# The influence of high-intensity interval training on the development of speed-strength abilities in 16-17-year-old taekwondo athletes

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## Abstract

This article presents the results of a study on the effectiveness of using high-intensity interval training (HIIT) to develop the speed-strength abilities of 16-17-year-old taekwondo athletes. The relevance of the study is driven by the need to improve the system of special physical training for athletes and to find effective means of increasing the level of speed-strength preparedness in taekwondo. The objective was to determine the influence of a high-intensity interval training program on the speed-strength performance indicators of 16–17-year-old taekwondo athletes. The study involved 20 athletes aged 16–17 with the Candidate for Master of Sport (CMS) qualification, who were divided into control and experimental groups. The methods used in this work included analysis of scientific and methodological literature, pedagogical testing, a pedagogical experiment, and methods of mathematical statistics. The experimental group used a specially developed HIIT program that included exercises focused on speed-strength, strength, and sport-specific skills.

**Keywords:** Taekwondo, high-intensity interval training, HIIT, speed-strength abilities, special physical preparation, 16-17-year-old taekwondo athletes, pedagogical experiment.

## Introduction

Modern taekwondo is characterized by high-intensity competitive activity, a significant variety of technical actions, and the need to perform them under time constraints. The success of an athlete's performance is largely determined by their level of speed-strength development, which ensures high-speed execution of strikes, effective attacking and counter-attacking actions, and the ability to maintain high work capacity throughout the entire match.

In recent years, high-intensity interval training (HIIT) has become widespread in sports practice. This method involves alternating short periods of high-intensity work with intervals of active or passive rest. The effectiveness of this method has been confirmed by numerous studies in the field of developing aerobic and anaerobic performance, enhancing the body's functional capabilities, and improving the physical qualities of athletes at various skill levels.

Despite a significant number of scientific studies on the application of HIIT in cyclical and game-based sports, the use of high-intensity interval training in the preparation of adolescent taekwondo athletes remains underexplored. The 16–17 age group is of particular interest, as it is a favorable period for improving speed-strength abilities and developing athletes' sport-specific physical preparedness.

Consequently, there is a need for a scientific rationale for the effectiveness of using high-intensity interval training to develop the speed-strength abilities of 16–17-year-old taekwondo athletes. Addressing this issue would help optimize the training process and enhance the effectiveness of preparing athletes for competition.

One of the most promising approaches is high-intensity interval training (HIIT), which combines elements of weightlifting, gymnastics, and cardiovascular exercise. The HIIT system allows for the comprehensive development of key physical attributes, can be adapted to the specific demands of a chosen sport, and has already proven its effectiveness in various sports disciplines [1,2].

In his works, V.N. Platonov wrote that speed-strength should be viewed as the ability of the nervous and motor systems to achieve high levels of force in a minimal amount of time. To align with the principles of a rational methodology for developing speed-strength specific to different sports, this definition should be further specified. Speed-strength should be defined as the ability of the nervous and motor systems to achieve, in a minimal amount of time, the force indicators necessary for the highly effective motor actions required by a specific sport. This definition is further developed by differentiating speed-strength into explosive strength, which is exhibited under conditions of high resistance, and starting strength, which is demonstrated under conditions of low to moderate resistance. The process of developing speed-strength employs means

and methods that contribute both to its holistic development and to increasing the potential of the individual components that determine the level of this quality [1,10]. To develop speed-strength, exercises with weights, the shock method, plyometric exercises, and the complex method are used; additionally, training equipment is widely utilized.

Resistance training is the simplest, and at the same time, most effective way to develop speed-strength. At one time, I.P. Ratov demonstrated that with maximally fast movements using relatively light weights, it is possible to achieve the same degrees of muscle tension and the same indicators of maximum and average strength—and consequently, the same stimulus strength—as in exercises with heavy weights [2]. In Taekwondo, these qualities manifest in the speed of extending the leg for a strike, the power of pushing off during movements, and the ability to perform series of attacking actions at a high frequency with minimal time expenditure. According to research by Chaabène, competitive success in Taekwondo is largely determined by the level of speed and power developed in striking actions.

The development of speed-strength abilities takes on particular significance during adolescence (14-15 years), which is considered a sensitive period for improving motor abilities. According to L.P. Matveev, high plasticity of the neuromuscular system and increased sensitivity to training stimuli are observed during this age period. V.K. Balsevich also points out that adolescence is the most favorable period for forming basic motor qualities, including speed-strength abilities.

In particular, the relationship between speed-strength training and the effectiveness of striking actions during the pre-competition period requires further scientific substantiation.

Consequently, there is a need to develop and scientifically substantiate effective methods of speed-strength training aimed at increasing the special work capacity and competitive performance of 16–17-year-old taekwondo athletes [3,4,5].

*Objective of the study:* to scientifically substantiate and experimentally verify the effect of a high-intensity interval training program on the speed-strength fitness indicators of 16–17-year-old taekwondo athletes.

*Research tasks:*

1. To study and analyze scientific and methodological literature on the development of athletes' speed-strength abilities and the application of high-intensity interval training (HIIT) in sports training.
2. To determine the initial level of speed-strength fitness in 16–17-year-old taekwondo athletes using a battery of pedagogical tests.
3. To develop and implement a high-intensity interval training (HIIT) program aimed at developing the speed-strength abilities of 16–17-year-old taekwondo athletes.
4. To experimentally test the effectiveness of using HIIT in the training process and to assess the dynamics of the athletes' physical fitness indicators.

*Research methods:* analysis of scientific and methodological literature, pedagogical observation, pedagogical testing, pedagogical ex-

**Table 1. .HIIT Complex content**

| Complex | Objective | Key Exercises |
|---|---|---|
| *Strength and Speed Abilities* | Explosive power of the lower/upper body, starting speed | 30m sprint (5), box jumps 50cm (5x5), kicks on pads with max. power (4x15), 3kg ball throws (4x10), Burpees (4x10). |
| *Strength Abilities and Functional Fitness* | General endurance, functional strength | Burpees + jumping over obstacles (4×10), **EMOM*** complex (20 min), 2×200 m run (with acceleration), 50 cm box jumps (3×10) |
| *Speed-Strength and Anaerobic Work* | Special speed endurance and coordination | Half-squat jumps (4x10), Naeryo Chagi kicks (15 sec. x 4), 400 m run, skipping (1 min x 4), step platform exercises (10 min x 3) |

***Note:*** *HIIT—high-intensity interval training; exercise dosage is indicated as the number of sets and repetitions (e.g., 4×10 means 4 sets of 10 repetitions); "max."—performing the exercise with maximum intensity; EMOM (Every Minute On the Minute) —an interval training format in which a given exercise is performed at the start of each minute; 1 min—1 minute*

**Table 2.** **Pedagogical testing indicators at the start**

| Test Exercises | CG at the Start of the Experiment | EG at the Start of the Experiment |
|---|---|---|
| *30 m dash* | 4.47±0.05 | 4.45±0.06 |
| *Number of neryo-chagi kicks in 15s* | 24.8±0.8 | 25.1±0.7 |
| *Number of dolyo-chagi kicks in 15s* | 28.3±0.9 | 28.6±0.8 |
| *Standing long jump* | 239.4±3.1 | 240.2±2.9 |
| *Rope jumps for 30 s* | 82.5±2.3 | 83.1±2.1 |
| Step-ups for 30 s | 29.8±1.1 | 30.1±1.0 |

periment, and methods of mathematical statistics.

**Study Design**: The study involved 20 qualified taekwondo athletes who were randomly assigned to an experimental group (EG, n=10) and a control group (CG, n=10). All athletes had at least 6 years of training experience and held the rank of Candidate for Master of Sport. The study was conducted over a six-month macrocycle. The training program included two HIIT sessions per week, which were incorporated into the training plan. The content of the HIIT complexes was as follows

## Results and discussion

During the pedagogical experiment, data were obtained characterizing the effect of a high-intensity interval training (HIIT) program on the development of speed-strength abilities in 16–17-year-old taekwondo athletes. The initial stage of the experiment involved assessing the development level of speed-strength abilities in these athletes. The study included 20 athletes with the CMS (Candidate for Master of Sport) qualification, who were divided into a control group (CG, n=10) and an experimental group (EG, n=10). To determine the baseline level of physical fitness, the following pedagogical tests were used: 30-meter dash, number of neryo-chagi and dolyo-chagi kicks in 15 seconds, standing long jump, rope jumps in 30 seconds, and step-ups in 30 seconds.

Analysis of the test results showed positive dynamics in the indicators for the athletes in the experimental group. The most pronounced improvements were noted in tests related to performing striking techniques within a time limit, as well as in exercises assessing the speed-strength fitness of the lower limbs.

Based on the experiment's results, the participants in the experimental group showed an increase in the number of neryo chagi and dolyo chagi kicks in 15 seconds, and improved results in the 30 m run, standing long jump, rope jumps, and step-ups in 30 seconds. Positive changes were also recorded in the control group, but their magnitude was less significant.

Statistical analysis of the data obtained showed that the differences between the indicators of the experimental and control groups after the experiment were statistically significant for a number of the parameters studied ($p < 0.05$), which indicates the effectiveness of using the HIIT complex in the training process of taekwondo athletes. Thus,

**Table 3.** **Pedagogical testing indicators at the end of the experiment**

| Test exercises | CG at the end of the experiment | EG at the end of the experiment |
|---|---|---|
| *30 m run* | 4.39±0.05 | 4.27±0.04 |
| *Number of neryo chagi kicks in 15 s* | 26.7±0.8 | 29.4±0.7 |
| *Number of dolyo chagi kicks in 15 s* | 30.5±0.9 | 33.2±0.8 |
| *Standing long jump* | 245.8±3.0 | 253.6±3.2 |
| *Rope jumps for 30 s* | 86.9±2.2 | 93.8±2.4 |
| *Step-ups for 30 s* | 33.1±1.2 | 36.8±1.1 |

the results of the study confirm that the use of high-intensity interval training contributes to the more effective development of athletes' speed-strength abilities compared to traditional training methods.

## Conclusion

A review of scientific and methodological literature has shown that developing speed-strength abilities is a key area in the training of taekwondo athletes, as these qualities directly influence the effectiveness of technical actions, attack speed, and the athlete's ability to maintain a high level of competitive performance. The pedagogical experiment established that using a high-intensity interval training (HIIT) program positively impacts the development of speed-strength abilities in taekwondo athletes aged 16–17. Upon completion of the experiment, athletes in the experimental group showed more pronounced improvement than the control group in tests of speed, explosive strength, special speed endurance, and functional fitness (30m sprint, neryo-chagi and dollyo-chagi kicks, standing long jump, rope jumping, and step-ups). Statistical analysis of the data revealed significant differences between the indicators of the control and experimental groups post-experiment, confirming the effectiveness of using HIIT in the training system for 16–17-year-old taekwondo athletes. The developed high-intensity interval training program can be recommended for inclusion in the training process of athletes with a Candidate for Master of Sport (CMS) qualification to improve their speed-strength training and enhance their level of special physical performance.

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