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A comparative analysis between moderate intensity continuous and high-intensity interval cardio-rehabilitation training in athletes with arterial hypertension: a randomized controlled trial

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Objective

To compare the influence of moderate intensity continuous and high-intensity interval cardio-rehabilitation training on blood pressure in athletes with arterial hypertension.

Materials and methods

The study included 83 athletes of power sports (bodybuilding) with arterial hypertension. The average age of male athletes was 31.2± 4.5 years, and the body mass index was 32.4± 2.8 kg/m^2. The following methods were used: examination, questioning, triple measurement of blood pressure, ergospirometry and methods of mathematical statistics. Athletes were randomized into two groups: the HIIT group (n= 33), the MICT group (n= 30), and the control group RT (n= 20). For 120 days (3 times a week), HIIT and MICT athletes performed simultaneous physical rehabilitation.

Results

120 days after physical rehabilitation systolic blood pressure decreased in HIIT and MICT groups by 8.3 mm Hg and 7.7 mm Hg, respectively. A significant reduction in diastolic blood pressure in HIIT and MICT groups was 7.9 mmHg and 8.3 mmHg, respectively. A decrease of blood pressure in the control group was not statistically significant.

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Conclusion. *Despite similar benefits in cardio-rehabilitation, interval exercise required 38 % less time that can significantly affect adherence and exclude some participants of long rehabilitation.*

Key words: *arterial hypertension, interval training, bodybuilding, physical rehabilitation.*

Conflict of interests: None declared.

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Introduction

According to epidemiological data, cardiovascular diseases (CVDs) are the leading cause of death and disability worldwide [1, 2]. Patients with CVDs do not only have a range of chronic diseases that affect their quality of life, but also increase family and community economic burden. Historically, the "Athletic Heart" hypothesis has encouraged a dichotomous view on heart adaptation to exercising, depending on whether the physical activity is dynamic (runners and swimmers) leading to "cardiomegaly" [3] or isometric (strength athletics) with clear peripheral adaptations, heart enlargement and increased blood pressure [4]. Today, the classification of sports according to its physiological needs recognizes great variety of impacts, depending on physical activity, with the graded transition between the main categories: dynamic and static. Moreover, athletes with predominant static component (strength sports) have higher percentage of CVD, since static contractions stimulate mechanical and metabolic changes in skeletal muscle and sustained changes in blood pressure [5]. Therefore, it is of great practical importance to determine the appropriate, non-pharmacological strategy, to reduce CVD risk factors in strength sports athletes. Moderate-intensity continuous aerobic training (MICT) is considered to be an effective way to reduce CVD risk factors [6,7]. However, in recent years, an aerobic exercise protocol called high-intensity interval training (HIIT) has become more popular, which includes high-intensity intervals of aerobic work (with a heart rate (HR) of 80–100 % HRmax) from 60 to 240 seconds. Many researchers have shown that HIIT is one of the most effective means to improve cardiorespiratory endurance, reduce CVD risk factors [8] and lower blood pressure [9]. However, aerobic training, the «gold standard» for the prevention and treatment of CVDs, is not specific for strength athletics and, therefore, is not included in the training protocols of these athletes. The objective of this study was based on the analysis of mentioned above issues, the data of modern scientific literature and the requests of sports medicine physicians (who use physical rehabilitation methods in patients with arterial hypertension) and strength-trained athletes with arterial hypertension.

Materials and methods

The study was performed on the basis of the Department of Sports Medicine of Russian State University of Physical Education, Sport, Youth with 120-day follow-up. The study involved 83 strength-trained athletes (bodybuilders) with the sports qualifications of candidate to master of sports and mater of sports in heavy weight categories with arterial hypertension (AH), who were recommended aerobic exercises for treatment and prevention of AH. Athletes did not participate in competitions during the study. Athletes were randomized into two main groups: HIIT group (n= 33), MICT group (n=30) and RT control group (n=20). Average age of men was 31.2± 4.5 years, and body mass index was 32.4± 2.8 kg / m^2. All athletes signed written informed consent to participate in the study according to the ethical standards of scientific research in sports and physical activity 2020 (protocol No. 5, meeting of the Ethics Committee of the Russian State University of Physical Education, Sport, Youth and Tourism on 26.10.2017). The study used the following methods: medical examination, three-time measurement of blood pressure (in the morning from 8:00 to 11:00), ergospirometry and methods of mathematical statistics.

Ergospirometry

Aerobic capacity was assessed using MONARK 839 E bicycle ergometer (Monark AB, Sweden), the load was set starting from 20 W and increased for 20 W every 2 minutes. Gasometric analysis was performed using a CORTEX gas analyzer (Meta Control 3000, Germany), which measures oxygen consumption and carbon dioxide emission during each respiratory cycle. The test was performed at the rate of 75 rpm/min^{-1} to determine maximal oxygen consumption, blood pressure (BP) and heart rate at the BP level, and pedal

power at maximal oxygen consumption by the method of Pallarés et al [10].

Mathematical statistics methods

All the results obtained were processed using Microsoft Office Excel 2007 and Statistica 10.0 / W RUS Software, as well as statistical software package for biomedical sciences. Quantitative variables were summarized as mean (M). The significance of differences was determined by the Student's t-test for paired and unpaired samples. Differences were considered statistically significant when $p<0.01$.

Exercise protocols

Athletes from all groups trained for 120 days (3 times a week) according to the following protocols: 1) RT group: strength training — 5 exercises with a weight of 70–90 % of repetition maximum (1RM), 4 approaches with from 2 to 8 repetitions. One cycle of "approach+ rest (until complete recovery)" for 5 minutes. Exercises were performed for all major muscle groups and included: bench press, bar squats, deadlift, barbell forearm flexion, forearms extension. The training session lasted 100 minutes; 2) HIIT group: strength training — 5 exercises with a weight of 70–90 % of 1RM, 3 approaches with from 2 to 8 repetitions. The strength training technique was the same as in the RT group. After the strength protocol, aerobic work on bicycle ergometer was added, included 7 high-intensity intervals (at pedal power of 100 % of maximal oxygen consumption) for 2 minutes and low-intensity intervals with a heart rate of 85 % of anaerobic threshold (AT) for 2 minutes. During the ergospirometry test, the pedal power was set at the level of 85 % of AT, therefore, it was recommended to reduce the load to this level. The training session lasted 103 minutes; 3) MICT group: strength training — 5 exercises with a weight of 70–90 % of 1RM, 3 approaches from 2 to 8 repetitions for bench press exercises and 2 approaches for other exercises. The strength training technique was the same as in the RT group. After the strength protocol, continuous aerobic training on a bicycle ergometer for 45 minutes with an intensity of 60–80 % of pedal power of maximal oxygen consumption was added according to the guidelines of the American College of Sports Medicine (ACSM) 2019 [11] for the participants with arterial hypertension. The training session lasted 100 minutes.

Results and discussion

It has been suggested that HIIT may have positive effect on cardiovascular system. Overall, 33 systematic reviews (including 25 meta-analyzes) that included both healthy and people with various diseases showed that HIIT improved cardiorespiratory endurance, anthropometric parameters, vascular function, heart function, and body mass compared with inactive controls [12] Additionally, recent systematic reviews and meta-analyzes [13, 14, 15] have shown that: 1) HIIT and MICT similarly reduced blood pressure in adults with pre-established arterial hypertension; 2) HIIT was associated with larger increase of maximal oxygen consumption compared to MICT; 3) HIIT significantly decreased nocturnal diastolic blood pressure (DBP) compared with MICT; 4) HIIT significantly decreased daytime blood pressure compared with MICT; 5) the decrease in systolic blood pressure (SBP) after interval exercises did not differ from responses to MICT immediately and 60 minutes after exercise; 6) DBP decreased and

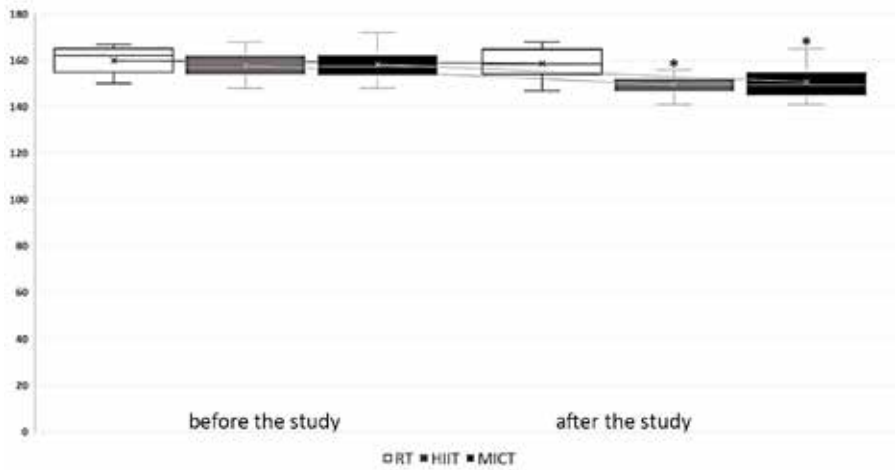

Figure 1. The dynamics of systolic blood pressure changes during different exercise protocols in strength-trained athletes
Comment: (*) statistically significant changes between groups — p<0,01.

Table. **BP dynamics during different exercise protocols in strength-trained athletes**

Group (N=83)	SBP (mmHg)			DBP (mmHg)		
	0 days	120 days	Δ	0 days	120 days	Δ
RT (n=20)	159,9±5,5	158,7±6,2	1,3	96,2±3,5	95,9±4,1	0,3
HIIT (n=33)	157,9±5,1	149,9±4,0	8,3*	96,1±4,8	88,2±4,6	7,9*
MICT (n=30)	158,3±6,3	150,6±6,1	7,7*	97,4±5,3	89,1±5,2	8,3*

Comment: (*) statistically significant changes between groups – p <0,01.

blood flow increased more 10–15 minutes after interval exercise compared with MICT. After 120 days of physical rehabilitation, SBP decreased in HIIT and MICT groups by 8.3 mm Hg and 7.7 mm Hg, respectively (Figure 1).

SBP insignificantly decreased in control RT group (–1.3 mm Hg) that was not statistically significant. According to meta-analysis by Smart and his colleagues [17], isometric exercises (that is common in bodybuilding training programs) alone, without aerobic work, have antihypertensive effect. However, in our study, BP did not decrease in the RT group during 120-day follow-up. The difference between the RT group and MICT and HIIT groups was statistically significant, unlike between aerobic work groups. After 120 days of physical rehabilitation, DBP significantly decreased in HIIT and MICT groups by 7.9 mm Hg and 8.3 mm Hg., respectively (Figure 2), and by 0.3 mm Hg — in the RT group that was not statistically significant. The difference between the decrease of DBP in MICT and HIIT groups was also not statistically significant. It is well known that a decrease in blood pressure by 7.5 mm. Hg. and by 10 mm. Hg. reduces the incidence of strokes by 46 % and 56 % and the incidence of coronary artery disease by 29 % and 37 % [16].

Comparative analysis of blood pressure reduction between the MICT and HIIT groups shows that both methods effectively reduce SBP and DBP (table), however, athletes from the HIIT group spent 38 % less time on exercising.

Conclusion

According to the analysis of modern scientific literature using the following databases: eLibrary, RSCI, PubMed, Cochrane Library, CINAHL, Web of Science, MEDLINE, SPORTDiscus and Scopus, we did not find studies that would prove the effectiveness of any aerobic exercises method in blood pressure lowering in strength-trained athletes with arterial hypertension. 120 days of simultaneous physical rehabilitation using HIIT, MICT and RT showed that: 1) blood pressure did not decrease in the RT group within 120 days; 2) simultaneous combinations of RT+ MICT or RT+ HIIT, similarly reduced SBP within 120 days of physical rehabilitation by 4.9 % and 5.3 %, respectively; 3) simultaneous combinations of RT+ MICT or RT+ HIIT, similarly reduced DBP within 120 days of physical rehabilitation by 8.5 % and 8.2 %, respectively; 4) despite similar effect on blood pressure, athletes from the HIIT group spent 38 % less time that can significantly affect adherence and exclude some participants of long rehabilitation. Further researches are required.

Conflict of interest: none declared.

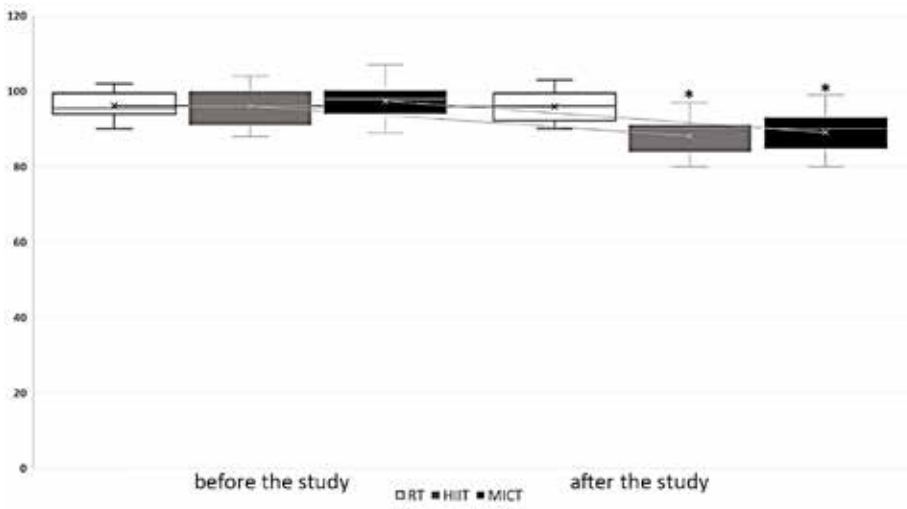

Figure 2. The dynamics of diastolic blood pressure changes during different exercise protocols in strength-trained athletes
Comment: (*) statistically significant changes between groups — p<0,01.

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