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PECULIARITIES OF MEN'S ADAPTATION POTENTIAL UNDER THE FORCE LOADS EFFECTS

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Abstract

We studied the problems of improving sports and fitness classes in strength fitness to increase the adaptive capacity of the body of untrained young men aged 20-21 years old by using different load regimes. In the analysis of scientific and methodological literature, it was found that the methodology and the impact of loads on adaptation processes are not comprehensively studied. In addition, effective and at the same time safe load regimens using various exercises in sports and recreation are not developed to the full extent. To study the impact of strength training, 20 untrained people were invited. They used two load modes: Group 1 - standard level and Group 2 - high-intensity and low-volume mode.

As a result of the analysis of the obtained indicators of adaptive potential in the 1st group, which were recorded during 3 months of training under power loads, the optimal period of duration of significant adaptive changes in their body, which intensified after the second month of training, was determined. The analysis of lean body weight shows an increase relative to the second month not only in the 1st group, but no significant changes were recorded in the 2nd group. The analysis of the results of the comprehensive body size of young men in both untrained groups show almost identical parameters. The level of coverage in the participants of the 1st group is on average 8.9% lower compared to the results obtained in the 2nd group.

Based on the results obtained, we can say that the most informative markers for assessing adaptive changes in the body of men with a low level of physical fitness are morphometric parameters of the body.

Key words: adaptive changes; physical activity; morphometric parameters; body composition; load regime.

Introduction. Due to the active automation of life in the modern world there is a decrease in motor activity which leads to deterioration of physical development and processes of adaptation to physical activity of different orientations, as well as the manifestation of various pathological conditions due to inadequacy of loads. All this stuff is of concern among specialists in physical culture and sports and among scientists in the field of biology and medicine. In modern literature the results of the researches on studying a problem of processes of adaptation of a human body to physical activities, namely on studying mechanisms of adaptation in professional sports are widely presented. At the same time, despite the global popularization of strength fitness, which is an affordable type of physical activity for both physical development and for the recovery of their body as a whole, the research to study the features of adaptive-compensatory reactions in such conditions of muscular activity and to develop the safest and most effective modes of operation are practically absent [7, 10]. The same problem can be observed not only while strength fitness but also in professional activities.

Due to new requirements, the main purpose of which is to achieve the maximum adaptive changes in the shortest period of time, which leads to a significant increase in the likelihood of physical fatigue and even the development of pathological conditions because of inadequate loads on their body. The peculiarities of adaptive-compensatory reactions of the human body in the conditions of force loads of different orientation, as well as the mechanism of finding effective and safe ways to optimize the training process taking into account the level of its physical development are insufficiently studied [3, 5, 7].

Accordingly, significant physical activity, especially during their long-term action, causes significant morphofunctional changes in the human body. Most often such situations occur in the initial stages of exercise, which are carried out under conditions of mismatch of the body's capabilities to the levels of the proposed training programs. The prevention of the development of these phenomena involves the systematic study of adaptive-compensatory reactions of the body to force loads which occur in conditions of prolonged motor activity of different orientations.

According to the above, the lack of effective methods for quantifying the amount of load is one of the main problems of the modern system of physical training of strength, the solution of which will allow to develop the most optimal and safe training regimes depending on the conditions of muscular activity and the level of training in order to achieve a high level of adaptive changes in the body.

The purpose of research is to establish safe load regimes in strength fitness to develop a comprehensive system for optimizing the adaptive-compensatory reactions of the human body in the conditions of muscular activity of different orientations.

Materials and methods of the research. The research was conducted in the period from September 2019 to September 2020 on the basis of the fitness center "D-Fitness", which is located at: 20A Rosvyhivska Street, Mukachevo, Zakarpattia region.

Direct measurements of indicators and work in the gym were carried out for 3 months (from September 2019 to November 2019 inclusively).

The study involved 20 males (aged 20-21 years old, mean body weight is 76.94 ± 2.31 kg).

2 research groups were formed from this contingent, depending on the purpose and tasks set: 10 untrained persons who trained in the mode of standard level of loading ($R_a = 0,64$ um.od.) - 1 group; 10 untrained persons who trained in the mode of high intensity and small volume of work ($R_a = 0.71$ um.od) - 2 group.

All examinations were performed before doing sport loads. To determine the critical limits of physical activity in conditions of acute muscle tension during strength training, one group of young men out of 10 took part in the studies. At the same time, the second group of 10 people participated in long-term studies (for three months), with a standard level training, the main purpose of which was to investigate the rate of adaptation in the body of the untrained contingent in a long training process without changing the level of physical activity and to determine the period of time required for the formation and consolidation of changes.

To conduct a detailed control of physical activity, a large number of different indicators were taken into account: human body weight, duration of muscle tension, level of muscle strength, number of motor actions, range of motion. The use of such indicators allows to assess the adequacy of the load regime during a certain training exercise in more detail and promotes the most effective development of physical qualities and certain muscle groups.

The exercises. Physical exertion was used as a model of muscular activity, in the process of conducting a series of studies. The structure of the model of muscular activity fully depended on the values of the main components of the training load, which include the

following indicators: duration of work in a separate set (s), pace of exercise (s), number of repetitions in a separate set, working weight (% from the maximum), the amplitude of the exercise (% from the complete one) and others.

A certain ratio of the values of the training load indicator in the process of muscular tension reflects the structure of the physical activity regime with the corresponding advantage of the indicators of the work intensity or its volume level.

At the beginning of the research, a number of studies were conducted to establish primary, reliably safe levels of physical activity for individuals who had not had physical training. To do this, we used the "standard" mode of physical activity: standard and high-intensity training in the process of training [12].

The following methods were used for the study: morphofunctional, these are anthropometry, using a height meter, centimeter tape, bioimpedancemetry using the device Omron BF-508, determining the parameters of maximum muscle strength; determination of the level of adaptational potential by calculating the formula for which blood pressure, heart rate, weight, height were measured and the age of the subject was taken into account.

To assess the primary level of the development of the maximum muscle strength of the surveyed contingent and to determine the dynamics of the parameters of these control indicators in the process of long-term strength fitness the method of control testing was used [9]. At the same time, the obtained data were used during the calculations of the level of physical activity. The maximum strength development of the following muscle groups was measured: pectoral muscles, leg and back muscles, triceps and biceps [4, 9]. The determination of these indicators was investigated systematically at intervals of one month. The measurements were performed before the start of the training session according to the generally accepted methods and, accordingly, at the end of the research period [1, 8, 10]. Taking into account the generally accepted technique of performing the exercise [2], the subjects were given three attempts after the warming-up in order to determine the maximum parameters of muscle strength. The results of the best attempt were entered into the study protocol.

Research results and their discussion. The nature of changes in the parameters of morphometric indicators of the body composition in general is a reflection of the adaptive potential of the human body to an adequate stimulus, namely the exercise.

One of the ways to improve the modes of training loads is to optimize the parameters of the intensity and volume of the strength work [6, 12].

The analysis of the initial research results shows that the indicators of the body size of young men of both untrained groups show almost identical parameters. The level of the studied indicators in the participants of the 1st group, on average, is only 8.9% ($p < 0.05$) lower compared to the results obtained in the 2nd group. This fact indicates that not always specialized training activities, which significantly increase the maximum muscle strength of a person during long-term strength sports, can be equally effective in increasing its morphometric parameters.

Table 1. - Parameters of indicators of the circumferential body size of the participants of the study groups, which were recorded during the experiment being conducted during 3 months, ($M \pm m$, $n = 20$)

| Body circumferences | Research groups | Stages of control | | | |
|---------------------|-----------------------|-------------------|-----------------------|-----------------------|-----------------------|
| | | Initial values | Monthly figures | | |
| | | | 1 st month | 2 nd month | 3 rd month |
| Chest | 1 st group | 101,9±1,29 | 103,75±1,35* | 105,15±1,41* | 105,98±1,41* |
| | 2 nd group | 109,58±0,6 | 112,20±0,31* | 114,13±0,28* | 116,13±0,23* |
| Shoulder | 1 st group | 32,83±0,33 | 33,53±0,38* | 34,08±0,39* | 34,48±0,40* |
| | 2 nd group | 39,55±0,29 | 40,50±0,30* | 41,13±0,30* | 41,74±0,30* |
| Forearm | 1 st group | 26,20±0,18 | 27,00±0,20* | 27,63±0,20* | 28,00±0,22* |
| | 2 nd group | 28,93±0,12 | 29,85±0,15* | 30,75±0,15* | 31,40±0,16* |
| Neck | 1 st group | 36,68±0,28 | 37,70±0,35* | 38,35±0,34* | 38,80±0,35* |
| | 2 nd group | 39,25±0,19 | 39,93±0,19* | 40,68±0,20* | 41,05±0,19* |
| Hip | 1 st group | 52,73±0,78 | 53,63±0,70* | 54,00±0,66* | 54,40±0,62* |
| | 2 nd group | 59,10±0,20 | 60,73±0,23* | 61,65±0,22* | 62,03±0,20* |
| Shin | 1 st group | 35,98±0,42 | 36,53±0,39* | 36,75±0,37* | 36,83±0,37* |
| | 2 nd group | 39,05±0,17 | 39,83±0,19* | 40,13±0,17* | 40,35±0,17* |

Note: * - $p < 0.05$, compared to the values of the previous month.

Analyzing the results, we see that the greatest positive long-term dynamics of increasing the studied indicators of anthropometry, regardless of the level of training of the participants and the characteristics of the modes of force used by them, was found during the control of forearm girth parameters by 6.9% ($p < 0.05$) in the first group. At the same time, the least positive tendency to increase the studied indicators is shown by the parameters of the circumferential size of the shin by 2.4% ($p < 0.05$) in the 1st group of untrained persons, to 3.3% ($p < 0.05$) in the 2nd group untrained people compared to their baseline values.

We can assume that the different ratio of motor units in working muscles can possibly be one of the reasons for so different rates of the increase in certain indicators of the overall body size of the study participants.

The analysis of the results of studies obtained after the third month of training shows a decrease in the growth rate of body circumference largely depends on the ratio of the parameters of intensity and volume of training sessions. The use of high-intensity and low-intensity training (high-intensity) mode during strength fitness exercises contributes to a more pronounced increase in body size than high-volume and medium-intensity loads (standard muscle activity).

In order to determine the most optimal mode of muscular activity in strength fitness for participants with different levels of training, while studying the characteristics of changes in body composition parameters, in a given range of strength training the appropriate studies were conducted (Table 2). While investigating the nature of changes in impedancemetry in groups of previously untrained young men under conditions of different exercise regimes ($Ra = 0.64$ and $Ra = 0.71$ units), we obtained results that differed not only in the level of dynamics but also in its direction.

Table 2 – The change in body composition of the studied contingent in the process of long-term strength training, $n = 20$

| Indicators of body composition | Research groups | Stages of control | | | |
|--------------------------------|-----------------------|-------------------|-----------------------|-----------------------|-----------------------|
| | | Initial values | Monthly figures | | |
| | | | 1 st month | 2 nd month | 3 rd month |
| LBM, kg | 1 st group | 67,90±1,70 | 68,76±1,78 | 69,0±2,0 | 69,80±1,85 |
| | 2 nd group | 69,80±1,90 | 72,70±2,11 | 71,45±2,10 | 71,50±2,10 |
| BFM, % | 1 st group | 11,7±0,35 | 13,20±0,52 | 11,20±0,33 | 12,50±0,43 |
| | 2 nd group | 17,9±0,59 | 16,8±0,54 | 16,78±0,54 | 17,10±0,58 |
| BMI, c.u. | 1 st group | 23,80±0,73 | 23,70±0,73 | 23,95±0,74 | 24,00±0,75 |
| | 2 nd group | 26,50±0,73 | 26,81±0,74 | 26,75±0,74 | 26,50±0,73 |

Indicators of lean body mass (LBM, kg) of participants of the two study groups registered at each stage of control during the three-month cycle, show a wavy dynamics with mostly positive character. The analysis of the study results shows that after the first month of training of the participants from the 2nd group, LBM indicators show an increase of 4.38% ($p < 0.05$). Representatives of the 1st group found a slight decrease in the studied indicator by 1.27%. The analysis of the study results obtained after the third month of training shows an increase in the LBM relative to the second month by 1.1% only in people of the 1st group. In addition, in the 2nd group no significant changes in the controlled indicator were recorded.

The results of the study indicate that the use in the training of high-intensity loads and small amounts of work by the members of the 2nd group, contributes to a more pronounced

increase in body LBM compared to the data found in the 1st group which was subjected to heavy loads volume and medium intensity.

The analysis of the dynamics of the average group parameters of the primary study results of body fat (BFM, %) in both groups shows that the lowest level of body fat (11.7%) at the beginning of the study was found in the 1st group. At the same time, the highest level of the controlled indicator was observed in the 2nd group (17.9%).

At the end of the first month of strength trainings, the average group parameters of body fat in boys of the 2nd group show a decrease. The results of studies established in adolescents of the 1st group, on the contrary, show an increase in the controlled body composition by 1.3%.

After the second month of research, controlled indicators of body fat in the 2nd group, show a further, almost imperceptible, tendency to reduce their parameters. In turn, the studied indicator of the body composition, determined in the 1st group of participants, on the contrary, shows a significant decrease in its level by 1.8%.

After the third month of trainings, despite the fact that the adaptation of the body of young men to power loads had to be finished by the end of the third month of training in a given mode of muscular activity, the results of studies in group 1 show an increase in body parameters by 1.1% . Therefore, to effectively reduce the body fat of young men, regardless of their level of training, in the process of long-term strength fitness for more pronounced dynamics, it is necessary to use a regime of high-intensity power loads with low workload ($Ra = 0.71 \text{ um}$).

The results of long-term control of the average group parameters of the body mass index (IMT) determined in the participants of the two experimental groups show different dynamics. The results of the study of the dynamics of the body mass index in the process of using the regime of high intensity strength training, which are set after the first month of training, show an increase in the level of the indicator in the 2nd group by 1.54% and in the 1st it is by 0, 67% compared to baseline.

Any significant changes in the studied body composition in untrained individuals did not occur after a month of intense training in the conditions of using the standard training regime. The increase in BMI in the 1st group was noticeable after the second and third months.

In the 2nd group, a significant trend of changes in the controlled indicator was also not recorded during this period of research, which indicates a high level of tolerance of their body to stimuli of this nature.

The functionality assessment was performed by calculating the adaptation potential according to the formula which took into account blood pressure, heart rate, weight, height and age (Fig. 1). Heart rate and blood pressure are undoubtedly the most important indicators of the functional activity of the cardiovascular system. During sports activities, heart rate and blood pressure are one of the most objective and accessible indicators of registration of the performed work capacity.

The observation of its changes during training allows to control the intensity of physical activity and the rate of adaptation of the body to physical activity.

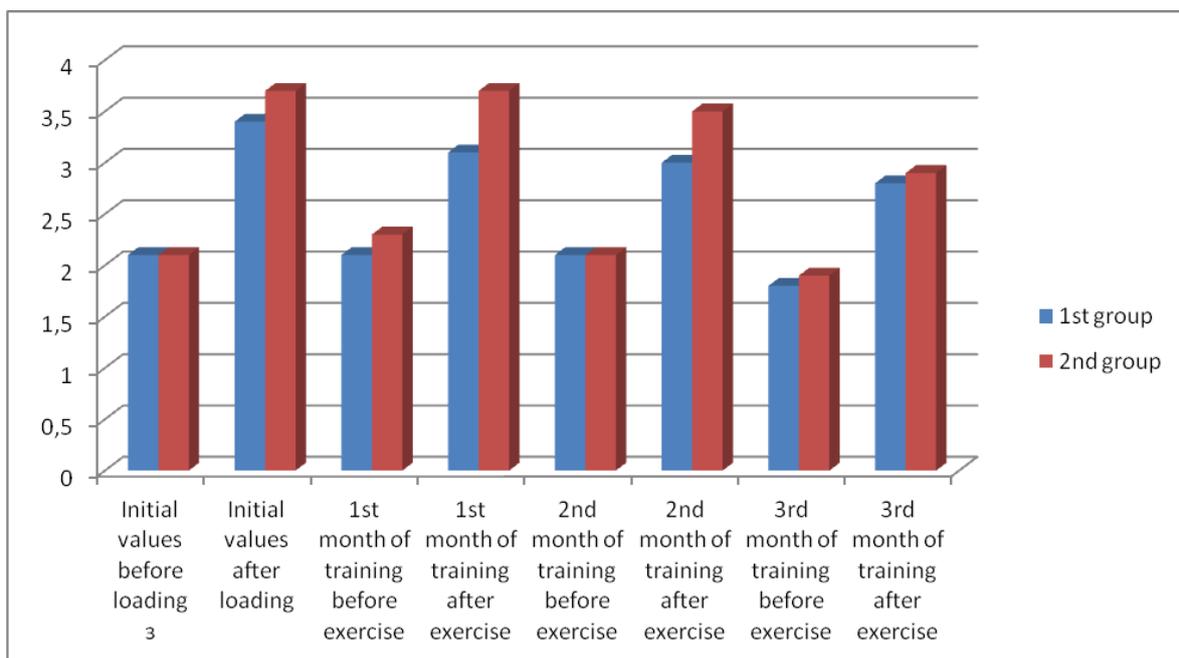


Fig.1. Indicators of the state of adaptive potential and functional capabilities of the body during three months of strength fitness (before / after exercise).

While analyzing AP, we can see that the adaptive capacity of the body depends on physical activity. The results show that the initial values of both experimental groups of untrained individuals had a tension of adaptation mechanisms (2.1 points), and therefore, the body's capabilities are better than after standard exercise - 3.4 points in the first group with a standard load corresponding to the limit level of adaptation mechanisms and unsatisfactory adaptation; as well as 3.9 points in the second group with high intensity and low workload, which corresponds to unsatisfactory adaptation. The value of AP in the range of up to 2.1 points, characterizes the satisfactory adaptive capacity of the body, which is observed in young men before training. An AP score of more than 2.1 to 3.2 points indicates the stress of

the body's adaptive capacity, which indicates sufficient functionality which is provided by functional reserves. AP in the range of 3.2-4.30 points indicates unsatisfactory adaptation and reduced functionality of the body.

At the end of the three-month experiment, we received an improvement in adaptive capacity in both before training (14.3%) and after it (17.65%) in the 1st group with a standard load. In the 2nd group with a high level of intensity, less positive adaptive changes can also be observed. There are, the AP rate improved by 9.53% before exercise, but the rate improved by 21.2% after it. We can say that the nature of the functional capabilities of the subjects when performing standard physical activity reflects the lower level of efficiency and adaptive capacity of the cardiovascular system. This is due to the fact that during exercises the heart works in the least economical mode and its compensatory capabilities are limited.

Conclusions. Studies have shown that safe exercise regimes are more conducive to strength-oriented muscle activity. According to the obtained results, new approaches to the methods of estimating the magnitude of force loads were proposed, taking into account the peculiarities of the conditions of muscular activity and the level of training of the contingent as well as the ways to further address the issue of finding informative methods for determining the degree of adequacy of training performance indicators to the functionality of untrained individuals.

Due to the results of the tasks set in the work, the following conclusions were made:

1. The integrated method of quantitative assessment of the magnitude of the load developed by us made it possible to determine the optimal parameters of work modes in the shortest possible time in the process of strength training, depending on the conditions of muscular activity and the level of human training.

2. The optimal duration of reliable adaptation changes in their body, which intensified after the second month of training was determined on the basis of the analysis of the results of the dynamics of maximum muscle strength and morphometric parameters in the 1st group of untrained contingent, which were recorded during 3 months of training in conditions of high-volume workloads and low intensity. The analysis of the study results obtained after the third month of training shows an increase in LBM relative to the second month by 1.1% only in persons of the 1st group, and in the 2nd group no significant changes in the controlled indicator were recorded. Although, relative to the initial LBM results the values in the 2nd group improved by 2.8% and in the 1st one by 2.4%. The results of the study indicate that the use in the training process of high-intensity loads and small workload by the representatives of the 2nd group contributes to a more pronounced increase in the LBM of the body,

compared with the data found in representatives of the 1st group who used the standard load mode.

3. The analysis of the initial results of the research shows that the indicators of the circumferential body size of young men of both untrained groups show almost identical parameters. The level of the studied indicators of the participants of the 1st group, is, on average, only 8.9% ($p < 0.05$) lower compared to the results obtained in the 2nd group. This fact indicates that not always specialized training activities, which significantly increase the maximum muscle strength of a person during long-term strength sports, can be equally effective in increasing its morphometric parameters. Despite the increase in the parameters of the magnitude of the force load with each passing month of training, the growth rate of body circumference is gradually slowing down, which indicates an increase in the body's resistance to this force.

4. It was found that it is during the use of the load mode of large volume of work and low intensity ($R_a = 0.64$ um. Units) compared with the mode of high intensity and small volume of work ($R_a = 0.71$ um. Units) when the central mechanisms of neurohumoral regulation of heart rhythms are strengthened due to decrease in parasympathetic activation of the autonomic nervous system on the sinus-atrial node. These results were recorded while calculating the adaptation potential.

In the process of three-month control of the dynamics of the basal level, quite significant adaptive changes were found in the form of increasing the morphometric parameters of the body and increasing the maximum muscle strength.

References

1. Vader D. The system of body construction. Fis (Moscow); 1991.
2. Vinogradova O.L., Popov D.V., etc. Optimization of the process of physical training: the development of new "sparing" approaches to strength training. Human physiology. 2018; 39 (5): 71–85.
3. Viru A. A. Functions of the adrenal cortex during muscle activity. Medicine (Moscow); 1984.
4. Volkov N.I., Nesen E. N, Osipenko A.A., Korzun S.N. Biochemistry of muscular activity. Olympic Literature (Kiev); 2001
5. Garkavi L.H., Kvakina E.B., Ukolova M.L. Adaptive reactions and resistance of an organism. Fakel (Rostov-on-Don); 1990

6. Kremer U.J., Rogol A.D. Endocrine system, sports and physical activity. Olympic Literature (Kiev); 2008
7. Kudrya O.N. Adaptive changes in the body of athletes engaged in power sports. Materials by correspondence region scientific-practical conference. 2017 November 10; Tomsk, Russia: CNTI, 2017.
8. Kurys V.N. Fundamentals of strength training. Soviet sport (Moscow); 2005
9. Laputin A.N. Athletic gymnastics. Health (Kyiv); 1990
10. Netroba A.I., Bravij J.R., Makarov V.A., etc. Evaluation of the effectiveness of training aimed at increasing the maximum arbitrary force without the development of muscle hypertrophy. Human physiology. 2018; 6: 89–96.
11. Platonov V.N. The system of training athletes in Olympic sports. General theory and its practical applications. Soviet sport (Moscow); 2015
12. Hartmann Y., Tunnemann H. Modern strength training. Stortferlag (Berlin); 1988