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Maximal strength development in a yearly training cycle of judo competitors

Radosław Laskowski, Andrzej Suchanowski

Jędrzej Śniadecki Academy of Physical Education and Sport, Department of Physiology, Gdańsk, Poland

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Summary

Introduction. According to Kenji Tomiki, athletic performance of judo competitors is affected by three basic and objective factors: flexibility and elasticity of muscles, static and dynamic strength and fitness of the neuromuscular system. The goal of this paper was to evaluate maximal strength of skeletal muscles, defined based on the results of standardized tests with a bar, performed during the general preparatory period included in the yearly training cycle of judo competitors. The outcome of the suggested training methods, oriented to the development of maximal muscle strength in judo competitors was evaluated.

Material and methods. The subjects were sports club AZS AWFiS competitors from Gdańsk (n=12, age= 22.4+1.8). Maximal anaerobic power was assessed using a 30-second version of Wingate Test, applied to lower extremities.

Results. The applied training methods significantly affected the levels of maximal muscle strength and maximal anaerobic power.

Conclusions. The applied methods of strength training may be used during judo training in order to increase maximal strength of the skeletal muscles and maximal anaerobic power.

Introduction

The significance of maximal muscle strength development for athletic performance improvement in most of the sports disciplines is generally accepted [1]. Muscle strength, being one of the motor abilities characteristic for human physical skills, is defined as: „… an ability to overcome or prevent external resistance through muscle exertion [2], maximal muscle strength is usually defined as a peak strength value under static conditions [3].

Strength depends on the following factors:

– the size of muscle cross-section – relative strength (1 cm2 of a cross-section may develop strength of 7-10kg)
– the number of muscular motor units,
– proportion of slow twitch (ST) muscle fibres to fast twitch (FT) fibres; the more FT fibers the greater strength can be developed by a given muscle;
– proportions of bone levers
– energy release from phosphocreatine decomposition,
– age,
– gender [4].

The increase in maximal muscle strength is mediated by two mechanisms, namely:

1. An increase in muscle fibres
2. An increase in the number of active motor units as a result of changes in movement control by the nerves; during the initial training period, an increase in strength developed during maximal contractions is mainly connected with the stimulation of a bigger number of motor units.

After about two weeks, an increase in strength occurs, mainly due to hypertrophy. Skeletal muscle hypertrophy is the result of systematic exertion with prevailing isometric or dynamic contractions of high intensity. Muscular hypertrophy is connected with the increase in the level of s myofibrillar and cytoplasmic protein in muscle fibres. Moreover, protein stimulation is influenced by hormones, such as insulin and thyroid hormone [5].

According to Czumakow et al. [6], Inokuma et al.[7] and Sato et al. [8] strength training is the basic factor contributing to successful performance in combat sport competitors. The Japanese who are the creators and propagators of judo thought for a long time that agility and technical skill perfection were the basic factors warranting success in this discipline, neglecting at the same time physical training. However, the successful performance of European judo competitors undergoing thorough strength training made the Japanese judo trainers verify their attitude and include strength training in their program. In judo, it is essential to train three kinds of strength. Judo fight involves dynamic strength including jerk, quick and slow strength and static strength. A yearly judo training cycle is divided into two six-month microcycles. One such microcycle

comprises three periods: preparatory, start and transition period. The preparatory period involves conditioning. This period is the longest one (lasting about 8 weeks). According to the regularities of conditioning, Matwiejew et al. [9] divided this period into two sub-periods involving comprehensive and specific preparation.

The entire process of strength training comprises three stages, namely:

1. General strength training aimed at the development of all body muscles;
2. Directed training involving muscle work that should be similar to general structure of movement for certain groups of techniques;
3. Special strength training consisting in the development of strength in the muscles which have a significant influence on the development of a given technique.

Trzaskoma [11] claims that success in judo depends on comprehensive training of the competitor, necessary to master successful movement technique. Maximal strength of all body muscles is a factor having a substantial effect on successful performance during sport fights, we should remember, however, that improvement of this physical trait is not the sole purpose of training.

The goal of the paper was to evaluate maximal strength of skeletal muscles, which was defined based on standardized tests with a bar during the preparatory period of the yearly judo training cycle. The evaluation included the effect of suggested training methods oriented to the development of maximal muscle strength in judo competitors.

Material and methods

The tests were carried out in a group of judo competitors, members of AZS AWFiS sports club in Gdańsk.

During the discussed training period, two training methods were applied to develop maximal strength of the skeletal muscles. Each method was applied within 4 weeks. The training sessions were held twice a week and comprised 4 kinds of exercises with a bar, namely:

– squatting with a bar on the shoulders,
– bench press in supine position
– pull ups
– two hand clean and jerk in prone position

The first method involved a fixed number of repetitions with fixed load while the second one involved fewer repetitions during exercises with increased load. Each method included two sub-periods (4 training units) lasting two weeks (Table 2).

Maximal strength of skeletal muscles was examined three times: during Test 1, performed prior to the training period, Test 2 – after the application of the first training method developing maximal strength of skeletal muscles and Test 3 –after finishing training using the second method.

For comprehensive evaluation of maximal muscle strength in the subjects, the maximal values obtained in the four events (bench press, pull ups, squat, clean and jerk) were summed.

During the same periods the level of anaerobic fitness was assessed based on maximal anaerobic power (Power max W/kg) and the amount of exercise performed (J/kg). 30 s Wingate test was applied on lower extremities [10]. All the mechanical parameters of this test were calculated using MCE V 2.0 software [11].

For statistic analysis the ANOVA variance analysis was applied. The arithmetic means and standard deviation (SD) of the studied features were calculated. Statistic significance was calculated between the arithmetic means of the studied features in judo competitors.

Results

The obtained results are presented in Table 3. Statistically significant differences were noted in maximal strength (peak torque) and maximal anaerobic power during the four events and consecutive tests. Conversely, no statistically significant changes were observed during the Wingate Test for the amount of exercise performed.

Discussion

According to Kenji Tomiki [12], the performance of judoists is affected by three basic and objective factors: muscle flexibility and elasticity, static and dynamic strength, and fitness of the neuromuscular system.

An adequate planning of muscle strength development requires the knowledge of the principles, methods or physiological mechanisms involved in muscle strength regulation and also of the relations between the number of repetitions performed during exercises and the developed fitness of the muscular system. The basic training goal is to develop is body adaptation to increasing loads. According to Inbar et al. [13] training is ineffective if the load applied does not exceed the previously applied training stimulus. This principle was observed during the training sessions in this experiment.

The literature pertaining to this topic suggests [1,7,8] that strength training contributes to improvement in athletic performance, plays a role in contusion prophylaxis and prepares athletes to undertake different kinds of specific exercise.

Shmidtbleicher [14] claims that the minimal period of increasing maximal muscle strength in high class competitors (in disciplines which do not require strength as a primary factor) should last from 6 to 8 weeks. The effectiveness of the discussed

Tab. 1. Characteristics of the studied judo competitors (mean± SD)

n	Age (years)	Body mass (kg)	Body height (cm)	BMI (kg/m^2)	BSA (m^2)	Training record (years)
12	22.4 ±1.8	82.4 ± 9.6	173.3 ±7	27.4 ±1.2	2.0 + 0.2	11.5 ± 1.4

process also depends on training frequency. The results of multiple studies [1, 14, 15] indicate that strength training carried out three times a week allows the trainees to develop a significant increase in muscle strength. One training session a week ensure about 60% increase in strength acquired during three training sessions weekly, 4 training sessions a week allow to obtain a 105-113% increase in strength and 5-6 sessions a week – 120-140% increase in strength. Considering the significant difference in strength increase with 2-3 training units and a slight difference with 3-4 weekly training units, we can assume that 3 training sessions a week are enough to provide the required increase in muscle strength.

In the light of these facts and due to the fact that the study subjects participated in 8 training units weekly, developing their technical and tactical skills and endurance decided to carry out two units of strength training weekly. The applied exercises provided stimulation of the biggest and most important muscle groups. The applied strength training significantly affected the level of maximal muscle strength and maximal anaerobic power (Table 3). The mean value of anaerobic power obtained from the first test was 10.8±0.6 (W/kg) and the mean value of the same parameter obtained from the third test was 11.7± 0.3 (W/kg). The differences were statistically significant (p<0.1). The studies by Sikorski [16] and Mickiewicz [18] indicate higher values of

Tab. 2. The methods of maximal strength development in skeletal muscles, used during the study period by judo competitors (MS – maximal strength obtained during the tests)

Training units		**Load**			**Sub-periods**
Tuesday	Friday	Number of series	Number of repetitions	Load (% MS)	I
Testl					
1	2	5	5	80	
3	4	5	5	80	
5	6	5	5	80-85	II
7	8	5	5	80-90	
Test 2					
1	2	1 1 1 1 1 1	8 6 4 3	60 70 80 90	III
3	4				
5	6	1 1 1 1 1	6 4 3	70 80 90 95	IV
7	8				
Test 3					

Explanation: 5 series x 5 repetitions with load equal to 80% of maximal strength (MS); 1 series x 8 repetitions with load equal to 60% of maximal strength (MS);

Tab. 3. The sum of mean values obtained during the four events (bench press, squat, pulling up, clean and jerk) (kg) (kg/body mass); maximal anaerobic power (Watt/kg) and exercise (J/kg) obtained from Wingate test (mean values±SD)

n	Test	Maximal muscle strength (kg)	Maximal muscle strength (kg/body mass)	Maximal anaerobic power (Watt/kg)	Exercise (J/kg)
12	Test 1	451.6 ±23.8	5.4 ±0.29	10.8 ±0.6	255 ±12.8
12	Test 2	469.4 ± 24.56*	5.7 ±0.3*	11.3 ±0.7**	258 ± 14.7
12	Test 3	487.1+25.5**	6.2 ±0.25**	11.7±0.3*	260.1 ± 14.4
	1-2	*	*	*	-
	1-3	**	**	**	-
	2-3	*	*	-	-

p<0.05*,p<0.01*

maximal anaerobic power in the best judo competitors. In these studies, the best results were even 14 (W/kg). The values of maximal muscle strength obtained from the four events (bench press, pull ups, squat, clean and jerk) in the studied judo competitors were statistically significant both between the first and second test and between the second and third test. This is indicative of correctly applied training load. However, the training load did not significantly affect exercise potential stimulating glycolysis processes. This is manifested by the lack of significant changes in the amount of exercise performed during Wingate Test. We may assume that it would be possible to increase maximal muscle strength in the studied subject after limiting specialist training and increasing the number of training units to three weekly sessions. The question is whether such an increase is really necessary?

Conclusions

The applied methods of strength training may be used during judo training in order to increase maximal strength of the skeletal muscles and maximal anaerobic power.

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Address for correspondence:
Radosław Laskowski
Akademia Wychowania Fizycznego i Sportu
Zakład Fizjologii
ul. Wiejska 1
80-336 Gdańsk
tel. /058/ 5547180, 606681066
lasradek@awf.gda.pl