Interrelation of indicators of body composition with the effectiveness of competitive activity of highly qualified biathletes

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Abstract

Objective of the study was to determine the relationship between the body composition of highly qualified biathletes and the indicators of competitive activity at the stages of long-term training.

Methods and structure of the study. The scientific work was carried out with the participation of biathletes of the qualification Master of Sports, Master of Sports of International Class and Honored Master of Sports in the sports seasons of 2015-2022. Bioelectrical impedance analysis (BIA) was carried out on a Maltron Bioscan 920-II using the equations for the European population with the choice of the level of sports fitness - "Athlete".

Results and conclusions. Monitoring of changes in body composition using BIA Maltron BioScan 920-II and caliperometry allows you to assess current and cumulative changes in the process of long-term training of biathletes with high accuracy and reliability. Using the BIA Maltron BioScan 920-II allows you to obtain indicators that are not available using the caliperometry method. As a result of the analysis, indicators of body composition were identified that can be successfully used in monitoring body composition under the influence of training and competitive loads. The highest relationship among the analyzed indicators of body composition with the speed of movement along the distance has the sum of fat folds and the percentage of adipose tissue (R=0.44-0.51 at P>0.05). An increase in the loss to the leader in terms of movement speed was recorded with a decrease in the content of intracellular water in the body (ICW), protein, potassium, glycogen, percentage of adipose tissue, an increase in the content of extracellular water in the body (ECW) and total body water (TBW).

Keywords: *body composition assessment, bioelectrical impedance analysis (BIA), Maltron Bioscan 920-II, caliperometry, highly qualified biathletes.*

Introduction. The assessment of body composition is of great importance in the analysis of the effectiveness of training programs, diet and other aspects related to the nutrition of an athlete [1, 3]. Modern trends in the development of sports require new approaches to the analysis of body composition, one of which can be BIA [5]. Comparison of BIA with the “gold standard” in assessing body composition contributed to the development of correct regression equations for athletes, which made it possible to conduct a qualitative analysis in sports populations [4]. In 2015, segmental BIA was used for the first time to assess the composition of various body segments in athletes [2].

Objective of the study was to determine the relationship between the body composition of highly qualified female biathletes and the indicators of competitive activity at the stages of long-term training.

Methods and structure of the study. The study was conducted with the participation of biathletes of Masters of Sports, Master of Sports international class and honored Masters of Sports qualifications in the sports seasons of 2015-2022. Age of athletes - 24.1±3.4; height - 166.9±4.4 cm; weight-58.4±3.2 kg.

Bioelectrical impedance analysis (BIA) was carried out on a Maltron Bioscan 920-II using the equations for the European population with the choice of the level of sports fitness - “Athlete”. On the days of the study, the weight of athletes was measured with an accuracy of 0.1 kg, data on height were entered into the program with an accuracy of 1 cm. All measurements were taken in the morning at the same time after waking up in the supine position. The electrodes were attached to the athlete’s hand at the knuckles and wrist, as well as to the foot of the same side of the

body, according to the BioScan 920-II user manual. The assessment of body mass components using the caliperometry method was carried out according to the recommendations of T.F. Abramova [1]. The performance data were obtained during the stage tests in the analytical department of the sports training center of the Ministry of Sports of Russia. Statistical calculations were performed using the Microsoft Office Excel 10 software package.

Results of the study and their discussion. Table 1 shows the indicators of body composition, physical and functional fitness of the biathletes of the Russian national team at the stages of the annual training cycle, obtained using the BIA Maltron Bioscan 920-II and caliperometry. Almost all indicators of body composition have low and medium values of correlation coefficients with indicators of general and special physical fitness, VO_2, and time of work in the MPC test (R = 0.10-0.40 at P>0.05). The coefficient of correlation of height and weight of the body, the integral indicator of BMI with the occupied place in the overall standings of the World Cup, with the speed of movement along the distance and the speed rating turned out to be lower than statistically significant values and was at the level of r=0.06-0.16 at P>0, 05. The coefficient of correlation of height and weight of the body, the integral indicator of BMI with the occupied place in the overall standings of the World Cup, with the speed of movement along the distance and the speed rating turned out to be lower than statistically significant values and was at the level of r=0.06-0.16 at P>0, 05. The highest relationship among the analyzed indicators of body composition with the speed of movement along the distance has the sum of fat folds and the percentage of adipose tissue (R=0.44-0.51 at P>0.05).

Figure 1 shows the dynamics of body composition indicators for biathletes of the Russian national team in 2015-2021. The indicators of muscle mass in these biathletes were at the average level (about 50.1-51.3%), and the fat mass was at the level above the average

Table 1. *Indicators of body composition and physical performance of the biathletes of the Russian national team in the season 2021-2022*

Indicators	Preparation period		Competitive period
	start	end	
BIA Maltron Bioscan 920-II			
height, sm	169,3±5,3	169,3±5,3	169,3±5,3
weight, kg	59,4±3,2	60,7±2,5	60,1±2,8
Body mass index, kg/м^2	20,7±0,7	21,2±0,7	21,0±0,9
FFM,%	86,0±0,8	86,9±0,8	86,6±0,9
FAT, %	13,1±0,8	13,1±0,8	13,4±0,9
TBW, %	65,0±1,6	65,4±1,4	64,7±1,3
ECW, %	42,4±0,8	42,7±0,8	41,8±0,6
ICW, %	57,6±0,8	57,3±0,8	58,2±0,6
ECW/ ICW	0,73±0,02	0,74±0,03	0,72±0,02
BCM, %	58,5±2,4	58,6±1,3	62,3±4,9
ECM,%	28,4±2,0	28,4±2,0	24,2±4,2
Protein, %	23,8±0,9	23,8±0,5	25,3±2,0
Mineral, %	9,5±0,4	9,5±0,2	10,1±0,8
Muscle, %	49,9±2,0	50,0±1,1	53,1±4,2
Glycogen, гр	500±47	602±26	634±63
caliperometry			
MM,%	49,8±2,3	50,4±2,6	50,3±2,2
FM, %	15,1±3,1	14,8±2,7	14,0±3,6
Sum of 7 fat folds, мм	60,5±10,4	58,8±12,7	50,9±11,6
Indicators of physical and functional fitness			
IGFP, units	66,6±7,7	88,7±4,6	-
ISFP, units	27,3±3,1	78,5±10,5	-
VO^2 ml/min/kg	54,7±3,1	68,6±0,8	-
Operation time in the test maximum oxygen consumption, с	183±20	210±40	-

Note: BMI (body mass index); FFM - lean body mass; FAT - total body fat; TBW is total body water; ECW is the content of extracellular water in the body; ICW is the content of intracellular water in the body; ECW/ ICW - content of extracellular water in the body to intracellular water; BCM, body cell mass; ECM, extracellular body mass; Protein - the total amount of protein in the body; Mineral - the total mass of minerals in the body; Glycogen - the total mass of glycogen in the body; Muscle - the total mass of muscles in the body; MM - muscle mass; FM - fat mass; IGFP - index of general physical fitness; ISFP - index of special physical fitness.

Table 2. *Indicators of competitive activity and body composition of biathletes of the Russian Olympic team in the 2020-2022 season*

Name	Season	1*	2*	3*	4*	5*	6*
Mir-va S.	20-21	20	22,68	4,7	48,20	14,30	53
	21-22	29	22,14	6,3	47,65	18,86	62,1
K-vich I.	20-21	28	22,49	6,4	52,1	11,50	46,0
	21-22	23	22,28	5,6	52,5	11,35	42,7
Nig-na У.	20-21	33	22,37	6,8	44,67	12,97	52,1
	21-22	28	22,18	6,2	47,11	10,26	39,6
K-na L.	20-21	44	22,13	9,1	48,2	9,65	51,0
	21-22	61	21,78	10,7	44,5	13,70	49,8
Rez-va K.	21-22	8	22,56	2,5	50,75	10,53	37,8
Vas-va V.	21-22	37	22,05	7,40	47,39	18,81	70,7

Note: 1 - place in speed at the stages of the World Cup; 2* - speed at the stages of the World Cup, km/h; 3* - SC (speed coefficient - loss to the leader in seconds per 1 km distance; 4* - Muscle mass, %; 5* - fat mass, %; 6* - sum of 7 fat folds, mm.*

(12.7-15.3%). The study showed that the average values of weight indicators, BMI, fat and muscle mass in biathletes of the Russian national team remained virtually unchanged over many years. At the same time, during these seasons, Russian biathletes did not experience an increase in the speed of movement along the distance and a significant improvement in speed indicators at the stages of the Biathlon World Cup. Training loads did not cause significant adaptive changes in the body, which was probably the result of insufficiently effective training programs used.

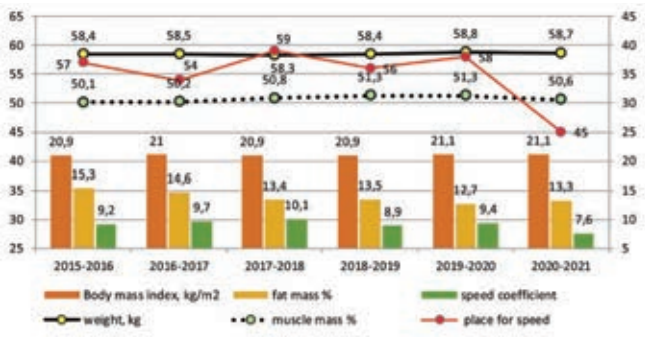

Figure 1. *Dynamics of body composition indicators and indicators of competitive activity for biathletes of the Russian national team in the seasons of 2015-2021*

Table 2 shows the indicators of competitive activity and body composition of biathletes of the Russian national team in the 2021-2022 season. Analyzing the data in Table 2, we can conclude that the speed of movement along the distance is a limiting factor for Russian biathletes. At the same time, Russian biathletes in the 2020-2022 seasons. the correlation coefficient of the location in terms of speed and speed coefficient with the sum of fat folds and the percentage of fat mass was R= 0.40-0.42. The leader of the Russian national team in the 2021-2022 season. K. R-va had the most optimal values of adipose (10.53%) and muscle tissue (50.75%). At the same time, the athlete occupied the 8th position in the world in the speed rating of biathletes with a loss to the leader of 2.5 s per 1 km of distance.

Russian biathletes competing at the OWG 2022 and winning silver medals in the 4x6 km relay had lower values for the percentage of fat mass (12.25±2.11%) and the sum of 7 fat folds (45.5±11.2 mm) with higher values of muscle mass (49.65±2.5%) than biathletes competing in the IBU Cup (Table 3). In biathletes of the IBU Cup level, the fat values were 16.29±3.6%, the total fat folds were 60.25±14.1 mm, the percentage of muscle mass was 46.95±2.04%.

The most significant (significant) differences between the groups were observed in the speed of passing the distance, the percentage of adipose tissue and the sum of 7 fat folds. Differences in the time of work in the maximum test, maximum oxygen consumption, percentage of muscle mass were not significant.

Table 3. *Indicators of functionality, competitive activity and body composition of female biathletes of the Russian national team in the 2021-2022 season*

Group	1*	2*	3*	4*	5*	6*	7*
WOG 2022	25,1±10,7	5,6±1,9	206±41	67,7±3,3	49,8±2,6	12,08±3,1	45,02±11,0
IBU 21-22	63,6±28,7	9,8±2,9	197±25	65,8±2,8	46,5±1,9	16,5±6,7	62,6±11,2

Note: 1 - place in speed at the stages of the World Cup; 2* - speed coefficient (loss to the leader in seconds per 1 km distance); 3* - time of work in the maximum test of the maximum oxygen consumption, s; 4* - maximum oxygen consumption, VO2 ml / min / kg; 5* - muscle mass%; 6* - fat mass, %.; 7* - sum of 7 fat folds.*

Table 4. *Negative dynamics of indicators of body composition and speed of passing competitive distances for a biathlete of the Russian national team of the honored master of sports qualification in the seasons of 2018-2022.*

season	1*	2*	3*	4*	5*	6*
2018-2019	31	10	3,00	53,1	50,8	10,0
2019-2020	23	23	5,40	54,4	49,5	13,9
2020-2021	19	22	4,70	55,8	48,2	14,3
2021-2022	32	28	6,30	57,4	47,6	15,1

Note: 1 - place in the overall standings of the Biathlon World Cup; 2* - place in terms of speed; 3* - loss to the leader in seconds per 1 km distance; 4* body weight, kg; 5* - muscle mass, %; 6* - fat mass, %.*

The negative dynamics of body mass components is expressed in a decrease in muscle mass, an increase in fat mass, and an increase in body weight (Table 4). The highest indicators of the speed of movement along the distance were registered with optimal values of muscle and adipose tissue. In the seasons of 2020-2022, in our opinion, the training strategy was incorrectly chosen for this athlete, which was indirectly evidenced by a decrease in the speed rating against the background of an increase in the fat component and a decrease in the muscle component of body weight (Table 4). On the other hand, the positive dynamics of the muscle component and the decrease in the fat component are clearly reflected in the indicators of competitive activity. The highest values of movement speed were recorded at high values of muscle mass and low values of fat mass.

Body composition monitoring of biathletes using BIA Maltron BioScan 920-II during performance at the Biathlon World Cup in the 2021-2022 season. showed multidirectional dynamics of indicators, which probably reflected the state of the body during the period of preparation and participation in competitions. An increase in loss to the speed leader was recorded with a decrease in ICW, protein, potassium, glycogen, percentage of adipose tissue, an increase in ECW and total body water (TBW). This trend in body composition may indicate a risk of reduced strength and aerobic capacity. The data obtained can serve as a basis for a deeper analysis of the body composition of highly qualified biathletes during the basic training and at the stages of approaching the main starts of the season. An analysis of the individual dynamics of body composition can be used as a criterion for changing adaptive changes as a result of the training program used.

Conclusions. Monitoring of changes in body composition using the BIA Maltron BioScan 920-II and caliperometry makes it possible to assess current and cumulative changes in the process of long-term training of biathletes with high accuracy and reliability. As a result of the analysis, indicators of body composition were identified that can be successfully used in monitoring body composition under the influence of training and competitive loads.

The highest relationship among the analyzed indicators of body composition with the speed of movement along the distance has the sum of fat folds and the percentage of adipose tissue (R=0.44-0.51 at p>0.05). An increase in the loss to the leader in terms of movement speed was recorded with a decrease in the content of intracellular water in the body (ICW), protein, potassium, glycogen, percentage of adipose tissue and an increase in the content of extracellular water in the body (ECW) and total body water (TBW).

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