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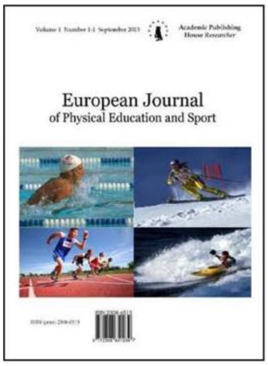

High-Intensity Interval Training for Hypertensive Power Sports Athletes: A Randomized Controlled Trial

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Abstract

Hypertension is a common diagnosis in power sports athletes.

Objective. Evaluate the effect of high-intensity aerobic work on blood pressure, oxidative capacity, hypertrophy and strength of working muscles in power sports athletes.

Methods. 55 representatives of power sports (powerlifting), heavy weight categories were involved in the research. Athletes were randomized into two groups: the main group (n = 35) and the control group (n = 20). All athletes were subjected to a comprehensive examination before and after the beginning of the research, including: survey, examination, three-time measurement of blood pressure, bioimpedance analysis and calculations of body composition indices, gas analysis, measurement of the oxygenation level of muscle tissue, ultrasonographic measurements of anatomical cross-sectional area of quadriceps muscle of thigh, estimation of maximum arbitrary power of quadriceps muscle of thigh and methods of mathematical statistics.

The athletes of the main group trained 60 days (3 times a week) on a bicycle ergometer according to the high-intensity interval protocol, and the participants of the control group trained 60 days (3 times a week) according to their traditional power protocol.

Results. After 60 days of training, there was a decrease in oxygenation by 72 %, an increase in power and working time at the level of maximum oxygen consumption and an increase in the cross-sectional area of quadriceps muscle of thigh in athletes of the main group. Athletes of the main group experienced a significant decrease in arterial blood pressure: systolic arterial pressure by 4.7 %, diastolic arterial pressure by 5.6 %.

Conclusion. The physical rehabilitation protocol we developed allows athletes of power sports to effectively and safely influence hypertrophy, as well as the oxidizing abilities of working muscles and arterial blood pressure.

Keywords: arterial hypertension, physical rehabilitation, powerlifting, aerobic work, interval method.

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1. Introduction

Hypertension is the most common abnormal diagnosis during pre-screening of the cardiovascular system (CVS) of athletes (Berge et al., 2015; De Matos et al., 2011; Schleich et al., 2016). Although the world's largest scientific communities on arterial hypertension in Europe, America, Canada, Great Britain, Australia and Russia have published recommendations for the detection, assessment and treatment of high arterial blood pressure (ABP) in the last 5 years (Table 1), it is still a question of where to start medical treatment of patients and especially athletes (Alper et al., 2019).

Table 1. Arterial blood pressure limits for diagnosis and initiation of treatment

ABP	ESC/ESH 2018 (Williams et al., 2018)	ACC/AHA 2017 (Whelton et al., 2017)	Canada 2018 (Nerenberg et al., 2018)	Australia 2016 (National Heart Foundation of Australia, 2016)	NICE 2019 (National Institute for Health and Care Excellence, 2019)	Russia 2019 (Chazova, Gernakova, 2019)
Definition of the hypertension's diagnosis						
SAP (mmHg)	≥140	≥130	≥140	≥140	≥140	≥140
DAP (mmHg)	≥90	≥80	≥90	≥90	≥90	≥90
Beginning of antihypertensive therapy						
SAP (mmHg)	≥140	≥140	≥160	≥160	≥140	≥140
DAP (mmHg)	≥90	≥90	≥100	≥100	≥90	≥90
Notes: SAP – systolic arterial pressure; DAP – diastolic arterial pressure; ESC – European Society of Cardiology; ESH – European Society of Hypertension; ACC – American College of Cardiology; AHA – American Heart Association; NICE – National Institute for Health and Care Excellence.						

The greatest percent of prevalence of the hypertension (H) is fixed in such sports as weightlifting, American soccer and baseball where athletes reach the body weight of ≥136 kg (Weiner et al., 2013). Also, the burden of H from 55.4 % to 83 % is noted in a subgroup of athletes of power sports of heavy weight category (Chobanian et al., 2003; Guo et al., 2013). Physical exercise is a cornerstone in non-pharmacological hypertension therapy. In total, 17 meta-analyses and one systematic review (594.129 adult ≥ 18 years) gave the convincing proofs demonstrating that: 1) there is inverse relation a dose answer between aerobic work and the arising hypertension at adults with normal ABP; 2) aerobic work reduces the risk of cardiovascular disease (CVD) progression among adults with arterial hypertension (AH); 3) aerobic work reduces ABP in adults with normal arterial blood pressure, pre-hypertension, and AH; And 4) the amount of ABP response to aerobic training varies depending on the ABP at rest, and adults with pre-hypertension have more advantages than normal ABP (Pescatello et al., 2019). It is well documented in scientific periodicals that regular physical activity of aerobic character reduces ABP and is an effective strategy for prevention and treatment of hypertension (Börjesson et al., 2016). However, many experts argue that aerobic work compromises the growth of muscle mass and power caused by power training (Baar, 2014; Murach, Bagley, 2016), and it causes concern of aerobic work using in rehabilitation programs of power sports athletes. The purpose of research was formulated on the basis of problem situation's analysis, data of modern scientific literature and requests of sports doctors, trainers and power sports athletes.

The aim of research: to estimate the influence of high-intensity aerobic work on arterial blood pressure, oxidative abilities, hypertrophy and the strength of working muscles in power sports athletes.

2. Methods and organization of research

Research took place on the basis of the sports medicine department at Russian State University of Physical Education, Sport, Youth and Tourism. 55 representatives of power sports (powerlifting), having sports qualification Candidate for Master of Sports and Master of Sports and heavy weight categories (body weight – 101, 4 ± 5.3 kg) participated in research. Athletes were randomized into two groups: main group (n = 35) and control group (n = 20). The average age of men-athletes was 31, 0 ± 7.3 years. According to ethical standards of scientific research in sports and physical activity of 2020 all participants gave voluntary informed consent to participate in the research (Harriss et al., 2019). All athletes had a comprehensive examination before and after the research including: survey, inspection, three-time ABP measurement, bioimpedansometry and body composition index calculations, gas analysis (determination of anaerobic threshold (AnT) and heart rate's (HR) at this level, maximum oxygen consumption (MOC) and pedaling power on MOC), measurement of oxygenation level (measurements of hemoglobin and myoglobin saturation) in muscle tissue, ultrasonographic measurements of anatomical cross-sectional area (CSA) of quadriceps muscle of thigh, estimation of maximum arbitrary power of quadriceps muscle of thigh.

Bioimpedansometry and indexes calculations of body's composition. Bioimpedance analysis was performed on the "Medass-ABC-02" apparatus (Russia), where the percentage of muscle and fat tissue was estimated, and after there were calculated the body mass index (BMI), fat mass index (FMI), fat free mass index (FFMI) and fat-to-muscle ratio (FMR). The FMI index allows for taking into account the amount of body fat mass in kilograms divided by the growth square. The FMI index was calculated by the formula: FMI = D/H2, (kg/m2) (VanItallie et al., 1990), where D is the fat weight (kg); H is the body length (m). The FFMI index takes into account the amount of defatted body weight in kilograms divided by the growth square. The FFMI index was calculated by the formula: FFMI = FFM/H2, (kg/m2) (VanItallie et al., 1990). The FMR was determined as the ratio of fat mass to defatted body muscle mass. FMR was calculated by the formula FMR = D/FFM, where: D is fat mass (kg); FFM – degreased body weight (kg) (Park, Kim, 2016). The defatted body weight (FFM (Fat Free Mass)) was calculated by the formula W * [1- (D/100)], where W is body weight (kg); D – weight of fat (%) (Kouri et al., 1995).

Gas-metric analysis. The step test was performed on a cycle ergometer "MONARK 839 E" (Monark AB, Sweden), the starting load was set from 20 W with 20 W added every 2 minutes. The gas-metric analysis was carried out using a "CORTEX" gas analyzer (Meta Control 3000, Germany) measuring oxygen consumption and carbon dioxide release from inhalation to inhalation. The heart rate and R-R intervals were fixed by the monitor of heart rhythm "POLAR RS800" (Finland). The test was carried out at the speed of 75 rpm before definition of MOC, the AnT, by HR at the level of the AnT and the pedaling power on MOC (Pallarés et al., 2016).

The "Moxy Monitor" system (USA) was used for measuring of oxygenation level on the lateral head of quadriceps muscle of thigh. The "Moxy" infrared sensor was attached to the lateral head of quadriceps muscle of thigh at the nerve entry point. This method allows measuring the hemoglobin and myoglobin levels in working muscle capillaries.

Ultrasonographic measurements. All participants had ultrasonographic measurements of the anatomical cross-sectional area of quadriceps muscle of thigh before the introduction of the training protocol, and two more control measurements were taken at intervals of 30 days. Measurements were carried out 5-6 days after the last training to prevent swelling affect on muscle size. The CSA of quadriceps muscle of thigh was evaluated at rest using B-mode ultrasonic imaging with a 1.6-5.0 MHz linear sensor, a scanning surface length of 65 mm, and a width of 17 mm (Vivid 7 Dimension/Vivid 7 PRO, General Electric). For better acoustic adhesion, the scanning surface of the sensor and the skin surface of the muscle were coated with a special gel, and the sensor was oriented along the mid-sagittal axis of the muscle. It was carried out an echography of all four heads of a muscle. A zone of arrangement of the sensor for echolocation was at distance of 25 cm proximally from the patella basis on the front, anterointernal and anteroexternal thigh surface of a thigh. All measurements were taken on the right leg after examinees were in supine position within 20 min for providing a possibility of liquid shift. According to researches of echograms digital values of all four portions it was determined degree of hypertrophy expressiveness by the quadriceps muscle of thigh.

Assessment of the arbitrary power's maximum of quadriceps muscle of thigh. The assessment of the arbitrary power's maximum of quadriceps muscle of thigh was performed by one-repeat maximum (1RM) test, using monoarticular exercise of lower leg' extension while sitting in a simulator (HOIST RS-1401, USA). All test sessions were conducted in the morning, at the same time of day. Participants did the exercise at a given 2 second pace for both concentric and eccentric phases. Participants were advised to avoid tiring exercises and sports for 48 hours before each test. An important aspect of burden testing was that performed approaches were prior to muscle failure, defined as an inability to perform a concentric phase of muscle contraction. During the first day of testing, after 5-minute warm-up on a cycling ergometer and demonstration of the correct exercise technique, tests were conducted for the maximum number of repeats measured for a certain load, followed by using a prognostic equation to calculate 1RM Brzycki M: 1RM (kg) = Burden weight (kg)/(1.0278-0.0278 number of repeats (kg)) (Brzycki, 1993). In the second procedure after warm-up the load intensity was set at 90 % of the calculated 1RM and increased for 2.5-5.0 % after each successful lift, until the subject was unable to perform a concentric phase in full motion amplitude. Rest periods between approaches were 2-3 minutes, in the present research 1RM during lower leg extension was usually achieved within 3-4 attempts in all participants. The repetition was valid if the subject could perform it in control without help. All measurements were performed on the right leg and all test procedures were carried out by the same researcher.

Arterial blood pressure measurements. According to clinical recommendations developed by experts of the Russian Medical Society on arterial hypertension and approved at the meeting of the plenary on November 28, 2013 and the profile commission on cardiology on November 29, 2013 the method of self-control SCBD was used for independent ABP measurements (Chazova et al., 2015). Traditional automatic certified tonometers for home use were used in accordance with SCBD. BD measurements were carried out in the morning (from 7:00 to 8:00 am). Measurements were performed 3 times with an interval of at least 1 min on the left hand, all three BD values were recorded in the table and average values were recorded in the archive protocol.

Protocols of physical activity. Athletes of the main group trained for 60 days (3 times a week) according to the following protocol: aerobic work on cycling ergometer with 7 high-intensity intervals (at pedaling power 100 % of MOC) for 2 minutes and low-intensity intervals with HR at the level of 85 % of AnT for 2 minutes were added to traditional power work. Training session time was 28 minutes. Athletes of control group trained for 60 days (3 times a week) according to the traditional power protocol.

3. Results and discussions

It is well known that the percentage of subcutaneous adipose tissue (SAT) is a better predictor of H and CVS diseases (Wang et al., 2015) than BMI, so in 1990 VanItallie TB and co-authors (VanItallie et al., 1990) proposed to use the FMI and FFMI indices for more detailed anthropometric measurements. Later Rao KM and co-authors showed that FMI≥6.6 kg/sq.m well correlated at men with H (Rao et al., 2011). In 2016 Park J. and co-authors proposed the use of the FMR index, which determined as the ratio of fat mass to defatted body muscle mass also for better correlating with ABP and metabolic syndrome components (Park, Kim, 2016). Later a large population observational research (34,182 men and 32,647 women aged 20 and over) showed that FMR correlated well with H (Chen et al., 2019). Anthropometric measurements of power sports athletes of heavy weight categories showed that athletes have rather high indicators of muscle mass. Also "Powerlifting sports" athletes of heavy weight categories which participated in the research have rather high percentage of SAT. For comparison, athletes of the specified sports have the following percent of SAT: wrestlers (≤13 %), sumo wrestlers (24.1-29.6 %), football players (≤15 %), judokas (17.4 %), water-polo players (18.1 %), and climbers (7.8-11.3 %) (Jonnalagadda et al., 2004). It is well known that athletes with increased fat weight may be more prone to metabolic diseases, weight-related injuries than other sports groups and the general population and it leads to a reduction in life expectancy by 10 years (Saito et al., 2003). Several meta-analyses have shown that high intensity aerobic training (HIAT) can be an effective component of body composition management programs (Keating et al., 2017; Wewege et al., 2017). Moreover, the meta-analysis of Viana and co-authors showed that interval training provided by 28.5 % more reduction of total absolute fat mass (kg) than uniform aerobic training (Viana et al., 2019). 60 days of intervention were reliably reduced SAT in the main group by 2.6 %, BMI by 0.7kg/m2, and FMI by 1.0 kg/m2. Changes in these values were not statistically significant in the control group (Table 2).

Table 2. Anthropometric characteristics of hypertensive power sports athletes of heavy weight categories

Group (N=55)	SAT (%)		BMI (kg/m²)		FMI (kg/m²)	
	0 days	60 days	0 days	60 days	0 days	60 days
main (n=35)	32,0±3,1	29,6±3,0*	34,6±1,5	33,8±1,5*	11,0±1,0	10,0±1,0*
control (n=20)	33,3±4,5	33,5±4,5**	35,0±2,2	35,3±2,1**	11,1±1,2	11,0±1,2**
Note: the statistically significant differences of the compared indicators are marked on the right by asterisk * – p <0,05; *– p>0,05; **						

It is well known that high BMI is associated with CVD and increasing of premature mortality, and also 30 % higher risk of all-cause mortality for each 5 kg/m2 increase in BMI (Whitlock et al., 2009). Accordingly, any reduction in BMI will lead to the prevention of CVD and an increase in life expectancy. Also, Ortega and co-authors (Ortega et al., 2016) researched various body composition indicators and its relations to CVD mortality and all-cause mortality. The results showed that excess fat mass was significantly connected with mortality from CVD and mortality from all causes. It is interesting that FFM connected with a 20 % increased probability of CVD mortality. Later Colpitts and co-authors (Colpitts et al., 2019) indicated that: 1) BMI is a strong predictor of metabolic syndrome and diabetes; 2) attention should be paid to muscle quality (increasing oxidative abilities) but not greater FFM for prevention further cardio-metabolic risk factors. After 60 days of the research there was an increase of FFMI in the main group by 0.3 kg/m2 and in the control group by 0.4 kg/m2, but these data were not statistically significant (Table 3). Also, in the main group there was a significant decrease in the ratio of fat weight to defatted body muscle mass (FMR) by 0.1 and in the control group this ratio remained unchanged.

Table 3. Anthropometric characteristics of hypertensive power sports athletes of heavy weight categories

Group (N=55)	FFMI (kg/m²)		FMR	
	0 days	60 days	0 days	60 days
main (n=35)	23,5±1,6	23,8±1,6**	0,5±0,1	0,4±0,1*
control (n=20)	23,7±1,5	24,1±1,5**	0,5±0,1	0,5±0,1**
Note: the statistically significant differences of the compared indicators are marked on the right by asterisk * – p <0,05; *– p>0,05; **				

Aerobic efficiency is very often characterized by MOC. MOC is defined as the highest rate of oxygen consumption and using by the body during intense exercise. MOC is used for both sports and medical purposes as a determinant of physical efficiency or as a risk indicator of health and longevity (Kodama et al., 2009). Many researchers noted that high intensity work of aerobic character (despite of short muscle stimulus) causes recruitment of all muscle fibers in the working muscle that leads to convincing changes in mitochondrial content of all active muscle and growth of oxidative abilities of working muscles (Gibala, Little, 2019; MacInnis, Gibala, 2016). After 60 days of trainings reliably athletes of the main group increased AnT work capacity and oxygen consumption by 22.7 and 14.5 % respectively (Tables 4 and 5). Also, the work capacity and oxygen consumption at the MOC level increased by 18.5 and 13.6 %, respectively. In the control group of athletes there were no reliable changes in oxidative abilities of muscles.

Table 4. Indicators of gas-metric testing of power sports athletes

Group (N=55)	Capacity on AnT (W/kg)			OC on AnT (ml/kg)		
	0 days	60 days	Δ	0 days	60 days	Δ
main (n=35)	2,2±0,3	2,7± 0,3	0,5*	26,9± 2,5	30,8±1,8	3,9*
control (n=20)	2,3±0,2	2,2±0,3	0,1**	26,3± 3,2	25,8± 3,0	0,5**
Note: the statistically significant differences of the compared indicators are marked on the right by asterisk * – p <0,05; *– p>0,05; **						

Table 5. Indicators of gas-metric testing of power sports athletes

Group (N=55)	Capacity on AnT (W/kg)			OC on AnT (ml/kg)		
	0 days	60 days	Δ	0 days	60 days	Δ
main (n=35)	2,7 ± 0,2	3,2 ± 0,2	0,5*	31,5±2,5	35,8±1,2	4,3*
control (n=20)	2,8± 0,2	2,7± 0,3	0,1**	30,9±2,8	31,3±2,9	0,4**
Note: the statistically significant differences of the compared indicators are marked on the right by asterisk * – p <0,05; *– p>0,05; **						

During the first testing at the end there was a decrease of oxygenation in the lateral head of quadriceps muscle of thigh in the main group from 59.4 % to 41.3 % and in the control group from 57.6 % to 43.8 % (Table 6). After 60 days of training the main group showed a significant decrease of oxygenation from 59.8 % to 28.7 % (31.1 % compared to 18.1 % at the beginning), while the control group had a decrease of oxygenation from 58.3 % to 41.9 % (16.4 % compared to 13.8 % at the beginning of the research) which was not statistically significant. According to the results of the research it is possible to note not only a 72 % decrease of oxygenation, but also an increase in the work capacity at the level of MOC and the time of work for the participants of the main group. This indicates an increase in the oxidative capacity of high threshold muscle fibers (MF) of the working muscles because it has been able to work longer and more efficiently and this is possible only by increasing the mitochondrial apparatus and capillarization the high threshold MF.

Table 6. Indicators of oxygenation in the lateral head of quadriceps muscle of thigh of power sports athletes

Group (N=55)	Before research			After research			Δ, %
	SmO2 beginning	SmO2 ending	Δ, %	SmO2 beginning	SmO2 ending	Δ, %	
Main (n=35)	59,4±13,1	41,3±12,3	18,1	59,8±9,6	28,7±8,3	31,1	72*
Control (n=20)	57,6±10,2	43,8±11,7	13,8	58,3±12,5	41,9±10,6	16,4	19**
Note: the statistically significant differences of the compared indicators are marked on the right by asterisk * – p <0,05; *– p>0,05; **							

In fact, mitochondrial adaptation to aggravated training marks opposite results. Although the stimulus triggered by such training caused large changes in levels of myofibrillar protein and muscle fiber hypertrophy, original researching has shown little change in mitochondrial content was observed, resulting in "dilution" of mitochondrial content in the growing fiber. This adaptation is physiologically disadvantageous because of mitochondrial content's dilution increases the diffusion distance between the capillary and the mitochondrial location that can lead to deterioration of endurance and operability (Groennebaek et al., 2017). In some researching, it has been reported that the MOC (Bishop et al., 1999) values were unchanged, as well as unchanged (Green et al., 1999) or lower mitochondrial density, oxidative enzyme activity, and capillary density in hypertrophic muscles, were unchanged after the burdened training (Tesch et al., 1989).

After 60 days of physical rehabilitation, there was an increase of CSA of the quadriceps muscle of thigh, which was statistically significant at a distance of 25 cm from the base of the patella in the control and main group (Tables 7 and 8). The difference in hypertrophy of the quadriceps muscle of thigh was not reliable between groups.

Table 7. Cross-sectional area of quadriceps muscle of thigh at the athletes of the main grou

Muscle name	Before researching (cm^2)	60 days (cm^2)	Δ
Musculus rectus femoris	18,95±1,52	24,58±1,28	+5,62*
Musculus vastus medialis	9,37±1,53	16,5±1,43	+7,12*
Musculus vastus lateralis	42,77±3,5	55,54±3,49	+12,76*
Musculus vastus intermedius	23,41±2,44	28,53±2,43	+5,12*
Note: the statistically significant differences of the indicators from the baseline are marked on the right by asterisk * – p <0,05; *			

Table 8. Cross-sectional area of quadriceps muscle of thigh at the athletes of the control group

Muscle name	Before researching (cm^2)	60 days (cm^2)	Δ
Musculus rectus femoris	21,32±1,37	27,44±1,35	+6,12*
Musculus vastus medialis	9,92±1,41	16,33±1,38	+6,41*
Musculus vastus lateralis	41,65±3,8	54,88±3,6	+13,23*
Musculus vastus intermedius	20,89±3,18	27,43±3,06	+6,54*
Note: the statistically significant differences of the indicators from the baseline are marked on the right by asterisk * – p < 0,05; *			

It is well known that development of muscle strength is supported by a combination of morphological and nerve factors including cross-sectional area and muscle architecture, muscle hardness, set of motor units, speed coding, synchronization of motor units and neuromuscular braking (Suchomel et al., 2018).

Respectively, regular and periodic practice / training of 1RM nullifies or at least reduces the difference in power caused by any power training (heavier or with easy loading) and it indicates that the most part of differences in power is connected with practice of 1PM which improves neuromuscular adaptation (Morton et al., 2016). However meta-analysis of Androulakis-Korakakis P and his colleagues showed that performing one approach of 6-12 repeats with loads in the range of 70-85 % of 1RM, 2-3 times a week before achieving a will or short-term muscle failure within 8-12 weeks can lead to a significant power increase in bench press and squats in men (Androulakis-Korakakis et al., 2019). Participants of the main group trained at pedaling power of 100 % of MOC, it corresponds to the range of 80-85 % of 1RM. Reliably there was an increase in muscle strength extending the right lower leg by 6.5 % in the main group and in the control group by 7.1 % after 60 days of training exposure. The difference was not statistically significant between the groups (Table 9).

Table 9. Assessment of the maximum arbitrary power in the quadriceps muscle of thigh of the right leg at the participants of the research

Group (N=55)	Before researching (kg)	After researching (kg)	Δ
Main (n=35)	119,6±15,5	127,4±15,0	+7,8*
Control (n=20)	125,2±10,7	134,1±9,5	+8,9*
Note: the statistically significant differences of the indicators from the baseline are marked on the right by asterisk * – p <0,05; *			

Recent systematic reviews and meta-analyses (Costa et al., 2018; Way et al., 2018) have shown that: 1) HIAT and uniform aerobic training (UAT) provided a comparable decrease of ABP at rest in adults with pre-set H; 2) HIAT was associated with a greater increase of MOC compared to UAT; 3) HIAT results to significant decrease of night DAP compared to UAT; 4) was found almost a significant greater decrease of daily ABP at HIAT compared to UAT. After 60 days of HIAT on a cycle ergometer there was a reliable decrease of ABP at athletes of the main group: SAP by 4.7 %, DAP by 5.6 %. In the control group the ABP changes was not statistically significant (Table 10). It is well known that a reduction in DAP of 5 mmHg within 5 years decreases the risk of stroke by 34% and the risk of coronary heart disease (CHD) by 21 %. Decrease by 7.5 mmHg and by 10 mmHg reduces by 46 % and 56 % the incidence of stroke and by 29 % and 37 % the incidence of CHD (Chazova et al., 2015).

Table 10. Comparative analysis of arterial blood pressure in power sports athletes

Группа (N=55)	SAP (mmHg)			DAP (mmHg)		
	0 days	60 days	Δ	0 days	60 days	Δ
Main (n=35)	159,1±5,8	151,7±4,9	-7,4*	93,3±7,3	85,9±6,7	-7,3*
Control (n=20)	158,0±6,1	156,1±6,0	-1,7**	92,7±5,1	94,1±6,0	+1,4**
Note: the statistically significant differences of the compared indicators are marked on the right by asterisk * – p <0,05; *– p>0,05; **						

4. Conclusion

Analyzing and summarizing the sources of modern scientific literature has prevented us from answering key questions as to whether HIAT can create primary stimulus for skeletal muscle hypertrophy and whether muscles are able to increase their size and become stronger while maintaining oxidative abilities. Our thesis regarding the ability of cyclic training above AnT to cause working muscle hypertrophy is confirmed by a number of researches (Harber et al., 2012; Hudelmaier et al., 2010; Nuell et al., 2019), but the simultaneous growth of oxidative abilities and the reaction of ABP to such training has not been sufficiently explored. It is necessary to include HIAT for prevention and treatment of CVD to power sports athletes because high-intensity aerobic training recruit's similar high threshold muscle fibers that both power training and both physical activities offer the same incentives to create chronic physiological adaptations to muscles as well as for cardiorespiratory efficiency and for strength growth and muscle hypertrophy (Steele et al., 2018). Our research shows that physical rehabilitation over 60 days demonstrated an increase in the oxidative ability growth of the working muscles (MOC increased by 13.6 %) and this increase was accompanied by a rise quadriceps muscle of a thigh and a decrease in ABP. The training protocol of aerobic work developed by us and built based on metabolic variables, will allow athletes to effectively and safely influence to oxidative abilities of working muscles without losing basic power indicators. A further priority area is to carry out pedagogical work among power sports athletes for inclusion of aerobic cycling ergometric sessions in training protocols.

5. Conflict of interests

The authors declare that there is no conflict of interest.

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