MINISTRY OF EDUCATION

ECOLOGICAL UNIVERSITY OF BUCHAREST

FACULTATY OF PHYSICAL EDUCATION AND SPORT

International Scientific Conference

"ACTUALITIES AND PERSPECTIVES OF PHYSICAL EDUCATION AND SPORT SCIENCES"

5th edition

April, 04th, 2024

Romania, Bucharest, Doina Cornea, no. 1G

Editura PRINTECH

Tipar executat la:

S.C. ANDOR TIPO S.R.L. – Editura PRINTECH

Site: www.andortipo.ro; www.printech.ro

Adresa: Str. Tunari nr. 11, Sector 2, Bucharest

Proceedings of the International Scientific Conference
"Actualities and Perspectives of Physical Education and Sport Sciences"
5th edition, April, 04th, 2024

ISSN 2734-8512

ISSN-L 2734-8512

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ASSESSMENT OF THE LEVEL OF BODY RESISTANCE OF ADOLESCENT ATHLETES TO DIFFERENT LOADS IN BODYBUILDING

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Abstract. *The study purpose*. Determination of the level of body resistance of adolescent sportsmen to different power loads in bodybuilding using the spectral analysis of the heart rate variability method. *Materials and methods.* The study involved 60 adolescents aged 15-16 years who had been engaged in bodybuilding for 18 months. For each group, an experimental model of power load regimes was developed. The adolescent athletes had a low level of resistance to these models. A heart rate monitor "Polar RS800CX" was used to record the parameters of spectral analysis in the study participants. *Results*. The obtained results showed that both group representatives had a high level of very-low-frequency oscillations of cardiac intervals (VLF) in the range of 61.2-66.1% before exercise. After using the power load regimen 1 (R_a=0.58) by one of the groups, the vegetative balance (LF/HF) increased 5 times compared to the state of rest. *Conclusions*. The power load regimen 1 (R_a=0.58) used by adolescent athletes in bodybuilding training promoted the greatest increase in the parameters of VLF and LF/HF indicators, as well as a decrease in the level of LF and HF. These changes in the spectral analysis indicators reflect the priority predominance of the central circuit of heart rhythm regulation due to the activation of neurohumoral and metabolic factors.

Key words: *bodybuilding, adolescent athletes, heart rate variability, resistance, power load.*

1. Introduction

The search for effective mechanisms for improving the bodybuilding training system, taking into account the age characteristics of athletes, is causing a wide range of discussions not only among leading scientists in this sport but also among specialists in medicine and biology (Chen & Nakagawa, 2023). The implementation of this problem requires researchers to conduct several experimental studies using physiological and biochemical diagnostic methods to determine clear criteria for assessing the optimal load limits for a certain age (Chernozub et al., 2023).

Determining the optimal parameters of intensity and volume of loads adequate to the functional capabilities of the adolescent body in the conditions of bodybuilding is one of the most difficult problems in this kind of sport (Chernozub et al., 2018; Latino & Tafuri, 2024). The complexity of this problem is associated with the destabilization of the neurohumoral system of their body caused by the peculiarities of puberty (Korobeinikova et al., 2024).

One of the key factors in solving the problem related to the development of optimal load regimes for adolescent athletes is to determine the limits of their body resistance to the relevant physical stimuli. According to a number of authors (Balakarthikeyan et al, 2023; Grégoire et al, 2023), the use of the heart rate variability

method in the practical implementation of this problem is an effective marker for assessing the state of regulatory mechanisms and neurohumoral regulation of cardiac activity. In most cases, it is the spectral analysis indicators that allow the determination of the level of resistance of the body to the magnitude of the load, based on monitoring the processes associated with the activation of the central circuit and the enhancement of sympathetic regulation of the cardiovascular system.

The study purpose. Determination of the level of body resistance of adolescent athletes to different power loads in bodybuilding training using the spectral analysis of the heart rate variability method.

2. Material and method

The study involved 60 adolescents aged 15-16 years who had been engaged in bodybuilding for 18 months. Two experimental groups of 30 people (A and B) were formed. For each of the groups, we developed experimental models of power load regimens. Adolescent athletes had a low level of resistance to these models as they had not used such loads in bodybuilding before. During the research, group A used power load regimen 1 (R_a=0.58), and group B – power load regimen 2 (R_a=0.70).

The spectral method of heart rate variability analysis was used to provide information on the power distribution depending on the frequency of oscillations. The following indicators were studied: high-frequency spectrum of cardiac intervals (HF, %), low-frequency spectrum (LF, %), very-low-frequency spectrum (VLF, %), and the index of vagosympathetic interaction (LF/HF). These parameters were evaluated at rest and after exercise under the conditions of using the proposed modes by the participants of the study. A heart rate monitor "Polar RS800CX" (Finland) was used to record the parameters of spectral analysis in the examined adolescent athletes.

Statistical analysis of the study results was performed using the IBM *SPSS*Statistics 26 software package (StatSoftInc., USA).

3. Results and Discussions

Table 1 presents the experimental models of power load regimens used by adolescent sportsmen in bodybuilding.

The main difference between the presented models of power load regimens is the value of the used parameters of the work amount. At the same time, the parameters of the work amount, in the given conditions of muscular activity, depend on the features of the exercises used and the recruitment of certain types of motor muscle units. The variability of the combination of the above load components has a significant impact on the parameters of the projectile working mass and the work amount in each set.

Table 1 *Models of power load regimens used by the examined groups during the research*

Models of power load regimens	Main characteristics
Power load regimen 1 (R_a=0.58)	Priority usage of loads with a large amount of work. The main energy source is muscle glycogen. Exercises are performed with full amplitude with an emphasis on increasing the duration of the negative phase of the movement. The predominant involvement during muscle contraction of fast contractile muscular motor units of type A. Exercises with a wide range of simultaneous involvement of a large number of synergists and stabilizers are used together with muscle agonists. In the main sets, the projectile working mass is 62-65% of 1RM.
Power load regimen 2 (R_a=0.70)	Prioritizes the use of exercises with a low amount of work. A combined mechanism of ATP resynthesis is used through creatine phosphate and muscle glycogen. The activity of fast contractile muscle units of type B is increased. Exercises with a wide range of simultaneous involvement of a large number of synergists and stabilizers along with muscle agonists are used. Isolated exercises with preliminary exhaustion of synergist muscles are used. The indicators of the projectile working mass in the main sets are 71-76% of 1RM.

The results of changes in the indicators of spectral analysis of heart rhythm in the examined adolescent bodybuilders during the research are presented in Table 2.

The analysis of the results obtained at rest before exercises indicates that there was no difference in the indicators of low-frequency oscillations of cardiac intervals (LF) and vegetative balance (LF/HF) in participants of both groups. However, there was a significant intergroup difference between the parameters of cardiac interval power (Total).

The study showed that representatives of both groups had a high level of very-low-frequency cardiac interval fluctuations (VLF) in the range of 61.2-66.1% before exercise. The reference values of this indicator range from 15-30%. This fact testifies to the tension of all regulatory systems (hyper adaptive state of the organism) in adolescents of both groups engaged in bodybuilding.

Table 2 *Parameters of spectral analysis of the heart rate of the representatives of the examined groups during the study, (median, interquartile range (IQR), n=60*

1. 2. Indicators 3.	4. Groups 5.	6. Before exercise 7. (at rest)	8. After exercise
9. Very-low frequency spectrum, % (VLF)	A	61.20 (15.7)	96.50 (4.7) *
	B	66.10 (10.6)	85.25 (5.8) *
10. Low-frequency spectrum, % (LF)	A	23.60 (12.1)	3.10 (4.9) *
	B	23.70 (13.2)	11.92 (6.1) *
11. High-frequency spectrum, % (HF)	A	15.20 (4.2)	0.40 (0.4) *
	B	10.20 (7.9)	2.83 (0.9) *
12. Total, мс^2	A	4486.15 (2882.13)	1379.00 (739) *
	B	2322.49 (2509.82)	1072.00 (136) *
13. LF/HF ratio, ms^2	A	1.55 (2.11)	7.75 (1.21) *
	B	2.32 (1.99)	4.21 (1.42) *

*Note: *is p<0.05, compared to the state of rest (before exercise)*

At the beginning of the study, the athletes of group B had the index of high-frequency oscillations of cardio intervals (HF) of 10.2% of the total spectrum power at a norm of 15-25%. This fact indicates a shift in the autonomic balance towards the predominance of the sympathetic system in representatives of group B before exercise.

The results of the spectral analysis after using the developed power load regimens demonstrated different trends of changes. The advantage of the very-low-frequency spectrum of heart rhythm oscillations was revealed, especially in the group of sportsmen after using the power load regimen 1 (R_a=0.58). The most pronounced decrease (by 3.2) in the total power of the spectrum of cardio interval oscillations was observed in athletes of group A who used the load with a large amount of work. This fact testifies to the decrease in the total level of activity of different links of the regulatory mechanism.

After using the power load regimen 1 (R_a=0.58) by one of the groups, the vegetative balance (LF/HF) increased 5 times compared to the state of rest. This fact indicates the strengthening of the central mechanisms of neurohumoral regulation of heart rhythm due to a decrease in the parasympathetic activation of the autonomic nervous system to the sinus node.

4. Conclusions

Application of the power load regimen 1 (R_a=0.58) by adolescent athletes in bodybuilding promoted the greatest increase in the parameters of VLF and LF/HF indicators, as well as a decrease in the level of LF and HF. These changes in the spectral analysis indicators reflect the priority predominance of the central circuit of heart rhythm regulation due to the activation of neurohumoral and metabolic factors.

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