Evaluation and comparative analysis of the type of heart rate regulation for load determination in physical culture lessons

UDC [612.172.2+612.176] – 053.5

PhD, Associate Professor **I.V. Mishchenko**[1]
PhD, Associate Professor **M.P. Lebedeva**[1]
PhD, Associate Professor **L.A. Sharenkova**[2]
PhD, Associate Professor **V.S. Smolina**[2]
[1]Northern (Arctic) Federal University named after M.V. Lomonosov, Arkhangelsk
[2]North State Medical University, Arkhangelsk

Corresponding author: i.mischenko@narfu.ru

Received by the editorial office on 03.25.2023

Abstract

Objective of the study was to determine the type of heart rate regulation of younger schoolchildren as an indicator of adaptation to school loads, including physical exercises in physical education lessons and in sports sections.

Methods and structure of the study. The analysis of heart rate variability in schoolchildren aged 7-10 years was carried out, in which 156 schoolchildren (70 boys and 86 girls) took part. The study was carried out with the apparatus "Varicard" with the software "Integrated system of cardiointervalometry", version 6.2. Indicators of heart rate variability are objective indicators of the tone of the autonomic nervous system (its sympathetic and parasympathetic divisions). They also reflect an assessment of the severity of the body's adaptive response to external stimuli (training load, physical activity, living conditions, region of residence, weather and other stressors). The functional state was assessed using a 4-point system (4 types of regulation).

Results and conclusions. In the age group of 7-8 years, the third type of regulation predominates (moderate predominance of parasympathetic activity). The third type of regulation prevails in both boys and girls. The functional state is very good, the optimal state of the regulatory systems. These schoolchildren are shown physical education classes, motor loads without restrictions. A third of the surveyed schoolchildren in this age group has the first type of regulation, which indicates a moderate tension of regulatory systems. Schoolchildren with the first type of regulation are advised to limit emotional stress, physical education without restrictions. In the age group of 9-10 years, the third type of regulation also prevails in both boys and girls. In the general group, this is 60.5%. In this age group with the first type of regulation, there are twice as many girls as boys. As a result of the study, it was found that 81.4% of schoolchildren aged 7-10 years old can engage in physical education without restrictions. And 18.6% of schoolchildren are shown physical education classes in a health-improving mode.

Keywords: *heart rate regulation, junior schoolchildren, girls, boys, working capacity, physical activity.*

Introduction. Currently, the state pays special attention to preserving the health of the younger generation and increasing the attractiveness of physical education and sports. The unfavorable climatic conditions of the European North place high demands on the adaptive systems of the human body as a whole, and even more so when engaging in physical exercise at the age of 7-10 years (junior schoolchildren), when the body's adaptive systems are being formed.

Objective of the study was to determine the type of heart rate regulation of younger schoolchildren as an indicator of adaptation to school loads, including physical exercises in physical education lessons and in sports sections.

Methods and structure of the study. 156 schoolchildren from 7 to 10 years old took part in the experiment, including 86 girls and 70 boys. All schoolchildren were divided into 2 groups: 7-8 years old and 9-10 years old. The study of heart rate variability (HRV) was carried out no earlier than 1.5-2 hours after eating, in a room with a temperature of 20-22 degrees. At the time of the examination, all interference leading to emotional arousal was eliminated, and no physical activity (physical education lesson or sports training)

was carried out before the observation. When analyzing HRV, an individual approach was carried out taking into account the type of autonomic regulation, according to the classification of N.I. Shlyk [7]: moderate predominance of central regulation (type I), pronounced predominance of central regulation (type II), moderate predominance of autonomous regulation (type III), pronounced predominance of autonomous regulation (type IV). The study was carried out using a Varicard device with the software "Integrated Cardiointervalometry System", version 6.2.

Results of the study and discussion. Variability or variability, including heart rate, reflects the influence of control signals that reconfigure organs or systems in the interests of maintaining homeostasis or adapting the body to new conditions. Indicators of heart rate variability are objective indicators of the tone of the autonomic nervous system (its sympathetic and parasympathetic divisions). They also reflect an assessment of the severity of the body's adaptive response to external stimuli (educational load, physical activity, living conditions, weather and other stressors).

In the spectrum of short recordings (from 2 to 5 minutes), to assess nonspecific adaptation mechanisms, it is customary to distinguish three main spectral components of the total power (TP) of HRV: a) very low (VLF), b) low (LF) and c) high frequencies (HF). Based on the data obtained, the vegetative indicator and type of regulation were calculated. The functional state was assessed using a 4-point system (4 types of regulation).

In the age group of 7-8 years (Table 1), the third type of regulation predominates (moderate predominance of parasympathetic activity). 51.4% (36 people) who took part in the survey have it. The third type of regulation predominates both among boys - 48.3% (14 people) and among girls - 53.7% (22 people). The functional state is very good, the optimal state of the regulatory systems. These schoolchildren are recommended to participate in physical education and physical activity without restrictions. It is noteworthy that a third of the examined schoolchildren in this age group have the first type of regulation, which indicates moderate tension in regulatory systems. These are boys - 34.5% (10 people) and girls - 31.7% (13 people). Schoolchildren with the first type of heart rate regulation are advised to limit emotional stress and engage in physical exercise without restrictions. Schoolchildren with the second type of regulation (reduced functional state of regulatory systems) 10% (7 people) are recommended to engage in physical education in a health-improving mode, excluding high-intensity exercises. This type of heart rate regulation may reflect severe fatigue of the body. The fourth type of regulation 5.7% (4 people) may be "physiological" or reflect overfatigue and overstrain of the body. These physical education schoolchildren are assigned to a low-intensity health treatment group.

In the age group of 9-10 years (Table 2), the third type of regulation also predominates both in boys - 63.4% (26 people) and in girls - 57.8% (26 people). In the general group this is 60.5% (52 people). In this age group with the first type of regulation, there are twice as many girls as boys (24.4% and 12.2%, respectively). It is noteworthy that there are almost three times more schoolchildren with the fourth type of regulation in the age group of 9-10 years than in the group of 7-8 years (15.1% and 5.7%, respectively). This may be due to the increasing study load, increased time spent playing on the computer and mobile phone, and disruption of work and rest schedules. This study once again confirms that the number of children participating in the health treatment group is increasing from year to year.

Conclusions. The study revealed that 81.4% of schoolchildren (127 people) aged 7-10 years can engage in physical education without restrictions. This is 56.4% (88 people) with the third type of heart rate regulation and 25% (39 people) with the first type of heart rate regulation. Schoolchildren with the second

Table 1. *Type of heart rate regulation in the age group 7-8 years*

Groups	Type of regulation			
	1	2	3	4
General group (n=70)	23	7	36	4
Boys (n=29)	10	3	14	2
Girls (n=41)	13	4	22	2

Table 2. *Type of heart rate regulation in the age group 9-10 years*

Groups	Type of regulation			
	1	2	3	4
General group (n=86)	16	5	52	13
Boys (n=41)	5	5	26	5
Girls (n=45)	11	--	26	8

and fourth types of regulation (18.6%, 29 people) are recommended to take physical education classes in a health-improving mode. This must be taken into account in physical education lessons to preserve the health of the younger generation.

References

1. Baevsky R., Chernikova A. Analiz variabelnosti serdechnogo ritma: fiziologicheskiye osnovy i osnovnyye metody provedeniya [Analysis of heart rate variability: physiological basis and basic methods]. Cardiometry. Issue 10. May 2017. pp. 66-76; DOI: 10.12710/cardiometry.-2017.6676 Online access: www.cardiometry.net/issues/no10-may-2017/heart-rate-variability-analysis
2. Gribanov A.V., Kotsova O.N., Anikina N.Yu., Pankov M.N., Korelskaya I.E. Sezonnyye izmeneniya tserebralnogo energoobmena pri raznom urovne trevozhnosti u molodykh lyudey v arkticheskoy zone Rossiyskoy Federatsii [Seasonal changes in cerebral energy exchange at different levels of anxiety in young people in the Arctic zone of the Russian Federation]. Chelovek. Sport. Meditsina. 2021. Vol. 21. No. 4. pp. 73-80.
3. Igisheva L.N., Kazin E.M., Galeev A.R. Vliyaniye umerennoy fizicheskoy nagruzki na VSR u detey mladshego i srednego shkolnogo vozrasta [Influence of moderate physical activity on HRV in children of primary and secondary school age]. Fiziologiya cheloveka. 2006. No. 3. pp. 55-61.
4. Lavrova N.Yu. Osobennosti serdechnogo ritma u detey mladshego shkolnogo vozrasta v osenniy i vesenniy periody pod vliyaniyem uchebnoy deyatelnosti [Features of the heart rhythm in children of primary school age in the autumn and spring periods under the influence of educational activities]. PhD diss. abstract. Kazan. 2003. 23 p.
5. Murashko E.V., Osokina G.G. Sovremennyye aspekty sindroma vegetososudistoy distonii u detey i podrostkov. Klinika, diagnostika, podkhody k terapii [Modern aspects of the syndrome of vegetovascular dystonia in children and adolescents. Clinic, diagnostics, approaches to therapy]. Vestnik aritmologii. 2000. No. 18. pp. 49-50.
6. Sapozhnikova E.N., Shlyk N.I., Krasnoperova T.V. Vozrastnyye, polovyye i individualnyye osobennosti variabelnosti serdechnogo ritma u detey v vozraste 7-12 let razlichnykh grupp vegetativnoy regulyatsii serdechnogo ritma [Age, sex and individual characteristics of heart rate variability in children aged 7-12 years of various groups of autonomic regulation of heart rate]. Variabelnost serdechnogo ritma. Teoreticheskiye aspekty i prakticheskoye primeneniye [Heart rate variability. Theoretical aspects and practical application]. Abstracts of the International Symposium (Izhevsk, November 20-21, 2003). Izhevsk: Udmurtskiy universitet publ., 2003. pp. 36-37.
7. Shlyk N.I. Serdechnyy ritm i tip regulyatsii u detey, podrostkov i sportsmenov [Heart rate and type of regulation in children, adolescents and athletes]. Izhevsk: Udmurtskiy universitet publ., 2009. 259 p.
8. Shlyk N.I., Baevsky R.M. Ritm serdtsa i tip vegetativnoy regulyatsii v otsenke urovnya zdorovya naseleniya i funktsionalnoy podgotovlennosti sportsmenov [Heart rhythm and type of autonomic regulation in assessing the level of health of the population and the functional fitness of athletes]. Proceedings national symposium. Izhevsk: Udmurtskiy universitet publ., 2016. 608 p.
9. Shumikhina I.I. Osobennosti adaptivnykh vozmozhnostey organizma u studentov s uchotom analiza VSR [Features of the adaptive capabilities of the body in students, taking into account the analysis of HRV]. Izhevsk: Udmurtskiy gosudarstvennyy universitet publ., 2016. pp. 289- 293.