

IMPROVING PERFORMANCE IN SPORTS USING A COMPLEX OF MOTIONS CONTROL MEANS

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At present there is a great number of data on biomechanical foundation of rational technique of bicycle pedalling (3,8,13,14,15,16).

However, at the stage of direct preparation for competitions high effectiveness of sport movements is especially important and the formation of tempo-speed parameters of movements is of great value but the technical preparation has not yet got a proper foundation (1, 3, 9).

Besides, there has not been worked out a united method which would take into account the development of the functional systems of the organism and the improvement of the technique in the whole system of training (4,2). The questions of formulating motion tasks of special purpose which are expressed in achieving particular values of technique indices and the level of functioning of the organism systems have not been sufficiently disclosed (10, 12).

METHODS OF RESEARCH

The basis for the given research is Doctor Ratov's (1976) conception of "artificial controlling environment". A cycling training machine of adaptive type has been worked out in accordance with this conception (7). The operating principle of the training machine has been described earlier (5, 10, 11, 12). The peculiar feature of the training machine is the presence of simulating means of competitive activity drawn at its most to the real conditions, and its adaptivity, that is, its ability to work out algorithms of improving sports technical performance in the process of training proper.

Under the conditions of the given stand a complete cycle of training was organized in the real time: analysis of sports technique-simulation of optimal characteristics of movements for gaining the result intended - working out the controlling influence - analysis of the influence result and working out a new decision (4,6).

To analyse the technique of bicycle pedalling and the level of functioning the organism systems the following research methods were used in the work: strain dynamometry, vectorial dynamography, biomechanical cinematography, electromyography, gasanalysis, indirect calorimetry and methods of motions control.

THE FORMATION OF MOTION TASKS FOR SPECIAL PURPOSE ON THE BASIS OF SIMULATION EXPERIMENT

Simulating the conditions of the record competitive activity by high-class sportsgirls in 1000 metres heat under the training machine conditions showed that while using the artificial activation of muscles the sportsgirls could cover the distance of 846 meters at the record speed (15 m/sec) which is 177 meters more than that under ordinary conditions. It enabled the sportsgirls to near the world record.

The achievement of these results was due to the reduction of pulse expense per meter by 27.8% at the same value of oxygen demand. The mechanical power in this case did not change, but the metabolic one reduced by 25.3%. The mechanical effectiveness increased from 14.2% to 18.7%. The results of the experiment are presented in Table 1.

The results of the research undertaken enabled us to get simulating characteristics of the intended conditions for competitive activity for each sportsman individually which are expressed by speed value and the time of its retaining, by useful power developed on the shaft of the bicycle carriage, by the necessary mechanical power values of the body segments and also by the metabolic power level sportsmen should develop at the predetermined level of motion effectivity (Fig. 1.).

In the course of the experiment a system of motion tasks of special purpose has been worked out which enables coaches to realize in succession separate elements of simulating characteristics with the help of the complex of the motions control means (Fig. 1.)

Biomechanical and bioenergetic indices of sportsgirls' pedalling at the record speed of 15 m/sec using artificial activation of muscles (n=6)

Experiment conditions	Working time	Path covered	Oxygen demand	Oxygen expense per 1 path metre	Metabolic power	Mechanical power of		Mechanical effectiveness	Kinematic moment in knee-joint
						seg-ments	centre of mass		
	sec	m	l	ml/m	watt	watt	watt	%	Nm
With stimulation	53.4±4.68	846.3±196.1	10.4±1.6	12.2±1.9	4077±627	148±2	16.0±7	18.7	12.4±1.25
Without stimulation	41.3±5.36	669.3±80.6	10.5±1.6	15.6±2.3	5112±778	125±10	12.2±2	14.2	10.4±0.46
Mean difference	10.1±0.7	177±12	0.1±0.05	3.4±0.2	1035±75	23±7.2	3.8±2	4.5	2.0±0.1
Trustworthiness of differences	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	<0.05		P<0.05

Note: t-Student criterion and trustworthiness of shifts were estimated by the mean difference of conjugate variants.

SIMULATION CHARACTERISTICS

MOTION TASKS FOR SPECIAL PURPOSE

Speed, 15 m/sec. Time of retaining 1.05,0 min. Pedalling frequency 2.4 hertz. Path covered at one revolution of the connecting-rod 6.94 m.

Retain the speed of 15 m/sec during 1.05,0 min at frequency of 2.4 hertz. Improve the seat to minimize flow-around. Obtain rectilinear motion.

Useful power at the shaft, 600 watt.

Improve distribution of efforts in pedalling cycle. Reduce non-uniformity of twisting moment in the cycle. Remove unnecessary motions, reduce oscillations of the centre of mass of the system "bicycle - sportsman ". Improve the seat with regard for anatomical peculiarities.

Mechanical power of segment, 150 watt.

Improve distribution of the levels of muscular activity. Reduce the level of summary muscular activity.

Metabolic power 4 kilowatt
at the effectivity of
266 joule/m.

Increase functional abilities
of the organism:
MOC = 51 - 57 ml/kg
AST = 12.5 m/sec.
Introduce supplementary energy
power additions into the process
of performing the motions.

Figure 1: Simulation characteristics and motion tasks for special purpose

STUDY AND FOUNDATION OF THE POSSIBILITIES TO REALIZE THE WORKED-OUT METHODS

In the course of the experiment a consistent mastering of the motions control methods was carried out, each motion task being mastered at two sessions.

Task One: improve the seat and remove unnecessary motions at pedalling. In this case the position of the sportsgirl on the bicycle was indicated by the video control instrument on the basis of video camera and video monitor. Effectivity of the given task was evaluated by the pulse expense of the work. While improving the seat the pulse expense at the speed of 8 m/sec during 5 minutes trustworthily reduced.

Task Two: reduce maximum amplitudes of oscillation of the centre of mass of the system "bicycle-sportsman". For this purpose the monitor screen gave information of the values of efforts exerted on the tensoplatfrom with the bicycle training machine mounted on it. The value of the amplitude reduction and the pulse expense of the standard work were estimated as effectivity criterion.

Task Three: reduction of non-uniformity of torque moment in the pedalling cycle. For this purpose the training machine was equipped with a torque sensor. Signals from the sensor were processed and put onto the induction monitor. Sportsgirls must fulfill pedalling so that variation of the torque moment value does not exceed 20 %. The aim was to achieve the fulfillment of the task at the expense of self-regulation of muscular tensions.

Task Four: redistribution of the level of muscular activity and reduction of summary electrical activity of muscles. In this case two methods of motions control were used. The first method was the method of muscular tension autocontrol, the second one was artificial activation of muscles which enables the sportsman to re-distribute the levels of muscular activity and concentrate the efforts at the most important motion stages.

With the first method urgent information of the level of integral electrical activity of muscles was given to the sportsgirls and they had to reduce it at the expense of spontaneous relaxation, self-regulation with the use of psychoregulation methods, retaining the given speed of pedalling. Effectivity of such kind of control was estimated by the pulse expense of the work.

It has been found out that the usage of the given method leads to the trustworthy 5 - 7 % average reduction of the summary electrical activity of muscles in the group of 18 sportsgirls under the experiment which, in its turn, reduces the pulse expense of the work by 3 - 4 %.

With the second method electromyogram was recorded before and after the influence. In this case a trust-worthy change in the levels of electrical activity was revealed which expressed itself in the increase of the summary electrical activity in the phase of pressing the pedal by 15 - 20 %, in shortening the time of activity, and in the reduction of the summary activity in the cycle of pedalling.

It was also revealed that the stimulation of the muscles on the front surface of the hip increases the mechanical work of segments and vertical oscillations, but the stimulation of the muscles on the back surface of the hip reduces them and promotes the formation of the more "circular" pedalling, and that in order to get maximum effect the regimes of pedalling must be selected individually according to the errors.

For the total estimation of the effectivity of the given complex of motion tasks for special purpose in general testing was done before and after the experiment which included the fulfillment of the standard work during five minutes at the speed of 8 m/sec. The results of the testing are presented in Table 2.

The table shows that during the stage of the experiment the pulse expense per metre of the path reduced by 15.3%, and the level of the electrical activity of muscles at the speed of 8m/s reduced by 9.5%. Maximum oxygen consumption did not change during the experiment and the level of the threshold of anaerobic exchange slightly increased by 4.3%. All this shows the increase of motion effectivity.

EXPERIMENTAL CHECK OF EFFECTIVITY OF THE TECHNICAL PERFORMANCE CONTROL AT THE STAGES OF DIRECT PREPARATION FOR COMPETITIONS

Experimental check of effectivity of the worked out methods was carried out in the course of the general experiment with 6 high-class sportsgirls participating in it. The experiment lasted one year. 10 sessions on the training machine with the experimental methods mentioned above were conducted before each competition cycle.

During this stage once a week the sportsgirls had training sessions on the training machine in simulating the intended regime of competitive activity. Training on the stand was combined with training on the track and highway.

TABLE 2
Change in the Indices of Testing in the Course of the Experiment (n = 18)

Serial number	Indices	At the beginning of the experiment	At the end of the experiment	Trustworthiness of differences
1.	Pulse expense per metre, beat/metre V = 8 m/sec	0.26±0.05	0.22±0.06	P < 0.05
2.	Maximum oxygen consumption (MOC) ml/kg/min	49.3±4.6	51.4±5.2	P < 0.05
3.	Threshold of anaerobic exchange (AET), ml/sec	9.3±0.2	9.7±0.3	P < 0.05
4.	Summary electrical activity of muscles mv/sec V=8m/sec	4.2±0.3	3.8±0.4	P < 0.05

The main part of the training session on the stand constituted the formation of the rhythmic structure of pedalling with the record speed. For this purpose automatic feed back was used in the training machine which made it possible to reduce the resistance value so that the sportsgirls participating in the experiment could retain the given speed during the time needed. In the course of mastering the rhythm-speed structure the task of filling this structure with force and energetical content was being solved. To reach that aim the resistance value was raised from session to session nearing the natural one.

Further work on simulating the motion regimes reached on the stand was conducted on the track and highway using the methods of artificial activation of muscles. Testing took place before and after the experiment. The results of the testing are presented in Table 3.

It shows that the level of the pulse expense of the work reduced by 15 - 20% on the average, the summary electrical activity during the pedalling cycle reduced by 29.5%.

During the stage of the experiment sports results in 500 m time trial improved by 1.83 sec, in 200 m flying - start heat - by 0.21 sec. Operation time until failure on the training machine at the speed of 15 m/sec increased from 43.3 sec to 54.2 sec. The participants of the experiment showed high results in the main competitions of the year.

TABLE 3

Change of Motion Effectivity Indices at Fulfillment Step Load on the Training Machine during the General Experiment (n = 6)

Serial number	Indices	: At the beginning of the experiment	: At the end of the experiment	: Trustworthiness of differences
1.	The sum of cardiac cycles while fulfilling the work : 1200 j, $v=11$, 1m/sec, : Power 118 w, : Time 2 min	306±16	253±18	P < 0,05
2.	Pulse expense per metre of the path, : beat/m	0.23±0.01	0.19±0.01	P < 0.05
3.	Summary electrical activity of muscles : at the power of 118 W, : mW/sec	4.63±0.2	3.26±0.3	P < 0.05

CONCLUSIONS

1. The results of the experiment proved that using the complex of motions control means makes it possible to realize the motion potential of cyclists and improve sports results to a greater extent.

2. Simulation characteristics of realizing the intended regimens of competitive activity have been got which are expressed by the values of speed and the time of its retaining, by useful power developed on the shaft of the bicycle carriage, by necessary values of mechanical power of the body segments, and also by the level of the metabolic power which a sportsgirl must develop at the given level of motion effectivity.

3. A system of motion tasks for special purpose has been worked out which makes it possible to realize step by step the separate elements of simulating characteristics in order to fulfill the main motion task, that is to retain the record speed during the time needed.

4. It has been checked experimentally that it is possible to realize the worked out motion tasks with the help of the complex of motions control means. It has been shown that already after a short session period it is possible to achieve trustworthy changes in the motion characteristics and to increase their effectivity while using separate tasks worked out for special purpose.

5. There has been defined the approach to the organization of the training process at which under the training machine conditions not only the rational regimens of the pedalling technique and the sportsman's mastering of the pedalling tempo with record speed are to be formed but also the adequate training loads are to be selected.