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POWER OUTPUT OF JUDO ATHLETES AND HIGH-SPEED NEUROMUSCULAR CONTROL

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ABSTRACT. ***Introduction****:* Muscles are the main driving force in the locomotive system. Moreover, their activity is crucial for athletic performance. The power they generate allows for higher performance. Increasing the power output is essential for constant performance. Energetic consistency is vital for a consistent neuromuscular control of technique. ***Hypothesis***: A specific physical training period influences the evolution of power output and high-speed technique control. ***Methods and Materials****:* Seventeen female subjects from Romania's Junior Olympic Judo Team took part in our study with the age between 14 and 20 years old. The MGM-15 Jump Carpet was used for the power output and energetic consistency tests. ***Results***: There was no significant statistical difference between the initial and final power output measurement but there was a strong correlation between them. ***Conclusions***: The physical training period the subjects undergone may have had an impact over the way the power output increases or decreases regarding to the initial value due to their correlation. The high-speed technique control does not seem to be affected by a high-intensity workout period, though we have listed a series of possible causes for this result.

Keywords: judo, power, speed, neuromuscular control, technique

REZUMAT. ***Puterea dezvoltată de sportivii de judo și controlul neuromuscular la viteze mari de execuție. Introducere***: Mușchii sunt principalul motor în cadrul sistemului locomotor. Activitatea lor este crucial pentru performanța sportivă. Puterea generată de aceștia permite atingerea unei performanțe ridicate. Creșterea puterii generată este esențială pentru performanță constantă în timp. Consistența energetică este vitală pentru un control neuromuscular consistent al tehnicii. ***Ipoteză****:* O perioadă de antrenament fizic specific influențează puterea generată și controlul tehnicii la viteze mari de execuție. ***Metode și Materiale***: 17 subiecți de gen feminin din cadrul Lotului Olimpic al României de Judo categoria Juniori cu vârsta cuprinsă între 14 și 20 de ani au participat la studiul nostru. Covorul de sărituri MGM-15 a fost folosit pentru testele de putere generată și pentru măsurarea variabilității energetice. ***Rezultate****:* Nu a fost identificată o diferență semnificativ statistică între valoarea inițială și finală a puterii dezvoltate.

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S-a identificat o corelaţie semnificativ statistică între valorile puterii dezvoltate înainte şi după perioada de antrenament. ***Concluzii****:* Perioada de antrenament fizic în care au fost integraţi subiecţii a avut un impact asupra modului în care puterea dezvoltată creşte sau scade comparativ cu valoarea iniţială datorită corelaţiei dintre aceste momente. Controlul tehnicii la viteze mari de execuţie pare să nu fi fost influenţată de perioada de pregătire fizică, cu toate acestea am identificat câteva posibile cauze pentru acest rezultat.

Cuvinte cheie: judo, putere, viteză, control neurmuscular, tehnică

Introduction

The power developed by the muscles is different from the traction force of the muscle contraction. Power measures the muscle labor in a given period of time. The power is dependent not only to the force of contraction of the muscle, but also to the length and the number of contractions in a minute. In general, muscle power is measured in kg-m/min (kilogram-force meter/minute). Thus, a muscle that can lift a weight of 1 kg at a height of 1 m in one minute or can move sideways against a resistant object of 1 kg in a minute has a power of 1 kg-m/min. The maximum power that can be produced by all muscles of a trained athlete, with all the muscles working together, has the following values:

For the first 8-10 sec., Maximum power is 7000 kg-m/min;
For the first minute, maximum power is 4000 kg-m/min;
For the first 30 minutes, maximum power is kg-m/min 1700;

Johnson and Bahamonde (1996) tested the power output of students while trying to find a reliable power measurement.

"Cognitive control" is a construct from contemporary cognitive neuroscience that refers to processes that allow information processing and behavior to vary adaptively from moment to moment depending on current goals, rather than remaining rigid and inflexible. Cognitive control processes include a broad class of mental operations including goal or context representation and maintenance, and strategic processes such as attention allocation and stimulus-response mapping. Cognitive control is associated with a wide range of processes and is not restricted to a particular cognitive domain. For example, the presence of impairments in cognitive control functions may be associated with specific deficits in attention, memory, language comprehension and emotional processing. Given its pervasive influence, impaired cognitive control could account for many of the widespread impairments exhibited by people with schizophrenia and other neurodevelopmental disorders (Carter & Cho 2004).

Objective

A period of intense physical training affects the power output and high speed neuromuscular control of judo practising athletes.

Materials and Methods

Seventeen female subjects took part in our study with the age between 14 and 20 years old. All the subjects were athletes that compete in national and international judo competitions and are part of the Romania's Junior Olympic Judo Team. During the specific physical training period, all subjects underwent the same routine at the same location. The test's protocol was explained to the participants and written informed consent was obtained from them.

All the subjects were briefed beforehand regarding what the experiment consisted of and what they were required to do. The subjects were assured that any personal information would not be made public and their personal data recorded will be analysed under the cover of anonymity. Moreover the subjects were instructed how to control social and routine aspects of their lives so that those variables would not interfere with the experiment's results. Also, after the briefing, the subjects were asked to confirm their understanding of what was required on a premade consent form.

For the measurements we've used the MGM-15 jumping carpet that offers data regarding the force-speed asymmetry and also the structural consistency of a subject's movement control. The carpet is used in the Miron Georgescu Modified Test that requires the subject to perform 1 set of 15 consecutive jumps on both legs, on left and on the right leg each. The data recorded is then analysed by the instrument's software and final coefficients are offered.

We've conducted 2 measurements for the whole research. One was done before and one was after the physical training period. This schedule allowed us to identify as accurately as possible the effects of the training over the force-speed asymmetry.

The protocol for each measurement was as follows:

- The subjects were accommodated with the instrument;
- The subjects were informed with regards to the test's requirements;
- The subjects had 10-15 minutes for warm-up;
- The subjects could dry-test a few jumps;
- The subject started the test with 3 sets of 15 jumps (both legs, right leg, left leg) with 15 seconds pause between the sets.

The analysis of the data was done using the SPSS v.17 software. For the statistical analysis we've used the paired sample t-test to determine the influence of the training period over the chosen coefficients.

We've focused out attention on 2 coefficients offered by the software: general power output and EVC (energetic variability coefficient). The general power output refers to the energy measured in Watts that the subject uses to complete a task and is measured globally. This coefficient only reflects the intrinsic power output of a person that doesn't take into account special angles or techniques for isolated movements. The EVC (Energetic variability coefficient) refers to the ability to control the technique at high execution speeds. The average value for the test on both legs is between 3 and 3.5. High values mean that the subject can't control the execution of a technique at high repetition or execution speeds. Besides these, high-end values for a subject mean that the movement necessary for that technique isn't automated or that the technique has been learned in a deficient way that requires more active cognitive control.

Results

A paired-samples t-test was conducted to compare the value of the initial power output (Power_Ini) and the value of the final power output (Power_End) for the judo athletes. There was no significant difference in the scores of the initial test (M= 3.5465, SD= 0.45673) and of the final test (M= 3.5535, SD= 0.53040) conditions; t(16)= -.076, p = 0.940. These results suggest that the training programme the subjects undergone did not affect either positive or negative the power output (Table 3). There was a very strong positive correlation between initial power output and final power output (Table 2).

A paired-samples t-test was conducted to compare the value of the initial EVC (EVC_Ini) and the value of the final EVC (EVC_End) for the judo athletes. There was no significant difference in the scores of the initial test (M= 6.2500, SD= 2.05307) and of the final test (M= 6.9241, SD= 2.42039) conditions; t (16)= -.771, p = 0.452. These results suggest that the training programme the subjects undergone had no influence on the control of the technique at high speeds. (Table 3)

Table 1. Main statistics of the paired sample t-test

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Power_Ini	3.5465	17	.45673	.11077
	Power_End	3.5535	17	.53040	.12864
Pair 2	EVC_Ini	6.2500	17	2.05307	.49794
	EVC_End	6.9241	17	2.42039	.58703

Table 2. The correlation values for the two coefficients

Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	Power_Ini & Power_End	17	.712	.001
Pair 2	EVC_Ini & EVC_End	17	-.294	.251

Table 3. Paired sample t-test results

Paired Samples Test				
		t	df	Sig. (2-tailed)
Pair 1	Power_Ini - Power_End	-.076	16	.940
Pair 2	EVC_Ini - EVC_End	-.771	16	.452

Discussion

The results of this study have not confirmed an existing relation between the EVC's values before and after a period of intense physical training. All things considered this was expected to happen but the high value of uncorrelated data suggested there might be an underlining set of causes that maybe have influenced the results. One cause for the lack of correlation of the data might be due to high intensity of the workout. This is to be expected after a period of intensive physical training due to the fact that the overall performance of the motor system decreases shortly after such a stress.

A second possibility for the results regarding the EVC might be due to the fact that muscle tiredness may affect the neuromuscular control of the movements. Besides this aspect overall fatigue also decreases the cognitive awareness that may be the reason for slower and weaker muscular control of technique at high speeds. One more cause that might have influenced the EVC, during our study, might be the quantity of pure neuromuscular control exercises that might have improved the movement control. Even though some exercises were included in the training program their role was not the center or focus of the workout.

There was a strong correlation between the before and after data regarding the power output. This may suggest, considering that the correlation is strongly positive, there is a directly proportionate relation between the data. In other words when one increase the other will increase also and vice-versa. This is an interesting result due to the fact that it implies that if a group of athletes have a high power output before a training period the output at the end of it will be high also. Considering this aspect we can concur that, for out subjects, a series of these types of training periods one after another may have a positive influence

over the power output from one period to another. Out subjects were athletes that were involved in judo competitions that are not as regular as a football championship for example. In general their completion season is a series of week-long competitions that are spread throughout the year. Between these the athletes have intense training periods. This may be the reason why our group reacted so well to the training workout regarding power output. This is not a generalization of the results, but an observation that there is a strong correlation for out group regarding the power output before and after a training period.

Conclusions

After the analysis of the data we were able to conclude the followings:

- There was no statistical difference between the data of EVC and power output before and after the training period, meaning that we can't be sure that the workout had an effect over the variables recorded;
- There was a strong and positive correlation between the before and after data of power output;
- We've offered some possible causes for the statistical results;
- The correlation of the power output data before and after may be due to the specific way of training used by our group.

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