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Differentiated Training Model for Marathon Runners on Building Tempo and Speed Endurance Based On the Types of Energy Metabolism

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Abstract

This article discusses the issues of improving the quality of the training process for marathon runners in competition preparation by utilizing the application of a differentiated training model based on the types of energy metabolism for the development of tempo and speed endurance. The studies conducted have shown that marathon runners of different energy metabolism types adapt differently to competitive loads, as well as to speed and tempo development. The process of adaptation of their functional systems (which define tempo and speed endurance) occurs mainly due to the differentiation of the tools and methods used correspondingly to the type of energy metabolism. It allows not only for the more effective expansion of the cardiorespiratory system capabilities but also for bringing athletes to a higher level of tempo and speed endurance development. As a result of the study, it was revealed that for aerobic athletes, tempo endurance should be developed by using standard continuous training, while speed endurance should be developed through repeated training. Tempo endurance in anaerobic marathon runners should be developed by using interval training, while speed endurance should be developed through non-maximal effort training with a normalized number of distance segments. Tempo endurance in marathon runners of the mixed type of energy metabolism should be developed by using the variable training method, while speed endurance should be developed through a combination of non-maximal effort and repeated training with a fixed number of distance segments.

Keywords: *marathon running; muscle activity; types of energy metabolism; training of marathon runners*

Introduction

Competitive activities of high-class marathon runners are highly demanding regarding their physical fitness level (Skof, Hadzic, & Dervisevic, 2012; Bolotin & Bakayev, 2017a; Bakaev, Bolotin, & Aganov, 2016). The basis of specialized training for long-distance running lies in the development of special endurance to varied speed and tempo of running in the course of competitive activities (Bakayev, Bolotin, & You, 2018; Przybyła et al., 2016; Bakayev, Vasilyeva, Kalmykova, & Razinkina, 2018). The efficiency of developing this physical quality is determined by a directed impact of different energy production mechanisms on the athlete's body based on the type of energy metabolism (Bakayev et al., 2018; Bohuslavska, Furman, Pityn, Galan, & Nakonechnyi, 2017; Bolotin & Bakayev, 2016).

A large number of the articles devoted to this problem are only indirectly related to the issues of energy supply for muscle activity in marathon runners (Bolotin, & Bakayev, 2017b; Boullosa, Tuimil, Leicht, & Crespo-Salgado, 2009; Vesterinen et al., 2013; Pieralisi et al. 2017). This contradiction limits the possibilities of using differentiated tools and methods for developing special endurance in marathon runners (Auersperger, Jurov, Laurencak, Leskosek, & Skof, 2020; Manzi, Iellamo, Impellizzeri, D'Ottavio, & Castagna, 2009). The methods of developing special endurance in marathon runners, differentiated based on the types of energy metabolism, are only used to a limited extent (Bolotin, & Bakayev, 2017a). Preliminary studies have shown that without

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taking into consideration the type of energy metabolism of an athlete, it is difficult to increase the results of high-class marathon runners by more than 1.5% in specialized training during competition preparation.

Aim of the study to determine the efficiency of specialized training techniques for athletes in long-distance running while taking into consideration the types of energy metabolism.

Methods

Sixteen marathon runners specialized in long-distance running (from 10 to 100 km) took part in the study. The participants were in the age range of 25 to 37 years. To test the developed training options, four groups of athletes were formed depending on the energy metabolism type: aerobic type runners, anaerobic type runners, mixed type runners, and the group for which no account was taken of the energy metabolism types. The experiment lasted for six weeks of the special preparatory stage of training. The tools and methods of specialized training for each group of athletes were developed based on the characteristics of their mechanism of energy supply for muscle activity. To substantiate the training model for marathon runners, a comparative analysis was performed based on the functional capabilities of athletes from various groups that were differentiated by the type of energy metabolism.

To address the challenges of the study, we used the express-diagnostics D&K test (Dushanin, 1986) to assess the functional state and reserve capabilities of the athletes. Following the algorithms of the programme, energy metabolism types of athletes were determined based on the morphology and height analysis of the R wave (i.e., the main ECG wave) and S wave (i.e., the intermittent ECG wave) in an electrocardiogram recorded on three limbs, with three augmented and six precordial leads.

The data obtained enable calculating the following parameters:

1. Capacity of anaerobic supply of energy (CANSE), which characterizes the ability to carry the load in the 3rd, 4th, and 5th intensity zones.
2. Anaerobic disposal threshold (ANDT), which characterizes an athlete's predisposition to anaerobic work, expressed as a percentage.
3. Capacity of aerobic supply of energy (CASE) aerobic source index, which characterizes the ability to fulfil the load in the 1st and 2nd intensity zones.
4. Aerobic disposal threshold (ADT), which characterizes an athlete's predisposition to aerobic work, expressed as a percentage.
5. Total metabolic capacity (TMC), which characterizes the total work capacity of the body.
6. Power of creatine phosphate energy supply (PCPES), which characterizes the speed performance of marathon runners.
7. Glycolytic power supply (GPS), which characterizes the speed endurance of marathon runners.
8. Power of aerobic energy supply (PAE), which characterizes the ability to demonstrate general endurance, as well as to recover from anaerobic work.
9. Anaerobic metabolic threshold (AMT), which characterizes the efficiency of aerobic energy supply mechanisms.

The efficiency of managing the training process was achieved through differentiating the methods of specialized training for marathon runners, depending on the characteristics of their energy supply for muscular activity.

Tempo endurance of the primarily aerobic marathon runners was developed by using long-term continuous exercise, while speed endurance was developed through repeated training.

In athletes of the anaerobic type of energy metabolism, tempo endurance was developed by using interval training, while speed endurance was developed through submaximal effort training with a fixed number of run segments.

Tempo endurance in athletes of the mixed type of energy metabolism was developed by using the variable training method, while speed endurance was developed through a combination of non-maximal effort and repeated training with a fixed number of distance segments. Standard tools and methods for developing tempo and speed endurance were used for the control group of marathon runners.

The load for marathon runners was selected (Table 1) based on the current result in the 10,000 m run (Table 2) and the marathon run (Table 3). The number of run segments' repetitions and the weekly volume of the training load were selected depending on the level of the functional state of the athletes.

To manage the special training, we have developed and used a system to control the training process. It included running power testing, lactate profile testing, skinfold test, and the blood profile test. The system was used to plan the programme of training for marathon runners while taking into consideration the heart rate beat and the type of energy metabolism.

Table 1. Main Training Load Parameters of Marathon Runners at the Special Preparatory Stage of Training for Competitions (6 Weeks)

Load parameters	Groups of subjects divided by the type of energy metabolism			
	Aerobic type	Anaerobic type	Mixed type	Without reference to metabolism
Daily running distance, km	60–80	42–62	46–70	46–70
Weekly running distance, km	350–480	240–370	270–420	270–420
Number of training per week	12	12	12	12
Main training exercise	6×3,000 m 4×9,000 m	4×(5×2,000 m) 6×6,000 m	3×(2×2,500 m) 4×8,000 m	8×2,500 m 2×9,000 m
Training method	Balanced, repeated	Interval, submaximal effort	Variable, non-maximal effort	Balanced, repeated, interval

Results

As a result of the studies, differences in the dynamics of specialized tests parameters were revealed. These differences depended on the energy metabolism type of marathon runners (Tables 2, 3).

In the 10,000 m run, athletes of the aerobic type showed an improvement, in a time of 44.1 s; the increase in the results was 2.4% ($p<0.05$). Marathon runners of the mixed type of energy metabolism had their results improved by 32.7 s; the increase was 1.8% ($p<0.05$). The test groups of the anaerobic energy

Table 2. Result Dynamics in the 10,000 m Run of Marathon Runners of Various Types of Energy Metabolism (Min)

Period of testing at the special preparatory stage of training	Groups of subjects divided by the type of energy metabolism			
	Aerobic type	Anaerobic type	Mixed type	Without reference to metabolism
Beginning of the stage	31.52±0.11	31.44±0.18	31.40±0.17	31.48±0.16
End of the stage	30.78±0.15	30.17±0.11	30.87±0.13	30.91±0.18

Legend: Seconds to minutes were converted as follows: 0.1 min = 6 sec; 0.2 min = 12 sec; 0.3 min = 18 sec, etc.; 1.0 min = 60 sec.

metabolism type showed an improvement in the temporal index by 82.3 s; the increase was 4.2% (p<0.01). The average improvement in this test among athletes from the group with no reference to the type of energy metabolism was 38.8 s, which corresponded to an increase of 2.2% (p<0.05).

In marathon running, the aerobic athletes had their average distance passing time improved by 6 min 3 s; the increase was 2.9% (p<0.05). Athletes from the group of mixed type of energy metabolism showed an improvement in time of 6 min 52 s; the increase in results was 3.3% (p<0.05). The subjects from the group of anaerobic energy metabolism had their average result improved by 5 min 7 s; the increase was 2.4%. The average improvement in this test among athletes from the group with no reference to the type of energy metabolism was 5 min 2 s, which corresponded to an increase of 2.3% (p<p0.01).

Table 3. Result Dynamics in Marathon Running of Athletes of Various Types of Energy Metabolism (Min)

Period of testing at the special preparatory stage of training	Groups of subjects divided by the type of energy metabolism			
	Aerobic type	Anaerobic type	Mixed type	Without reference to metabolism
Beginning of the stage	139.22±1.14	146.36±1.18	143.31±1.14	141.27±1.12
End of the stage	133.19±1.16	141.29±1.12	136.88±1.15	136.21±1.14

Table 4 presents the results of evaluating the functional and reserve capabilities of the athletes before and after completing the special preparatory stage of training.

Table 4. Dynamics of functional and reserve capabilities parameters of marathon runners as a result of completing the special preparatory stage of training

Testing period	Groups of subjects divided by the type of energy metabolism			
	Aerobic type	Mixed type	Anaerobic type	Without reference to metabolism
Capacity of anaerobic supply of energy (CANSE), p.d.u.				
before	45.32±13.68	71.08±6.91	124.67±8.76	76.22±34.63
after	48.86±11.23	76.91±4.89	136.19±9.31	82.53±11.15
t	0.63	2.18*	2.45*	0.83
Capacity of aerobic supply of energy (CASE), p.d.u.				
before	240.17±21.37	229.51±17.63	204.41±21.69	226.65±29.49
after	260.21±18.23	249.53±13.68	218.92±18.67	244.85±16.83
t	2.21*	2.87*	1.37	2.51*
Total metabolic capacity (TMC), p.d.u.				
before	285.53±12.33	300.63±21.42	329.06±22.18	302.78±34.07
after	308.52±14.38	326.47±19.22	355.23±23.01	327.65±18.87
t	4.10**	2.98**	2.34*	2.98**
Power of creatine phosphate energy supply (PCPES), p.d.u.				
before	31.54±2.35	29.55±1.95	38.75±2.26	32.64±5.93
after	34.79±2.17	32.03±2.19	41.93±2.12	35.57±2.16
t	3.23**	2.96**	2.86*	2.17*
Glycolytic power supply (GPS), p.d.u.				
before	31.60±2.65	29.52±2.47	33.57±2.03	31.28±3.19
after	34.35±2.76	31.94±2.03	35.77±1.58	33.75±2.12
t	2.35*	2.47*	2.35*	3.00**
Power of aerobic energy supply (PAE), p.d.u.				
before	57.48±4.43	52.12±5.80	46.39±4.03	51.62±9.67
after	62.25±3.22	56.03±6.13	51.63±4.34	56.28±8.96
t	2.63*	1.60	2.57*	1.56

Legend: ** – p<0.01; * – p<0.05

Discussion

Thus, as a result of using the differentiated training methods for marathon runners, a significant increase in the parameters of the functional and reserve capabilities was revealed. It should also be noted that in the absence of a significant increase in the CANSE and PAE indices in the group of athletes with no reference to the type of energy metabolism, a significant increase in these indices was observed in the groups of mixed and anaerobic types of energy metabolism.

The data obtained enable concluding that the differentiated methods of preparing marathon runners for competitions that take energy metabolism types into consideration are efficient.

As a result of carrying out the special preparatory stage of training for competition preparation of marathon runners with various types of energy metabolism, a different reaction of the body to the training load was recorded. Athletes of anaerobic and mixed types of energy metabolism adapted to speed-power work more quickly, while aerobic athletes were better in adapting to long-term endurance work, which suggests that considering the types of energy metabolism may be critical for the definition of the tools and methods used for athlete training.

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Conflict of Interest
The authors declare that there is no conflict of interest.

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