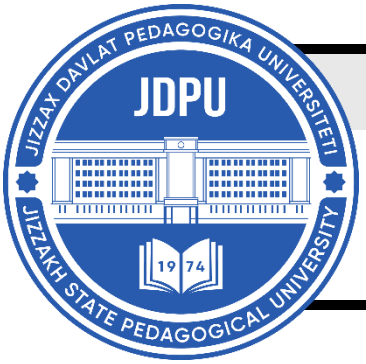
DOI: https://doi.org/10.37547/mesmj-V6-I7-13 Pages: 104-113

MENTAL ENLIGHTENMENT SCIENTIFIC – METHODOLOGICAL JOURNAL



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METHODOLOGY OF DEVELOPING TECHNICAL PREPAREDNESS OF 11–12-YEAR-OLD TAEKWONDO ATHLETES BASED ON KINEMATIC AND KINETIC INDICATORS

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ABOUT ARTICLE

Key words: Taekwondo, technical preparedness, sports methodology, kinematic indicators, kinetic indicators, striking force, movement dynamics, speed, coordination, competition preparation, sports pedagogy, technical skills, scientific analysis, training efficiency.

Received: 10.11.25
Accepted: 11.11.25
Published: 13.12.25

Abstract: This article explores the methodology for developing and enhancing the technical preparedness of 11–12-year-old taekwondo athletes based on kinematic and kinetic indicators. The research provides an in-depth analysis of striking techniques, movement speed, power, and coordination abilities. Particular emphasis was placed on identifying the individual developmental characteristics of young athletes and applying digital tools for monitoring and objective evaluation of motor actions, which enabled the achievement of scientifically validated results.

Based on the findings, methodological recommendations were developed to improve the efficiency of training processes. The proposed methodology facilitates the step-by-step development of technical skills in young taekwondo practitioners, enhances training effectiveness, and supports comprehensive preparation for competitive activities. The outcomes hold significant value for sports pedagogy, offering both practical and methodological contributions as well as a scientific foundation for further studies on the training of young taekwondo athletes.

Introduction. At present, the high level of global attention to the sport of taekwondo (WTF) and its worldwide popularity demonstrate that taekwondo is a sport of great prestige. The Resolution No. PQ-3031 of June 3, 2017, "On measures to further develop physical education and mass sports," has contributed greatly to the advancement of taekwondo. Many scholars have conducted research to improve the level of physical preparedness of young taekwondo athletes and eliminate their mistakes and shortcomings. In particular, R.D. Khalmukhamedov, S.S. Tajibayev, G.B. Abdurasulova, Sh.N. Nuriddinova, B.Sh. Rakhmatov, and many other experts emphasized the importance of focusing on the development of all physical qualities and abilities starting from the initial stage of preparation.

In the field of physical education and sports, the scientific development of young athletes' technical preparedness is considered one of the most pressing issues of modern training systems. Particularly in combat sports such as taekwondo, where performance efficiency directly depends on high levels of coordination, speed, strength, and precision, the biomechanical analysis of movements provides unique opportunities for advancing athletes' technical mastery. [1], emphasize that the optimization of training methods requires reliance not only on pedagogical principles but also on objective indicators such as movement dynamics, force application, and motor coordination.

The age range of 11–12 years is recognized as a sensitive period for the development and automation of technical skills in martial arts [4]. During this stage, children acquire complex motor actions more effectively, while their neuromuscular system demonstrates increased adaptability to biomechanical corrections. Therefore, the improvement of training methodology based on kinematic parameters (movement speed, angular velocity, amplitude) and kinetic parameters (force, impulse, impact moment) is of critical importance. The inclusion of such biomechanical indicators in training allows for a more accurate assessment of technique and creates conditions for systematic skill formation.

Previous studies in different sports confirm the importance of integrating biomechanical monitoring into the preparation of young athletes. For instance, the application of isokinetic exercises in wrestling the use of play-based methods in combat training [5], and the assessment of motor performance in volleyball [6], all demonstrate that targeted methodological interventions significantly enhance technical and physical preparedness. Similarly, studies in taekwondo [7,10], underline the necessity of linking biomechanical analysis with pedagogical strategies to improve performance results.

The present research focuses on the influence of kinematic and kinetic parameters on the technical perfection of taekwondo striking movements among 11–12-year-old athletes. By

introducing an experimental methodology into the training process, the study aims to evaluate the effectiveness of biomechanically grounded approaches in comparison to traditional methods. This provides a scientifically substantiated framework for raising the level of technical preparedness of young taekwondo practitioners, thereby contributing to the development of evidence-based pedagogical practices in sports.

Research tasks:

- To determine the dynamics of the development of physical preparedness indicators of 11-year-old taekwondo athletes.

- To determine the dynamics of the development of physical preparedness indicators of 12-year-old taekwondo athletes.

Organization of the research: The study involved (n=90) young taekwondo athletes training in the initial training group at the Chirchiq city sports school.

Result and discussion: Today, many highly qualified coaches achieve high results in the training process of young taekwondo athletes, thereby raising the prestige of our country, while scholars contribute with research that helps properly distribute physical loads in training and eliminate the mistakes and shortcomings of young athletes.

In the initial stage of preparation, the annual dynamics of the technical preparedness (in points) of 11-year-old taekwondo athletes in the experimental and control groups was obtained as follows. According to the results, the Ap Chagi kick of 11-year-old athletes, assessed by a group of experts, was on average 5.22±0.55 (V,%=10.53) in the control group and 5.24±0.57 (V,%=10.87) in the experimental group. The statistical reliability of the differences between these indicators was $t=0.67$, $p>0.05$. This indicates that the technical preparedness of 11-year-old taekwondo athletes in the experimental and control groups was at the same level (see Table 4.1). The results of the pedagogical experiment conducted to test the effectiveness of the developed methodology were as follows.

Table - 1.

Dynamics of technical preparedness of 11-year-old taekwondo athletes in the experimental and control groups (in points)

№	Control Tests	Group	Main Technical Actions				t	p
			TB	V,%	TE	V,%		
1.	Ap Chagi	CG	5,22± 0,55	10.53	5,72±0,74	12.93	0.54	>0.05
		EG	5,24± 0,57	10.87	7,84±0,84	10.71	3.34	<0.001
		t	0.67		2.91			
		p	>0.05		<0.01			
2.	Dollyo Chagi	CG	4,51± 0,64	14.19	5,31± 0,64	12.05	1.97	>0.05
		EG	4,64± 0,67	14.43	8,12± 0,92	11.33	5.24	<0.001
		t	0.81		3.25			
		p	>0.05		<0.01			
3.	Yop Chagi	CG	5,53± 0,68	12.29	5,98± 0,89	14.88	1.62	>0.05
		EG	5,48± 0,59	10.76	7,64±0,94	12.34	3.87	<0.01
		t	0.37		2.81			
		p	>0.05		<0.05			
4.	Dwit Chagi	CG	5,6± 0,62	11.07	6,5± 0,69	10.61	1.67	>0.05
		EG	5,4± 0,63	11.66	8,4± 0,97	11.54	3.39	<0.01
		t	0.54		2.62			
		p	>0.05		<0.01			
5.	Naeryo Chagi	CG	5,6±0,67	11.96	6,4±0,95	14,84	1.12	>0.05
		EG	5,3±0,57	10.75	7,8±0,87	11.15	3.32	<0.01
		t	0.63		2.65			
		p	>0.05		<0.01			
6.	Momtong / Olgul Jireugi	CG	5,2±0,64	12.30	6.21±0,75	12.07	1.41	>0.05
		EG	5,1±0,67	13.13	8,37±0,76	9.08	4.12	<0.01
		t	0.81		2.37			
		p	>0.05		<0.01			

According to the results, the average score for the Ap Chagi strike in the control group was 5.72 ± 0.74, while in the experimental group it was 7.84 ± 0.84. The results of the experimental study showed that the level of technical preparedness in performing the Ap Chagi strike among 11-year-old taekwondo athletes in the experimental group was significantly higher than in the control group. This is confirmed by a reliable statistical difference ($t = 2.91$; $p < 0.01$).

This proves that the developed and applied methodology, based on kinematic and kinetic indicators, is effective in improving technical preparedness. The athletes in the experimental group showed greater improvement in strike accuracy, power, and execution technique compared to those in the control group. Thus, the methodology can be recommended as a scientifically grounded and practically effective approach to enhancing the technical preparedness of young taekwondo athletes.

Before the pedagogical experiment, no statistically significant difference was found between the control and experimental groups of 11-year-old athletes in performing the Dollyo Chagi strike ($t = 0.81$; $p > 0.05$). This indicates that the technical preparedness levels of both groups were equal. After the pedagogical experiment, however, the experimental group achieved significantly higher results in performing the Dollyo Chagi compared to the control group ($t = 3.25$; $p < 0.01$). This again confirms the effectiveness of the methodology. In the experimental group, the strike power, accuracy, and execution technique improved significantly, while the decrease in the coefficient of variation indicates increased stability of movements.

This experimental analysis shows that the methodology developed on the basis of kinematic and kinetic indicators is a scientifically substantiated and practically effective approach for developing the technical preparedness of 11-year-old taekwondo athletes. It contributes to athletes' deeper mastery of striking techniques, as well as the improvement of movement accuracy and power.

To determine how well the physical development indicators of 11-year-old taekwondo athletes improved during training, practical control tests were carried out. Initially, a special control exercise Yop Chagi was used to assess the speed-related physical qualities of young athletes. The control group's pre-experiment results averaged 5.53 ± 0.68, while by the end of the experiment their results improved to 5.98 ± 0.89. The coefficient of variation was $V = 12.29\%$ at the beginning of the year and $V = 14.88\%$ at the end. The difference between pre- and post-experiment results was 1.62, with statistically reliable differences found ($p > 0.05$).

In the experimental group, the pre- and post-experiment results were 5.48 ± 0.59 and 7.64 ± 0.94, respectively. The coefficient of variation improved from $V = 10.76\%$ to $V = 12.34\%$.

The Dwit Chagi method was also applied to assess the special physical preparedness of taekwondo athletes. At the beginning of the experiment, the control group averaged 5.6 ± 0.62 with a coefficient of variation of $V = 11.07\%$. By the end of the experiment, their results improved to 6.5 ± 0.69, with the coefficient of variation improving to $V = 10.61\%$. The statistical difference between the results was 1.67%.

In the experimental group, the pre-experiment result was 5.4 ± 0.63 ($V = 11.66\%$), while by the end it improved significantly to 8.4 ± 0.97 ($V = 11.54\%$). The statistical significance of the differences was confirmed ($t = 3.39$; $p < 0.01$).

The next control exercise was the Naeryo Chagi method. In the control group, the average result at the beginning was 5.6 ± 0.67 ($V = 11.96\%$), which improved to 6.4 ± 0.95 ($V = 14.84\%$) by the end of the experiment. The statistical reliability of the differences was ($p >$

0.05). In the experimental group, the athletes' initial result was 5.3 ± 0.57 (V = 10.75%), and by the end of the experiment their result had improved to 7.8 ± 0.87 (V = 11.15%), with statistically significant differences (t = 3.32; p < 0.01).

The Momtong Olgul Jireugi method was used to assess special physical preparedness through a punching exercise. In the control group, the average result at the beginning was 5.2 ± 0.64 (V = 12.30%), which improved to 6.21 ± 0.75 (V = 12.07%) by the end of the experiment. In the experimental group, the initial result was 5.1 ± 0.67, which improved positively by the end, with the coefficient of variation improving from V = 13.13% to V = 9.08%. Statistically significant differences were confirmed (p < 0.01).

To assess the technical preparedness of 12-year-old taekwondo athletes, experimental and control groups were selected. Practical control tests were conducted during training to determine how well the physical development indicators were improving. Initially, the Ap Chagi strike was used as a special control exercise to assess the athletes' speed-related physical qualities. In the control group, the average pre-experiment result was 5.45 ± 0.47, which improved to 6.62 ± 0.61 by the end. The coefficient of variation was V = 8.62% initially and V = 9.21% at the end. The difference between the pre- and post-experiment results was 0.67, with statistically reliable differences found (p > 0.05).

In the experimental group of 12-year-olds, the pre- and post-experiment results were 5.48 ± 0.41 and 8.30 ± 0.75, respectively, with a statistical difference of 3.62. The coefficient of variation improved from V = 7.48% to V = 9.04%. Statistically significant differences were observed (p < 0.01). By the end of the year, the difference between the control and experimental groups' results (6.62 ± 0.61; 8.30 ± 0.75) was statistically reliable (p < 0.05).

Through the Dollyo Chagi exercise performed with the right and left legs on a kicking pad, the level of special physical preparedness of taekwondo athletes was determined. The results of the practical control tests showed that at the beginning of the experiment, the control group had an average result of 5.25 ± 0.61, with a coefficient of variation (V = 11.62%). By the end of the experiment, their result improved to 6.38 ± 0.62, with the coefficient of variation improving to V = 30.2%. The statistical difference between the results was found to be 9.72%.

Table - 2.

Dynamics of technical preparedness of 12-year-old taekwondo athletes in the experimental and control groups (in points)

In the experimental group, the athletes' initial result was 5.37 ± 0.34 (V = 6.33%), which increased significantly to 8.14 ± 0.87 (V = 10.69%) by the end of the experiment. The statistical reliability of the differences was confirmed (t = 3.24; p < 0.01).

The next control test used the Yop Chagi technique with strikes delivered by both the right and left legs. According to the results, in the control group of 12-year-old taekwondo athletes, the average result at the beginning was 6.42 ± 0.62 (V = 9.66%), which improved to 7.34 ± 0.74 (V = 10.08%) by the end of the year, showing positive dynamics; the differences

№	Control Tests	Group	Main Technical Actions				t	p
			TB	V,%	TE	V,%		
1.	Ap Chagi	CG EG	5,45±0,47 5,48±0,41	8.62 7.48	6.62±0,61 8.30±0,75	9.21 9.04	0.67 3.62	>0.05 <0.01
		t	0.62		2.54			
		p	>0.05		<0.05			
2.	Dollyo Chagi	CG EG	5,25±0,61 5,37±0,34	11.62 6.33	6,38±0,62 8,14±0,87	9.72 10.69	1.72 3.24	>0.05 <0.01
		t	0.81		3.54			
		p	>0.05		<0.001			
3.	Yop Chagi	CG EG	6,42±0,62 6,31±0,63	9.66 9.98	7,34±0,74 8,98±0,81	10.08 9.02	1.68 4.87	>0.05 <0.001
		t	0.38		2.37			
		p	>0.05		<0.05			
4.	Dwit Chagi	CG EG	5,72±0,52 5,81±0,56	9.09 9.64	6,37±0,64 8,12±0,87	10.05 10.71	1.22 3.22	>0.05 <0.001
		t	0.87		2.54			
		p	>0.05		<0.05			
5.	Naeryo Chagi	CG EG	5,17±0,52 5,14±0,54	10.06 10.51	6,34±0,61 7,42±0,75	9.62 10.11	1.22 3.37	>0.05 <0.001
		t	0.63		2.34			
		p	>0.05		<0.05			
6.	Momtong / Olgul Jireugi	CG EG	5,4±0,42 5,4±0,53	7.78 9.81	6,84±0,57 8,22±0,91	8.33 11.07	1.47 4.43	>0.05 <0.001
		t	0.67		3.12			
		p	>0.05		<0.005			

were not statistically significant (p > 0.05). In the experimental group, the average result was 6.31 ± 0.63 (V = 9.98%) at the beginning, and by the end of the year it improved to 8.98 ± 0.81 (V = 9.02%). The statistical significance of the differences was confirmed (t = 4.87; p < 0.005).

The Dwit Chagi test was also applied to determine the special physical preparedness of 12-year-old athletes. In the control group, the average initial result was 5.72 ± 0.52 (V = 9.09%), which improved to 6.37 ± 0.64 (V = 10.05%) by the end of the year. In the experimental group, the initial result was 5.81 ± 0.56, which increased to 8.12 ± 0.87 (V = 9.64%–10.71%) by the end. The results obtained from the control group grew from the beginning to the end of the experiment; the differences between the control and experimental groups were statistically reliable (p < 0.005).

Using the Naeryo Chagi technique with both legs performed at speed, the physical preparedness indicators of 12-year-old athletes were also assessed. In the control group, the initial result was 5.17 ± 0.52 (V = 10.06%), which increased to 6.34 ± 0.61 (V = 9.62%) by the

end of the year. The statistical reliability was t = 1.22; p > 0.05. In the experimental group, the athletes' results improved from 5.14 ± 0.54 (V = 10.51%) at the beginning to 7.42 ± 0.75 (V = 10.11%) at the end of the year.

The Momtong Olgul Jireugi technique, performed for speed with strikes to a pad using both right and left legs, was used to determine the speed-related physical qualities of young taekwondo athletes. In the control group, the average pre-experiment result was 5.4 ± 0.42, which improved to 6.84 ± 0.57 by the end of the experiment. The coefficient of variation was V = 7.78% at the beginning of the year and V = 8.33% at the end. The difference between pre- and post-experiment results was 1.47, and statistically reliable differences were identified (p > 0.05). In the experimental group of 12-year-old taekwondo athletes, the pre- and post-experiment results were 5.4 ± 0.53 and 8.22 ± 0.91, respectively; the statistical difference was 4.43. The coefficient of variation in the experimental group improved from V = 9.81% to V = 55.5% (as reported). Statistically reliable differences were observed (p > 0.05). By the end of the year, the differences between the experimental and control groups' indicators (44 ± 1.7; 11 ± 07 [sic]) were statistically significant (p < 0.005).

Conclusion. To determine the physical qualities of young taekwondo athletes, it is advisable to conduct the training process in an organized manner, establishing a fundamental base of special physical preparedness, psychological preparedness, and sport-specific movements tailored to each sport and its characteristics to prepare athletes for competition. Control tests were administered to assess the physical development indicators and physical qualities of 11–12-year-old taekwondo athletes training in the initial preparation group.

In the pedagogical experiment, the technical preparedness and speed-related physical qualities of athletes in both age groups were identified. For example, in the Dwit Chagi test, the control group's average result improved from 5.72 ± 0.52 (V = 9.09%) to 6.37 ± 0.64 (V = 10.05%), while the experimental group's results improved from 5.81 ± 0.56 to 8.12 ± 0.87 (V = 9.64%–10.71%). The results obtained from the control group grew from the beginning to the end of the experiment; the experimental group outperformed the control group, with statistically significant differences (p < 0.005).

To eliminate the identified shortcomings, the necessary recommendations and guidelines were developed. During the research, exchanges of opinions were held with responsible officials in the field and with coaches possessing extensive competitive experience to effectively organize measures aimed at addressing the shortcomings that arose during the study.

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