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Strength Training of Young Taekwond Does (Wt.) Based on The Biomechanical Structure of Competitive Technical Actions

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Annotation. This article presents the results of a study of young taekwondo athletes' (WT) strength training based on the biomechanical structure of competitive technical actions.

Key words: Young taekwondo athletes, strength training, biomechanics, competitive technical actions.

Introduction. All over the world, the number of people practicing taekwondo, one of the oriental martial arts, has gained a worthy place in the field of martial arts. Of course, the rapid development of taekwondo has led to an increase in the importance of sports competitions in this sport at the international level among athletes and attracted significant attention from spectators. For effective physical training of young taekwondo athletes, it is necessary to manage the development of the athletes' body with the help of modern technologies and taking into account sensitive periods. Particular attention is paid to the selection and orientation of talented athletes in the main sports, establishing a system for forming sports reserves, and achieving high results in popularizing sports among young people[1].

According to Lee Jong Ki (2003), the main scientific, methodological and educational literature on taekwondo is devoted to the basic technique of performing movements and, to a greater extent, to the study of complex exercises (Kim Se Hett, 1993, Lee Tse Bong, 2000, Song In Deok, 2002, etc.). The works of Yu. B. Kalashnikov (1998), O. G. Epov (2000) are devoted to the analysis of maneuvering tactics of taekwondo athletes in fights; research on the technique of striking was carried out by Choi Sung Mo, E. Glebov (2002), Lee Jong Ki (2003) determined the technical -tactical characteristics of competitive sparring in taekwondo.

The purpose of this article is the strength training of young taekwondo athletes based on the biomechanical structure of competitive technical actions

Research objectives.

1. Identify the most effective sports taekwondo techniques used in competitive activities

[1]Concept for the development of physical culture and sports in the Republic of Uzbekistan until 2025. January 24, 2020 https://lex.uz

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2. Determine the biomechanical structure of technical actions in taekwondo and the characteristics of the leading muscle groups according to electromyography (EMG) data.

3. To develop and experimentally substantiate a method of strength training for young taekwondo athletes at the stage of basic training.

Methods and organization of research. Analysis of scientific and scientific-methodological literature, analysis of video recordings of competitive fights, biomechanical assessment, electromyography, special dynamometry, pedagogical experiment, methods of mathematical statistics.

Contingent of subjects. 30 people took part in the pedagogical experiment, biomechanical and bioelectrical studies

We analyzed data from video recordings of taekwondo fights at the 2020 Olympic Games (new rules) and compared them with those previously obtained by Lee Jong Ki (2003), who analyzed fights from the 2000 Olympic Games, the 1999 and 2001 World Championships (old rules), this made it possible to identify the six most effective technical actions. At the same time, data from video recordings of the final, semi-final and fights for 3rd place at the 2004 Olympic Games, which we examined from the standpoint of technical actions of an elite group of athletes assessed by judges, allowed us to narrow the range of technical actions to three. The fact is that direct punches and kicks were not effective and were not evaluated by the judges in the final part of the competition.

The use of a circular kick with a turn through the back is random. In fact, in the final part of the 2020 Olympics, this blow was recorded only once - in a fight among men in the weight category over 80 kg.

Taking into account the above, a side kick (dolio) and a straight kick with a turn through the back (dvit) were subjected to a comprehensive analysis, as technical actions, the use of which is prioritized by the judges - the most effective technical actions in Taekwondo WT (Table 1)

Table 1
Volume of application (Vpr) and integral effectiveness (Rint) of leading technical actions (%)

Indicators	Technical actions		
	Lateral	Straight with a turn	Falling from top to bottom
Vpr	93.86	3.49	2.64
Rint	11.19	0.72	0.24

Vpr - application volume - ratio of application amount of a specific strike to the number of all performed (real) strikes, in %

Rint - integral effectiveness - quantity ratio estimated strikes of a particular strike to the number of all performed (real) beats

For statistical analysis, data on effective TD, excluding hits not assessed by the judges

- side kicks (dolio) - highly effective,

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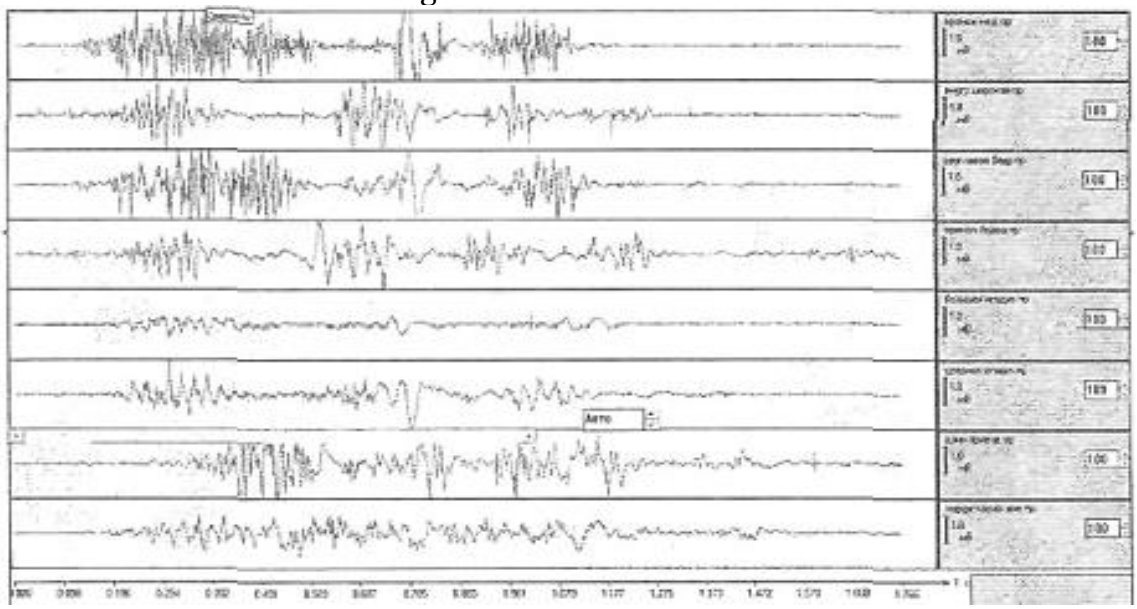
- direct kicks with a turn through the back (dvit) - effective
- falling blows from top to bottom (nerio) - conditionally effective.

This section of the work presents a biomechanical analysis in comparison with EMG indicators of highly qualified taekwondo athletes when they perform the most effective TDs. The implementation of this approach to analysis became possible thanks to the frame-by-frame combination of video and EMG in a single time scale SIDE KICK – DOLIO



Pic. 1. Electromyogram of the leading muscle groups when performing a side kick (Spanish P-o, MS).

Direct kick with a turn through the back - DVIT. Comparing the EMG data we obtained with the biomechanical phases of a direct kick with a turn through the back, we obtained the following picture

Table 2.
Data from turn-amplitude analysis of muscle activity during exercise side kick with an interval of 0.1 s.

TD phase	Time, t,c	1 Gastrocnemius muscle, µV	2 Internal wide, µV	3 Biceps femoris muscle, µV	4 Straight hip, µV	5 Gluteus maximus, µV	6 Gluteal medius, µV	7 Long actuator, µV	8 Oblique abdominal muscle, µV
1 phase =0,28 c	0,1	273	159	217	127	0	153	0	0
	0,2	476	303	417	311	157	274	152	255
	0,3	557	212	585	287	155	263	212	346
2 phase =	0,4	328	0	536	107	0	0	738	189

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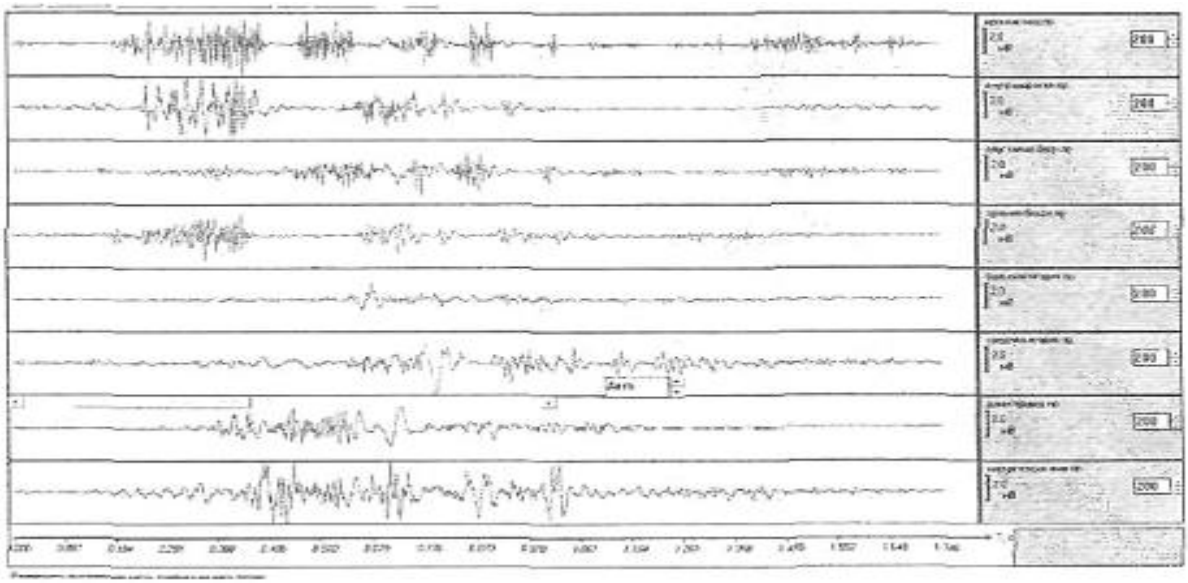
0,22 c	0,5	181	140	283	537	0	142	325	231
3 phase =	0,6	158	461	155	337	0	205	202	190
0,28 c	0,7	509	346	436	280	130	294	374	208
4 phase	0,8	226	150	262	216	0	121	365	145
=0,12 c	0,9	347	333	222	216	147	291	298	160
Total strike time: ttot.=0.90 s									



Pic. 2. Electromyogram of the leading muscle groups when performing a straight kick with a turn through the back.

It is important to note that hip extension occurs at some distance from the axis of rotation, and the activity of the gluteus medius dominates the activity of the gluteus maximus. And, conversely, when the hip is brought as close to the axis of rotation as possible, high activity of the gluteus maximus muscle is manifested. The subsequent increase in the activity of the leading hip extensor occurs at the moment of the beginning of leg extension in the hip joint, which begins at the end of the 3rd phase, providing inhibition of hip flexion with subsequent extension in the 4th phase. The activity of the gluteus maximus and medius muscles determines the trajectory of the extension of the leg when bending it in the hip joint. The increase in the activity of the long adductor muscle at the end of the 2nd, beginning of the 3rd phase is caused by the emergence of centrifugal forces due to rotation of the torso and rotation of the hip joint. Activation of the hip adductor muscle is due to the need to keep the hip close to the axis of rotation of the body (Pic. 2)

A comparative analysis, combined in time of electrical muscle activity with a biomechanical analysis of the phases of technical actions, showed their complementary correspondence, which was the basis for the formation of a set of strength exercises aimed at developing the leading muscle groups involved in performing effective strikes. Knee flexors and extensors, hip flexors and extensors; adductor and abductor muscles of the thigh, flexors and extensors of the trunk, muscles of the "twisting" of the trunk, flexors of the foot.

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Results and its discussion. In order to experimentally substantiate the effectiveness of using strength training means, two groups of subjects of 8 people in each were formed - experimental and control - athletes of the 1st-2nd category in taekwondo. Participants in the experiment belonged to the same age group (boys 12-14 years old) and had no significant differences by level of physical fitness. Both groups carried out special training within the framework of a developed program for sports clubs in taekwondo. The difference was that 4 out of 5 classes in a weekly cycle had significant differences. The experimental group conducted training on these days, including specially developed means and method. The control group trained according to the generally accepted program typical for this stage of training.

The method of strength training included exercises with weights and with the resistance of one's own body. We divided all the leading muscle groups into 4 pairs, combining them in accordance with the phase structure of performing technical actions. The exercises were performed until expressed fatigue, the duration of the exercise was 20-40 s, the mode of muscle work was static-dynamic, 60% of the maximum (Table 4)

Table 4.

Microcycles of preparation	Days	TD phase	Exercises	Exercise time, s	Rest time, min	Number of approaches, number of times
1st week	Mon		Squats Calf Raises	20-40	5-6	4
	Tue		Turns with a harness Backbends	20-40	5-6	4
	Thur		Torso raises Pelvic lifts	20-40	5-6	2
	Fri		Leg adduction with tourniquet Leg abduction with tourniquet	20-40	5-6	2
2nd week rest						
3rd week	Mon		Squats Calf Raises	20-40	5-6	5
	Tue		Turns with a harness Backbends	20-40	5-6	2
	Thur		Torso raises Pelvic lifts	20-40	5-6	2
	Fri		Leg adduction with tourniquet Leg abduction with tourniquet	20-40	5-6	2
2nd week rest						

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The rest interval was filled with strength exercises for the next pairs of muscle groups and aerobic exercises (development of flexibility). The first two training days, the taekwondo athletes of the experimental group performed developmental strength training, and on the next two days, a tonic version of strength training, for the same muscle groups, respectively - characterized by a smaller number of approaches, only 2 approaches (V Blakh, S Eliseev, V Igumenov, N Kulik, Yu Migasevich, B Podlivaev, V Seluyanov, S Tabakov, 2005)

In the pre-competition training period, the volume of strength training was reduced, so that the athletes performed only the tonic part of strength training.

Analysis of the competitive activity of the participants in the pedagogical experiment revealed significant advantages of the experimental group in such an important indicator as the reliability coefficient of the KNA attack in the experimental group before the experiment was 0.20, and after - 0.41 (an increase of 51.22%), in the control group similar data - before - 0.22, after - 0.32 (increase 31.25%) - Table 5

Table 5
Increase in the reliability coefficient of control and experimental attacks groups based on the results of a pedagogical experiment

Group	Indicator	n	$\bar{x}\pm m$	t	P
Experimental	KNA	**8**	0,20±0,01	7,07	<0,05
Control		**8**	0,10 ±0,01		

All athletes of the experimental group were among the prize-winners of the championship of the Republic of Uzbekistan in Tashkent, having completed a significantly larger number of fights compared to athletes from the control group.

Thus, a method of strength training for taekwondo athletes based on the biomechanical structure of competitive technical actions was developed and experimentally tested and turned out to be significantly more effective and efficient than the generally accepted one.

Conclusion.

Analysis of scientific and methodological literature made it possible to establish that the selection of means and methods of special physical training in various types of martial arts is carried out on the basis of biomechanical compliance with competitive activity. However, insufficient attention to the study of various components of taekwondo mastery, including strength training, confirms the need for a scientifically based solution to this problem.

Analysis of competitive activity made it possible to determinean arsenal of technical actions used in a sports match according to the rules of the World Taekwondo Federation: punches - "jirugi", straight kicks - "miru", side kicks - "dolio", falling kicks from top to bottom - "nerio", straight kicks with turning over the back - “dvit”, circular kicks with a turning through the back - "hurio".

The biomechanical structure of a straight kick with a turn through the back - “dvit” consists of the following phases: 1) phase - elastic squat, 2) phase - rotation of the body with

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simultaneous extension of the legs, 3) phase - flexion of the striking leg, 4) phase - extension of the striking leg and stop rotation of the torso

As a result of the pedagogical experiment, the feasibility of including special means of power was statistically confirmed preparation in the preparatory period in the amount of 30-35% based on biomechanical structure of competitive TD This is reflected in a significant, compared to the control group, increase in the speed-power characteristics of a side kick by 60% - “gradient” of force and by 47% - FMax and a direct kick with a turn through the back by 53% - “gradient” of force and 30% - FMax.

The developed and experimentally tested strength training methodology contributed to improving the quality of competitive activity of young taekwondo athletes, which allowed them to increase the attack reliability coefficient (ACC) from 0.20 to 0.43, i.e. more than doubled

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