"IDO MOVEMENT FOR CULTURE. Journal of Martial Arts Anthropology",
Vol. 16, no. 4 (2016), pp. 31–37
DOI: 10.14589/ido.16.4.5

## COACHING

Tomas Herrera-Valenzuela[1,2(ABCDEF)], Pablo Valdes-Badilla[3,4 (ABCDEF)], Emerson Franchini[5(DEF)], Jonatas Ferreira da Silva Santos[5(DEF)], Rodrigo Ramirez-Campillo[6,7(DEF)], Antonio Garcia-Hermoso[2(DEF)], Samuel Duran-Aguero[8(DEF)], Juan Pablo Castaneda-Gomez[2(DEF)]

[1] Laboratorio de Inmunología de la Reproduccion, Facultad de Química y Biología. Universidad de Santiago de Chile, USACH (Chile)

[2] Laboratorio de Ciencias de la Actividad Física, el Deporte y la Salud. Universidad de Santiago de Chile, USACH (Chile)

[3] Instituto de Actividad Física y Salud, Universidad Autonoma de Chile (Chile)

[4] Departamento de Educacion Física, Facultad de Educacion, Universidad Autonoma de Chile, sede Temuco (Chile)

[5] Martial Arts and Combat Sports Research Group, Sport Department, School of Physical Education and Sport, University of Sao Paulo, Sao Paulo (Brazil)

[6] Department of Physical Activity Sciences, Universidad de Los Lagos, Osorno (Chile)

[7] Department of Physical Education, Sport and Recreation, Universidad de La Frontera, Temuco, (Chile)

[8] Carrera de Nutricion y Dietetica. Facultad de Ciencias de la Salud, Universidad San Sebastian, (Chile)

Corresponding author: Tomas Herrera-Valenzuela, e-mail: tomas.herrera@usach.cl

# Effects of multi-component training on the physical fitness of young taekwondo athletes

Submission: 26.04.2016; acceptance: 10.06.2016

**Key words:** sports, martial arts, combat sports, conditioning

**ABSTRACT**

Background and Problem. Taekwondo is an Olympic sport characterized by the extensive use of kicking techniques which require a significant amount of explosive force and agility [Valdes-Badilla *et al.* 2014; Perez-Gutierrez *et al.* 2015]. It is considered an intermittent-high intensity short duration discipline, in which the predominance of the aerobic and anaerobic systems is alternated [Campos *et al.* 2012; Bridge *et al.* 2009; Herrera *et al.* 2014; Matsushigue *et al.* 2009; Santos *et al.* 2011; Thompson, Vinueza 1991]. The aim of this study is thus to determine the effects of a 16-week multi-component training programme on the physical fitness of a group of young taekwondo athletes.

Material and Methods. A group of 22 well-trained athletes (8.8. ± 0.5 years old, body mass 34.6 ± 6.7 kg, height 1.35 ± 0.1 m, and BMI 18.8 ± 2.7) was trained throughout the 16 weeks The training volume was divided in a constant ratio of 60% specific taekwondo training and 40% multi- component training. The multi-component training was divided into strength (10%), endurance (10%), speed (20%), agility (30%) and flexibility (30%) training. The athletes' performance in long jump, in the number of abdominal crunches completed in 30s and in speed-agility tests as well as their flexibility were measured before and after the 16-week training period.

Results. After the 16-week training period, an increase in long jump performance was observed in both the boys ($p<0.01$; ES=1.60) and the girls ($p<0.05$; ES=0.74). Likewise, improvements in the abdominal crunches in 30s test for both genders (boys, $p<0.01$; ES=1.50; girls, $p<0.05$; ES=0.89) were observed. Additionally, performance in the speed-agility test was improved in both the boys ($p<0.01$: ES=-1.37) and the girls ($p<0.05$; ES=-1.16). No significant differences were observed in the "sit and reach" test after the intervention.

Conclusions. In conclusion, a multi-component training programme, in the initial stages of the sport, can be an effective way of improving physical fitness and consequently the performance of young taekwondo athletes in competition.

## Introduction

Taekwondo is an Olympic sport characterized by an extensive use of kicking techniques that require an important amount of explosive force and agility [Valdes-Badilla *et al*. 2014; Perez-Gutierrez *et al*. 2015]. It is considered an intermittent-high intensity discipline of short duration, in which the aerobic and anaerobic systems alternate their predominance [Campos *et al*. 2012; Bridge *et al*. 2009; Herrera *et al*. 2014; Matsushigue *et al*. 2009; Santos *et al*. 2011; Thompson, Vinueza 1991]. Performance can be influenced by physical fitness [Pieter, Heijmans 2003], more specifically through increases in aerobic and anaerobic power, muscular strength and power, flexibility and agility [Bridge *et al*. 2009; Pieter 1991; Heller *et al*. 1998; Bouhlel *et al*. 2006; Markovic *et al*. 2008; Bridge *et al*. 2014]. Therefore, development of muscular strength and endurance of the lower limbs are the main objectives of training, as both are considered critical during the execution of the kicking techniques [Bridge *et al*. 2014].

Nonetheless, the effects of taekwondo training on physical fitness remain unclear, in spite of an increased interest in taekwondo research over the last four years [Valdes-Badilla *et al*. 2014; Perez-Gutierrez *et al*. 2015]. For instance, a review by Fong and Ng [2011] concluded that specific taekwondo training could be associated with improvements in anaerobic performance and flexibility, but had no clear effects on aerobic capacity and muscular strength. Similarly, a low-frequency (twice a week) taekwondo training programme resulted in improved flexibility and long jump performance in the female adolescents [Kim *et al*. 2011]. However, a more recent study on the adolescent girls established that an extensive period (~1 year) of intense taekwondo training led to improved outcomes in coordination and flexibility, but also resulted in a significant decrease in long jump test performance [Kim *et al*. 2015]. In addition to this inconclusive evidence, most study designs of the available research are descriptive and cross-sectional and few of them focus on multi-component training and its effects on physical fitness of taekwondo athletes. The aim of this study was thus to determine the effects of a 16-week multi-component training programme on the physical fitness of a group of young taekwondo athletes.

## Material and Methods

### Participants

Twenty-two (n=11 male; n=11 female) young, well-trained, taekwondo athletes completed this study. Their mean ± SD age was 8.8. ± 0.5 years, body mass 34.6 ± 6.7 kg, height 1.35 ± 0.1 m, and BMI 18.8 ± 2.7. Gender specific characteristics are described in table 1. Participants had an average of three years of taekwondo training (4 times per week, 60-120 min per session) and at least one year in competition. Parents of all participants gave their written informed consent with expressed assent from the subjects before participating in this study, which was approved by the local Ethical Committee in compliance with the Declaration of Helsinki.

### Measurements

Body mass (kg), height (m) and body mass index (BMI – kg/m$^2$) were determined using previously described protocols. To determine body mass and height, a digital scale (Scale-tronix, USA) and a stadimeter (Seca, model 220, Germany) with a precision of ± 0.1 kg and ± 0.1 cm, respectively, were used.

Following all anthropometric measurements, subjects were asked to move to the taekwondo gymnasium of the CEO Chile (Olympic Training Centre of Chile), where they completed a guided general warm-up. Then, they performed the physical fitness tests. Performance was evaluated for long jump (cm), flexibility test (cm), abdominal crunches in 30 s (repetitions) and speed with changes of direction in 10x5 m (s) using protocols previously described in the EUROFIT (Council of Europe, 1993), and Fitnessgram Healthy Fitness Zone (California Department of Education, 2012) series.

For the two-footed long jump performance test, subjects were asked to jump forward using a counter-movement but without a previous run-up. Following two attempts, the maximum reached distance from the starting line to the closest contact spot was recorded. Flexibility was assessed using the "sit and reach" test. Participants were asked to sit on the floor with their legs extended and reach forward with their arms extended. The maximum distance reached with the fingertips following two attempts was registered. For the abdominal crunches in 30 s test, subjects were asked to lay down on the floor with their knees in a 90° angle, their feet on the ground, and perform as many abdominal crunches as they could in the allowed time. The speed with changes

**Table 1.** Group demographics measured before the intervention. All data are Mean ± SD.

| | Total (n = 22) | Girls (n = 11) | Boys (n = 11) |
|---|---|---|---|
| Age (years old) | 8.8 ± 0.5 | 9.0 ± 0.5 | 8.6 ± 0.5 |
| Body mass (kg) | 34.6 ± 6.7 | 34.0 ± 6.0 | 35.2 ± 7.4 |
| Height (m) | 1.35 ± 0.1 | 1.35 ± 0.1 | 1.35 ± 0.1 |
| BMI (kg/m$^2$) | 18.8 ± 2.7 | 18.4 ± 2.7 | 19.2 ± 2.6 |

*BMI= Body Mass Index*

of direction in 10x5 m test consisted of a set of 10 runs from one spot to another separated by 5 m. Subjects were asked to stand on one end and react to an auditory signal after which they had to run at a maximum speed from end to end, until completion of 10 runs. Time was recorded from the moment the signal was given until the end of the tenth run, using a standard stopwatch.

The same measurement protocols were applied before and after the 16-week training period.

### Procedures

Athletes trained during a 16-week period four sessions per week (i.e. Monday, Tuesday, Thursday and Friday). All training sessions consisted of taekwondo-specific training and multi-component training (Table 2), but differed in training volume during the 16-week period.

Training volume was regulated using a progressive periodization. The total time per session increased through three weeks and decreased during the fourth week. This system was repeated four times across the 16-week period. Nevertheless, a constant relative distribution of 60% and 40% of training time (per session) was maintained for taekwondo-specific and multi-component training, respectively. Likewise, training times for multi-component training was divided into strength (10%), endurance (10%), speed (20%), agility (30%) and flexibility (30%). The distribution characteristics are presented in Table 3.

### Statistical Analysis

All values are reported as mean ± standard deviation (SD). Relative changes (%) in dependent variables and Cohen´s d effect size (ES) are expressed with 95% confidence interval (CI). Normality and homoscedasticity assumptions for all data before and after intervention were checked using the Shapiro–Wilk and Levene's tests, respectively. Training-related effects and relative changes for the boys and girls were assessed using a two-way ANOVA with repeated measures (groups × time). The α level was set at $p \leq 0.05$ for statistical significance. All statistical calculations were performed using the STATISTICA statistical package (Version 8.0; StatSoft Inc., Tulsa, OK, USA). In addition to this null hypothesis testing, data were also assessed for clinical significance using an approach based on the magnitudes of change. Threshold values for assessing ES were 0.20, 0.60, 1.2 and 2.0 for small, moderate, large and very large, respectively [Hopkins 2009]. High intra-class correlation coefficients for the different performance measurements were obtained, varying between 0.81 and 0.96.

## Results

Table 4 describes the values for all dependant variables (pre and post training).

After the 16-week training period, an increase in long jump performance was observed in both the boys ($p<0.01$; ES=1.60) and the girls ($p<0.05$; ES=0.74). Likewise, improvements in the abdominal crunches in 30 s test for both genders (boys, $p<0.01$; ES=1.50; girls, $p<0.05$; ES=0.89) were observed. Additionally, performance in the speed-agility test was improved both in the boys ($p<0.01$: ES=-1.37) and the girls ($p<0.05$; ES=-1.16). No significant differences were observed in "sit and reach" test after the intervention.

## Discussion

The aim of this study was to investigate the effect of periodized training on the performance of young taekwondo athletes of both sexes. The main findings of this study comprised of increased two-footed long jump,

**Table 2.** Detailed description for both training modalities used across the 16-week training period.

| TRAINING CONTENT | | DESCRIPTION |
|---|---|---|
| **Taekwondo-specific training** | Guard | Low, medium and high, individually and in pairs. |
| | Movements | Lineal, lateral, diagonal, pivoting, etc. |
| | Kicking Techniques | Front, lateral, round, descendent, spinning, in movement, in-chains and jumping |
| | Fist strikes and blocks | Attack and defence, with/without opposition, main focus in coordination of movements |
| | Combat | Attack drills (direct and indirect). Defensive drills (i.e. anticipation, counter-attack, weaving and blocking) |
| **multi-component training** | Strength | Wrestling games in pairs, jumps, exercises using body weight, abdominal crunches, push-ups, etc. |
| | Endurance | Chasing games; Games for initiation in collective sports (with ball): football, handball, rugby, etc. |
| | Speed | Races, relay games, backwards races, etc. |
| | Agility | Coordination ladder drills. |
| | Flexibility | Dynamic flexibility through warm-up exercises |

**Table 3.** Training volumes (min) for specific taekwondo training and multi-component training (strength, speed, endurance, flexibility, agility).

| | W1 | W2 | W3 | W4 | W5 | W6 | W7 | W8 | W9 | W10 | W11 | W12 | W13 | W14 | W15 | W16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Taekwondo Training (Monday, Tuesday, Thursday, Friday)** | 144 | 168 | 192 | 156 | 168 | 192 | 216 | 180 | 216 | 240 | 264 | 228 | 240 | 264 | 288 | 252 |
| **Strength (Monday, Thursday)** | 9.6 | 11.2 | 12.8 | 10.4 | 11.2 | 12.8 | 14.4 | 12 | 14.4 | 16 | 17.6 | 15.2 | 16 | 17.6 | 19.2 | 16.8 |
| **Speed (Monday, Thursday)** | 19.2 | 22.4 | 25.6 | 20.8 | 22.4 | 25.6 | 28.8 | 24 | 28.8 | 32 | 35.2 | 30.4 | 32 | 35.2 | 38.4 | 33.6 |
| **Endurance (Tuesday, Friday)** | 9.6 | 11.2 | 12.8 | 10.4 | 11.2 | 12.8 | 14.4 | 12 | 14.4 | 16 | 17.6 | 15.2 | 16 | 17.6 | 19.2 | 16.8 |
| **Flexibility (Monday, Tuesday, Thursday, Friday)** | 28.8 | 33.6 | 38.4 | 31.2 | 33.6 | 38.4 | 43.2 | 36 | 43.2 | 48 | 52.8 | 45.6 | 48 | 52.8 | 57.6 | 50.4 |
| **Agility(Tuesday, Friday)** | 28.8 | 33.6 | 38.4 | 31.2 | 33.6 | 38.4 | 43.2 | 36 | 43.2 | 48 | 52.8 | 45.6 | 48 | 52.8 | 57.6 | 50.4 |

W = Week.

**Table 4.** Training effects on physical fitness in young taekwondo athletes following a 16-weeks multi-component training programme.

| | **Pre-test Mean ± SD** | **Post-test Mean ± SD** | **Changes (%)** | **Effects size (95% CI)** |
|---|---|---|---|---|
| **Two-footed long jump (cm)** | | | | |
| Total | 145 ± 10.2 | 158 ± 12.5 [b] | 8.6 (5.3, 11.9) | 1.03 (0.65, 1.41) ** |
| Girls | 143 ± 12.7 | 155 ± 15.3 [a] | 8.0 (2.9, 13.3) | 0.74 (0.27, 1.20) ** |
| Boys | 147 ± 7.0 | 161 ± 8.4 [b] | 9.2 (4.4, 14.2) | 1.60 (0.78, 2.42) *** |
| **Abdominal crunches in 30 s (repetitions)** | | | | |
| Total | 21.9 ± 3.2 | 26.1 ± 3.5 [b] | 19.2 (12.8, 26.0) | 1.22 (0.83, 1.60) *** |
| Girls | 21.7 ± 3.1 | 25.4 ± 4.3 [a] | 16.3 (7.1, 26.2) | 0.89 (0.41, 1.32) ** |
| Boys | 22.1 ± 3.4 | 26.8 ± 2.4 [b] | 22.2 (12.3, 33.0) | 1.50 (0.87, 2.14)*** |
| **Speed-Agility test 10×5-m (s)** | | | | |
| Total | 21.9 ± 1.2 | 20.1 ± 1.4 [b] | -8.1 (-10.6, -5.7) | -1.35 (-1.77, -0.92) *** |
| Girls | 21.7 ± 1.2 | 20.2 ± 1.2 [a] | -6.8 (-10.9, -2.4) | -1.16 (-1.91, -0.41) ** |
| Boys | 22.1 ± 1.3 | 20.0 ± 1.6 [b] | -9.5 (-12.4, -6.4) | -1.37 (-1.83, -0.91) *** |
| **sit and reach (cm)** | | | | |
| Total | 10.1 ± 4.4 | 11.6 ± 4.5 [b] | 16.4 (3.5, 30.8) | 0.33 (0.07, 0.58) * |
| Girls | 13.3 ± 3.6 [c] | 14.7 ± 3.7 [c] | 11.3 (4.6, 18.4) | 0.35 (0.15, 0.56) * |
| Boys | 7.2 ± 3.6 | 8.5 ± 2.7 | 21.7 (-4.5, 55.1) | 0.50 (-0.12, 1.12) * |

P1: before intervention; P2: after 16-weeks of multi-component training; [*]small; ** moderate; *** large; [a, b]: significant differences with P1 ($p<0.05$ and $p<0.01$, respectively); [c]: significant differences with the boys group ($p<0.05$).

abdominal crunches in 30 s, speed-agility test 10×5-m and "sit and reach" to changes in performance between 8 -19% after 16 weeks of periodized training (multi-component).

The two-footed long jump of young taekwondo athletes increased 8% for the females, ~ 9% for the males and averaged 8.6% for both groups. An increased standing long jump has been described for female taekwondo practitioners after a period of 12 weeks of intervention (Kim, 2011). Thus we suggest that this increase in performance is linked to the training conducted, since young people were pre-pubertal and the effect of maturation probably was not decisive to explain the results. Previous studies that investigated the acute effect using jumps have shown that during the taekwondo fights muscle power of lower limbs increases [Chiodo *et al*. 2011]. This effect has been attributed to the manifestation of the post-activation potentiation. Muscle power is of great importance for the realization of a blow in taekwondo [Bridge *et al*. 2014; Santos *et al*. 2015]. A meta-analysis conducted by Payne *et al*. [1997] showed that after 8-12 weeks of strength training of young people under 18 years old, including children 6 years and also practitioners of wrestling and martial arts, there was an increase between 30% and 40% of muscle strength. In addition, the improvement in muscle power can be important when applying for a blow, the chances of reaching the opponent without conceding counter-attacks are higher.

Abdominal crunches in 30 s increase when comparing the pre- and post-test, an increase of 22%, 16% and 19% for the boys, girls and in total, respectively. Muscular endurance is an important feature for taekwondo athletes, as they should have power to apply and also to receive impacts over combat. This feature is also associated with health standards. Previous studies with taekwondo athletes show that these subjects have good abdominal strength [Schwartz *et al*. 2015; Fong, Ng 2011].

Speed-Agility test 10×5-m of the young taekwondo athletes improved after the intervention period by 9%, 7% and 8% for the boys, girls and the total respectively. Currently it can be suggested that the speed and flexibility are important characteristics for taekwondo. A difference has been shown between men (sprint-medalists: 4.62 ± 0:41 s vs. non-medalists: 4.81 ± 0:51 s) [Sadowski *et al*. 2012] and women (sprint medalists-20-m: 3.6 ± 0.2 s vs. non-medalists: 3.81 ± 0.1 s) [Markovic *et al*. 2005]. Agility mainly seemed to be an important feature which has distinguished medal athletes and non-medalists of both sexes [Sadowski *et al*. 2012; Markovic *et al*. 2005].

"Sit and reach" test increases only among girls compared the pre and post-intervention (11%). There were differences between the flexibility presented by the girls compared boys in pre (Girls: 13.3 vs Boys: 7,2 cm) and post moment (Girls: 13.3 vs Boys: 7,2cm) intervention. Taekwondo female athletes have shown a greater range of motion than male, but there is still little evidence showing greater flexibility in women [Heller *et al*. 1998; Toskovic *et al*. 2004; Rivera *et al*. 1998]. In the study by Kim *et al*. [2011], an increase in flexibility (pre: 16 ± 7 cm to 18 ± 6 cm) after a 12-week intervention period. Flexibility is an important feature for performing complex actions on the taekwondo and associated muscle strength and endurance can help maintain body posture. Athletes often need to perform blows on the head of the opponent, those techniques may yield more points (3 or 4 points) (WTF, 2015). In addition, more flexible athletes can generate more powerful blows, the main reason to explain this statement is that these athletes will perform the movement for greater trajectory, which can result in an increased acceleration time [Turner 2009]. Good flexibility is associated with reduction of musculo-skeletal disorders [Magnusson, Renstrom 2006; Woods *et al*. 2007], and is a component of physical fitness related to health. It has been shown that taekwondo athletes have good flexibility ("sit-and-reach" 55 ± 19 cm classification:> 90% percentile rank) [Heyward 2010]. However, it seems possible to assert that flexibility is important in the match context, not discriminating medalists and non-medalists athletes [Markovic *et al*. 2005]. The big difference between the data of this study and previous study is associated with the instrument used (Weells bank), which favours individuals with long limbs, due to the increased range of longer arms, rather than those with smaller limbs, who cannot reach far. Although this method is the most widely used to measure the flexibility of taekwondo athletes [Bridge *et al*. 2014], however it does not correspond in general with the results of research that determine movement range of other joints [Zak, Sterkowicz 2006] that serve as references for taekwondo athletes.

Note that all tests used in this study to obtain strength measurements, endurance, agility and flexibility are described in different batteries of tests for children and adolescents [AAHPERD, 1988; EUROFIT 1993]. In summary, the multi-component training could be an effective method for development of physical fitness for taekwondo athletes in the initial stages of the sport. These types of training could be included in sports initiation, considering the inclusion of a greater amount of activities to develop flexibility.

## References

1. American Alliance for Health, Physical Education, Recreation and Dance (1998), *Health-Related Physical Fitness [Test Manual],* Author, Reston, VA.
2. Bouhlel E., Jouini A., Gmada N., Nefzi A., Ben Abdallah K., Tabka Z. (2006), *Heart rate and blood lactate responses*

*during taekwondo training and competition*, "Sci Sports", vol. 21, no. 5, pp. 285-290.
3. Bridge C., Jones M., Drust B. (2009), *Physiological responses and perceived exertion during international Taekwondo competition*, "Int J Sports Physiol Perform", vol. 4, no. 4, pp. 485-493.
4. Bridge C.A., Santos J.F.D., Chaabene H., Pieter W., Franchini E. (2014), *Physical and physiological profiles of taekwondo athletes*, "Sports Med", vol. 44, no. 6, pp. 713-733.
5. California Department of Education. *Fitnessgram healthy fitness zone chart* (2012), Available at http://www.cde.ca.gov/ta/tg/pf/documents/healthfitzone09.pdf:; Revised in 10.07.2015.
6. Campos F.A., Bertuzzi R., Dourado A.C., Santos V.G., & Franchini E. *Energy demands in taekwondo athletes during combat simulated*. (2012), "Eur J Appl Physiol", vol. 112, no. 4, pp. 1221-1228.
7. Chiodo S., Tessitore A., Cortis C., Ammendolia A., Iona T., Capranica L. (2011), *Effects of official taekwondo competitions on all-out performances of elite athletes*, "J Strength Cond Res", vol. 25, no. 2, pp. 334-339.
8. EUROFIT: Handbook for the EUROFIT Tests of Physical Fitness. Council of Europe, Committee for the Development of Sport, Second edition, Strasburg (1993), pp. 42-60.
9. Fong S.S., Ng G.Y. (2011), *Does Taekwondo training improve physical fitness?*, "Phys Ther Sport", vol. 12, no. 2, pp. 100-106.
10. Heller J., Peric T., Dlouha R., Kohlíkova E., Melichna J., Novakova H. (1998), *Physiological profiles of male and female taekwon-do (ITF) black belts*, "J Sport Sci", vol. 16, no. 3, pp. 243-249.
11. Herrera T., Cancino J., Franchini E., Henríquez-Olguín C., Aedo E. (2014), *Physiological and physical profile of taekwondo athletes of different age categories during simulated combat*, "Ido Movement for Culture. Journal of Martial Arts and Anthropology", vol. 14, no. 2, pp. 36-40.
12. Heyward V.H. (2010), *Advanced fitness assessment and exercise prescription*, 6° edition, Human Kinetics, Champaign.
13. Hopkins W., Batterham A., Marshall S., Hanin J. (2009), *Progressive Statistics*. "Sportscience", vol. 13, pp. 55-70. Avaible at: sportsci.org/2009/prostats.htm. Accessed 10.07.2015.
14. Kim H.B., Jung H.C., Song J.K., Chai J.H., Lee E.J. (2015), *A follow-up study on the physique, body composition, physical fitness, and isokinetic strength of female collegiate Taekwondo athletes*, "J Exerc Rehabil", vol. 11, no. 1, pp. 57-64.
15. Kim H.B., Stebbins C.L., Chai J.H., Song J.K. (2011), *Taekwondo training and fitness in female adolescents*, "J Sports Sci", vol. 29, no. 2, pp. 133-138.
16. Magnusson P., Renstrom P. (2006), *The European college of sports science position statement: the role of stretching exercise in sports*, "European Journal of Sport Science", vol. 6, no. 2, pp. 87-91.
17. Markovic G., Misigoj-Durakovic M., Trninic S. (2005), *Fitness profile of elite Croatian female taekwondo athletes*, "Coll Antropol", vol. 29, no. 1, pp. 93-99.
18. Markovic G., Vucetic V., Cardinale M. (2008), *Heart rate and lactate responses to taekwondo fight in elite women performers*, "Biol Sport", vol. 25, no. 2, pp. 135-146.
19. Matsushigue K., Hartmann K., Franchini E. (2009), *Taekwondo Physiological responses and match analysis*, "J Strength Cond Res", vol. 23, no. 4, pp. 1112-1117.
20. Payne V.G., Morrow J.R., Johnson L., Dalton S.N. (1997), *Resistance training in children and youth: a meta-analysis*, "Res Q Exerc Sport", vol. 68, no. 1, pp. 80-88.
21. Perez-Gutierrez M., Valdes-Badilla P., Gomez-Alonso M.T., Gutierrez-Garcia C. (2015), *Bibliometric analysis of taekwondo articles published in the Web of Science (1989-2013)*, "Ido Movement for Culture. Journal of Martial Arts and Anthropology", vol. 15, no. 3, pp. 8-21.
22. Pieter W. (1991), *Performance characteristics of elite taekwondo athletes*, "Korean J Sports Sci", vol. 3, pp. 94–117.
23. Pieter W., Heijmans J. (2003), *Training and competition in taekwondo*, "J Asian Martial Arts", vol. 12, no. 1, pp. 8-22.
24. Rivera M., Rivera-Brown A., Frontera W. (1998), *Health related physical fitness characteristics of elite Puerto Rican athletes*, "J Strength Cond Res", vol. 12, no. 3, pp. 199–203.
25. Sadowski J., Gierczuk D., Miller J., Cieslinski I. (2012), *Success factors in elite WTF taekwondo competitors*, "Arch Budo", vol. 8, no. 3, pp. 141–146.
26. Santos V., Franchini E., Lima-Silva A. (2011), *Relationship between attack and skipping in Taekwondo contests*, "J Stength Cond Res", vol. 25, no. 6, pp. 1743-1751.
27. Schwartz J., Takito M., Del Vecchio F., Antonietti L., Franchini E. (2015), *Health-related physical fitness in martial arts and combat sports practitioners*m, "Sport Sci Health", vol. 11, no. 2, pp. 171-180.
28. Thompson W., Vinueza C. (1991), *Physiological profiles of male and female Taekwondo black belts*, "Sports Med Training Rehabil", vol. 3, no. 1, pp. 49-53.
29. Toskovic N.N., Blessing D., Williford H.N. (2004), *Physiologic profile of recreational male and female novice and experienced Tae Kwon Do practitioners*, "J Sports Med Phys Fit", vol. 44, no. 2, pp. 164–172.
30. Turner A. (2009), *Strength and conditioning for taekwondo athletes*, "UKSCA", vol. 15, pp. 15-27.
31. Valdes-Badilla P., Perez-Gutierrez M., Herrera-Valenzuela T. (2014), *Bibliometric analysis of Iberoamerican scientific production regarding taekwondo*, "Rev Horiz Cienc Act Fís", vol. 5, no. 2, pp. 78-88.
32. Woods K., Bishop P., Jones E. (2007), *Warm-up and stretching in the prevention of muscular injury*, "Sports Medicine", vol. 37, no. 12, pp. 1089-1099.
33. World Taekwondo Federation. Competition Rules. Available http://www.wtf.org/wtf_eng/site/rules/competition.html. Accessed: 28 Oct 2015.
34. Zak S., Sterkowicz S. (2006), *A relative evaluation of the development of flexibility in boys at the ages between 8 and 15,* "Biol Sport", vol. 23, no. 4, pp. 401-412.

## Efekty wieloskładnikowego programu treningowego na sprawność fizyczną młodych zawodników taekwondo

**Słowa kluczowe:** sport, sztuki walki, sporty walki, uwarunkowanie

**Abstrakt**

Problem. *Taekwondo* jest sportem olimpijskim charakteryzującym się szerokim wykorzystaniem technik kopnięć, które wymagają dużej siły rażenia i zwinności. Taekwondo uznaje się za dyscyplinę o krótkotrwałej przerywanej wysokiej intensywności, w których systemy tlenowe i beztlenowe przeważają naprzemiennie. Celem badania było określenie wpływu 16-tygodniowego wieloskładnikowego programu treningowego na sprawność fizyczną w grupie młodych zawodników taekwondo.

Materiał i metody. Grupa 22 dobrze wytrenowanych sportowców (8,8 ± 0,5 lat, masa ciała 34,6 ± 6,7 kg, wzrost 1,35 ± 0,1 m i BMI 18,8 ± 2,7) była szkolona w ciągu 16 tygodni w czasie treningów, w których 60% czasu przeznaczono na szkolenia taekwondo i 40% na szkolenia wieloskładnikowe. Trening wieloskładnikowy podzielono na części szkolące: siłę (10%), wytrzymałość (10%), prędkość obrotową (20%), sprawność (30%) i elastyczność (30%). Wyniki w skoku w dal, elastyczności, wykonywanie „brzuszków" w ciągu 30 sekund i testy prędkości oraz sprawności mierzono przed i po 16-tygodniowym okresie treningowym.

Wyniki. Po 16-tygodniowym okresie szkolenia, stwierdzono poprawę wyników w skoku w dal u zawodników ($p < 0,01$; ES = 1,60) i zawodniczek ($p < 0,05$; ES = 0,74). Podobna poprawa nastąpiła dla obu płci w ilości wykonywanych brzuszków w ciągu 30 s (chłopcy, $p < 0,01$; ES = 1,50; dziewczynki, $p < 0,05$; ES = 0,89). Oprócz tego, wyniki w teście szybkości i sprawności poprawiły się u chłopców ($p < 0,01$: ES = -1,37) i dziewcząt ($p < 0,05$; ES = -1,16). Nie stwierdzono istotnych różnic w testach sprawdzających odległość sięgania w pozycji siedzącej (*sit and reach test*).

Wnioski. Podsumowując, wieloskładnikowy program szkoleniowy, w początkowej fazie trenowania tego sportu, może być skutecznym sposobem na poprawę kondycji fizycznej, a tym samym efektywności młodych zawodników trenujących taekwondo.