Method for Training of Long Distance Runners Taking into Account Bioenergetic Types of Energy Provision for Muscular Activity

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Keywords: Long-distance Runners, Peculiarities of Energy Provision for the Muscular Activity, Bioenergetics Types, Training Method.

Abstract: The paper shows that the improved training process quality can be achieved by the use of different methods for training of long-distance runners taking into account peculiarities of energy provision for their muscular activity. The essence of these methods consists in the following: for sportsmen with “aerobic type” of provision for their muscular activity, tempo endurance should be developed, mainly, by the method of standard continuous exercise and speed endurance should be developed by the repetition method; for sportsmen with “anaerobic type” of provision for their muscular activity, tempo endurance should be developed, mainly, by the method of standard interval exercise and speed endurance should be developed by the submaximal effort method with standardized number of repetitions of sections covered; for sportsmen with “mixed type” of provision for their muscular activity, tempo endurance should be developed, mainly, by the method of variable continuous exercise and speed endurance should be developed by the combination of the repetition method and submaximal effort method with standardized number of repetitions of sections covered.

1 INTRODUCTION

The competitive activity of long-distance runners makes high requirements to their physical fitness level (Bakaev et al., 2015; Bolotin and Bakayev, 2017; Bolotin et al., 2017; Kuznetsova et al., 2015). Training of long-distance runners is based on the development of physical qualities among which different endurance types are the most important (Ammann and Wyss, 2015; Bolotin and Bakaev, 2015). The development of these qualities is possible only in case of the targeted influence on their physiologic systems and, in particular, mechanisms of energy provision for the muscular activity (Bakaev et al., 2016; Osipov et al., 2016).

The literature analysis shows that most papers concerning training of long-distance runners do not contain well-grounded scientific information characterizing peculiarities of the energy provision for their muscular activity. This limits significantly the possibilities to differentiate means and methods for development of different endurance types in the training process. The problems concerning the use of the methods for development the endurance in long-distance runners, in which different bioenergetic types of energy provision for the muscular activity would serve as a differentiation criterion are also insufficiently investigated.

2 ORGANIZATION AND METHODS

Objective of the study is to assess the method efficiency for training long-distance runners taking into account peculiarities of energy provision for their muscular activity.

Research Design. We examined 28 Russian long-distance runners aged 19 – 27 years. The runners specialized in the race for the distance of 5000 meters. Training for the competitions took place in 4 groups with 7 sportsmen in each: “aerobic type”, “mixed type”, “anaerobic type” and a group without consideration of the energy provision type for the muscular activity. The experiment lasted for 6 months. The training means and methods were selected taking into account the bioenergetic types of energy provision for sportsmen’ muscular activity. In

Bolotin A. and Bakayev V.
Method for Training of Long Distance Runners Taking into Account Bioenergetic Types of Energy Provision for Muscular Activity.
DOI: 10.5220/0006516101260131
In *Proceedings of the 5th International Congress on Sport Sciences Research and Technology Support (icSPORTS 2017)*, pages 126-131
ISBN: 978-989-758-269-1

order to substantiate the sportsmen training methods taking into account the bioenergetic types, we:
- determined sportsmen' bioenergetic types;
- performed the comparative analysis of the parameters of the functional condition and reserve possibilities of the sportsmen's organism in different bioenergetic groups.

A method for rapid diagnostics of the functional condition and reserve possibilities of the sportsmen's organism with the help of the "D&K Test" program developed by V. Karlenko was used (Karlenko et. al., 2008). This method for rapid diagnostics of the organism functional condition and reserve possibilities was used in order to determine the bioenergetic type of sportsmen. The program analyzed the R and S wave height in the electrocardiogram recorded in the standard and pectoral leads. As a result we calculated the parameter values characterizing the power, capacity, efficiency of the anaerobic and aerobic energy provision systems for the muscular activity. The following parameters were assessed during the study:

1. ANMC is anaerobic metabolic capacity. It characterizes the ability to perform the stress in the third, fourth and fifth intensity zones.
2. ANMC (%) is anaerobic utilization capacity. It characterizes runners' predisposition to anaerobic work in percentage.
3. AMC is aerobic metabolic capacity. It characterizes the ability to perform the stress in the first and second intensity zones.
4. AMC (%) is aerobic utilization capacity. It characterizes runners' predisposition to aerobic work in percentage.
5. TMC is total metabolic capacity. It characterized the organism's total capacity for work.
6. CPMP is creatine phosphate metabolic power. It characterizes runners' speed abilities.
7. GLMP is glycolytic metabolic power. It characterizes runners' speed endurance.
8. AMP is aerobic metabolic power. It characterizes the abilities to general endurance and also to recovery after the anaerobic work.

The improved training process quality was achieved by the use of different methods for training of long-distance runners (Bolotin and Bakayev, 2016; Bolotin and Bakayev, 2017; Zakharova and Mekhdieva, 2016). The peculiarities of energy provision for their muscular activity were taken into account:

- for sportsmen with "aerobic type" of provision for their muscular activity, tempo endurance was developed, mainly, by the method of standard continuous exercise and speed endurance was developed by the repetition method;
- for sportsmen with "anaerobic type" of provision for their muscular activity, tempo endurance was developed, mainly, by the method of standard interval exercise and speed endurance was developed by the submaximal effort method with standardized number of repetitions of sections covered;
- for sportsmen with "mixed type" of provision for their muscular activity, tempo endurance was developed, mainly, by the method of variable continuous exercise and speed endurance was developed by the combination of the repetition method and submaximal effort method with standardized number of repetitions of sections covered;
- for the sportsmen group without taking into account the bioenergetic type, the wider range of means and methods for development of the tempo and speed endurance was used.

All athletes had a different level of preparedness, therefore the tempo training load for runners was selected based on the current result in the 800 meters (Table 1) and in the 5000 meters (Table 2). The number of repetitions of the runs and the weekly amount of running training load were selected depending on the preparedness of the runners. The weekly volume of running training load ranged from 100 to 140 km. To manage the training process, the "Adidas Coach" and "Garmin Forerunner 60 Men Black HRM + Foot Pod" systems were used to record statistics during the training period. These systems were used to plan a training program for runners, taking into account the heart rate and the type of energy supply for muscle activity.

Table 1: Approximate training tempo loads for runners at 800 m (min, sec).

Current result (min, sec)	Tempo for repetitions (sec)		Interval tempo (sec)	
800 m	200 m	400 m	200 m	400 m
1.50	0.26	0.54	0.27	0.58
1.55	0.27	0.55	0.28	0.59
2.00	0.28	0.57	0.29	0.61
2.05	0.29	0.60	0.30	0.64
2.10	0.30	0.62	0.32	0.68
2.15	0.31	0.64	0.33	0.71
2.20	0.32	0.67	0.34	0.74
2.25	0.33	0.71	0.35	0.78
2.30	0.34	0.75	0.36	0.82

Table 2: Approximate training tempo loads for runners at 5000 m (min, sec).

Current result (min, sec)	Tempo for repetitions (min, sec)			Interval tempo (min, sec)		
5000 m	200 m	400 m	800 m	400 m	1000 m	1200 m
13.50	0.30	0.61	2.02	0.67	2.48	3.21
14.10	0.31	0.62	2.05	0.68	2.50	3.24
14.30	0.32	0.64	2.08	0.70	2.55	3.30
14.50	0.32	0.65	2.11	0.71	2.58	3.33
15.10	0.33	0.66	2.14	0.72	3.00	3.36
15.30	0.34	0.68	2.16	0.74	3.05	3.42
15.50	0.35	0.70	2.20	0.77	3.13	3.51
16.10	0.36	0.72	2.24	0.78	3.15	3.54
16.30	0.37	0.74	2.28	0.80	3.20	4.00
16.50	0.37	0.75	2.30	0.81	3.22	4.03
17.10	0.38	0.76	2.32	0.82	3.25	4.06
17.30	0.39	0.78	2.36	0.84	3.30	4.12
17.50	0.39	0.79	2.38	0.85	3.33	4.15

Note: weekly volume 100-140 km

3 RESULTS AND DISCUSSION

The study shows that runners with different type of energy provision for the muscular activity need different training methods (Kuznetsova et al., 2015). The prevalence of different regulatory mechanisms for recovery after the stress was revealed depending on the types of energy provision for the muscular activity.

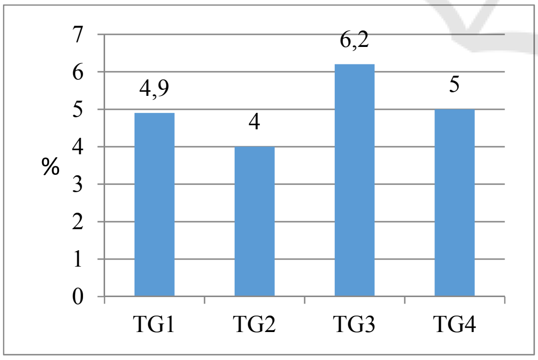

Figure 1: Changes in result increase during the race for a distance of 800 meters (%). TG1 - aerobic type, TG2 - mixed type, TG3 - anaerobic type, TG4 - without considering their bioenergetic type.

In the race of a distance of 800 meters (Figure 1), the sportsmen of the "aerobic type" group showed the time reduction by 10.7 s, i.e. the increase of results was 4.86% (P <0.05), the sportsmen of the "mixed type" group showed time reduction by 8.8 s, i.e. the increase was 4.06% (P <0.05), the sportsmen of the "anaerobic type" group showed time reduction by 13.2 s, i.e. the increase was 6.24% (P <0.05).The mean time reduction in this test in sportsmen from the group without considering their bioenergetic type was 10.9 s what corresponded to the increase by 5.05% (P <0.01).

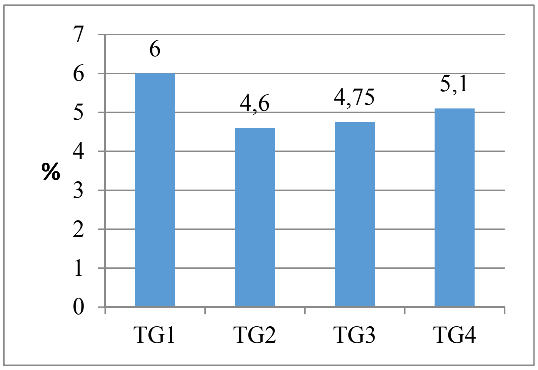

Figure 2: Changes in result increase during the race for a distance of 5000 meters (%). TG1 - aerobic type, TG2 - mixed type, TG3 - anaerobic type, TG4 - without considering their bioenergetic type.

In the race of a distance of 5000 meters (Figure 2), the sportsmen of the "aerobic type" group showed the time reduction by 43.3 s, i.e. the increase of results was 6.07% (P <0.05), the sportsmen of the "mixed type" group showed time reduction by 32.8 s, i.e. the increase was 4.58% (P <0.05), the sportsmen of the "anaerobic type" group showed time reduction by 33.6 s, i.e. the increase was 4.75%. The mean time reduction in this test in sportsmen from the test group without considering their bioenergetic type was 36.57 s what corresponded to the increase by 5.13% (P <0.01).

Table 3 and Figure 3 show the assessment results of the functional reserve possibilities of sportsmen's organism before and after the experiment. The increase of ANMC value in the sportsmen of "aerobic type" was 3.54 conditional units (7.8%), the sportsmen of the "mixed type" group showed the increase by 5.83 conditional units or by 8.2% (P <0.05), the sportsmen of the "anaerobic type" group had the increase by 11.45 conditional units or by 9.2% (P <0.05). The mean increase of ANMC value in the sportsmen of the test group without consideration of their bioenergetic type was 6.4 conditional units (8.4%).

Table 3: Assessment results of the parameters characterizing the functional and reserve possibilities of sportsmen's organism in the experiment (conditional units).

	Test group (TG)			
	Aerobic type (TG1)	Mixed type (TG2)	Anaerobic type (TG3)	Without consideration of bioenergetic type (TG4)
Anaerobic metabolic capacity (ANMC), conditional units				
before	45.42±13.68	71.07±6.9	124.65±8.96	76.12±34.63
after	48.96±11.23	76.9±4.89	136.1±11.32	82.52±9.15
t	0.62	2.19*	2.44*	0.84
Aerobic metabolic capacity (AMC), conditional units				
before	240.1±21.36	229.5±17.63	204.41±21.69	226.65±29.49
after	260±18.13	249.5±13.68	218.92±18.67	244.85±16.83
t	2.22*	2.89*	1.38	2.50*
Total metabolic capacity (TMC), conditional units				
before	285.5±12.3	300.6±21.42	329.06±22.18	302.78±34.07
after	308.52±14.38	326.4±19.22	355±23.01	327.65±18.87
t	4.10**	2.98**	2.34*	2.98**
Creatine phosphate metabolic power (CPMP), conditional units				
before	31.54±2.35	29.55±1.95	38.75±2.26	32.64±5.93
after	34.79±2.167	32.03±2.19	41.93±2.12	35.57±2.16
t	3.23**	2.96**	2.86*	2.17*
Glycolytic metabolic power (GLMP), conditional units				
before	31.60±2.65	29.52±2.47	33.5±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**
Aerobic metabolic power (AMP), conditional units				
before	57.48±4.43	52.12±5.80	46.39±4.03	51.62±10.60
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

Note: **-P <0.01; *-P <0.05

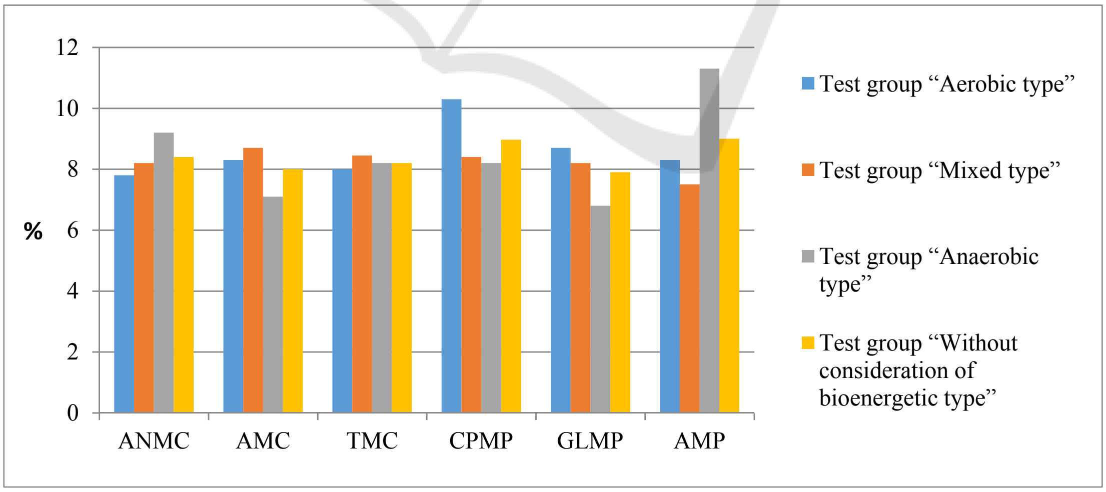

Figure 3: Increase dynamics of the parameters characterizing the functional and reserve possibilities of sportsmen' organism in different groups (%). ANMC - anaerobic metabolic capacity, AMC - aerobic metabolic capacity, TMC - total metabolic capacity, CPMP - creatine phosphate metabolic power, GLMP - glycolytic metabolic power, AMP - aerobic metabolic power.

The increase of AMC value in the sportsmen of "aerobic type" was 19.9 conditional units or 8.3% (P <0.05), the sportsmen of the "mixed type" group showed the increase by 20 conditional units or by 8.7% (P <0.05), the sportsmen of the "anaerobic type" group had the increase by 14.51 conditional units or by 7.1%. The mean increase of AMC value in the sportsmen of the test group without consideration of their bioenergetic type was 18.2 conditional units or 8.03% ($P < 0.05$).

The assessment of TMC value changes in the sportsmen of “aerobic type” group showed the increase by 23.02 conditional units or 8.05% ($P < 0.01$), the sportsmen of the “mixed type” group showed the increase by 25.8 conditional units or by 8.45% ($P < 0.01$), the sportsmen of the “anaerobic type” group had the increase by 25.94 conditional units or by 8.2% ($P < 0.05$). The mean increase of TMC value in the sportsmen of the test group without consideration of their bioenergetic type was 24.87 conditional units or 8.22% ($P < 0.01$).

The increase of CPMP value in the sportsmen of “aerobic type” was 3.25 conditional units or 10.3% ($P < 0.01$), the sportsmen of the “mixed type” group showed the increase by 2.48 conditional units or by 8.4% ($P < 0.01$), the sportsmen of the “anaerobic type” group had the increase by 3.18 conditional units or by 8.2% ($P < 0.05$). The mean increase of CPMP value in the sportsmen of the test group without consideration of their bioenergetic type was 2.93 conditional units or 8.97% ($P < 0.05$).

The assessment of GLMP value changes basing on the test results in the sportsmen of “aerobic type” group showed the increase by 2.75 conditional units or 8.7% ($P < 0.05$), the sportsmen of the “mixed type” group showed the increase by 2.42 conditional units or by 8.2% ($P < 0.05$), the sportsmen of the “anaerobic type” group had the increase by 2.27 conditional units or by 6.8% ($P < 0.05$). The mean increase of GLMP value in the sportsmen of the test group without consideration of their bioenergetic type was 2.47 conditional units or 7.9% ($P < 0.01$).

The increase of AMP value in the sportsmen of “aerobic type” was 4.77 conditional units or 8.3% ($P < 0.05$), the sportsmen of the “mixed type” group showed the increase by 3.91 conditional units or by 7.5%, the sportsmen of the “anaerobic type” group had the increase by 5.24 conditional units or by 11.3% ($P < 0.05$). The mean increase of AMP value in the sportsmen of the test group without consideration of their bioenergetic type was 4.66 conditional units or 9.03%.

Thus, the use of the experimental training method in the sportsmen resulted in revealing the confident increase of the parameter values characterizing the functional and reserve possibilities of the organism, namely, AMC, TMC, CPMP and GLMP. It should be mentioned also that although there was no confident increase of ANMC and AMP values in the sportsmen group without consideration of the organism bioenergetic type, we observed confident increase of these parameters in the groups of “mixed” and “anaerobic” types. The obtained data allows to make a conclusion of the efficiency of the experimental training method for long-distance runners taking into account the peculiarities of energy provision for their muscular activity.

4 CONCLUSIONS

1) The different organism’s response to the training stress was observed during preparation for the competitions in the sportsmen with different type of energy provision for muscular activity. The sportsmen of the test groups recovered after the training stress more rapidly.
2) Studies have shown that athletes with "anaerobic" and "mixed" type of muscular activity quickly adapt to speed-strength work, and runners "aerobic" type to the long work on endurance. Further research in this direction can provide a more accurate prediction of the efficiency of the training process when you use an individual approach to the planning of the running activity of varying intensity.
3) This is evidence of the fact that consideration of bioenergetic types of energy provision for muscular activity in long-distance runners may underlie the determination of training means and methods for sportsmen.

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