Development of strength and power in qualified martial artists using plyometric training

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Abstract

Objective of the study was to analyze the effect of deep jumps on the manifestation of power and the generation of strength in qualified martial artists involved in judo and sambo.

Methods and structure of the study. The experiment was attended by 10 athletes specializing in judo and sambo wrestling, with sports qualifications "Candidate for Master of Sports" and "Master of Sports of Russia". In the experimental program, the athletes did deep jumps from a dosed height of 50 cm, followed by long jumps. Each jump was performed with a concentration on achieving maximum effort. The work was carried out serially, five jumps in a series with a rest between series of 2 minutes. The subjects performed this load three times a week. The tests were performed in the laboratory on a “Monark” bicycle ergometer (Sweden) and a dynamographic simulator.

Results and conclusions. As a result of the training program, there was a significant improvement in such indicators as maximum power (by 7.1%), peak power (by 11.1%), time to reach maximum power (by 22.4%), time to reach 97% of maximum power (by 27.8%). As a result of the work done, the values of the maximum force and the time to achieve it have improved. The plyometric mode of operation can be recommended for inclusion in the training process of athletes in order to develop the maximum power of the alactic anaerobic process of energy supply and improve the speed of its deployment.

Keywords: *deep jumps, muscle strength and power, isometric muscle contractions, bicycle ergometry, Wingate test.*

Introduction. One of the modes of muscle work when performing speed-strength exercises is plyometric. Plyometric movements are based on muscle stretching under the influence of significant weights, followed by a rapid transition to its contraction [1, 2]. Elastic energy during eccentric contraction is stored in elastic components and transferred during concentric contraction as the contractile and elastic components of muscle fibers contract [3, 4]. So far, there is clearly not enough methodological materials that reflect the peculiarities of dosing the load and the specificity of the effects of combatants using individual plyometric exercises to develop strength and speed-strength abilities.

Objective of the study was to analyze the effect of deep jumps on the manifestation of power and the generation of strength in qualified martial artists involved in judo and sambo.

Methods and structure of the study. The experiment involved 10 athletes specializing in judo and sambo, qualifications Candidate for Master of Sports and Master of Sports, aged 19-20 years, height 175-187 cm, body weight 67-87 kg.

In the experimental program, the athletes performed deep jumps from a dosed height of 50 cm, followed by long jumps. Each jump was performed with a concentration on achieving maximum effort. The work was carried out serially, five jumps in a series with a rest between series of 2 minutes. The subjects performed this load three times a week. Moreover, in the first microcycle, three series were performed, in the second - four, in the third and fourth - five series each. In total, 12 training sessions were held during the month, in which 255 jumps were performed in the specified mode.

To evaluate the effectiveness of the method used, the athletes were asked to perform work on a bicycle

ergometer with a maximum duration of 30 s, with the aim of achieving and maintaining the maximum cadence (Wingate test). In this case, the power curve was recorded. The test was performed on a "Monark" bicycle ergometer (Sweden). Digital data were entered into a computer using an ADC and processed in the Excel program. An example of a power curve recording is shown in Figure 1.

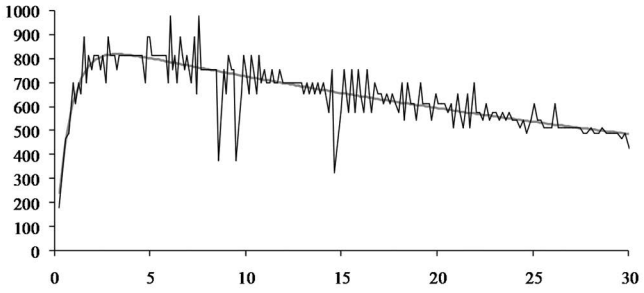

Figure 1. *The power curve of athlete D. in the Wingate test. On the ordinate - power, W. On the abscissa - time, s. Sawtooth curve - actual values. Smoothed curve - calculated values*

In addition, athletes in the laboratory on a specially designed simulator performed in isometric mode an exercise for the quadriceps muscles of the thighs to hold 1 minute of maximum effort. The exercise was performed while sitting on the edge of the bench, with an angle in the knee joint equal to 130°.

Efforts were registered using strain gauges, digital data were entered into a computer through an ADC and processed in the Excel program. An example of recording a force curve is shown in Figure 2.

After completing the experimental program, the athletes underwent a second laboratory examination on a bicycle ergometer in the Wingey test and holding 1 minute of maximum effort.

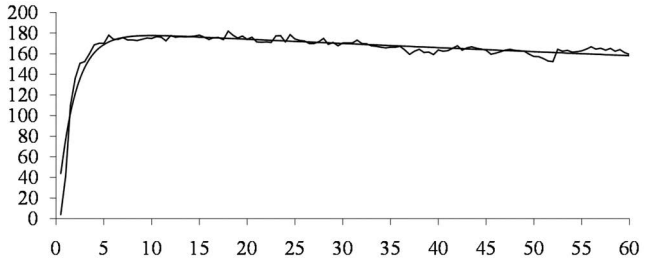

Figure 2. *The strength curve of athlete D. when holding 1 minute of maximum effort. On the ordinate - force, kg. On the abscissa - time, s. The jagged curve is the actual values. Smoothed curve - calculated values*

Results of the study and their discussion. Bicycle ergometric test data are presented in Table 1.

There was a significant improvement in such indicators as W_0 (by 5.1%), W_{max} (by 7.1%), W_{peak} (by 11.1%), $W_{97\%}$ (by 7.1%), ∑W (by 3, 2%), T_{max} (by 22.4%), T_1 (by 27.8%). At the same time, the values of such indicators as T2 (by 23.4%) and T_{hold} (by 20.5%) significantly worsened. The values of the power increase constants (K_1) and the power decrease constants (K_2) did not change significantly.

Data on the indicators of the force curve when holding 1 min of maximum effort are presented in table 2.

As can be seen from the data presented in the table, there was a significant improvement in such indicators as F_0 (by 8.9%), F_{max} (by 6.8%), F_{peak} (by 8.7%), $F_{97\%}$ (by 6.8%), ∑F (by 14.9%), T_{max} (by 35%), T_1 (by 16.7%). At the same time, the values of such indicators as T_2 and T_{hold} significantly worsened. The values of force increase constants (K_1) and force decrease constants (K_2) did not change significantly.

Conclusions. As can be seen from the results of the research, deep jumps in the proposed mode gen-

Table 1. *Average values of indicators calculated from the power curve of the Wingate test before and after the experiment*

Indicators	Designation and dimension	Before experiment, x	After the experiment, x	p
Possible achievable power	W_0, W	889,2	934,7	< 0,01
Max power	W_{max}, W	820,3	878,5	< 0,01
Peak power	W_{peak}, W	980	1089	< 0,01
Power 97% maximum	$W_{97\%}$, W	795,7	852,1	< 0,01
Total power	∑W, J	19381,8	20010,2	< 0,01
Time to reach maximum power	T_{max}, s	3,26	2,53	< 0,01
Time to reach 97% of maximum power	T_1, s	2,16	1,56	< 0,01
Hold time 97% of maximum power	T_2, s	5,43	4,16	< 0,01
Maximum power holding time	T_{hold}, s	3,27	2,60	< 0,01
Constant of power increase	K_1, s^{-1}	0,020	0,022	> 0,01
Power reduction constant	K_2, s^{-1}	1,302	1,983	> 0,01

Table 2. *Average values of indicators calculated from the force curve when holding maximum efforts before and after the experiment*

Indicators	Designation and dimension	Before experiment, x	After the experiment, x	p
Possibly achievable strength	F_0, kg	182,7	198,9	< 0,05
Max strength	F_{max}, kg	177,6	189,7	< 0,05
Peak strength	F_{peak}, kg	181,9	197,8	< 0,05
Strength 97% of maximum	$F_{97\%}$, kg	172,3	184	< 0,05
Total work	∑W, J	9875,3	11346,2	< 0,05
Time to reach maximum strength	T_{max}, s	10	6,5	< 0,05
Time to reach 97% of maximum strength	T_1, s	6	5	< 0,05
Hold time 97% of maximum force	T_2, s	24	18,5	< 0,05
Maximum Force Holding Time	T_{hold}, s	18	13,5	< 0,05
Effort increase constant	K_1, s^{-1}	0,002	0,007	> 0,05
Effort reduction constant	K_2, s^{-1}	0,552	0,601	> 0,05

erally have a beneficial effect on the generation of strength and power. There was a significant improvement in such indicators as maximum power (by 7.1%), peak power (by 11.1%), time to reach maximum power (by 22.4%), time to reach 97% of maximum power (by 27.8%). As a result of the work done, the values of the maximum force and the time to achieve it have improved. The plyometric mode of operation can be recommended for inclusion in the training process of athletes in order to develop the maximum power of the alactic anaerobic process of energy supply and improve the speed of its deployment.

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