Control over the training process on the basis of athletes' organism functional state analysis

Yriy S. Vanyushin*, Gulina K. Khuzina

Kazan State Agrarian University
Kazan, Russia

ORCID: 0000-0003-2667-6124, kaf.fv.kgau@mail.ru*

ORCID: 0000-0003-1672-1980, gulina1585@mail.ru

Abstract: Functional state is a special state of an organism. It provides correspondence with the demands of different kinds of sport, including cyclic kinds of sport. We consider the functional state as a difficult system reaction, dynamically changing during activity. It is estimated according to the results of labor and professional activity. **Materials.** The indices of cardiorespiratory system study and these results use for the athletes' functional state control. **Research methods.** Scientific literature analysis and summarizing, methods of mathematical statistics, tetrapolar chest rheography method by Kubicek (1970) in modification of Yu.S. Vanyushin (2011); the indices of external respiration (FR(frequency of respiration), RV(respiration volume), MVR(minute volume of respiration)) were defined by pneumotography; the indices of gas exchange were defined with the help of gas analyzers of oxygen and carbon dioxide. The coefficient of oxygen use (COU₂) and arterial-venous difference according to oxygen (AVDO₂) were calculated. **Results.** According to the research results functional state of an organism adaptation and change happens mainly in the subsystems. They take an active part in motor actions fulfillment by a person. The most developed are the following mechanisms, connected with MVB and COU₂ indices increase. **Conclusion.** The revealed age-related characteristics of oxygen provision help to use physical loads during the training process and solve the problems concerning endurance development in different periods of postnatal ontogenesis. **Keywords:** functional state, cardiorespiratory system, bicycle ergometer, ontogenesis, training process.

For citation: Yriy S. Vanyushin*, Gulina K. Khuzina. Control over the training process on the basis of athletes' organism functional state analysis. Russian Journal of Physical Education and Sport. 2020; 15(1): 132-134. DOI: 10.14526/2070-4798-2020-15-1-165-168

INTRODUCTION

Functional state is a special state of an organism. It provides correspondence with the demands of different kinds of sport, including cyclic kinds of sport. We consider the functional state as a difficult system reaction, dynamically changing during activity. It is estimated according to the results of labor and professional activity [1]. The results decrease in these kinds of activity is the sign of the functional state disorder. Each functional state is demonstrated as a unique combination of different indices and organism reactions. The notion "functional state" is closely connected with the notion "functional system". Cardiorespiratory system belongs to functional system. This system belongs to individual functional systems and its function is to provide oxygen. [5]. It influences sports results and health state of those, who train.

It is the indicator of the whole functional state of an organism. It is important to study cardiorespiratory system in order to estimate athletes' functional state, especially in athletes, who go in for the kinds of sport directed toward endurance development.

The aim of the research work is to study cardiorespiratory system indices with the help of noninvasive research methods and control functional state of athletes on the basis of these indices.

RESEARCH METHODS

Methodical techniques choice and the volume of the research work were conditioned by the aim of this research work. The research work was held in the laboratory of functional diagnostics of "Physical upbringing" department at Kazan State Agrarian University. 15-16 year-old teen-agers and

adults-athletes (36-60 years old) took part in the research work.

The indices of the central hemodynamics (HR, SV(stroke volume), MVB) were determined by tetrapolar chest rheography according to Kubicek (1970) in modification of Yu.S. Vanyushin (2011). The indices of external respiration (FR(frequency of respiration), RV(respiration volume), MVR(minute volume of respiration)) were defined by pneumotography. The indices of gas exchange were defined with the help of gas analyzers of oxygen and carbon dioxide. The coefficient of oxygen use (COU_2) and arterial-venous difference according to oxygen ($AVDO_2$) were calculated.

RESULTS AND DISCUSSION

The way of sports results improvement in kinds of sport, connected with endurance development, is functional and reserve capacities of cardiorespiratory system widening. [3]. In this case the most reasonable mechanism of oxygen provision is cardiac output increase. However, the results of our research works prove MVB (minute volume of blood) growth decrease during the transfer from one load to another. It is achieved by not efficient way, owing to HR (heart rate) increase in terms of insignificant increase of impact output. [2, 4] That is why we can come to the conclusion that there are other mechanisms, directed to oxygen consumption satisfaction during motor activity. These mechanisms include external respiration. It belongs to the factors, which limit the opportunity of achieving high sports results.

At the level of respiratory system the adaptation is characterized by maximal mobilization of external respiration. It is demonstrated by lung ventilation increase. [7-16]. The highest values of lung ventilation were registered in the groups of teen-agers (15-16 years old) and athletes at the age of 36-60. The mechanism connected with external respiration indices increase during the load of the increasing power fulfillment at bicycle ergometer in these groups, is a dominating one and physical working capacity is provided by significant cardiorespiratory system tension. In this case there are different ways of achieving maximum values of lung ventilation. In the group of teen-

agers it happens owing to the rate of respiration increase, in the group of adults it happens owing to respiration depth increase. This fact can be explained by age-related characteristics of organism development, as by the age of 16 the process of morphofunctional respiration system formation is finished. The training process should be directed toward respiration system potential development. It will provide aerobic productivity of an organism increase. It should be noted that the received by us results of lung ventilation are not the criterion of a high training level. In this case oxygen and energetic values of respiration increase. In these conditions the adaptation to physical loads is realized best of all by means of effectiveness increase of oxygen transport and utilization system. [8-10] It is proved by great blood circulation index and cardiac index in the group of teen-agers at the age of 15-16. In the group of adults (36-60 years old) in terms of the same oxygen consumption during the load of the increasing power fulfillment COU_2 values increase.

CONCLUSION

Thus, the process of functional state of an organism adaptation and change happens mainly in the subsystems, which take an active part in motor actions fulfillment by a person. [6] The most developed are the following mechanisms, connected with MVB and COU_2 indices increase.

The revealed age-related characteristics of oxygen provision help to use purposefully physical loads during the training process and solve the problems concerning endurance development during different periods of postnatal ontogenesis

REFERENCES

1. Anokhin P.K. *Uzlovye voprosy teorii funkcional'noj sistemy* [Key questions of functional theory system]. Moscow: Nauka. 1980: 197 [In Russ.].
2. Vanyushin Yu.S., Khayrullin R.R. Cardiorespiratory system as the indicator of athletes' functional state. *Teoriya i praktika fizicheskoy kul'tury = Theory and practice of physical culture*. 2015; 7: 11-14 [In Russ., In Engl.].
3. Vanyushin Yu.S., Khayrullin R.R., Rakhimov I.M. The threshold of an adequate hemodynamic reaction among athletes during the increasing power load. *Teoriya i praktika fizicheskoy kul'tury = Theory and practice of physical culture*.

2016; 9: 42-44 [In Russ., In Engl.].

4. Vanyushin Yu.S., Khayrullin R.R. *Kardiorespiratornaya sistema v ontogeneze pri adaptacii k funkcionan'nyim nafruzkam. Monografiya* [Cardiorespiratory system in ontogenesis during adaptation to functional loads. Monograph]. Kazan. "Otechestvo" publishing house. 2016: 200 [In Russ.].

5. Pavlov I.P. *Izbrannye trudy* [The selected works]. Moscow: Medicine. 1999: 445 [In Russ.].

6. Vanyushin Yu.S., Khuzina G.K. Criteria of athletes' functional state. *Aktual'nye problemy fizicheskoy kul'tury, sporta i turizma: materialy XII mezhdunarodnoj nauchno-prakticheskoy konferencii, posvyachennoj 70-letuyu kafedry fizicheskogo vospitaniya UGATU* [Urgent problems of physical culture, sport and tourism: materials of the XII International scientific-practical conference, dedicated to the 70-th anniversary of Physical upbringing department of Ufa State Aviation Technical University]. 2019: 431-435 [In Russ.].

7. Hedman K., Tamas E., Henriksson J., Bjarnegard N., Brudin L., Nil E. Female athletes' heart: Systolic and diastolic function related to circulatory dimensions. *Scandinavian Journal of Medicine & Science in Sports*. 2015; 25(3): 372-381.

8. Prakas K., Sharma S. The Electrocardiogram in Highly Trained Athletes. *Clinics in Sports Medicine*. 2015; 34 (3): 419-431.

9. Yu.S. Vanyushin, N.A. Fedorov. Cardiorespiratory system state of sportsmen with different types of blood-circulation during physical load. *Pedagogiko-psihologicheskie i medicobiologicheskie problemy fizicheskoy kul'tury i sporta = Pedagogico-psychological and medicobiological problems of physical culture and sport*. 2017; 12(1): 160-166. DOI: 10.14526/01_2017_196 [In Russ., In Engl.]

10. Yuriy S. Vanyushin, Nikolay A. Fedorov,

Guliya K. Khuzina, Ahmet G. Yarullin. Criteria of biological reliability of the growing body and adult athletes. *Pedagogiko-psihologicheskie i medicobiologicheskie problemy fizicheskoy kul'tury i sporta = Russian journal of Physical Education and Sport*. 2019; 14(2): 97-102. DOI 10.14526/2070-4798-2019-14-2-97-102 [In Russ., In Engl.].

11. Bonacci J., Chapman A., Blanch P., Vicenzino B. Neuromuscular adaptations to training, injury and passive interventions: Implications for running economy. *Sports Medicine*. 2009; 39(11): 903-921. DOI: 10.2165/11317850-000000000-00000.

12. Hunter I., Smith G.A. Preferred and optimal stride frequency, stiffness and economy: Changes with fatigue during a 1-h high-intensity run. *European Journal of Applied Physiology*. 2007; 100(6): 653-661. DOI: 10.1007/s00421-007-0456-1.

13. Larsen H.B. Kenyan dominance in distance running. *Comparative Biochemistry and Physiology Part 1: Molecular and Integrative Physiology*. 2003; 136(1): 161-170. DOI: 10.1016/S1095-6433(03)00227-7.

14. Lucia A., Esteve-Lanao J., Olivan J., Gomez-Gallego F., San Juan A.F., Santiago C., ... Foster C. Physiological characteristics of the best Eritrean runners-exceptional running economy. *Applied physiology, nutrition, and metabolism*. 2006; 31(5): 530-540. DOI: 10.1139/h06-029.

15. Morin J.B., Samozino P., Zameziati K., Belli A. Effects of altered stride frequency and contact time on leg-spring behavior in human running. *Journal of Biomechanics*. 2007; 40(15): 3341-3348. DOI: 10.1016/j.jbiomech.2007.05.001.

16. Santos E.L., Gianella-Neto A. Comparison of computerized methods for detecting the ventilatory thresholds. *European Journal of Applied Physiology*. 2004; 93(3): 315-324. DOI: 10.1007/s00421-004-1166-6.

Submitted: 03.02.2020

Author's information:

Yuriy S. Vanyushin – Doctor of Biological Sciences, Professor, Kazan State Agrarian University, 420000, Russia, Kazan, Karl Marks str., House 65, e-mail: kaf.fv.kgau@mail.ru

Gulina K. Khuzina – Candidate of Agricultural Sciences, Associate Professor, Kazan State Agrarian University, 420000, Russia, Kazan, Karl Marks str., House 65, e-mail: gulina1585@mail.ru