Research Article

Peculiarities of runners adaptation to the conditions of middle altitude

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ABSTRACT

Aim: Parameters of heart pump function of the track athletes, specializing in short, long, and super long distances running, in the process of training and adaptation to the middle altitude conditions, have been studied in the research. **Materials and Method:** The HR and the SV in track athletes were measured with the help of device for computer analysis РПКА2–01, intended for work in the hardware-firmware complexes of medical purpose. The tetrapolar thoracic rheography method was used for determining the SV. **Result and Discussion:** It was revealed that, during the 6 weeks of muscle training in the middle altitude conditions, all the groups of examined track athletes had a reliable increase in heart rate (HR), in comparison with baseline data. At the same time, the most pronounced increase in the HR, in the process of muscle training in middle altitude conditions, occurred in sprinters, and the least changes in the HR were revealed in long-distance runners and marathon runners. It was established that the parameters of the stroke volume in all groups of track athletes, in the process of muscle training in middle altitude conditions, were reduced. **Conclusion:** The most positive adaptation to training in the middle altitude conditions, at the end of training camp, was observed only in long-distance runners and marathon runners.

KEY WORDS: Adaptation, Heart rate, Long-distance runners and marathon runners, Middle altitude conditions, Muscle loads, Pump function, Sprinters, Stroke volume, Training

INTRODUCTION

Track and field athletics belong to the one of the most popular and accessible sports.[1-3] Fundamentally organized training, using new approaches and methods, are necessary for the successful athletic training.[2,4-6] One of the such approaches is the training in the middle altitude conditions. Such trainings are used to train athletes of different specializations: Track athletes, swimmers, wrestlers, cyclists, as well as representatives of all winter kinds of sports.[7,8]

In sports practice, there are many examples, where some outstanding athletes or entire teams, conducting training camps in the middle altitude conditions, both in the preparatory period and immediately before responsible starts, achieve significant sports results.[4-6,9]

Leading specialists of many kinds of sports widely use the training of athletes in the difficult middle altitude conditions (1300-2500 m above sea level).[1,7,8] The physiological meaning of such training in the middle altitude conditions is that they are successfully used to increase the functionality of athletes, improve volitional and physical abilities, increase resistance to hypoxia, and increase overall and special resistance of the body.[2,5] In this regard, high hypoxia causes significant rearrangements in the body's functional systems, stimulates adaptation mechanisms, and thereby enhances the efficiency of the athlete and the tolerance of extreme muscular loads.[3] The positive effect of training in the middle altitude conditions, as a whole, does not cause doubts among specialists. At the same time, the specifics of athletes adaptation to the middle altitude conditions are not fully understood. Moreover, the reaction of the heart pump function of the athletes, during adaptation to the middle altitude conditions, remains practically unexplored. This is the reason for the relevance of the chosen topic.

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The purpose of the research is to study the peculiarities of adaptation of the heart pump function of various specializations athletes to the middle altitude conditions.

Objectives of the Study

The objectives of this study are as follows:

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- To study the changes in the heart rate (HR) of track athletes during adaptation to the middle altitude conditions.
- To reveal the peculiarities of changes in the parameters of the stroke volume (SV), during the adaptation of various specializations athletes to the middle altitude conditions.

METHODS

The HR and the SV in track athletes were measured with the help of device for computer analysis РПКА2–01, intended for work in the hardware-firmware complexes of medical purpose. The tetrapolar thoracic rheography method was used for determining the SV.[10]

Methodology and Organization of the Research

Studies were conducted in natural conditions in Kislovodsk, on the basis of sports training center of representative teams of Russia "Yug sport." A total of 77 athletes were included in the research. The athletes were conditionally divided into 4 groups as follows:

- The first group consisted of sprinters;
- The second group included middle-distance runners;
- The third group consisted of long-distance runners;
- The fourth group included marathon runners.

Training camps were held for 6 weeks. Training was conducted twice a day and 6 days a week.

RESEARCH RESULTS

As our studies showed, the HR of short-distance runners (sprinters) at rest was 59.7 ± 2.7 bpm on the day of arrival in the training camp. By the end of the 1st week of systematic muscular training in middle altitude conditions, the HR of these athletes had increased by 12.7 bpm and reached 72.4 ± 1.4 bpm ($P < 0.05$). The increase in HR occurred during the 2nd week of muscle training, where the HR reached 74.7 ± 1.8 bpm. However, during the following weeks of systematic muscle training, there was a steady trend toward a decrease in HR of these athletes. By the end of the 6th week, the HR had been 65.5 ± 2.3 bpm.

Consequently, during the first 2 weeks, the HR of sprinters increases significantly, and further, there is a certain tendency to decrease the HR.

In other athletes, specializing in running for middle, long, and marathon distances, a significant increase in the HR occurred only in the 1st week of muscle training in middle altitude conditions. However, this increase in HR was significantly lower than that of sprinters.

On the 1st day of arrival, middle-distance runners had the HR 54.1 ± 2.4 bpm. By the end of the 1st week of systematic muscular training in the middle altitude conditions, the HR of these athletes had reached 60.2 ± 2.1 bpm. During the following 2 weeks of muscle training, the parameters of HR remained approximately at the same level. Starting from the 4th week, HR values gradually decreased, and by the end of the 6th week, the HR had been 58.2 ± 2.1 bpm.

In long-distance runners, on the day of arrival, the HR at rest was 49.1 ± 2.4 beats/min. In the next 2 weeks, there was no significant change in HR. In the 2nd week, the HR reached 54.3 ± 2.1 beats/min, and in the 3rd week, it reached 54.1 ± 1.8 beats/min. By the end of the 4th week, the HR had slightly decreased to 53.5 ± 1.9 beats/min. At the 6th week, the HR was 52.2 ± 2.1 beats/min.

Herewith, more significant decrease in the HR was observed in marathon runners. In these athletes, the HR at rest on the day of arrival was 47.8 ± 2.4 beats/min. At the end of the 1st week, the parameters were 54.1 ± 2.1 bpm. By the end of the 4th week, the HR had decreased to 51.2 ± 2.4 beats/min. Moreover, on the 6th week, the HR indicators were 49.1 ± 2.4 beats/min. It should also be noted that, in all athletes, the values of HR during the 6th week of staying in middle altitude conditions were significantly higher in comparison with the initial values, i.e., with HR values, recorded on the 1st day of training.

Thus, it can be concluded that the changes in the HR of athletes, training in the middle altitude conditions, depend on their specialization. It is common for all athletes that, in the 1st week of muscle training, all athletes have an increase in the HR. The group of sprinters had an increase in HR during the 2nd week of muscle training.

During the next weeks, all athletes had a decrease in HR, and by the end of the 6th week of muscle training, there had been some adaptation of athletes to middle altitude conditions. However, the decrease in HR in the 6th week to the level of baseline values was observed only in long-distance runners and marathon runners.

In our opinion, the increase in HR during the 1st week was connected with the process of acclimatization of athletes to the middle altitude conditions (Table 1).

We also have analyzed changes in the SV in athletes during training in the middle altitude conditions. As our studies showed, in athletes, specializing in running for short distances (sprinters), the SV at rest, on the day of arrival to the training camp, was 78.4 ± 3.1 ml. By the end of the 1st week of systematic muscular training in middle altitude conditions, the SV in these athletes had decreased by 6.9 ml and amounted to 71.5 ± 2.1 ml. Although this difference does not reach reliable values, there is a steady tendency to decrease of SV in sprinters. During the next 5 weeks of systematic muscle training in middle altitude conditions, the indicators of SV in these athletes gradually decreased. At the 6th week of muscle training in middle altitude conditions, sprinters had the SV 64.4 ± 3.1 ml. This value was lower by 14.0 ml, compared to the SV, registered on the day of arrival at the training camp. Consequently, the parameters of SV of sprinters steadily decreased during the 6 weeks of muscle training in middle altitude conditions and remained at a low level until the end of training camps.

In athletes, specializing in running for middle distances, the values of the SV on the day of arrival to the training base were 98.7 ± 2.7 ml. Unlike other athletes, these athletes had an inadequate increase in SV output by 8.8 ml at the 1st week of muscle training and reached 107.5 ± 3.7 ml. This difference does not reach reliable values, but there is a tendency to an increase in the values of SV. In the 2nd and 3rd weeks of muscle training, the values of SV significantly decreased, and by the end of the 3rd week of muscle training, the SV values had been 78.8 ± 3.1 ml, which was 19.9 ml less than the baseline data. In the next 2 weeks of systematic muscle training, the SV of middle-distance runners gradually began to increase, and by the 5th week of training, they had reached 97.4 ± 3.7 ml, which was at the level of the base values. However, during the 6th week of muscle training, there was a significant decrease in SV up to 85.7 ± 3.4 ml, which was 11.7 ml less than the values, recorded in the 5th week of muscle training.

Long-distance runners had the SV 112.5 ± 3.1 ml on the day of arrival. It should be noted that these values were significantly higher in comparison with the SV of all previous groups of athletes. Since the 1st week of muscle training, the SV of long-distance runners has begun to decrease on average by 8-10 ml. At each week and by the end of the 5th week of muscle training, the values of the SV had been 89.3 ± 3.4 ml. This value was 23, 2 ml less in comparison with the values of the SV, registered on the day of arrival ($P <0.05$). At the 6th week of muscle training, these athletes had a significant increase in the SV by 15.2 ml, compared to the values, obtained at the 5th week, and reached 104.5 ± 3.5 ml ($P <0.05$). Consequently, long-distance runners, during all 5 weeks of muscle training, had a decrease in the SV. However, in the 6th week of muscle training, athletes adapted to the middle altitude conditions, and as a result, the SV parameters increased.

The SV of marathon runners on the day of arrival was 107.7 ± 3.4 ml. During 4 weeks of systematic muscular training, the SV values for these athletes gradually decreased, and by the end of the 4th week, they had been 89.4 ± 2.4 ml ($P <0.05$). At the 5th and the 6th weeks of muscle training, the SV values increased slightly to 90-95 ml but did not reach the initial values. Thus, summarizing the above, it can be said that systematic muscular training in middle altitude conditions has an uneven effect on the changes in SV of athletes with different specialization. During the first 4 weeks of muscle training, all athletes had a stable tendency to decrease the SV parameters, except for a group of middle-distance runners, which had an increase in the SV during the 1st week.

According to our data, track athletes at the end of the training camps had a peculiar adaptation to the middle altitude conditions, which was expressed by an increase in the SV to the level of the initial values. At the same time, the sprinters had no increase in the SV to the level of the initial values at the end of the training camps (Table 2).

DISCUSSION

The experimental data, obtained by us, have convincingly demonstrated that track athletes of different specializations gave mixed response to the conditions of training in middle altitude conditions, by the changes in the parameters of heart pump function.

The severity of changes in the HR in athletes, training in the middle altitude conditions, depends on their specialization. It is common for all athletes that, during the 1st week of muscle training, all athletes had an increase in the HR, and in the group of sprinters, there was an increase in the HR also during the 2nd week of muscle training.

During the next weeks, all athletes had a decrease in the HR, and by the end of the 6th week of muscle training, there had been some adaptation of athletes to

Table 1: Changes in the heart rate (bpm) in track athletes

Day/week	Sprinters	Middle-distance runners	Long-distance runners	Marathon runners
The 1st day of arrival	59.7±2.7	54.1±2.4	49.1±2.4	47.8±2.4
The 1st week	72.4±1.4*	60.2±2.1*	54.4±2.7*	54.1±2.1*
The 2nd week	74.7±1.8	60.1±1.9	54.3±2.1	53.1±2.3
The 3rd week	72.5±1.9	60.1±1.7	54.1±1.8	52.3±1.9
The 4th week	70.2±1.7	59.5±1.4	53.5±1.9	51.2±2.4
The 5th week	68.3±2.1	58.9±2.3	52.8±2.3	50.3±1.7
The 6th week	65.5±2.3	58.2±2.1	52.2±2.1	49.1±2.4

*The difference is reliable in comparison with the values of the previous group ($P<0.05$)

Table 2: Changes in the stroke volume (ml) in track athletes

Day/week	Sprinters	Middle-distance runners	Long-distance runners	Marathon runners
The 1st day of arrival	78.4±3.1	98.7±2.7	112.5±3.1	107.7±3.4
The 1st week	71.5±2.1	107.5±3.7*	104.7±2.7*	91.5±2.7*
The 2nd week	69.4±3.4	88.5±2.1*	97.5±3.1	88,4±3.1
The 3rd week	72.4±3.0	78.8±3.1*	91.5±3.4	85.7±2.8
The 4th week	67.5±3.2	85.4±2.1	97.7±2.4	89.4±2.4
The 5th week	61.4±2.7	97.4±3.7*	89.3±3.4	95.5±2.7
The 6th week	64.4±3.1	85.7±3.4*	104.5±3.5*	90.7±2.1

*The difference is reliable in comparison with the values of the previous group ($P<0.05$)

the middle altitude conditions. However, the decrease in the HR, during the 6th week of the training, to the level of base values, was observed only in long-distance runners and marathon runners.

We suppose that the increase in the HR during the 1st week was due to the process of acclimatization of athletes to the middle altitude conditions. The main factor of the influence of mountain climate on the body is hypoxia, i.e., the lack of oxygen. In this regard, the requirements for the work of the cardiovascular, respiratory, and other body systems are increasing. At a height, restorative processes of the body proceed slowly. Therefore, the repeated execution of even short-term exercises under these conditions causes a faster fatigue (decreased efficiency) than at sea level.

Reduction in the HR of athletes in the middle altitude conditions indicates a positive effect of training because, during the long stay in mountain conditions, there are adaptive changes in the body, which contribute to increase of efficiency in these specific conditions.

Systematic muscular training in middle altitude conditions has an uneven effect on the changes in SV of athletes with different specialization. During the first 4 weeks of muscle training, all athletes had a stable tendency to decrease the SV parameters, except for a group of middle-distance runners, which had an increase in the SV during the 1st week.

The greater part of the studied groups of athletes, by the end of training camps, had acclimatized and adapted to the middle altitude conditions. It was reflected in the increase of the SV parameters to the level of the initial values. At the same time, it should be noted that the sprinters had no increase in the SV to the level of the initial values at the end of the training camps.

CONCLUSIONS

During the 6 weeks of muscle training in the middle altitude conditions, all the groups of examined track athletes showed a significant increase in the HR, in comparison with initial data. The most pronounced increase in the HR, in the process of muscle training in the middle altitude conditions, had been seen in sprinters, and the least changes of the HR had been revealed in long-distance runners and marathon runners.

The indicators of the SV in all groups of athletes were reduced in the process of muscle training in the middle altitude conditions. Relative adaptation to the training in the middle altitude conditions at the end of training camps was observed only in long-distance runners and marathon runners.

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