardio-respiratory system, facilitate fat burning and tone up the musculoskeletal mass without its hypertrophy. We have not registered any significant differences in response to the power and aerobic training among the persons with normal and high arterial pressure; but the parameters of the bioelectrical impedance analysis improve faster and within shorter time periods for the people with normal arterial pressure in comparison with the persons suffering from high blood pressure as the former probably have better adaptation capabilities of their cardio-respiratory system.

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