Sivas Cumhuriyet University Journal of Sport Sciences, 6(3): 247-260, 2025

Sivas Cumhuriyet University
Journal of Sport Sciences

| cuspor.cumhuriyet.edu.tr | Founded: 2020 Available online, ISSN: 2717-8919 Publisher: Sivas Cumhuriyet Üniversitesi

Do Static and Dynamic Core Training Programs Affect Some Biomotor Performance in Young Taekwondo Athletes?

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Research Article

Acknowledgment

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History
Received: 16/10/2025
Accepted: 20/11/2025

ABSTRACT

Objective: The aim of this pilot study was to investigate the effects of an 8-week combined static and dynamic core training program, in addition to routine taekwondo practice, on strength, speed, balance, and taekwondo-specific kicking performance in young taekwondo athletes.

Methods: Twenty-one young athletes (8 males, 13 females; mean age = 13.2 ± 0.8 years; weight:52.60±6.59 kg; height:158.75±5.70 cm; 13 female age:13.08±0.76 years., weight:50.13±5.75 kg, height:155.85±4.10 cm), completed an 8-week core training intervention (3 sessions/week, 35 min). A single-group pretest–post-test design was employed. Outcomes included core strength (leg-lift, plank, sit-ups, push-ups), lower-limb strength and power (leg press, leg mass, relative leg strength, vertical jump), speed (30-m sprint), balance (stork test), and taekwondo-specific kicking power (palding chagi, yop chagi, spinning palding chagi) measured with a PSS device. Data were analysed using Wilcoxon signed-rank tests, with effect sizes (r) and 95% confidence intervals reported.

Results: Significant improvements were observed in leg-lift, plank, sit-ups, push-ups, vertical jump, 30-m sprint, leg press, leg mass, and relative leg strength (all $p < .05$, $r = 0.45–0.68$). Kicking performance increased for palding chagi, yop chagi, and spinning palding chagi ($p < .05$, $r = 0.42–0.60$). No significant changes were found in stork balance ($p > .05$)
Conclusion: This uncontrolled pilot study suggests that an 8-week combined static and dynamic core training program may improve strength, sprint, and taekwondo-specific kicking performance in young athletes, while balance remained unchanged.

Keywords: Taekwondo; Core training; Palding chagi; Yop chagi; Kicking; Strength

Statik ve Dinamik Core Egzersiz Programları Genç Taekwondo Sporcularının Bazı Biyomotor Performansını Etkiler mi?

Bilgi

**Sorumlu yazar*

Süreç
Geliş: *16/10/2025*
Kabul: *20/11/2025*

ÖZ

Amaç: Bu pilot çalışmanın amacı, rutin tekvando antrenmanına ek olarak 8 haftalık statik ve dinamik karın kasları antrenman programının genç tekvando sporcularının güç, hız, denge ve tekvandoya özgü tekme performansları üzerindeki etkilerini araştırmaktır.

Yöntemler: 21 genç sporcu (8 erkek, 13 kadın; ortalama yaş = 13,2 ± 0,8 yıl; vücut ağırlığı = 52,60 ± 6,59 kg; boy uzunluğu = 158,75 ± 5,70 cm'dir. Kadın sporcuların (n = 13) yaş ortalaması = 13,08 ± 0,76 yıl, vücut ağırlığı = 50,13 ± 5,75 kg ve boy uzunluğu = 155,85 ± 4,10 cm'dir. 8 haftalık bir core antrenmanı (haftada 3 seans, 35 dakika) gerçekleştirdi. Araştırmada tek gruplu ön test-son test tasarımı kullanıldı. Sonuçlar arasında core gücü (bacak kaldırma, plank, mekik, şınav), alt ekstremite gücü ve kuvveti (bacak presi, bacak kütlesi, göreceli bacak gücü, dikey sıçrama), hız (30 m sprint), denge (stork testi) ve tekvandoya özgü tekme gücü (palding chagi, yop chagi, spinning palding chagi) PSS cihazı ile ölçüldü. Veriler Wilcoxon işaretli sıra testleri kullanılarak analiz edildi ve etki büyüklükleri (r) ve %95 güven aralıkları rapor edildi.

Bulgular: Bacak kaldırma, plank, mekik, şınav, dikey sıçrama, 30 m sprint, bacak presi, bacak kütlesi ve göreceli bacak gücü (tümü $p <.05$, $r = 0,45–0,68$) alanlarında önemli iyileşmeler gözlemlendi. Palding chagi, yop chagi ve spinning palding chagi'de tekme performansı arttı ($p <.05$, $r = 0,42–0,60$). Stork dengesinde önemli bir değişiklik gözlenmedi ($p> .05$).
Sonuç: Bu kontrolsüz pilot çalışma, 8 haftalık statik ve dinamik karın kasları egzersiz programının genç sporcuların kuvvet, sprint ve tekvandoya özgü tekme performansını iyileştirebileceğini, ancak denge performansının değişmediğini göstermektedir.

Anahtar Kelimeler: Özet, Anahtar kelime, Virgül, Baş harf, Büyük

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How to Cite: Aydemir, B., Yılmaz, D.S., Marangoz, İ., Kırkbir, F., Mülazımoğlu, O.& Özkara A.B (2025). Statik ve Dinamik Core Egzersiz Programları Genç Taekwondo Sporcularının Bazı Biyomotor Performansını Etkiler mi?. *Sivas Cumhuriyet University Journal of Sport Sciences, 6*(3):247-260.

Introduction

Taekwondo, a concept derived from the sports philosophy of Far Eastern countries, has recently gained currency and adapted to technological advancements. From training to competition, its dynamics have undergone significant changes, and athlete performance has become increasingly prominent. These advancements have also led to the development of new training methods (Wu et al., 2016; Suchomel et al., 2016; Li, 2014; Li, 2012). New training models for athletes to achieve peak performance and maintain improved performance are frequently studied in the literature. Varied training methods have been reported to improve athlete performance (Ölmez and Akcan, 2021). In combat sports, in particular, research has become a focus of research on the most appropriate training methods for each branch.

While improved athlete performance is crucial for competitive performance, training sessions should be tailored to the specific sport. In sports like taekwondo, which are physically, and physiologically complex, peak performance is essential and achieving this requires a tailored training program. This program should be technically and tactically diverse, as well as include various exercise types that enhance physical performance. (Knuttgen, 2019).

Core training is one of the training methods used to help athletes achieve peak performance. Core training is an important training method that supports athletes in sustaining intense loads, enables physical adaptation to meet physical demands, and maintains performance. (Yıldız and Ünlü, 2016). Core exercises are one of the training methods that help athletes achieve the performance they need and contribute to the development of motor performance. (Mülazımoğlu, 2019). The core is defined as the middle region encompassing the hips, waist, abdomen, knees, and sternum, and is considered a crucial area for athletes to maintain spinal balance. It is defined as the development of physical strength in athletes, resisting external resistance, and performing bodyweight exercises. (Santana, 2005). Core exercises stabilize the spine, helping to distribute the energy generated throughout the body. (Li et al., 2021; Sun et al., 2016; Park, 2018). Core exercises also contribute to physical development by supporting muscle strength development. (Granacher et al., 2014). Core exercises allow athletes to carry more stress and load, thus contributing to more positive performance development (Nayyab et al., 2021). It is recommended that core exercises be systematically designed from simple to complex, from easy to difficult (Stephenson and Swank, 2004; Jones, 2013).

Core exercises promote muscle and strength development in athletes and are said to contribute significantly to functions such as dynamic balance. They are also crucial for injury prevention or rehabilitation in combat sports such as taekwondo. (Seo et al., 2020). Taekwondo is a sport that combines many complex skills. Taekwondo athletes must have a strong physique, and core training is a key factor in achieving this. The core area, known as the center of the human body, allows athletes to maintain a more balanced and powerful structure. Its importance for improving athletes' performance is clearly emphasized in the literature. Dynamic and static core training allows us to increase muscular endurance, strength, and mobility. Therefore, the core program is recognized as an important training method in training. (Kozlenia et al., 2024; García-Ramos et al., 2024; Ceylan et al., 2022; Chun et al., 2021; Seo et al., 2020). Other factors to improve the performance of athletes are height, weight, body composition, aerobic-anaerobic power, strength, speed, flexibility, technique and tactics (Suchomel et al., 2016). When examining specific performance parameters, balance, jumping, and endurance performance hold a critical place in taekwondo. The positive impact of core exercises on these parameters highlights the importance of including them in training programs. (Aslan et al., 2018; Sun et al., 2021; Capelli et al., 2016). Additionally, core exercises are frequently preferred in combat sports as they contribute to the development of speed, quickness, agility and speed performance (Ölmez et al., 2022).

8-week core exercises (dynamic and static) applied to young taekwondo athletes have a significant positive effect on some biomotor and taekwondo technical performances. Core musculature contributes to proximal stability and force transmission during high-velocity kicking; thus, enhancing core endurance and control may translate into greater kicking impulse and consistency in taekwondo (Yılmaz and Ateş, 2024).

To our knowledge, few studies have examined the combined effects of static and dynamic core training in youth taekwondo athletes, and no prior work has used PSS-measured kicking energy together with relative leg strength as primary outcomes. Recent studies support the relevance of core function to athletic performance (Ceylan, 2022; Padulo et al., 2013; Padulo et al., 2014). The aim of this study was to investigate the effects of an 8-week static and dynamic core training program, in addition to routine practice, on strength, speed, balance, and taekwondo-specific kicking performance in young taekwondo athletes.

Limitations

Since the study was conducted during a period when international organizations were busy, the desired sample size could not be reached.

The study was conducted with young taekwondo athletes who were not in the competition period and since the desired number could not be reached, the control group could not be determined.

No a priori power calculation was performed, and the absence of a control group limits causal inference. The study should therefore be considered exploratory

Although leg mass, thigh mass, and calf mass were collected, only total leg mass was presented in the results tables. This omission is a limitation of the current report.

The young taekwondo athletes in the study received only 8 weeks of core training.

In addition, although leg mass, thigh mass, and calf mass were measured according to the Hanavan method, only total leg mass was reported in the results tables. This omission represents another limitation of the present study.

The calculation of leg mass using the Hanavan method, while commonly applied, has limited validation in youth athletes and may reduce measurement precision. This represents an additional limitation of our study. In addition, previous work has highlighted the role of joint stability and injury prevention in young athletes (Migliorini et al., 2023), which is particularly relevant when interpreting the potential long- term benefits of core training.

Method

Participants

They did not prefer to make a priori analysis in determining the number of participants, because the participants included all athletes competing in a club's similar age category. No randomization was performed, because all eligible young taekwondo athletes from the same club and age category were included in a single intervention group. Therefore, the study design represents a single-group pretest– posttest approach without a separate control group. Therefore, all athletes consisting of 15 male and 15 female athletes in the 12-14 age category of the club were accepted as participants, but those who could not meet the inclusion criteria due to reasons such as regular participation in training or dropping out were excluded. At the end of the study, the data of a total of 21 volunteer taekwondo athletes, 8 males (age:13.25±0.89 yrs., weight:52.60±6.59 kg, height:158.75±5.70 cm) and 13 female (age:13.08±0.76 yrs., weight:50.13±5.75 kg, height:155.85±4.10 cm), who met the in-collusion criteria, were examined in this study. The athletes are in the red-black belt category and above belt category and have been practicing for the past 2 years. Informed consent forms and parental permissions were obtained from the participants. The necessary per-missions were obtained from Erzincan Binali Yıldırım University Human Research Health and Sports Sciences Ethics Committee (Number: E- 88012460-050.01.04-276518 Date: 17.07.2023) for this research.

Balance Strength and Speed Measurement

Stork Balance: In test, participants are positioned on a wooden floor with them without shoes and hands on their waist. The foot of the non-tested limb is fixed medial to the knee joint of the other limb. The participant is asked to fix his/her eyes on a point placed 5 meters away. The participant rises on tiptoe on the support leg and is asked to maintain the position for 1 minute and the timer starts with the command to rise. If the participant fails to maintain the position of the foot fixed medial to the knee, pulls one or both hands away from the waist and the heel of the support foot touches the ground, the stopwatch is stopped, and the second value is recorded. The test is repeated 3 times, and the best score is taken (Karimijashni et al., 2023).

Vertical Jump: The athletes will jump upwards with all their strength without taking a step and without bouncing on the time and distance scaled sensitive floor (Smart jump brand) and the distance jumped will be determined in centimeters on the device. After the athletes jumped 2 times, the best degree was recorded as the vertical jump value (Gençoğlu et al., 2023).

30-meter sprint: It was measured with a 30-meter sprint test using a photocell. The sprint was run with maximal tempo on the designated track. Time was determined in seconds (Baranovič and Zemková, 2021).

Leg Press Strength: The participant firstly tries to determine the weight that they can lift maximally. Afterwards, he/she makes a single trial with the maximum weight, they can lift, and it is recorded in kg (Marangoz and Keleş, 2022).

Leg Mass Calculation: Hanavan method used for leg mass in the study (Hanavan, 1964) Thigh, calf and foot measurements took to calculate leg mass. For the thigh, the distance between the tibial point and the inguinal fold, for the calf, the distance between the tibial point and the medial malleolus points and for the foot, after determining the medial malleolus and the whole foot, the measurements were calculated as defined by the Hanavan model method. "Leg Volume and Mass Calculation Programmer for Athletes" developed by Marangoz and Özbalcı (2017) was used as the calculation programmer.

Determination of Leg Mass: The following method was used respectively to determine the relative leg strength.

Total Thigh Mass: Body weight and the circumference of the thigh were measured where it gives the widest measurement.

Total Calf Mass: The circumference of the calf was measured where it gives the widest measurement.

Total Foot Mass: Ankle circumference and foot length were measured.

The data of these measurements were calculated in the leg mass calculation programmer using the formulas below and the total leg mass was determined.

Total Thigh Mass = 0.074*Body Weight + 0.138*Thigh Circumference - 4.641 Total Calf Mass = 0.135* Calf Circumference -1.318

Total Foot Mass = 0.003*Body Weight + 0.048*Ankle Circumference + 0.027*Foot Length - 0.869 (Marangoz, 2022).

Determination of Relative Leg Strength: The athletes' leg strength was divided by the total mass of the leg, and the relative strength of the leg was found in kg.

Relative Leg Strength = Leg Press Strength / Leg Mass (Marangoz, 2022).

Taekwondo specific strike tests

Palding Strikes: Participants performed the 3 different palding kick techniques most used in competitions (palding-chagi, yop-chagi and spinning palding-chagi). Three attempts were allowed with the right and left feet for each technique, and the best attempt from the recorded measurements was accepted as the final score. Electronic Protection Scoring Systems (PSS) were used to measure the effect of the strikes.

Electronic Protection Scoring Systems (PSS): Each athlete was placed in the area marked at the length of them

own legs. The athlete performed a warm-up in accordance with the Taekwondo Performance Test (TPP) protocol to try before the test. After the warm-up, electronic system vests were connected to the dummy and the sandbag, and the same process was performed on the electronic vests. Each numerical data received was transferred to the system. In this study, Dadeo brand Electronic Protection Scoring Systems (PSS) were used to measure the kick power of the participants. The World Taekwondo Federation (WTF) integrated technology into the combat modality in 2009, leading to a more objective scoring system. The PSS include sensors that register the number and power of the hits scored. This scoring is achieved using different sensors located in different areas of the chest protector and helmet, indicating the power and location of the hits. Currently, there are only two brands approved by the WTF for such purposes, namely Daedo and KPNP. Data on the energy from valid kicks in Joules (J) are collected from an electronic monitor and made available instantly by a wireless system (Kozlenia et al., 2023; Márquez et al., 2022; Del Vecchio et al., 2011).

The PSS device was factory-calibrated before testing. Vertical jump was measured with, which has been shown to be valid and reliable in previous studies. Inter-rater reliability for the leg press test was not assessed, which is a limitation.

Figure 1. Step 1: starting point of movement.

Step 2: full rotation of the foot on the ground.

Step 3: knee angle of the kicking foot.

Step 4: full moment

Procedures

Flowchart

The procedure of the study is illustrated in Figure 2. A total of 30 Taekwondo athletes (15 males and 15 females) participated in the study. After excluding athletes with irregular training or missing data, analyses were conducted on 21 participants (8 males and 13 females). During the eight-week intervention period, participants performed a routine Taekwondo training program three times per week in addition to a core training program. Core strength, sprint, jump, leg mass, and kicking performance were assessed in both pretest and posttest sessions.

Taekwondo training

The athletes continued their standard taekwondo training program, which was carried out three times per week with each session lasting 90 minutes (Tabla I). Each session began with a 10 minute warm-up (e.g., dynamic mobility, skipping, jumping jacks, agility ladder drills, coordination exercises, medicine ball toss, or dynamic stretching with shuttle runs depending on the day). This was followed by 35–40 minutes of technical–tactical practice that included kicking combinations, partner drills, counter techniques, and reaction-based exercises. The middle part of the training consisted of 20–25 minutes of sparring and tactical scenarios, such as two 3-minute sparring rounds, offensive–defensive drills, or short high-intensity rounds. Conditioning exercises were then performed for 15–20 minutes, incorporating agility ladder runs, short sprints, plyometric box jumps, shuttle runs, resistance exercises, and partner conditioning. Each training session concluded with a structured 10-minute cool-down phase, including stretching, relaxation, and breathing exercises such as yoga-based routines.

Core training

In addition to their routine taekwondo training 3 days a week, the participants ap-plied a 35-minute core training program (Table II) consisting of 7 different exercises 3 days a week with one day off. 15- minute warm-up exercises were performed before the training. They rested for 60 seconds between each exercise and 30 seconds between each set. Each session concluded with a structured 10-minute cool-down phase including stretching and breathing exercises, which was missing in the initial description.

Statistical Analysis

The data of the study were analyzed with SPSS 26.00 package program. Normality analysis was performed to determine whether the quantitative variables fit the normal distribution. Since the sample size of the study was 21 people, Shapiro-Wilk was analyzed. According to the normal distribution criteria, nonparametric analyzes were performed because the variables were p<.05. Frequency and descriptive statistics were used for descriptive statistics, and Wilcoxon Test was used for pretest-posttest comparison analyses. The variable names in the tables were coded as "1" for the pretest and "2" for the posttest. The level of significance for the overall analyses was set at p<.05.

Results

Table 3. In line with the purpose of the study, the mean and standard deviation values of all variables of male and female participants before and after8 weeks of dynamic and static core training are shown in Table 3.

Table 4. Comparison analyses of the posttest and pretest averages of male participants are shown in Table 3. After 8 weeks of dynamic and static core training, the

increase in leg lift (p=.011) and plank (p=,011), which are among the static core strength abilities of the participants, was found to be significant. Dynamic core strength skills such as sit-ups (p=.011) and push-ups (p=.040) were found to have significant increases. In the stork balance test used to measure the static balance skills of the participants, the change in both feet balance was not significant (p>.05). In the vertical jump test, which is an important measure of explosive power ability, a significant increase was found in the participants' posttest values compared to the pretest (p=.011). Similarly, a significant improvement was found in the speed skill at the 30 m sprit test time (p=.012).

Among the strength parameters, the significant increase in the leg press test (p=.011) was paralleled by the leg mass (p=.012) and relative leg strength (p=.012) measurements. 8 weeks of core training also revealed significant changes in important technical strikes specific to taekwondo. Significant increases were found in right paldingchagi (p=.012), right yopchagi (p=.018), left yopchagi (p=.012), right spinning paldingchagi (p=.011) and left spinning paldingchagi (p=.012) strike strengths. Only the change in left paldingchagi (p>.05) was not significant.

It was observed that the rate of athletes who showed a positive change in their post-test scores compared to their pretest scores, especially in tests measuring strength ability (leg lift, plank, sit-ups, vertical jump, leg press, leg mass, relative leg strength) and tests measuring speed ability (30m sprint), was 100%. In parallel with these increases, the in-creases in the striking power in taekwondo-specific striking techniques were found to be positive in all athletes in right paldingchagi, left yopchagi and both-foot spinning paldingchagi strikes (in Table 4).

Table 5. Comparison analyses of the posttest and pretest averages of female participants are shown in Table 4. After 8 weeks of dynamic and static core training, the increase in leg lift (p=.001) and plank (p=.001), which are among the static core strength abilities of the participants, was found to be significant. Dynamic core strength skills such as sit-ups (p=.001) and push-ups (p=.002) were found to have significant increases. In the stork balance test used to measure the static balance skills of the participants, the change in both feet balance was not significant (p>.05). In the vertical jump test, which is an important measure of explosive power ability, a significant increase was found in the participants' posttest values compared to the pretest (p=.001). Similarly, a significant improvement was found in the speed skill at the 30 m. sprit test time (p=.001).

Among the strength parameters, the significant increase in the leg press test (p=.001) was paralleled by the leg mass (p=.001) and relative leg strength (p=.001) measurements. 8 weeks of core training also revealed significant changes in important technical strikes specific to taekwondo. Significant increases were found in all strike strength; right (p=.001) and left (p=.002) paldingchagi, right (p=.001) and left (p=.001) yopchagi, right (p=.001) and left (p=.002) spinning paldingchagi. In all strength, speed and explosive power tests except balance ability, positive changes in favor of post-tests occurred in all female participants. In addition, in all other taekwondo-specific strike tests except left paldingchagi and left spinning paldingchagi (both positive rank: 92.31%), the participant rank in which positive changes were observed was determined as 100 percent (in Table 5). n all strength, speed and explosive power tests except balance ability, positive changes in favor of post-tests occurred in all female participants. In addition, in all other taekwondo-specific strike tests except left paldingchagi and left spinning paldingchagi (both positive rank: 92.31%), the participant rank in which positive changes were observed was determined as 100 percent (in Table 5).

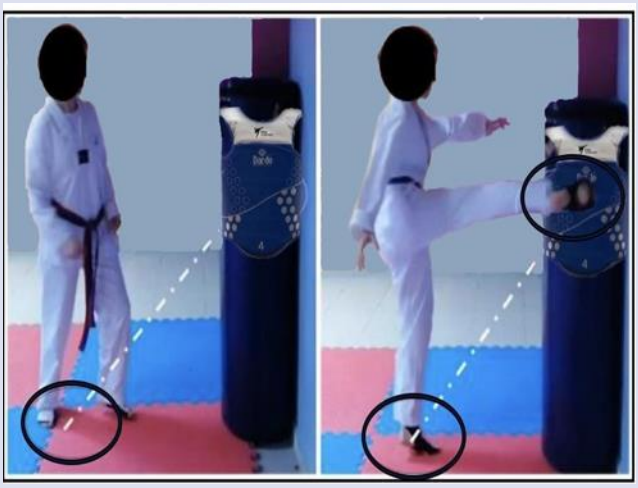
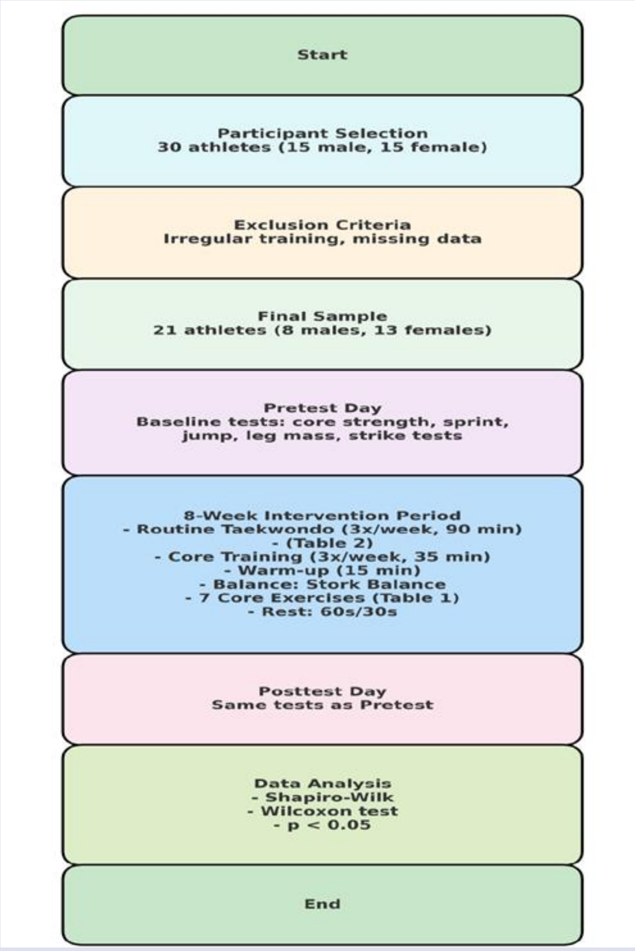


Figure 1. Taekwondo specific strike tests



Picture 2. Procedures

Table I. Taekwondo training program

Content	Day 1	Day 2	Day 3
Warm-up (10 min)	Dynamic mobility, skipping, jumping jacks	Agility ladder, coordination drills, medicine ball toss	Dynamic stretching, shuttle runs
Technical–Tactical (35–40 min)	Kicking combinations, partner drills (e.g., palding chagi, dollyo chagi)	Combination kicks, counter techniques, partner drills	Combined kick sets, reaction drills
Sparring / Tactical Practice (20–25 min)	2×3 min sparring rounds	Offensive & defensive scenarios	Short, high- intensity rounds
Conditioning (15–20 min)	Agility ladder, short sprints	Plyometric box jumps, shuttle run	Resistance drills, partner conditioning
Cool-down (10 min)	Stretching + breathing exercises	Static stretching, relaxation	Yoga-based stretching & breathing

Table II. Core Training Program

Exercise	Duration	Set	Content
Bridge pose	100 sec.	2	Static stance in the bridge position then descend (both 5 seconds). 10 repetitions.
Body Extension	150 sec.	2	Sit on the floor with the knees bent and lift the arms forward. Lie backwards at a 45-degree angle and wait 15 seconds and return to the starting position and wait 15 seconds. 5 repetitions.
Sit-up	100 sec.	2	Lift the head and shoulders upwards and return to the initial position after 5 seconds of static. 10 repetitions
Sit-ups on Romanian bench	100 sec.	2	On the Romanian bench, knees bent, hands crossed and placed on the chest, return to the starting position after 5 seconds of static posture in the sit-up position. 10 repetitions
Abdominal contraction	100 sec.	2	Knees bent, hands crossed on the chest, contracting and relaxing the abdominal muscles for 5 seconds while breathing in and out. 10 repetitions.
Rotation of the lower extremity on the ground	100 sec.	2	In the supine position, the arms are opened to the sides, ensuring body stabilization and rotation to the right and left with the knees bent at 90 degrees. 5 seconds to the right and 5 seconds to the left and 10 repetitions.
Scissors movement in the legs	100 sec.	2	Lie on your back in a supine position, legs extended, move your heels 10 cm up and down diagonally for 10 seconds. 10 repetitions.

Table 3. Descriptive statistics of pre-test and post-test values of male and female athletes.

Variebles	Male (n=8) X±SD	Female (n=13) X±SD
Leg Lift (Pre-test) (sec.)	31.50±4.24	24.69±2.32
Leg Lift (Post-test) (sec.)	35.88±6.36	28.85±2.30
Plank (Pre-test) (sec.)	22.38±3.96	16.15±2.23
Plank (Post-test) (sec.)	27.25±4.59	20.15±2.54
Sit-ups (Pre-test) (rep.)	18.88±2.85	15.38±2.14
Sit-ups 2(Post-test) (rep.)	23.38±3.16	18.46±3.26
Push-ups (Pre-test) (rep.)	13.88±2.36	9.85±2.61
Push-ups (Post-test) (rep.)	15.13±3.09	12.08±2.75
Stork Balance Right (Pre-test) (sec)	6.39±5.46	6.44±4.18
Stork Balance Right (Post-test) (sec.)	7.50±6.57	5.33±2.24
Stork Balance Left (Pre-test) (sec.)	8.64±4.70	8.10±4.33
Stork Balance Left (Post-test) (sec.)	11.32±7.59	13.76±2.63
Vertical Jump (Pre-test) (cm)	32.13±4.85	33.00±6.44
Vertical Jump (Post-test) (cm)	34.63±5.76	35.69±7.03
30m. Sprint (Pre-test) (sec.)	5.97±0.46	5.88±0.54
30m. Sprint (Post-test) (sec.)	5.49±0.47	5.39±0.55
Leg Press Strenght (Pre-test) (kg)	23.38±4.31	19.85±3.41
Leg Press Strenght (Post-test) (kg)	28.38±5.71	24.31±2.69
Leg Mass (Pre-test)	9.01±1.29	7.02±1.28
Leg Mass (Post-test)	9.07±1.28	7.08±1.27
Relative Leg Strenght (Pre-test)	2.63±0.54	2.89±0.58
Relative Leg Strenght (Post-test)	3.19±0.68	3.54±0.55
Right Palding Chagi (Pre-test) (J)	39.13±7.36	39.00±10.75
Right Palding Chagi (Post-test) (J)	47.00±6.12	46.85±12.40
Left Palding Chagi (Pre-test) (J)	33.88±7.85	38.00±13.79
Left Palding Chagi (Post-test) (J)	37.38±16.17	45.08±13.90
Right Yop Chagi (Pre-test) (J)	36.63±9.40	32.54±9.38
Right Yop Chagi (Post-test) (J)	44.38±8.45	40.00±9.96
Variebles	**Male (n=8) X±SD**	**Female (n=13) X±SD**
Left Yop Chagi (Pre-test) (J)	28.50±7.87	27.85±7.21
Left Yop Chagi (Post-test) (J)	35.88±8.29	33.62±8.65
Right Spinning Palding Chagi (Pre- test) (J)	33.75±9.92	32.85±8.22
Right Spinning Palding Chagi (Post- test) (J)	39.38±10.49	39.23±9.18
Left Spinning Palding Chagi (Pre- test) (J)	32.63±5.50	29.77±7.57
Left Spinning PaldingC hagi (Post- test) (J)	37.75±5.23	35.08±8.30

Table 4. Pre-test post-test analyses of variables of male athletes participating in the study

Variables		*n*	Mean Rank	Sum of Ranks	z	p
Leg Lift (post- test) Leg Lift (pre- test)	Negative Ranks	0			2.530	**011***
	Positive Ranks	8	4.50	36.00		
	Ties	0				
Plank (post- test) Plank (pre-test)	Negative Ranks	0			-2.536	**.011***
	Positive Ranks	8	4.50	36.00		
	Ties	0				
Sit-ups (post- test) Sit-ups (pre- test)	Negative Ranks	0			-2.533	**.011***
	Positive Ranks	8	4.50	36.00		
	Ties	0				
Push-ups (post- test) Push-ups (pre- test)	Negative Ranks	1	2.00	2.00	-2.058	**.040***
	Positive Ranks	6	4.33	26.00		
	Ties	1				
Stork Balance Right (post-test) Stork Balance Right (pre-test)	Negative Ranks	3	4.67	14.00	-.561	,.575
	Positive Ranks	5	4.40	22.00		
	Ties	0				
Stork Balance Left (post-test) Stork Balance Left (pre-test)	Negative Ranks	3	3.67	11.00	-.980	.327
	Positive Ranks	5	5.00	25.00		
	Ties	0				
Vertical Jump (post-test) Vertical Jump (pre-test)	Negative Ranks	0			-2.536	**.011***
	Positive Ranks	8	4.50	36.00		
	Ties	0				
30m. Sprint (post-test) 30m. Sprint (pre-test)	Negative Ranks	8	4.50	36.00	-2.524	**.012***
	Positive Ranks	0				
	Ties	0				
Leg Press Strength (post- test) Leg Press Strength (pre- test)	Negative Ranks	0			-2.546	**.011***
	Positive Ranks	8	4.50	36.00		
	Ties	0				
Leg Mass (post- test) Leg Mass (pre- test)	Negative Ranks	0			-2.524	**.012***
	Positive Ranks	8	4.50	36.00		
	Ties	0				
Relative LegStrength (post-test) Relative Leg Strength (pre- test)	Negative Ranks	0			-2.521	**.012***
	Positive Ranks	8	4.50	36.00		
	Ties	0				
Right Palding (post-test) Right Palding (pre-test)	Negative Ranks	0			-2.524	**.012***
	Positive Ranks	8	4.50	36.00		
	Ties	0				
Left Palding (post-test) Left Palding (pre-test)	Negative Ranks	1	8.00	8.00	-1.402	.161
	Positive Ranks	7	4.00	28.00		
	Ties	0				
Right Yop Chagi (post- test) Right Yop Chagi (pre-test)	Negative Ranks	0			-2.371	**.018***
	Positive Ranks	7	4.00	28.00		
	Ties	1				
Left Yop Chagi (post-test) Left Yop Chagi (pre-test)	Negative Ranks	0			-2.524	**.012***
	Positive Ranks	8	4.50	36.00		
	Ties	0				
Variables		*n*	**Mean Rank**	**Sum of Ranks**	**z**	**p**
Right Spinning Palding Chagi (post-test) Right Spinning Palding Chagi (pre-test)	Negative Ranks	0			-2.533	**.011***
	Positive Ranks	8	4.50	36.00		
	Ties	0				
Left Spinning Palding Chagi (post-test) Left Spinning Palding Chagi(pre-test)	Negative Ranks	0			2.527	**.012***
	Positive Ranks	8	4.50	36.00		
	Ties	0				

Table 5. Pre-test post-test analysis of variables of female athletes participating in the study

Variables		N	Mean Rank	Sum of Ranks	z	p
Leg Lift (Post- Test) Leg Lift (Pre-Test)	Negative Ranks	0			-3.195	**.001***
	Positive Ranks	13	7	91		
	Ties	0				
Plank (Post-Test) Plank (Pre-Test)	Negative Ranks	0			-3.194	**.001***
	Positive Ranks	13	7	91		
	Ties	0				
Sit-ups (post-test) Sit-ups (Pre-Test)	Negative Ranks	0			-3.193	**.001***
	Positive Ranks	13	7	91		
	Ties	0				
Push-ups (post-test) Push-ups (Pre- Test)	Negative Ranks	0			-3.097	**.002***
	Positive Ranks	12	6.5	78		
	Ties	1				
Stork Balance Right (Post-Test) Stork Balance Right (Pre-Test)	Negative Ranks	7	8.57	60	1.014	.311
	Positive Ranks	6	5.17	31		
	Ties	0				
Stork Balance Left (Post-Test) Stork Balance Left (Pre-Test)	Negative Ranks	7	5.71	40	-.384	.70
	Positive Ranks	6	8.5	51		
	Ties	0				
Vertical Jump (Post-Test) Vertical Jump (Pre-Test)	Negative Ranks	0			-3.211	**.001***
	Positive Ranks	13	7	91		
	Ties	0				
30m. Sprint (Post-Test) 30m. Sprint (Pre- Test)	Negative Ranks	13	7	91	-3.181	**.001***
	Positive Ranks	0				
	Ties	0				
Leg Press Strength (Post- Test) Leg Press Strength (Pre- Test)	Negative Ranks	0			-3.228	**.001***
	Positive Ranks	13	7	91		
	Ties	0				
Leg Mass (Post- Test) Leg Mass (Pre- Test)	Negative Ranks	0			-3.203	**.001***
	Positive Ranks	13	7	91		
	Ties	0				
Relative Leg Strength (Post-Test) Relative Leg Strength (Pre- Test)	Negative Ranks	0			-3.182	**.001***
	Positive Ranks	13	7	91		
	Ties	0				
Right Palding Chagi (Post-Test) Right Palding Chagi (Pre-Test)	Negative Ranks	0			-3.187	**.001***
	Positive Ranks	13	7	91		
	Ties					
Left Palding Chagi (Post-Test) Left Palding Chagi (Pre-Test)	Negative Ranks	1			-3.063	**.002***
	Positive Ranks	12	6.5	78		
	Ties					
Right Yop Chagi (Post-Test) Right Yop Chagi (Pre-Test)	Negative Ranks	0			-3.190	**.001***
	Positive Ranks	13	7	91		
	Ties					
Left Yop Chagi (Post-Test) Left Yop Chagi (Pre-Test)	Negative Ranks	0			-3.188	**.001***
	Positive Ranks	13	7	91		
	Ties					
Right Spinning Palding Chagi (Post-Test) Right Spinning Palding Chagi (Pre-Test)	Negative Ranks	0			-3.187	**.001***
	Positive Ranks	13	7	91		
	Ties					
Left Spinning Palding Chagi (Post-Test) Left Spinning Palding Chagi (Pre-Test)	Negative Ranks	1	1.5	1.5	-3.086	**.002***
	Positive Ranks	12	7.46	89.5		
	Ties					

DISCISSION

This study has several strengths, including the integration of both general fitness and sport-specific performance measures, as well as the use of PSS technology to objectively quantify taekwondo kicking power. The structured 8-week combined static and dynamic core training program represents a practical intervention relevant to coaches and practitioners.

The primary aim of our study was to examine the effect of 8-week dynamic and static core training on strike strength in taekwondo-specific techniques. Our results demonstrated that young athletes significantly improved their kicking performance and lower-limb strength measures, supporting the applicability of core training in adolescent taekwondo populations. Positive increases were observed in three important strike strengths in both female and male athletes. While significant increases were observed in right and left leg strike strength in all three-strike techniques in female athletes, on the contrary, the change in left palding strike strength was not significant in male athletes, where seven participants showed positive change and one participant showed negative change. Our secondary results supporting the development in this main finding were the increases in test results measuring strength, power and speed abilities in both genders. Dynamic and static core training improved the strength of the core muscles and both the mass and strength of the lower body muscles.

There are some previous studies reporting the positive contribution of core exercises to leg lift performance, which are parallel to the results of our study Sever, (2017) reported that the duration of the leg lift test increased significantly in both dynamic and static core groups in soccer players, and the plank test increased significantly only in the static core group. Shinkle et al., (2017) investigated the effect of dynamic and static core strength on shot accuracy in soccer players and reported a significant increase in leg raising and plank values of both static and dynamic core groups in pre-test and post-test results. Yıldız and Ünlü, (2016) found statistically significant differences in plank and leg lift parameters in pre-test and post-test intergroup comparisons in their study in taekwondo players. Previous study results support our study results, reporting that core exercises have a positive contribution to leg lift and plank performance (Smart et al., 2011; Cortell-Tormo et al., 2017; Byrne et al., 2014).

Previous study results that support our study results report that core exercises have a positive contribution to leg lift and plank performance. Junker and Stöggl, (2016) who reported the opposite result, compared the leg lift values before and after training in their study investigating the effects of foam rollers and trunk exercise training on some performance parameters in taekwondo players and found no statistically significant difference.

In a study conducted by Chun et al. (2021) on elite taekwondo athletes, they reported that the results of the 1-minute sit-ups test increased from 55.11 repetitions to 62.11. They also emphasized that 8-week core balance and core strength training improved postural stability and anaerobic power. These findings are consistent with our results in young taekwondo athletes, indicating that short-term core interventions can enhance both strength endurance and kicking performance. In addition, they recommended that the effectiveness of this short-term study should be utilized in the preparation stages of competitions (Yıldız and Ünlü, 2016) reported that dynamic and static core exercises had a significant difference on sit-ups performance in taekwondo athletes. In their study on tennis players, Arı and Çolakoğlu (2021) reported that 8-week core exercises were significantly effective on 30 s. sit-ups performance. In the literature review, it was determined that core exercises performed in different branches showed significance in sit-ups test results and these results were in parallel with the results of our (Lugowska et al., 2023; Sever, 2017; Chen et al., 2018).Yıldız and Ünlü (2016) found that core training applied to male taekwondo athletes had no effect on push-up test performance in pretest-posttest comparisons, but significant differences were found in dynamic and static core groups in in-group comparisons. In another study, the effect of 6-week core training on physical performance in male boxers was examined. The maximum push-up results of the group performing static core exercises showed a statistically significant difference compared to the dynamic core exercise group (Gottschall et al., 2018). In a study conducted in swimmers, 8-week functional core exercises were performed in the training group and as a result, a difference was reported for the push-up test in favor of the exercise group Kurt et al., (2023) The results of our study showed that, similar to previous studies, core exercises positively affected push-up performance.

In our study results, although not significant, an improvement was observed in balance performance in both genders. Previous studies have shown that core exercises ap-plied to male and female athletes in different branches have positive effects on right-left foot balance (Knuttgen, 2019; Shirazi and Sadeghi, 2020; Sever, 2017; Vitale et al., 2018). In a study conducted in women, a significant improvement in movement functions of core training was detected (Ko et al., 2025). This study showed similarity to our study. In addition to the information obtained from the literature, adding core exercises to regular taekwondo training has positive contributions to performance (Ouergui et al., 2021). Recent evidence also suggests that interventions such as self-myofascial release may influence flexibility and neuromuscular function (Russo et al., 2023), which could partly explain the observed improvements in kicking performance. However, the absence of a control group in our study limits the ability to attribute all observed improvements solely to the intervention. Future research should employ randomized controlled designs with larger samples to confirm these findings. Again, when the studies obtained from the literature are examined, the effects of core exercises on various biomotor performance and their positive results can be reported (Zemková, 2022; Valdés-Badilla, 2023; Han and Ju, 2023). When the literature is examined, positive results of core exercises on vertical jump and other athletic performance outcomes are expressed. When other studies are examined, it is reported that core exercises have a positive effect on balance and vertical jump (Vitale et al., 2018; Chijimatsu et al., 2020). Alternative explanations and confounders must be considered. Given the age of participants (12–14 years), natural growth and maturation may partly explain improvements in strength and sprint performance. Test familiarization could also have contributed to observed gains. Furthermore, device-related variability (e.g., PSS calibration, leg mass estimation) may have influenced measurement accuracy.

In another study conducted with male taekwondo athletes, there was no statistical difference in 10 m sprint test results (Marković et al., 2005; Perez-Gutierrez et al., 2017). A high level of physical and physiological performance is expected from athletes in taekwondo (Perez-Gutierrez et al., 2017; Kibler et al., 2006). In addition, recent rule changes have increased the point values of techniques and made it necessary for athletes to train accordingly. This necessity has led to the study of different training methods. Core exercises, one of these methods, minimize joint loads in activities such as strength, power generation and kicking (McCurdy et al., 2005). The primary goal of training is to develop the strength required for athletes to demonstrate branch-specific technical elements and to maximize performance.

In a study conducted on bowling athletes, it was stated that core exercises positively affected hand strength (Krishna et al., 2024). In research examining the effects of core exercises on plyometric studies, it is seen that core exercises affect plyometric studies and improvement in biomechanical muscle strength (Sasaki et al., 2019).

As taekwondo athletes advance to the elite level, their striking power increases. A previous study reported that senior athletes had higher absolute striking power than junior athletes during a match, and that this value increased as their weight divisions increased (Sasaki et al., 2020; Marquez et al., 2022). The results of this study also show that the results of our study, in which we examined the development of branch-specific technical striking performance in young taekwondo athletes through dynamic and static core exercises, indicate that we are focusing on the right target. Because the magnitude of the energy created by the striking on the opponent's Electronic Protection Scoring Systems is as important as the accuracy of the striking techniques. Therefore, branch-specific athletic performance skills should be developed as an important element as technical tactical exercises in training, and different training types such as core exercises should be preferred for these purposes.

CONCLUSİON

This small uncontrolled pilot study suggests that 8 weeks of combined core training may improve strength, sprint, and taekwondo-specific kicking in young athletes, while balance remained unchanged. Findings are preliminary and require confirmation in larger randomized controlled trials with maturation controls.

In conclusion, eight weeks of static and dynamic core training, in addition to routine taekwondo practice, significantly improved strength, speed, and taekwondo-specific kicking performance in young athletes. These results suggest that incorporating structured core exercises into youth taekwondo programs may enhance both biomotor and technical performance, although further research with controlled designs is warranted.

The positive effect of core exercises on plank performance and leg lifting may indicate that they increase body strength, so core exercises can be added to strength training in this age group.

It shows the positive effect of core exercises on anaerobic endurance during the prep-aeration period for the competition. Since the sport of Taekwondo mainly has an-aerobic power, core exercises in training can have a positive effect on anaerobic power.

These findings are preliminary and should be interpreted cautiously. Larger randomized controlled trials with maturation controls are needed to confirm causality. Furthermore, recent reviews emphasize post-activation potentiation mechanisms as potential contributors to striking power improvements (Formiglio et al., 2024), which may partly explain the positive changes observed in our taekwondo-specific kicking outcomes.

Balance performance is very important for the sport of taekwondo. The positive effect of core exercises on balance performance has been determined. In this direction, the addition of core exercises to taekwondo training may show significant improvements.

By applying this study to different age groups, the development in that age group can be observed.

It can be compared with other studies in terms of providing light to the studies conducted in different branches.

To study the results of the studies, its long-term effect can be observed.

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Araştırmanın Etik Taahhüt Metni

Yapılan bu çalışmada bilimsel, etik ve alıntı kurallarına uyulduğu; toplanan veriler üzerinde herhangi bir tahrifatın yapılmadığı, karşılaşılacak tüm etik ihlallerde "Sivas Cumhuriyet Üniversitesi Spor Bilimleri Dergisi ve Editörünün" hiçbir sorumluluğunun olmadığı, tüm sorumluluğun Sorumlu Yazara ait olduğu ve bu çalışmanın herhangi başka bir akademik yayın ortamına değerlendirme için gönderilmemiş olduğu sorumlu yazar tarafından taahhüt edilmiştir.