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Burakhan Aydemir , DUYGU SEVİNÇ YILMAZ * , İrfan Marangoz , Fatih Kırkbir , Olcay Mülazımoğlu , Abdullah Bora Özkara

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Examining the Relationship of Static and Dynamic Core Training with Strength, Speed, Jump and Taekwondo Kicking Performance in 12–14-Year-Old Taekwondo Players

Burakhan Aydemir [1,*] Duygu Sevinç Yılmaz [2], İrfan Marangoz [3], Fatih Kırkbir [4], Olcay Mülazımoğlu [5] and Abdullah Bora Özkara [4]

[1] Karadeniz Technical University, Department of Physical Education, Trabzon, Turkey
[2] Erzincan Binali Yıldırım University, Sports Science Faculty Erzincan, Turkey
[3] Kırşehir Ahi Evran University Sports Science Faculty, Kırşehir, Türkiye
[4] Karadeniz Technical University, Faculty of Health Sciences, Trabzon, Turkey
[5] Muğla Sıtkı Koçman University Faculty of Sports Sciences, Muğla, Turkey
* Correspondence: dsevinc@erzincan.edu.tr; +90-446-224-0025
† Senior Author: bora.ozkara@ktu.edu.tr.

Abstract: It is aimed to examine the relationship between static and dynamic core training with strength, speed, jumping and taekwondo hitting performance in 12-14 years old taekwondo players. One of the most important features is the determination of the research design. The population of the study consists of male and female athletes between the ages of 12-14 who have been active in taekwondo for at least 2 years at Trabzon, Turkey. The sample of the study consists of app-proximately 30 athletes, approximately 15 female and 15 male athletes between the ages of 12-14, who voluntarily accepted to participate in the study. 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 (n=30), Shapiro-Wilk was analyzed According to the normal distribution criteria, nonparametric analyzes were performed because the variables were $p<0.05$. Frequency and descriptive statistics were used for descriptive statistics, and Wilcoxon Test was used for pretest-posttest comparison analysis. The results showed that core exercises had positive changes in muscle strength, anaerobic power and branch-specific striking techniques.

Keywords: taekwondo; core; performance; physical activity; exercise; health

1. Introduction

Taekwondo is a far eastern sport of Korean origin. Taekwondo sport, which has been going on for many years, has been updated with the developing technology in recent years and has kept pace with technology. Today, changes in competition rituals have also created some dynamics. The competitive environment has increased and athlete performance has gained great importance. In this context, various training programs, models and methods have been developed [1–5]. Developing training models are among the subjects where research is focused. Training models are very important for athletes to get maximum efficiency. When the literature is examined, it is stated that different types of training models affect performance [6]. Training models that provide the most appropriate response to the needs of combat sports are the subjects that today's sports research is concentrated on. Different types of training models using similar energy systems can affect training and competition performance at different levels [7]. Training models should be designed for athletes to perform faster, stronger and better. In Taekwondo competitions, athletes' physical and

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physiological characteristics must be at a high level. Correct training is mandatory for high performance. In order to increase performance, it will be useful to include different physical exercises as well as technical exercises in the training programme [8]. In order to achieve maximum performance in sports, it is imperative to make preparations that can reach the highest point physically and mentally together with technical and tactical studies. Core training is one of the various training methods to optimise the physical fitness of athletes who aim to sustain intense loads and respond appropriately to the physiological and physical demands of the branch [9]. Core training is one of the popular methods that facilitate and improve the application of phenomena such as athletic development, development of basic motoric characteristics and technique-tactics [10]. The word core is considered as the part between the sternum and knees, abdominal region, waist and hips. Exercise programmes performed with the individual's own body weight to improve the physical strength characteristics of athletes, to keep the spine in balance, to improve their ability to resist resistance are called core training [11]. They are exercises created by stabilising the spine, abdomen, waist and hips. Core exercises ensure that the kinetic power generated is transferred to the body in a coordinated manner [12–14] Core exercises are exercises for working muscles that facilitate the athlete's performance development as well as technical tactical development [15]. Core exercises are thought to strengthen the core area and provide more load on the athlete. Strong core is expected to contribute to technical development and make movements more efficient [16]. Core exercises are recommended to be designed systematically according to strength and power development. Core exercises also contribute to motoric characteristics [17,18]**.** Core exercises, which are of great importance in many sports branches such as combat sports, are of great importance in terms of sports performance, motor capacity, balance development, rehabilitation and injury prevention, as they produce great strength and muscle strength for both the lower and upper body of the athlete in many sports branches such as combat sports. In addition, core exercises also support the increase of dynamic balance and functional strength [19]. Taekwondo requires physical strength, speed, flexibility and technical skills. In order for the athlete to be successful, it is important for the athlete to have a solid body structure and a strong core area. The core is a central area of the body and ensures that the movements are performed in a balanced manner. Core training aims to strengthen the core muscles and can improve performance in combat sports. Static core training increases the endurance and stability of the core muscles, while dynamic core training improves the strength and movement abilities of the core [20,21]. Other factors to improve the performance of athletes are height, weight, body composition, aerobic- anaerobic power, strength, speed, flexibility, technique and tactics [5]. The importance of balance, jumping, anaerobic power in taekwondo sport is known. According to the information obtained in the literature, the effect of core exercises on balance, jumping, aerobic and anaerobic power is expressed [22–24]. Taekwondo trains and develops the basic biomotor characteristics of its practitioners such as strength, speed, agility, quickness, endurance and balance [7]. In this direction, it is thought that Taekwondo athletes should include core exercises in their training programmes according to the information obtained from the literature, especially for the development of motor skills such as balance, jumping and speed. In this context, this study aims to investigate the relationship between static and dynamic core training with strength, speed, jumping and taekwondo hitting performance in taekwondo athletes.

2. Materials and Methods

The study was conducted in the experimental study model, which is one of the quantitative research methods. Experimental research is research conducted with a scientific approach using two sets of variables. It is a research method that you use to measure the differences between the first measurement and the second measurement. The experimental research process consists of stages such as determining the research topic, purpose, problem, variables, participants, forming groups, conducting the application, collecting and analysing data and comparing and evaluating the results. One of the most important features is the determination of the research design. Although there are many designs in experimental research, in the application dimension, the application form in which at least two groups are formed is generally preferred. Both groups are given a pre-test. After the

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application, a post-test is applied to both groups and a comparison is made with statistical methods [25].

Aim of the Study

It is aimed to investigate the relationship between static and dynamic core training with strength, speed, jump and taekwondo kick performance in 12-14 years old taekwondo players.

Research Group

The population of the study consists of male and female athletes aged 12-14 years who have been active in taekwondo for at least 2 years at Trabzon Bordo Mavim Sports Club in Trabzon province. The sample of the study consists of approximately 30 athletes, 15 female and 15 male athletes between the ages of 12-14, who voluntarily accepted to participate in the study.

Data Collection Tools

The following measurements were taken from the participants who voluntarily participated in the study and recorded in the data collection form

Measurement of Height and Body Weight: The aim is to determine the physical elements. In the height measurement, the subjects will be recorded in an upright position with bare feet and minimal clothing, feet heels together, head upright and eyes looking forward, by adjusting the caliper sliding on the scale to touch the subject's head [26].

Thigh Circumference: While the participant is in the anatomical position, it will be measured vertically from the midpoint between the groin and the proximal point of the patella with the help of a tape measure and recorded in cm.

Calf Circumference: The participant stands in the anatomical position with feet 20 cm apart and weight evenly distributed. The widest part of the calf area will be measured with a tape measure and recorded in cm.

Ankle Circumference: While the participant is in anatomical position, the ankle of the participant will be measured with the help of a tape measure and recorded in cm.

Foot Length: The participant extends his/her foot in a sitting position. The distance between the heel of the foot and the longest toe will be measured with a tape measure and recorded in cm.

Leg Press Measurement: The participant will first try to determine the weight that he/she can lift maximally. Afterwards, he/she will make a single trial with the maximum weight he/she can lift and will be recorded in [27].

Taekwondo Specific Palding Strike: Measurement will be taken using a branch-specific electronic system. The participant will perform the most commonly used palding kick in competitions. The participant will make 3 attempts with the dominant foot and the best result will be recorded in bars [28].

Leg Mass Calculation: Hanavan method will be used for leg mass measurement in the study [29]. Thigh, calf and foot measurements will be taken to calculate leg mass. For the thigh, the distance between the tibial point and the inguinal fold will be determined, for the calf, the distance between the tibial point and the medial malleolus point will be determined, and for the foot, after determining the medial malleolus and the whole foot, the measurements will be calculated as defined by the Hanavan model method. "Leg Volume and Mass Calculation Programme for Athletes" developed by Marangoz and Özbalcı will be used as the calculation programme [30].

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

For Thigh Mass Total; Body weight and the circumference of the thigh will be measured where it gives the widest measurement.

- For Calf Mass Total; the circumference of the calf will be measured where it gives the widest measurement.

- For Foot Mass Total; Ankle circumference and foot length will be measured.

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- The data of these measurements will be calculated in the leg mass calculation programme using the formulas below and the total leg mass will be 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 [27].

Determination of Relative Leg Strength: The leg strength of the athletes will be divided by the total mass of the leg and the relative strength of the leg will be determined in kg.

Relative Leg Force = Leg Press Force / Leg Mass [27,31].

Static Core Force

Leg Raise: It is one of the measurement methods used to measure the core strength of athletes. Athletes lie on their backs on a flat floor. They touch their elbows to the ground and lift the body off the ground. Then, without bending the legs, they lift them from the ground to the air in a tense manner. The test is terminated when the knees are bent and two or any of the feet touch the ground. The athlete lifts his/her feet off the ground together at any time and the time starts and continues until he/she is exhausted. The result of the last contact with the ground is recorded in seconds.

Plank

Athletes lie face down on the floor. They take a position with their elbows and fingertips on the floor. When the signal is given, they stand up on their fingertips and elbows. They take a position with the body parallel to the ground and the head facing forward. The test ends when two or one of the knees and elbows touch the floor and the result is recorded in seconds.

Dynamic Core Strength

Sit-ups The athlete lying on his/her back starts the test with his/her hands together at the nape of the neck, knees bent and the soles of the feet on the floor. The athlete lifted his/her torso upwards until his/her elbows touched his/her knees. Within 30 seconds, each number touching the knee was considered as the number of sit-ups. They were told to keep their hands behind their neck during the test and repetitions not in accordance with the rules were not counted [32].

Push-ups: Athletes lie face down on the floor. Hands are placed parallel to each other, at shoulder level and fingertips pointing forward. The body is lifted off the ground on the toes and hands. The movement oscillation continues with the abdomen, hips and head in one line. Push-ups continue for 30 seconds. Each swing in 30 seconds is recorded.

Stork Balance: In the Stork balance test, participants are positioned on a wooden floor with their shoes removed 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 metres 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.

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 (Smartjuamp brand) and the distance jumped will be determined in centimetres on the device. After the athletes jumped 2 times, the best degree was recorded as the vertical jump value.

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.

Data Collection

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The necessary permissions 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.

Data 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 (n=30), Shapiro-Wilk was analyzed. According to the normal distribution criteria, nonparametric analyzes were performed because the variables were $p<0.05$. Frequency and descriptive statistics were used for descriptive statistics (Table 1), and Wilcoxon Test (Table 2 and Table 3) was used for pretest-posttest comparison analyses.

Table 1. Core training program.

Movements	Content
Bridge	Static stance in the bridge position for 5 seconds and then descend. It is done in 10 repetitions.
Body Extension	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.
Sit-up	Lift the head and shoulders upwards and return to the initial position after 5 seconds of static. Continue with 10 repetitions.
Sit-ups on Romanian bench	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 are applied.
Abdominal contraction	Knees bent, hands crossed on the chest, contracting and relaxing the abdominal muscles for 5 seconds while breathing in and out. Performed 10 repetitions.
Rotation of the lower extremity on the ground	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	In the supine position on the back, with the legs stretched, the heels are raised 10 cm from the floor and lowered again and both legs are applied. Application with 10 repetitions.

3. Results

The aim of this study was to investigate the relationship between static and dynamic core training with strength, speed, jumping and taekwondo striking performance in taekwondo ath-letes.

The results showed that core exercises had positive changes in muscle strength, anaerobic power and branch-specific striking techniques.

In the study, the effects of core exercises applied to male and female taekwondo players on leg raises and plank performance to measure static core strength were compared and a statisti-cally significant difference was found. It was observed that core exercises performed in different branches had a positive effect on stork balance, but in our study, core exercises did not have a positive effect on taekwondo players' stork balance.

When the vertical jump test performances of the athletes were evaluated, the values of the group performing core exercises showed a statistically significant difference.

In our study, 30 m sprint was found to be statistically significant for the core training group in both male and female athletes.

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In our study, the athletes were made to perform right-left palding-chagi, yopcagi-chagi and burgupalding-chagi strokes from taekwondo-specific performance strokes. The stroke perfor-mances of the core exercise group (male-female) were statistically significant.

Table 2 shows the mean and standard deviation values of the descriptive statistics of the variables of male and female athletes.

Table 2. Descriptive Statistics of Variables of Male and Female Athletes Participating in the Study.

	Male (n=8)	**Female** (n=13)
	x±sd	x±sd
Age	13,25±0,89	13,08±0,76
Weight 1	52,60±6,59	50,13±5,75
Weight 2	52,68±6,36	50,93±
Height 1	158,75±5,70	155,85±4,10
Height 2	159,50±5,68	157,46±3,69
Leg Lift 1	31,50±4,24	24,69±2,32
Leg Lift 2	35,88±6,36	28,85±2,30
Plank 1	22,38±3,96	16,15±2,23
Plank 2	27,25±4,59	20,15±2,54
Sit-up 1	18,88±2,85	15,38±2,14
Sit-up 2	23,38±3,16	18,46±3,26
Push-up 1	13,88±2,36	9,85±2,61
Push-up 2	15,13±3,09	12,08±2,75
Stork Balance Right 1	6,39±5,46	6,44±4,18
Stork Balance Right 2	7,50±6,57	5,33±2,24
Stork Balance Left 1	8,64±4,70	8,10±4,33
Stork Balance Left 2	11,32±7,59	13,76±21,63
Vertical Jump 1	32,13±4,85	33,00±6,44
Vertical Jump 2	34,63±5,76	35,69±7,03
30m. Sprint.1	5,97±0,46	5,88±0,54
30m. Sprint.2	5,49±0,47	5,39±0,55
Right Palding 1	39,13±7,36	39,00±10,75
Right Palding 2	47,00±6,12	46,85±12,40
Left Palding 1	33,88±7,85	38,00±13,79
Left Palding 2	37,38±16,17	45,08±13,90
Right Yopça 1	36,63±9,40	32,54±9,38
Right Yopça 2	44,38±8,45	40,00±9,96
Left Yopça 1	28,50±7,87	27,85±7,21
Left Yopça 2	35,88±8,29	33,62±8,65
Right Auger 1	33,75±9,92	32,85±8,22
Right Auger 2	39,38±10,49	39,23±9,18
Left Auger 1	32,63±5,50	29,77±7,57
Left Auger 2	37,75±5,23	35,08±8,30
Upper Arm Length	23,75±2,49	21,08±1,80
Upper Arm Circumference	17,25±1,91	14,08±1,66
Lower Arm Circumference	13,75±1,98	11,38±1,80
Wrist Circumference	10,50±1,07	8,08±1,80
Wrist Width	7,25±0,71	6,08±1,19
Hand Claw Strenght 1	20,60±5,28	13,90±4,40
Hand Claw Strenght 2	22,39±5,54	16,29±5,46

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Arm Mass 1	3,96±0,99	3,03±0,84
Arm Mass 2	4,01±1,00	3,07±0,85
Relative_Arm_Force 1	5,30±1,16	4,73±1,43
Relative_Arm_Force 2	5,76±1,27	5,54±1,76
Thigh Circumference	44,88±3,80	36,54±4,61
Calf Circumference	29,25±2,60	25,85±3,89
Ankle Circumference	19,38±3,25	17,69±2,90
Foot Length	26,50±2,73	22,46±2,73
Leg Press Strentght 1	23,38±4,31	19,85±3,41
Leg Press Strentght 2	28,38±5,71	24,31±2,69
Leg Mass 1	9,01±1,29	7,02±1,28
Leg Mass 2	9,07±1,28	7,08±1,27
Relative Leg Force 1	2,63±0,54	2,89±0,58
Relative Leg Force 2	3,19±0,68	3,54±0,55

Table 3. Pre-test-post-test comparison analysis of the variables of the male athletes participating in the study. When these analyzes are examined; between height 2—height 1 (p⊚0.014, p⊚0.05*), between leg lift 2—leg lift 1 (p⊚0.011, p⊚0.05*), between plank 2—plank 1 (p⊚0.011), p⊚0.05*), sit-up 2—sit-up 1 (p⊚0.011, p⊚0.05*), push-up 2—push-up 1 (p⊚0.040, p⊚0.05*), vertical jump 2—vertical jump between 1 (p⊚0.011, p⊚0.05*), speed between 30m.2—speed 30m.1 (p<0.012, p⊚0.05*), right palding between 2—right palding 1 (p⊚0.012, p⊚0.05*), between right side 2—right side 1 (p⊚0.018, p⊚0.05*), between left side 2—left side 1 (p⊚0.012, p⊚0, 05*), between right auger 2—right auger 1 (p⊚0.011, p⊚0.05*), between left auger 2—left auger 1 (p⊚0.012, p⊚0.05*), hand claw force 2—hand paw strength between 1 (p⊚0.012, p⊚0.05*), arm mass between 2—arm mass 1 (p⊚0.011, p⊚0.05*), relative arm strength between 2—relative arm strength 1 (p⊚0.012, p⊚0.05*), between leg press force 2—leg press force 1 (p⊚0.011, p⊚0.05*), between leg mass 2—leg mass 1 (p⊚0.012, p While a significance was detected between ⊚0.05*) and relative leg strength 2—relative leg strength 1 (p⊚0.012, p⊚0.05*), no significance (p⊚0.05) was detected between the other variables. In addition, the positive or negative change status of the vari-ables in the pre-test-post-test analyzes of the male athletes participating in the research are given in the "% Increase/Decrease/Constant" column in Table 3.

Table 3. Pre-test Post-test Analyses of Variables of Male Athletes Participating in the Study.

Variables		N	% Increase/ Decrease/Fixed	Mean Rank	Sum of Ranks	z	p
Weight 2 Weight1	Negative Ranks	4	50,00%	3,00	12,00	-,339	,735
	Positive Ranks	3	37,50%	5,33	16,00		
	Ties	1	12,50%				
Height 2 Hegiht1	Negative Ranks	0	0,00%	,00	,00	-2,449	**,014***
	Positive Ranks	6	75,00%	3,50	21,00		
	Ties	2	25,00%				
Leg Raise 2 Leg Raise 1	Negative Ranks	0	0,00%	,00	,00	-2,530	**,011***
	Positive Ranks	8	100,00%	4,50	36,00		
	Ties	0	0,00%				
Plank 2 Plank 1	Negative Ranks	0	0,00%	,00	,00	-2,536	**,011***
	Positive Ranks	8	100,00%	4,50	36,00		
	Ties	0	0,00%				
Sit-up 2 Sit-up 1	Negative Ranks	0	0,00%	,00	,00	-2,533	**,011***
	Positive Ranks	8	100,00%	4,50	36,00		
	Ties	0	0,00%				
Push-up 2	Negative Ranks	1	12,50%	2,00	2,00	-2,058	**,040***

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Push-up1	Positive Ranks	6	75,00%	4,33	26,00		
	Ties	1	12,50%				
Stork Balance Right 2 **Stork Balance Right 1**	Negative Ranks	3	37,50%	4,67	14,00		
	Positive Ranks	5	62,50%	4,40	22,00	-,561	,575
	Ties	0	0,00%				
Stork Balance Left 2 **Stork Balance Left 1**	Negative Ranks	3	37,50%	3,67	11,00		
	Positive Ranks	5	62,50%	5,00	25,00	-,980	,327
	Ties	0	0,00%				
Vertical Jump 2 **Vertical Jump 1**	Negative Ranks	0	0,00%	,00	,00		
	Positive Ranks	8	100,00%	4,50	36,00	-2,536	**,011***
	Ties	0	0,00%				
Sprint 30m.2 **Sprint 30m.1**	Negative Ranks	8	100,00%	4,50	36,00		
	Positive Ranks	0	0,00%	,00	,00	-2,524	**,012***
	Ties	0	0,00%				
Right Palding 2 **Right Palding 1**	Negative Ranks	0	0,00%	,00	,00		
	Positive Ranks	8	100,00%	4,50	36,00	-2,524	**,012***
	Ties	0	0,00%				
Left Palding 2 **Left Palding 1**	Negative Ranks	1	12,50%	8,00	8,00		
	Positive Ranks	7	87,50%	4,00	28,00	-1,402	,161
	Ties	0	0,00%				
Right Yopça 2 **Sağ Yopça 1**	Negative Ranks	0	0,00%	,00	,00		
	Positive Ranks	7	87,50%	4,00	28,00	-2,371	**,018***
	Ties	1	12,50%				
Left Yopça 2 **Sol Yopça 1**	Negative Ranks	0	0,00%	,00	,00		
	Positive Ranks	8	100,00%	4,50	36,00	-2,524	**,012***
	Ties	0	0,00%				
Right Auger 2 **Right Auger 1**	Negative Ranks	0	0,00%	,00	,00		
	Positive Ranks	8	100,00%	4,50	36,00	-2,533	**,011***
	Ties	0	0,00%				
Left Auger 2 **Left Auger 1**	Negative Ranks	0	0,00%	,00	,00		
	Positive Ranks	8	100,00%	4,50	36,00	-2,527	**,012***
	Ties	0	0,00%				
Hand Claw Strength 2 **Hand Claw Strength 1**	Negative Ranks	0	0,00%	,00	,00		
	Positive Ranks	8	100,00%	4,50	36,00	-2,524	**,012***
	Ties	0	0,00%				
Arm Mass 2 **Arm Mass 1**	Negative Ranks	0	0,00%	,00	,00		
	Positive Ranks	8	100,00%	4,50	36,00	-2,530	**,011***
	Ties	0	0,00%				
Relative Arm Strength 2 **Relative Arm Strength 1**	Negative Ranks	0	0,00%	,00	,00		
	Positive Ranks	8	100,00%	4,50	36,00	-2,521	**,012***
	Ties	0	0,00%				
Leg Press Strength 2 **Leg Press Strength 1**	Negative Ranks	0	0,00%	,00	,00		
	Positive Ranks	8	100,00%	4,50	36,00	-2,546	**,011***
	Ties	0	0,00%				
Leg Mass 2 **Leg Mass 1**	Negative Ranks	0	0,00%	,00	,00		
	Positive Ranks	8	100,00%	4,50	36,00	-2,524	**,012***
	Ties	0	0,00%				
Relative Leg Strength 2 **Relative Leg Strength 1**	Negative Ranks	0	0,00%	,00	,00		
	Positive Ranks	8	100,00%	4,50	36,00	-2,521	**,012***
	Ties	0	0,00%				

*__p< 0,05__ Negative Ranks: Decrease Positive Ranks: Increase Ties: Fixed.

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In Table 4, the pre-test post-test comparison analysis of the variables of the female athletes participating in the study was made.

Table 4. Pre-test Post-test Analysis of Variables of Female Athletes Participating in the Study.

Variables		N	% Increase/ Decrease/Fixed	Mean Rank	Sum of Ranks	z	p
Weight 2 Weight1	Negative Ranks	4	61,54%	6,69	53,5	-,560	,575
	Positive Ranks	3	38,46%	7,5	37,5		
	Ties	1	0,00%				
Height 2 Hegiht1	Negative Ranks	0	0,00%	0	0	-3,114	**,002****
	Positive Ranks	6	92,31%	6,5	78		
	Ties	2	7,69%				
Leg Raise 2 Leg Raise 1	Negative Ranks	0	0,00%	0	0	-3,195	**,001****
	Positive Ranks	8	100,00%	7	91		
	Ties	0	0,00%				
Plank 2 Plank 1	Negative Ranks	0	0,00%	0	0	-3,194	**,001****
	Positive Ranks	8	100,00%	7	91		
	Ties	0	0,00%				
Sit-up 2 Sit-up 1	Negative Ranks	0	0,00%	0	0	-3,193	**,001****
	Positive Ranks	8	100,00%	7	91		
	Ties	0	0,00%				
Push-up 2 Push-up1	Negative Ranks	1	0,00%	0	0	-3,097	**,002****
	Positive Ranks	6	92,31%	6,5	78		
	Ties	1	7,69%				
Stork Balance Right 2 Stork Balance Right 1	Negative Ranks	3	53,85%	8,57	60	-1,014	,311
	Positive Ranks	5	46,15%	5,17	31		
	Ties	0	0,00%				
Stork Balance Left 2 Stork Balance Left 1	Negative Ranks	3	53,85%	5,71	40	-,384	,701
	Positive Ranks	5	46,15%	8,5	51		
	Ties	0	0,00%				
Vertical Jump 2 Vertical Jump 1	Negative Ranks	0	0,00%	0	0	-3,211	**,001****
	Positive Ranks	8	100,00%	7	91		
	Ties	0	0,00%				
Sprint 30m.2 Sprint 30m.1	Negative Ranks	8	100,00%	7	91	-3,181	**,001****
	Positive Ranks	0	0,00%	0	0		
	Ties	0	0,00%				
Right Palding 2 Right Palding 1	Negative Ranks	0	0,00%	0	0	-3,187	**,001****
	Positive Ranks	8	100,00%	7	91		
	Ties	0	0,00%				
Left Palding 2 Left Palding 1	Negative Ranks	1	0,00%	0	0	-3,063	**,002****
	Positive Ranks	7	92,31%	6,5	78		
	Ties	0	7,69%				
Right Yopça 2 Sağ Yopça 1	Negative Ranks	0	0,00%	0	0	-3,190	**,001****
	Positive Ranks	7	100,00%	7	91		
	Ties	1	0,00%				
Left Yopça 2 Sol Yopça 1	Negative Ranks	0	0,00%	0	0	-3,188	**,001****
	Positive Ranks	8	100,00%	7	91		
	Ties	0	0,00%				
Right Auger 2	Negative Ranks	0	0,00%	0	0	-3,187	**,001****

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Right Auger 1	Positive Ranks	8	100,00%	7	91		
	Ties	0	0,00%				
Left Auger 2 Left Auger 1	Negative Ranks	0	7,69%	1,5	1,5		
	Positive Ranks	8	92,31%	7,46	89,5	-3,086	**,002****
	Ties	0	0,00%				
Hand Claw Strength 2 Hand Claw Strength 1	Negative Ranks	0	0,00%	0	0		
	Positive Ranks	8	100,00%	7	91	-3,183	**,001****
	Ties	0	0,00%				
Arm Mass 2 Arm Mass 1	Negative Ranks	0	0,00%	0	0		
	Positive Ranks	8	100,00%	7	91	-3,194	**,001****
	Ties	0	0,00%				
Relative Arm Strength 2 Relative Arm Strength 1	Negative Ranks	0	0,00%	0	0		
	Positive Ranks	8	100,00%	7	91	-3,180	**,001****
	Ties	0	0,00%				
Leg Press Strength 2 Leg Press Strength 1	Negative Ranks	0	0,00%	0	0		
	Positive Ranks	8	100,00%	7	91	-3,228	**,001****
	Ties	0	0,00%				
Leg Mass 2 Leg Mass 1	Negative Ranks	0	0,00%	0	0		
	Positive Ranks	8	100,00%	7	91	-3,203	**,001****
	Ties	0	0,00%				
Relative Leg Strength 2 Relative Leg Strength 1	Negative Ranks	0	0,00%	0	0		
	Positive Ranks	8	100,00%	7	91	-3,182	**,001****
	Ties	0	0,00%				

*__p< 0,05__ Negative Ranks: Decrease Positive Ranks: Increase Ties: Fixed.

When these analyzes are examined; between height 2—height 1 (p<0.002, p<0.01**), between leg lift 2—leg lift 1 (p<0.001, p<0.01**), between plank 2—plank 1 (p <0.001, p<0.01**), between sit-up 2—sit-up 1 (p<0.001, p<0.01**), between push-up 2—push-up 1 (p<0.002, p<0.01**), between vertical jump 2—vertical jump 1 (p<0.001, p<0.01**), speed between 30m.2—speed 30m.1 (p<0.001, p<0.01**), right palding Between 2—right palding 1 (p<0.001, p<0.01**), between left palding 2—left palding 1 (p<0.002, p<0.01**), between right palding 2—right palding 1 (p<0.001, p<0.01**), between left peg 2—left peg 1 (p<0.001, p<0.01**), between right peg 2—right peg 1 (p<0.001, p <0.01**), between left peg 2—left peg 1 (p<0.002, p<0.01**), between hand claw force 2—hand claw force 1 (p<0.001, p<0.01 **), between arm mass 2—arm mass 1 (p<0.001, p<0.01**), between relative arm strength 2—relative arm strength 1 (p<0.001, p<0.01**), leg press force 2—leg press force 1 (p<0.001, p<0.01**), leg mass 2—leg mass 1 (p⊚0.001, p<0.01**) and relative leg force 2 While a significance was detected between—relative leg strength 1 (p<0.001, p<0.01**), no significance was detected between the other variables (p<0.05).

4. Discussion

In the literature research [33], compared the leg lifting values before and after training in the study in which he investigated the effects of foam rollers and core exercise training on some performance parameters in taekwondo players and did not report statistically significant differences [34], in his study in soccer players, reported that the duration of the leg lift test increased significantly in both dynamic and static core groups, and the plank test increased significantly only in the static core group. Similarly [35], 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. Similarly [9], found statistically significant differences in plank and leg lift parameters in pre-test and post-test intergroup comparisons in their study in taekwondo players. When other studies were examined, it was seen that core exercises were beneficial for leg raising and plank performance [36–38]. It was seen that the studies supported our

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study. In a study conducted by [20] on elite taekwondo athletes, they reported that the results of the 1-minute shuttle 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. In addition, they recommended that the effectiveness of this short-term study should be utilized in the preparation stages of competitions [20]. Ref. [9] reported that dynamic and static core exercises had a significant difference on shuttle performance in taekwondo athletes. In their study on tennis players, Arı and Çolakoğlu reported that 8-week core exercises were significantly effective on 30 s. shuttle performance [39]. In the literature review, it was determined that core exercises performed in different branches showed significance in shuttle test results and these results were in parallel with the results of our [34,40,41]. Ref. [9] 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 [9]. 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 [42]. 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 [43]. Literature information supports our study. It has been determined that core exercises performed on male and female athletes in different branches have positive effects on right-left foot stork balance [8,34,44–46] When the literature was reviewed, it was determined that core exercises applied to taekwondo branch were rare.

When the literature is examined, positive results of core exercises on vertical jump and other athletic performance outcomes are expressed [47]. When other studies are examined, it is reported that core exercises have a positive effect on balance and vertical performance [48,49].

In another study conducted with male taekwondo athletes, there was no statistical difference in 10 m sprint test results [9,50].

A high level of physical and physiological performance is expected from athletes in taekwondo [51,52] 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).[53]. In parallel with this, the high performance of the core exercise group in this study is among the expected results.

In a study conducted on bowling athletes, it was stated that core exercises positively affected hand strength [54]. In the 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 [55].

5. Conclusions

Core exercises can be included in the training program in addition to taekwondo training, as core exercises cause positive improvements in muscle strength, anaerobic strength and branch-specific technicians.

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-aration period for the competition. Since the sport of TAekwondo mainly has anaerobic power, core exercises in training can have a positive effect on anaerobic power.

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 addi-tion 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.

Core exercises can be added to the training program prepared by the taekwondo fed-eration for athletes in this age category.

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

In order to study the results of the studies in depth, its long-term effect can be ob-served.

A more detailed report can be created by linking the athletes' improving performance with the competition results.

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