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Body Composition and Heart Rhythm Variability in Elite Wrestlers

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Abstract

The aim of the research was to study the body composition and heart rhythm variability in elite wrestlers. In the study we used: Omron BF511 body composition monitor, we obtained and analyzed data on the body composition of 8 highly qualified athletes, members of the Ukrainian national team in Greco-Roman wrestling in 5 weight categories. 67 kg - 1 person, 72 kg - 1 person, 77 kg - 3 people, 87 kg - 2 people and 97 kg - 1 person. Vegetative regulation was assessed according to the indicators of statistical and spectral analysis of heart rhythm variability. For this purpose, we used a portable electrocardiograph with finger electrodes for an integral assessment of the functional state of the cardiovascular system "Fazagraf". The parameters of autonomic regulation and the results of spectral analysis in athletes were recorded. As a result of the study, it was found that the indicators of the body composition of the studied athletes have differences, but most of them correspond to the norm according to the Omron Healthcare rating scales. It was revealed that the hemodynamic supply of the body in highly qualified athletes occurs at a higher tension of the mechanisms of regulation of cardiac activity. Studies have shown that a high percentage of muscle mass is consistent with the activation of parasympathetic influences on the sinus node of the heart at rest state, which reflects the result of adaptive restructuring of the body during the training process.

Keywords: elite athletes, wrestling, body composition, heart rhythm

Introduction

Modern elite sport presupposes high competition among participants in sports competitions, coaches, functionaries and many other professionals who provide the training process (Slacanac, Baic, & Starcevic, 2017; McDonald, Deitch, & Bush, 2019; Kostiukevych et al., 2019). In this connection, in order to ensure an objective understanding of changes in the parameters of athletes' readiness, and to build a competitive system for training athletes of national teams, a scientific approach to the training process is relevant and does not raise doubts about its need.

In its implementation, it involves the study of various aspects of the sport preparation process and the search for ways to optimize it using the obtained research data (Keshavarz, Bayati, Farzad, Dakhili, & Agha-Alinejad, 2017; Chernenko et al., 2020). Along with the traditionally studied problems of physical, technical, tactical and other types of training, the problem of studying the component composition of the body of athletes in the precompetitive mesocycle of the preparatory period is urgent to assess the potential for correction of body weight due to fat tissue, as well as to determine changes in body composition caused by correction of its weight and, as a consequence of the effect on heart rhythm variability (Yukhymenko et al., 2019). This indicates the need for research and study of this problem.

The heart rhythm variability is a very relevant and infor-

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mative direction in the analysis of the adaptive reactions of the body of athletes. However, there is little understanding of the relationship between body composition and heart rhythm variability in elite athletes.

The aim of the research was to study the body composition and heart rhythm variability in elite wrestlers.

Methods

As a result of the studies using the Omron BF511 body composition monitor, we obtained and analyzed data on the body composition of bioimpedansometry (Kalantari et al., 2017) of 8 elite athletes, members of the Ukrainian National Greco-Roman wrestling team from 5 weight categories. 67 kg - 1 person, 72 kg - 1 person, 77 kg - 3 persons, 87 kg - 2 persons and 97 kg - 1 person.

Before the start of the study, each of the experimental athletes filled out a questionnaire that contains questions regarding consent or disagreement with the use of the step research for scientific purposes. The written consents were obtained from all athletes to conduct research in accordance with the recommendations of the ethical standards of the Helsinki Declaration. Ethical clearance on this research was provided by Commission on Biomedical Ethics of the National University of Ukraine on Physical Education and Sport (on 12/16/2020, minutes №. 2).

The functional state of the athletes was studied according to the characteristics of the vegetative regulation of the heart rhythm. Vegetative regulation was assessed according to the indicators of statistical and spectral analysis of heart rhythm variability. For this purpose, a portable electrocardiograph with finger electrodes was used for the integral assessment of the functional state of the cardiovascular system "Fazagraf" (Korobeynikov et al., 2018). The parameters of vegetative regulation and the results of spectral analysis in athletes were recorded.

Statistical analysis was performed using the software package STATISTICA 8.0. The main statistical characteristics of the studied indicators were determined in the work. Our sample was tested according to the normal distribution of the Gaussian function. However, the analysis revealed the absence of a normal distribution of the studied sample. That is why the nonparametric statistics with determine the median, lower quartile and upper quartile were used.

Results

As a result of the analysis, we can note the following, all the subjects 2 weeks before the expected start at important competitions had "working" weight indicators, exceeding the level of the body weight category by 1.3 - 5.4 kg. At the same time, among those athletes who were planning to go to the competition, the difference between the mass of the weight category and their own body mass was 1.3-3.5 kg, which indicates a possible control over their body mass by the athletes. The percentage of skeletal muscle mass is in range of 40.2-46.5%, which corresponds to "high" and "very high" levels of muscle mass according to the Omron Healthcare scale. By that, there was no clear relationship between the weight category and the percentage of skeletal muscle mass in the subjects. However, it should be noted that this indicator in 4 athletes, considered to be leaders in the team, was in the range of 44.7 - 46.5%, and for others - 40.2 - 42.9%, which refers the first to the group with a "very high" level of muscle mass, and the second - to the group with a "high" level of muscle mass.

The next investigated indicator - the percentage of body fat, was considered in accordance with the Omron Healthcare scale developed on the basis of studying the data presented in the publication (John et al., 2018), as well as the publication data (Zemková et al., 2017). Based on the results obtained, we can state that the percentage of fat in the two subjects was at a "low" level and is 7.2% and 7.9%, respectively. These values were the smallest of the entire sample, which is also consistent with the smallest difference in these athletes between the current level of body mass and the competitive level corresponding to the weight category of the athlete. In five athletes, the percentage of body fat ranged from 9.4% to 16.7%, which corresponded to the norm for men 18-39 years old according to the normalized scale (John et al., 2018), and one athlete had 21.1% body fat as a result of which was assigned to the group with a "high" level of fat.

Along with the percentage of body fat, the visceral fat indicator was studied, which shows the area of fat on the surface of internal organs. One unit of this indicator indicates an area of 10 sq.cm, and according to Omron Healthcare indicators, values from 1 to 9 cu (conventional units) are considered the norm. As a result of measuring this indicator, all the athletes under study were assigned to the group with a "normal" level, and the lowest values were recorded in athletes planning to go to competitions (5 and 6 cu, respectively). The highest values are 9 cu were recorded in two athletes, with one of them having the highest percentage - 21.1% body fat and the lowest percentage of muscle mass - 40.2%.

The resting metabolic rate tended to increase with increasing body weight in wrestlers, as shown in Table 1.

Table 1. Resting metabolic rate of elite wrestlers of different weight categories (in kcal) (n=8)

Body weight of wrestlers	Kcal
70.5	1679
73.3	1970
81.5	1833
81.9	1815
82	1830
88.5	2344
91.1	1928
100.2	2595

Although in two athletes weighing 73.3 kg and 88.5 kg, these indicators turned out to be higher than in athletes performing in a heavier weight category, which may indicate a more intensive course of their metabolic processes.

The functional state of the athletes was studied according to the characteristics of the autonomic regulation of the heart rhythm. Table 2 shows the values of the indicators of autonomic regulation of heart rhythm in Greco-Roman wrestlers.

Table 2. The value of autonomic regulation of heart rhythm in Greco-Roman wrestlers (median, lower and upper quartile)

Indicators	Value
Heart rate (HR), beat/min	76.81; 75.44; 95.38
Duration of RR cardio intervals (RRNN), мс	784.5; 700; 848
Standard deviation of cardio intervals (SDNN), мс	92; 52; 107
Average deviation of cardio intervals (RMSSD), мс	60.795; 40.68; 88.645
Number of consecutive cardio intervals pairs that differ by more than 50 ms (pNN50), мс	24.95; 11.575; 32.67
Ccoefficient of variation (CV), %	10.4515; 7.479; 13.62
HRV triangular index	13.1; 9.9085; 17.335
Stress index, cu	49.73; 30.045; 99.205

The results of the analysis of temporal indicators at rest state showed the following. The heart rhythm frequency (HRF) in the group is within the fluctuation range (Table 2). The average value of RR intervals in the group was slightly higher compared with conditional norm. The Standard Deviation of NN (RR) intervals (SDNN) in wrestlers indicates a more pronounced activity of the sympathetic division of the autonomic nervous system. For wrestlers, a decrease in the activity of the parasympathetic division of the autonomic nervous system is characteristic, as indicated by a lower Root Mean Square of the Successive Differences (RMSSD) value (Table 2). At the same time, a significant number of works, for example (Korobeynikov et al., 2016; Bakayev & Bolotin, 2019) note an increase in parasympathetic influences on the sinus node of the heart in athletes with a high level of fitness in a state of relative rest. Increased parasympathetic tone in wrestlers is associated with an increase in stroke blood volume and a decrease in blood pressure due to a prolonged diastole period (Korobeynikov et al., 2016; Bakayev & Bolotin, 2019).

Heart rhythm variability among wrestlers is reduced by almost 2 times compared to the norm. This is indicated by the proportion of NN50 divided by the total number of NN (R-R) intervals (pNN50) value (Table 2). Also, a peculiar centralization of heart rhythm control was revealed in elite wrestlers (Table 2). The results obtained on the analysis of heart rhythm variability indicators reflect a decrease in parasympathetic influences on the sinus node of the heart when the sympatho-vagus balance is shifted towards the prevalence of sympathetic influences. Thus, an increased tension of the mechanisms of regulation of the heart rhythm is observed. With an increase in the tension of the system of autonomous regulation of the heart rhythm in wrestlers, the humoral and sympathetic regulation channels are activated. This circumstance indicates an increase in the activation of the neurohumoral centers of the autonomic nervous system in wrestlers during the training process (Lucini et al., 2014). As a result of the activation of adaptive reactions, an increase in the tension of the heart rhythm regulation system is observed, aimed at ensuring a high level of central and peripheral blood circulation.

For a more detailed analysis of the mechanisms of heart rhythm variability, the concept of Baevsky et al. (2007) was applied (Table 3).

It was revealed that the presence of high values of the mode

Table 3. The value of the statistical characteristics of heart rhythm variability among Greco-Roman wrestlers (median, lower and upper quartile)

Indicators	Value
Histogram mode of cardio intervals (Mo), мс.	775; 675; 850
Amplitude of histogram mode of cardio intervals (AMo), %	36.06; 23.17; 45.85
Variation range of cardio intervals (MxDMn), мс.	398.45; 290; 578.15

amplitude of RR intervals (AMO%) indicator (Table 3) in elite wrestlers indicates the activation of the sympathetic link of the autonomic nervous system.

Table 4 shows the values of the spectral characteristics of heart rhythm variability in Greco-Roman wrestlers (median, lower and upper quartile).

Table 4. Values of spectral characteristics of heart rhythm variability among Greco-Roman wrestlers (median, lower and upper quartile)

Indicators	Value
Low frequency (LFn), %	51,4; 44,55; 66,3
High frequency (HFn), %	18,7; 15,8; 44,8
Ratio (LF/ HF)	3,06; 2,145; 5,745

Similar changes were revealed in the spectral indicators of heart rhythm variability. According to the low frequency spectrum of RR intervals (LFn) indicator (Table 4), elite wrestlers activate the sympathetic link of the autonomous regulation of the heart rhythm. Athletes have significantly higher high frequency spectrum of RR intervals (HF) contribution (Table 4). An increase in the influence of the sympathetic division of the autonomic nervous system is also indicated by the LF / HF ratio (Table 4).

Discussion

As a result of the study, it was stated that the indicators of the body composition of the highly qualified wrestlers have some differences, but most of them correspond to the norm (according to the Omron Healthcare rating scales). Also, a distinctive feature of the studied athletes is a high and very high percentage of skeletal muscle mass (in the range from 40.2 - 42.9% to 44.7 - 46.5%). At the same time, the highest values of this indicator were found among the leaders of the National Team. The studied variable indicator of the percentage of body fat was low and normal (in the range of 8-19.9%). At the same time, one athlete with a body weight of 81.5 kg showed the highest percentage of fat (high level, 21.1%). This athlete had the highest value of visceral fat (9 conventional units), although this indicator was in him within the upper limit of the norm.

Thus, the highest of the studied indicators of body composition have been demonstrated by athletes, preparing for responsible competitions and being the leaders of the National Team.

Comparison of the obtained results of the study with data by the authors (Zemková et al., 2017) confirms the data of our studies on the percentage of adipose tissue in the body of highly qualified wrestlers at the normal level in the range from 8 to 19.9%. At the same time, the authors' data (Zemková et al., 2017) disagree with ours on the dependence of this indicator on the athlete's body weight, since the studies cited by the authors use averaged data, which does not reflect the individual characteristics of highly qualified wrestlers.

Our research has shown that most wrestlers try to have a very low percentage of body fat as they adjust their body weight before each bout (Vardar, Tezel, Oztürk, & Kaya, 2007). Optimal body composition is one of the main concerns of elite wrestlers. Wrestlers and coaches see body fat percentage as a factor that needs to be controlled. It is believed that the lower percentages of fat mass are to be preferred.

According to the study of heart rhythm variability, it was found that the total power of the spectrum (TP) increases due to an increase in the power of the energy spectrum of the parasympathetic link of autonomic nervous regulation (high-frequency spectrum HF) and a decrease in the power of the low-frequency spectrum (LF). In elite wrestlers being at rest state, it is possible to activate maximum parasympathetic rhythm regulation with inhibition of sympathetic influences (Korobeynikov et al., 2016). Consequently, the hemodynamic supply of the organism of highly qualified athletes occurs under higher tension of the mechanisms of cardiac activity regulation.

The distinctive features of the heart rhythm in elite wrestlers were: decreased heart rhythm variability (low RMSSD, pNN50 values) with a predominance of sympathetic activity in the sympatho-vagus balance (high AMO values, %), as well as a significant decrease in the spectrum power in all frequency ranges. The elite wrestlers have a higher level of tension in the regulation of the heart rhythm in comparison with the wrestlers with low qualifications. With an increase of tension in the autonomous regulation system of the heart rhythm in elite wrestlers, humoral and sympathetic links of regulation have been activated. Thus, the spectral analysis of cardiointervals revealed a more perfect system of autonomic regulation in elite wrestlers with a simultaneous lower percentage of body fat.

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