

Special training of highway cyclists considering energy metabolism types

 **Vladislav Bakayev** . *Institute of Physical Education, Sport and Tourism. Peter the Great St. Petersburg Polytechnic University. Russian Federation.*
Alexander Bolotin. *Institute of Physical Education, Sport and Tourism. Peter the Great St. Petersburg Polytechnic University. Russian Federation.*

ABSTRACT

The competitive activity of racers on the highway makes high demands on the level of their physical fitness, since the competition can be held in the form of a multi-day race. The training of road racers is based on the development of physical qualities, among which the most important for them are different types of endurance. The development of these qualities is possible only with a purposeful impact on their physiological systems and, in particular, on the mechanisms of energy supply of muscle activity. Studies have shown that the success in preparing athletes for competitions largely depends on taking into account the individual characteristics of the mechanism of energy supply of muscle activity. For the training of racers on the highway, the solution of special tasks for the development of tempo and speed endurance is characteristic. Pace endurance is necessary for athletes to maintain high speed during the race on the highway, and speed endurance is necessary for them to build up speed at the finish line of the race. And the longer this finishing spurt is, the higher the athlete's final result will be. Studies have shown that special tasks during such training should be solved taking into account the type of energy metabolism in road racers. The article presents the results of studies on the development of the content of a model of training for road racers, taking into account the type of their energy metabolism.

Keywords: Performance analysis of sport, Physical conditioning, Road racers, Training model, Energy metabolism, Training process, Competition.

Cite this article as:

Bakayev, V., & Bolotin, A. (2022). Special training of highway cyclists considering energy metabolism types. *Scientific Journal of Sport and Performance*, 1(4), 259-265. <https://doi.org/10.55860/GYDT7530>

 **Corresponding author.** *Institute of Physical Education, Sport and Tourism. Peter the Great St. Petersburg Polytechnic University. Russian Federation.*

E-mail: vlad.bakaev@gmail.com

Submitted for publication May 31, 2022.

Accepted for publication July 12, 2022.

Published November 15, 2022.

[Scientific Journal of Sport and Performance](#). ISSN 2794-0586.

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doi: <https://doi.org/10.55860/GYDT7530>

INTRODUCTION

Competition activity of highway cyclists is highly demanding in terms of the level of their physical fitness (Kumstát et al., 2019; Novak & Dascombe, 2014; Maciejczyk et al., 2015). Specialized preparation for the multi-day race is based on development of special endurance for covering the race distance at unstable ambient temperatures (Spierer et al., 2004; Dushanin, 1986; Costa et al., 2012). The effective development of this physical quality is achieved through applying special loads to the athlete's organism considering the type of energy metabolism (Bakayev & Bolotin, 2020; Ganapolsky et al., 2019; Bolotin & Bakayev, 2017).

Quite many studies on this subject only indirectly mention special features of energy supply to the muscular activity of highway cyclists (Bakayev et al., 2018; Spencer et al., 2005; Porter et al., 2019; Prieur & Mucci, 2013; Sousa et al., 2013). This contradiction limits the possibilities for differentiated use of means and methods for the development of special endurance in highway cyclists. There is only limited use of methods for the development of special endurance in highway cyclists, differentiated by energy metabolism typology in athletes.

The objective of the study was to identify the effectiveness of methods for specialized training of highway cyclists, considering energy metabolism types.

MATERIAL AND METHODS

Twenty eight highway cyclists preparing to a multi-day race took part in the study. The subjects' age ranged from 17 to 20. To test the developed training options, 4 groups of athletes were formed depending on the type of energy metabolism: aerobic type, anaerobic type, mixed type, and regardless of the type of energy supply to muscle activity. The duration of the experiment was 6 weeks of a special preliminary training period. Means and methods of specialized training for each athlete group were developed taking into account the peculiarities of the mechanism of energy supply to muscle activity. To substantiate a training model of highway cyclists, we performed a comparative analysis of functional organism capabilities of athletes from various groups differentiated by the type of energy metabolism.

The study used D&K-Test, which is a method for rapid diagnosis of the functional state and reserve capabilities of athlete organism developed by S.A. Dushanin (1986). The program algorithms helped identify athletes belonging to one of energy metabolism types based on the analysis of the nature and height of the R- and S-wave of the electrocardiogram recorded in 3 standards, 3 augmented and 6 chest leads. The obtained data was used to calculate the following parameters:

1. Capacity of anaerobic energy supply (CANSE), which characterizes the ability to fulfil the load in the 3rd, 4th and 5th intensity zones.
2. Capacity of aerobic energy supply source (CASE), which characterizes the ability to fulfil the load in the 1st and 2nd intensity zones.
3. Total metabolic capacity (TMC) characterizing the total organism performance.
4. Power of creatine phosphate energy supply (PCPES), which characterizes the speed qualities of cyclists.
5. Power of glycolytic energy supply (GPS) characterizing the high-speed endurance of cyclists.
6. Power of aerobic energy supply (PAE) which characterizes the ability to show general endurance, as well as to recover after anaerobic work.

The effectiveness of training process management was achieved by differentiating the special training methods of cyclists depending on the peculiarities of energy supply to their muscular activity. The pace endurance of cyclists, mainly of aerobic energy metabolism type was developed using the method of continuous long-term exercise, and speed endurance – using repeated training method. In athletes with anaerobic energy metabolism type, pace endurance was developed by method of interval exercise, and speed endurance – by method of submaximal loads with fixed number of repetitions.

Cyclists with a mixed energy metabolism type developed pace endurance through a variable training method, and speed endurance – through combining the repeated training method with the method of sublimit efforts with a fixed number of repetitions of distance sections. For the control cyclist group, standard means and methods for the development of pace and speed endurance were used. The load for cyclists was selected on the basis of the current result in the individual 10 km (Table 1) and 25 km (Table 2) race. The number of repetitions and the weekly volume of training load were selected depending on the level of athletes' functional state. To manage specialized training, the training process control system was used. It included power testing on a special bench, lactate profile determination, skin fold test, and blood profile analysis. The system was used to plan a training program for cyclists taking into account heart rate and energy metabolism type.

Table 1. Basic parameters of the load of cyclists at the special preliminary stage of preparation for the competition (6 weeks).

Load parameters	Subject groups by the type of energy metabolism			
	Aerobic type	Anaerobic type	Mixed type	Regardless of metabolism type
Daily distance, km.	90-120	70-100	80-110	80-110
Weekly distance, km.	560-840	490-700	560-770	560-770
Number of training sessions per week	12	12	12	12
Basic training task.	8 x 5 km; 2 x 25 km	5 x 4 km; 5 x 10 km	2 x 10 km 3 x 20 km	3 x 10 km; 2 x 25 km
Training method.	Uniform, repeated	Interval, submaximal loads	Variable, sublimit loads	Uniform, repeated, interval

RESULTS AND DISCUSSION

The study identified differences in the dynamics of specialized test parameters depending on the energy metabolism types of cyclists (Tables 2, 3).

Table 2. Dynamics of results in the 10 km race for cyclists of various energy metabolism types (min).

Test period at the special preliminary stage of preparation	Subject groups by energy metabolism type			
	Aerobic type	Anaerobic type	Mixed type	Regardless of metabolism type
Stage beginning	11.8 ± 1.4	11.4 ± 1.8	11.7 ± 1.7	11.8 ± 1.6
Stage end	10.8 ± 3.5	10.3 ± 1.3	10.4 ± 1.3	11.1 ± 1.8

In the individual 10 km race, athletes of the aerobic energy metabolism type group showed an improvement in time by 60 s, the increase in results was 9.8% ($p < .05$). Cyclists of the mixed energy metabolism type group improved the result by 78 s, the increase was 10.4% ($p < .05$). Cyclists of the anaerobic energy metabolism type group showed an improvement of the time parameter by 66 s, the increase was 10.1% ($p < .05$).

.05). The average improvement in time in this test in cyclists of the group regardless of the type of energy metabolism was 42 s, which corresponds to an increase by 6.9% ($p < .01$).

Table 3. Dynamics of results in the 25 km race for cyclists of various energy metabolism types (min).

Test period at the special preliminary stage of preparation	Subject groups by energy metabolism type			
	Aerobic type	Anaerobic type	Mixed type	Regardless of metabolism type
Stage beginning	29.4 ± 2.4	29.6 ± 2.8	29.3 ± 2.8	29.7 ± 2.2
Stage end	28.4 ± 1.6	28.9 ± 2.2	28.8 ± 14.5	29.3 ± 2.4

Table 4. Dynamics of parameters of functional and reserve capabilities of the cyclists' organism as a result of the special preliminary stage of preparation.

Test period	Subject groups by energy metabolism type			
	Aerobic type	Mixed type	Anaerobic type	Regardless of metabolism type
<i>Anaerobic metabolic capacity (CANSE), conventional units</i>				
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
<i>Aerobic metabolic capacity (CASE), conventional units.</i>				
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*
<i>Total metabolic capacity (TMC), conventional units.</i>				
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**
<i>Power of creatine phosphate energy supply (PCPES), conventional units.</i>				
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*
<i>Power of glycolytic energy supply (GPS), conventional units.</i>				
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**
<i>Power of aerobic energy supply (PAE), conventional units.</i>				
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: **- $p < .01$; *- $p < .05$.

In the individual 25 km race, athletes of the aerobic energy metabolism type group showed an improvement in time by 60 s, the increase in results amounted to 6.9% ($p < .05$). Cyclists of the mixed energy metabolism type group improved the result by 42 s, the increase was 4.7% ($p < .05$). Cyclists of the anaerobic energy metabolism type group showed an improvement of average result by 30 s, the increase was 3.4%. The average improvement in time in this test in cyclists of the group regardless of energy metabolism type was 24 s, which corresponds to an increase of 3.1% ($p < .01$). Table 4 presents the assessment results of

functional and reserve capabilities of the athletes' organism before and after the special preliminary stage of preparation.

CANSE increase in aerobic type cyclists was 3.54 c.u. (7.8%), athletes of the mixed energy metabolism type group showed an increase by 5.83 c.u. or 8.2% ($p < .05$), athletes of the anaerobic energy metabolism type group showed an increase by 11.45 c.u. (9.2%) ($p < .05$). The average increase in CANSE in cyclists of the group regardless of energy metabolism type was 6.4 c.u. (8.4 %). The increase in CASE in athletes of the aerobic energy metabolism type group was 19.9 c.u. or 8.3% ($p < .05$), athletes of the mixed energy metabolism type group showed an increase by 20 c.u. or 8.7% ($p < .05$), athletes of the anaerobic energy metabolism type group showed an increase by 14.51 c.u. or 7.1%. The average increase in CASE in athletes regardless of the type of energy metabolism was 18.2 c.u. or 8.03% ($p < .05$).

Assessment of TMC dynamics in athletes of aerobic energy metabolism type group showed an increase by 23.02 c.u. or 8.0 5% ($p < .01$), athletes of the mixed energy metabolism type group showed an increase by 25.8 c.u. or 8.45% ($p < .01$), athletes of the anaerobic energy metabolism type group showed an increase by 25.94 c.u. or 8.2% ($p < .05$). The average increase in TMC in athletes of the group regardless of energy metabolism type was 24.87 c.u. or 8.22% ($p < .01$).

The increase in PCPES in athletes of the aerobic energy metabolism type group showed an increase by 3.25 c.u. or 10.3% ($p < .01$), athletes of the mixed energy metabolism type group showed an increase by 2.48 c.u. or 8.4% ($p < .01$), athletes of the anaerobic energy metabolism type group showed an increase by 3.18 c.u. or 8.2% ($p < .05$). The average PCPES increase in group of athletes regardless of energy metabolism type was 2.93 c.u. or 8.9% ($p < .05$).

The assessment of GPS dynamics according to the results of the experiment showed an increase by 2.75 c.u. in athletes of the aerobic energy metabolism type group or 8.7% ($p < .05$), athletes of the mixed energy metabolism type group showed an increase by 2.42 c.u. or 8.2% ($p < .05$), athletes of the anaerobic energy metabolism type group showed an increase by 2.27 c.u. or 6.8% ($p < .05$). The average increase in GPS in athletes of the group regardless of energy metabolism type was 2.47 c.u. or 7.9% ($p < .01$).

The increase in PAE in athletes of the aerobic energy metabolism type group was 4.77 c.u. or 8.3% ($p < .05$), athletes of the mixed energy metabolism type group showed an increase by 3.91 c.u. or 7.5%, athletes of the anaerobic energy metabolism type group showed an increase by 5.24 c.u. or 11.3% ($p < .05$). The average increase in PAE in cyclists of the group regardless of energy metabolism type was 4.66 c.u. or 9.03%.

Thus, as a result of the application of a differentiated training method, highway cyclists showed a significant increase in the functional and reserve capabilities of their organism. It is also noteworthy that in the absence of a significant increase in CANSE and PAE in the group of athletes regardless of energy metabolism type, there was a significant increase in these parameter values in mixed and anaerobic energy metabolism type groups. The obtained data suggests effectiveness of a differentiated method for training highway cyclists, considering energy metabolism types.

CONCLUSION

As a result of the implementation of the special preliminary stage of preparation of cyclists for the competitions with different energy metabolism types, a different reaction of the organism to the training load was recorded.

Athletes with anaerobic and mixed energy metabolism type adapt faster to speed and power work, and cyclists with aerobic energy metabolism type adapt to long-term endurance work. This indicates that the energy metabolism typology of cyclists can be the basis for determining the means and methods of training athletes in preparation for a multi-day race.

AUTHOR CONTRIBUTIONS

Conceptualization, A.B. and V.B.; methodology, A.B.; software, V.B; data analysis, A.B., V.B.; investigation, V.B. and A.B.; data curation, A.B; writing-original draft preparation, V.B.; writing-review and editing, V.B. All authors have read and agreed to the published version of the manuscript.

SUPPORTING AGENCIES

No funding agencies were reported by the authors.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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