

T.C.

YEDİTEPE UNIVERSITY

INSTITUTE OF HEALTH SCIENCES

MASTER'S PROGRAM IN SPORTS PHYSIOTHERAPY AND

REHABILITATION

**EFFECTS OF CORE STABILIZATION
EXERCISES ON BALANCE AND ENDURANCE IN
ADOLESCENT TAEKWONDO PLAYERS**

MASTER THESIS

A. BUSE BARUT,PT.

İSTANBUL-2021

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A. BUSE BARUT,PT.

ADVISOR: PROF. DR. RASMI MUAMMER

İSTANBUL-2021

APPROVAL

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Programme : Sports Physiotherapy
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APPROVAL

This thesis has been deemed by the jury in accordance with the relevant articles of Yeditepe University Graduate Education and Examinations Regulation and has been approved by Administrative Board of Institute with decision dated and numbered

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DECLARATION

I hereby declare that this thesis is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree except where due acknowledgment has been made in the text.

23.06.2021

A.BUSE BARUT



DEDICATION

I would like to dedicate this thesis to my parents Reyhan Barut and Pamir Barut, and to my sister Tuğçe Barut.



ACKNOWLEDMENT

I am grateful to Prof. Dr. Rasmi Muammer for guidance throughout my thesis and I am glad to be his student.



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LIST OF SYMBOLS AND ABBREVIATIONS

A	Anterior
AP	Anterior-posterior
ASIS	Anterior Superior Iliac Spine
BMI	Body Mass Index
Bos	Base of Support
CG	Control Group
cm	Centimeter
CSG	Core Stabilization Group
DBT	Dynamic Balance Test
MCET	McGill's Core Endurance Test
ML	Medio-lateral
m	Meter
PK	ProKin PK-200
PM	Posteromedial
PL	Posterolateral
R	Spearman's Rank Correlation Coefficient
rep.	Repetition
s	Second
SBT	Stork Balance Test
SD	Standard Deviation
SPSS	Statistical Package for Social Science
YBT	Y-Balance Test
WTF	World Taekwondo Federation
°	degree

ABSTRACT

Barut, A.B.(2021). Effects of core stabilization exercises on balance and endurance in adolescent taekwondo players, Yeditepe University, Institute of Health Sciences, Department of Physiotherapy and Rehabilitation, Master Thesis. Istanbul.

The purpose of the study is to search the effects of core stabilization exercises on balance and endurance in adolescent taekwondo players. The study included 30 taekwondo players (30M; 13,07±2,20 years) who applied to İbrahim Öztüfek Sport Club, Istanbul. The dynamic balance parameters of participants was determined using Y-Balance Test and Dynamic Balance Test. Stork Balance Test was used to determine static balance of participants. McGill's Core Endurance Test was used for the endurance parameters of participants. The 30 participants were divided into two groups as Core Stabilization Group (CSG)(n=15) and Control Group (CG)(n=15). Participants of both groups practices their taekwondo training. In addition to taekwondo training, the CSG started the core stabilization exercise program. The CSG applied the core stabilization exercise program 3 times a week for 30 minutes and for 6 weeks. After 6-week exercise programs, both groups were evaluated by repeating the tests. Statistical analyzes were performed using SPSS 22.0 version. The tests used for the difference between the before and after measurements taken by participants in two groups, Paired Sample T-Test for parametric variables and Wilcoxon Test for non-parametric variables. Each of the differences (delta) between these two groups (CSG and CG) was determined Independent Samples T-Test for parametric variables and Mann Whitney-U Test for non-parametric variables. The level of signifiante was accepted $p<0.05$. The main outcomes of our study comparing two groups, CSG showed greater improvement in the parameters of Stork Balance Test and McGill's Core Endurance Test ($p<0.05$). The CSG also improved in some of the parameters of Y-Balance Test and Dynamic Balance Test. Differences were seen in the other test results except for the dynamic test parameters. Consistent with hypothesis, core stabilization exercises program combined with taekwondo training was more effective to improve static balance and endurance findings of taekwondo players.

Key words : Dynamic balance, static balance, endurance, core stabilization, taekwondo players.

ÖZET

Barut, A.B. (2021). Genç Tekvando Sporcularında Kor Stabilizasyon Egzersizlerinin Denge ve Dayanıklılık Üzerine Etkileri. Yeditepe Üniversitesi Sağlık Bilimleri Enstitüsü, Fizyoterapi ve Rehabilitasyon Anabilim Dalı, Yüksek Lisans Tezi. İstanbul.

Çalışmanın amacı, genç tekvando sporcularında kor stabilizasyon egzersizlerinin denge ve dayanıklılık üzerindeki etkilerini araştırmaktır. Çalışmaya İstanbul İbrahim Öztüfek Spor Klübü'ne başvuran 30 tekvando sporcusu (30E; $13,07 \pm 2,20$ yaş) dahil edildi. Katılımcıların dinamik denge parametreleri için Y-Denge Testi ve Dinamik Denge Testi kullanıldı. Katılımcıların statik denge ölçümleri için ise Stork Denge Testi kullanıldı. Dayanıklılık ölçümleri için McGill Kor Dayanıklılık Testi kullanıldı. 30 katılımcıyı Kor Stabilizasyon Grubu (CSG) (n=15) ve Kontrol Grubu (CG) (n=15) olmak üzere iki gruba ayrıldı. Her iki grubun katılımcıları da tekvando eğitimlerini uyguladı. Tekvando eğitimine ek olarak CSG kor stabilizasyon egzersiz programına başladı. CSG kor stabilizasyon egzersiz programını haftada 3 kez, 30 dakika ve 6 hafta süreyle uyguladı. 6 haftalık egzersiz programları sonrası her iki grup da testler tekrarlanarak değerlendirildi. İstatistiksel analizler SPSS 22.0 versiyonu kullanılarak yapıldı. İki grubun sporcularından alınan öncesi ve sonrası ölçümler arasındaki fark için, parametrik değişkenler için Paired Sample T-Testi ve non-parametrik değişkenler için Wilcoxon Testi kullanıldı. Bu gruplar (CSG ve CG) arasındaki farklılıkların (delta) her biri parametrik değişkenler için Independent Samples T-Testi ve non-parametrik değişkenler için Mann Whitney-U testi kullanıldı. Anlamlılık seviyesi $p < 0.05$ olarak kabul edildi. İki grubu karşılaştıran çalışmamızın ana sonuçları, CSG Stork Denge Testi ve McGill Kor Dayanıklılık Testi parametrelerinde daha büyük gelişme gösterdi ($p < 0.05$). CSG, Y-Denge Testi ve Dinamik Denge Testi'nin bazı parametrelerinde de gelişme gösterdi. Dinamik test parametreleri hariç diğer test sonuçlarında farklar görüldü. Hipotez ile tutarlı olarak, tekvando eğitimi ile kor stabilizasyon egzersiz programının beraber uygulanması, tekvando sporcularının statik denge ve dayanıklılık bulgularını geliştirmede daha etkilidir.

Anahtar Sözcükler : Dinamik denge, statik denge, dayanıklılık, kor stabilizasyon, tekvando sporcuları

1. INTRODUCTION AND PURPOSE

‘Tae’, ‘Kwon’, ‘Do’

The meaning of the Tae is "to kick" or "to break with the foot ". The meaning of the Kwon is "to strike" or "to destroy with the hand or the fist". The meaning of the Do is "way" or "process". Therefore, Taekwondo is an unarmed self defense fighting technique. Taekwondo contains the skillful application of techniques like kicking, jump kicking, blocking, dodging, parrying with hands and feet. It is more than a simple skill in physical combat. It reflects a way of thinking and a lifestyle that requires strict discipline. It is a method of training both the mind and the body and attaches great importance to the development of moral character. [1].

Taekwondo is a martial art originating from Korea. It has been recognized as an official Olympic sport since the 2000 Sydney Olympics. It is a popular sport worldwide, with nearly 80 million people from over 200 countries participating. The number of children and adults engaged in martial arts, including taekwondo, is increasing by 20% to 25% each year, and taekwondo is a popular sport among children and adolescent. [2].

The performance in taekwondo can be evaluated according to the technical, tactical, psychological, physical and physiological characteristics of a player. For this reason, Taekwondo training has been developed to include these performance criteria [3]. From a physical conditioning perspective, the goal of taekwondo training is to teach players to manage physical activity and the physiological demands of fighting [4].

In taekwondo sport, physical activity and physiological criteria enable the competitors to develop their abilities in aerobic and anaerobic power, muscle strength, muscle power, balance, endurance, agility and speed [5]. For this reason, coaches and sports scientists should gather objective information about the physical performance abilities of the players in order to set training goals, develop short and long term exercise programs, and motivate players throughout exercise program [6]. This information is also useful in identifying physical attributes that aid competitive success and are the fitness standards required to compete [7].

In Taekwondo competitions, the ability of fast rotation, speed, agility, balance and endurance are required as attacking and defensive movements are made during the movements of opponents. At least 90% of these attacks are done with foot techniques [8]. Balance is very important for taekwondo sports as it includes many movements with one or both legs. Balance is the ability of the body to maintain equilibrium condition. Balance plays an important role in sports activities, due to a close relationship between equilibrium and motor function capacity, in maintaining balance and executing given tasks. Balance can be explained as standing in a static position on the base of support (BoS) with minimal movement and applying techniques while maintaining a dynamic movement with a stable stance. Therefore, static and dynamic balances are associated with increased performance in sports [9].

The ability of players to maintain their long-term physical activity depends on endurance. Players with the best endurance can perform well. Endurance is a criterion used as the "gold standard" to evaluate performance. The players exhibit maximum strength in the upper and lower extremities. They also exhibit endurance in the hip and trunk flexor muscles. Because successful players may have to compete in several competition in one day. Therefore, endurance is very important for taekwondo sport [6-10].

By applying core stabilization exercises, it is aimed to strengthen the deep muscles of the human body such as the central spine muscles, abdominal muscles, hip muscles and pelvic muscles. The spine, pelvis and abdominal muscles of the body in these regions are called core muscles [11]. Core stabilization is important because recent research has proven that core stabilization reduces the rate of injury to players, especially pre season training has a protective effect on injury [12].

According to the information obtained from the literature, it has been found that core stabilization has many benefits. Considering the importance of balance and endurance in taekwondo sport investigation of the relationship between core stabilization and balance, endurance results are thought to contribute to the improvement of sportive performance. In literature, there are very few study of effects of core stabilization exercises on balance and endurance in adolescent taekwondo players. As a result of this information, the aim of our study is to investigate the effects of core stabilization exercises on balance and endurance in adolescent taekwondo players.

Regarding these reasons, the aim of our study is compare the effects of taekwondo training program in Control Group (CG) with duration six weeks and core stabilization exercises combined with taekwondo training program in Core Stabilization Group (CSG)(for six weeks) on balance and endurance. The hypothesis of this study was following:

Hypothesis 0 (H0): There are not positive effects of core stabilization exercises on balance and endurance in adolescent taekwondo players.

Hypothesis 1 (H1): There are many positive effects of core stabilization exercises on balance and endurance in adolescent taekwondo players.



2.THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1. Taekwondo

2.1.1. Definition and History of Taekwondo

Taekwondo consist of combinations hand techniques, foot techniques and defense, batting techniques. In addition, the importance of ethics, respect and virtuous behavior in players is a sports branch. Taekwondo is a sport that emphasis on the development of ethical, respectful and virtuous behavior of players.

Taekwondo emerged in Korea and spread throughout the world. It is also the national sport of Korean people. The history of Taekwondo sport goes back 13 centuries stretches. The people who live in that time period were trying to protect themselves against human and wild animals that harm them. They developed a system using only foot techniques. The name of this system is “TAEGYON” which means “Foot System”. In the same period, other techniques, hand techniques, were studied in Korea. The name of this system is “KWONPOP” which means “Fist System”. In time, people systematized the defense techniques which they applied with their hands and feet and called it Taek-Kyon. Thus, the first foundations of Taekwondo were laid [13].

In 1994, Taekwondo sport entered in olympic sports in fourth place after the fight sports such as judo, box and wrestle. In 1975, the first World Championship was held in Korea. It was held in 1982 Seoul and 1992 Barcelona Olympics as a show sport. At the 2000 Sydney Olympics, it was officially included in the competitions program. Taekwondo is a sport of approximately 80 million people in the world and is held in 200 countries [14].

Taekwondo is practiced under various administrations. However, the World Taekwondo Federation (WTF) is officially responsible for enforcing the rules and regulations of Olympic events and World Championships. World Taekwondo Federation (WTF) will take place in the players of age, sex and weight organizes by category. It also organizes regularly at regional, national and international levels. The competitions are held for 2 minutes in 3 rounds with 1 minute intervals. In regional, national and international competitions, it includes eight different categories for players. (Men: 54, 58, 63, 68, 74, 80, 87 and +87 kg / Women: 46, 49, 53, 57, 62, 67, 73 and +73 kg).

In addition, in the Olympic races, it includes four different categories for players.(Men: 58, 68, 80 and + 80 kg / Women: 49, 57,67 and + 67 kg). The scoring system of the World Taekwondo Federation(WTF) is as follows: “a valid attack on the trunk protector 1 point, applies to the trunk protector swivel kick 2 points, a valid kick to the top 3 points and swivel kick to the top 4 points”. The applicable techniques are based on the designated scoring regions of the body and the permissible areas of the head applied strongly. The size of the Competition Area must be greater than 10m x 10m and smaller than 12m x 12m. [15].

In taekwondo competitions against any opponent, the belt, which indicates the current degree of the player, a protective vest, helmet and kuki are worn on a white suit. The competitions that start with a salute to show respect for the opponent end with salutations. The competitions are carried out in accordance with certain rules in addition to protective clothing to reduce the likelihood of disability. These rules can be specified as not being hit face by hand, not being hit below the waist, not being hit on the opponent who has fallen to the ground. If a player acts in violation of these rules, he or she is penalized with warning or negative points [16].

When player begins taekwondo, he/she will wear a white belt and a uniform, called a dobok in Korea. Doboks are made up of pants and a jacket. The pants have either a drawstring waist or an elastic waist. If pants have a drawstring waist, be sure that players tie them securely, but not too tightly Players will need to move freely in your uniform, so the pants must fit comfortably. Also, the jacket must fit comfortably. The belts are tied over the dobok at the waist and holds everything together[17] (Figure 2.1).



Figure 2.1: World Taekwondo Federation(WTF) Dobok [15]

One of the elements that should be mentioned about Taekwondo sport is related to the belts showing the rating. These belts show the point where the player comes in Taekwondo and are colored according to the level. The first of these is the white belt, people who have just started Taekwondo and do not have any prior knowledge about this art of defense. The next level, the yellow belt, depicts that one is gradually beginning to learn Taekwondo techniques, referring to the metaphor of a plant root taking root in the soil (referring to the fact that the roots are usually yellow). The next belt, the green belt, also refers to the metaphor of growth and bloom of the plant, which means that the person is now beginning to grow in Taekwondo. The blue belt, which is passed after the green belt, represents reaching the sky, indicating that the person is now approaching maturity in Taekwondo. At this level, players begin to stabilize their power and develop a focus to their studies as they reach out to obtain their potential. The next belt, the red belt, symbolizes danger and the sun, representing that the person is now dangerous to the attackers and can easily eliminate those who approach him with malice. In contrast to the white belt, the black belt, which symbolizes reaching maturity and a vast vastness through the space metaphor, represents the last belt in Taekwondo, which does not change color after this level. At this highest stage the mastery of techniques is reflected by calm honour and sincerity[18-19].

The classification system of the World Taekwondo Federation(WTF) is as follows (Figure 2.2):

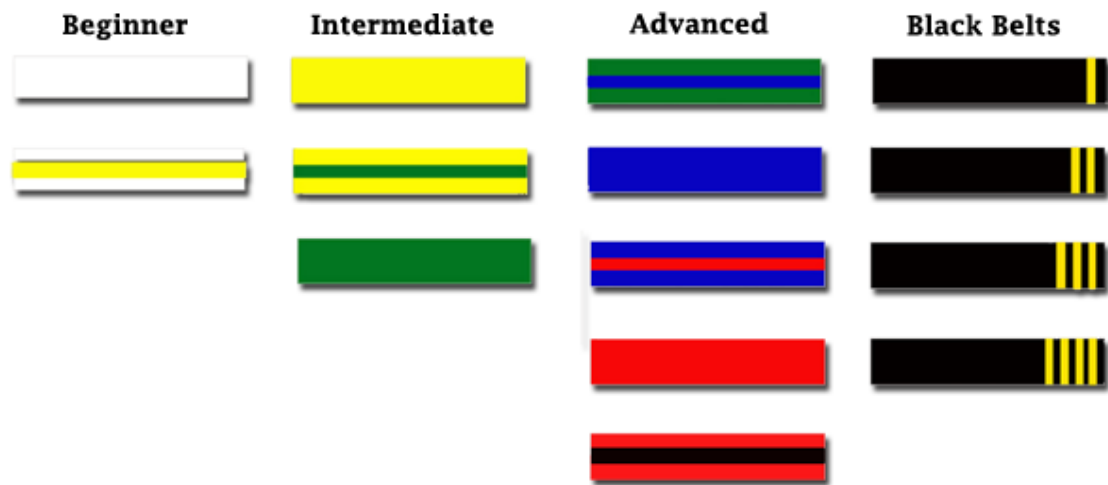


Figure 2.2 : The classification system of the World Taekwondo Federation(WTF) [15]

2.1.2. Physiological Requirements for Taekwondo

Determination of metabolic profile of sports branch for optimal performance it is necessary to determine the required functional conditions. Because a contest necessary for the best practice of technical skills throughout the functional and physical preparations should be completed [20]. Considering the increasing interest in Taekwondo sport, determining the physiological needs of Taekwondo sport and training programs accordingly preparing is very important [21].

In taekwondo sport, short and medium term loading and rest periods located. In addition, the taekwondo sport is usually used for all power (energy) and is an interval sport performed by movements of hand and foot techniques [22]. One of the factors affecting performance in taekwondo is physiological features (in addition to the technical, tactical, psychological and physical characteristics of the player) [10].

In taekwondo sport, while responding to attacks from the opponent speed, endurance, strength, balance, a high it requires reaction time and flexibility, and sudden movements take place. Nowadays, many researchers investigating the impact of specific training programs that are planned on physiological needs of Taekwondo sport [23].

In accordance with this information obtained, sporting performance can be improved and removal is thought to be more effective. However, the methods of obtaining this information are important in determining the physiological needs of the branch. In intermittent sports such as combat sports, the physiological requirements of players are difficult to examine in the laboratory environment. Therefore the physiological requirements are easier to identify during actual competitions [24]. Some of the physiological needs are genetically based and the other part is the factors that can be developed and maintained by training.

Each training session starts with warm-up program. First, the training begins with a training session of cardiovascular exercises e.g., running or jumping on the floor. After that, stretching exercises are performed. Because there are so many options to structure the warm-up program, and each instructor has his own techniques, we will not try to depict any specific exercises here. The proper exercises are applied after the warm-up: blocks, strikes and kicks [25].

Percentage of hand and foot techniques used in taekwondo competitions: hand 10%, foot 90% [8]. Taekwondo sport allows players to use their upper and lower extremities, thus allows them improving their physical fitness [26]. After competitions, a quick recovery will reduce the resting time of players and better performance in competition or training [27].

Taekwondo players start training and competitions around the age of 10. Youth matches should meet the physiological characteristics of children, protect them from excessive physiological stresses and focus on advancing the development of technical and tactical skills [28].

2.2. Core Region

2.2.1. Definition of Core

Core is an English word meaning central. In sports sciences, the term core is defined as the center of gravity, which is considered the midpoint of the human body[29]. The core region refers to the trunk or more specifically the lumbopelvic region of the body. The stability of lumbopelvic region is an important formation to support loads, to form the basis for upper-lower limb movements, to maintain the spinal cord and nerve roots [30].

The core region is a set of exercises that develop the central region of the body according to foreign sources. In terms of sports science, the expressions of core exercises, core strength, core endurance, and core stabilization refers to develop the muscles of the core region and trunk. The core region can improve sportive performance in a variety of ways. The Core region, provides stabilization of the lumbo-pelvic region which has an important place in the application of sporting techniques[31]. This area is a tool that performs force transfer from the lower part of the body to the upper part of the body and the muscles of the core region are directly involved when performing a movement [32].

Especially, the stability of the gluteal, abdominal and paraspinal muscles that consist of the spine, pelvic belt and abdominal belt and muscle, nerve bone and other tissues, is important for the performance [33]. The core region is the transition point of the balance of the movements of the extremities and force transfer. For this reason, the movements of the upper and lower extremities are considered as the motor center and powerhouse [34]. During motor movements, the core region has a supporting role in the movements of the extremities [35]. In order for the exercises to be performed in a balanced, necessary intensity, with speed and strength, this region must be strong [34]. The weakness of the core region muscles not only affects the sportive performance but also causes postural disorders [36].

2.2.2. Core Stability and Adolescent

Players and instructors might increase their compliance with core stability training if they provided with strong evidence which shows these types of exercises improve sportive performance as well as reduce injury rates. This information might be satisfying for adults groups; but information is lacking in much of the previous literature on core stability for adolescent. It is also important to understand the effects of exercise program for different populations such as adolescent or young players. From this perspective, another important point to explain about core stability is effectiveness adolescent. Exercise methods aimed at increasing the athletic performance of adolescents or improving their various abilities are a controversial issue in the literature. It is well known fact that adolescent players are not junior versions of adult players.

For example; regarding the stabilization of the trunk and adjustment of posture, the psoas major muscle is less developed in adolescent players than in adult players [37].

Therefore, age should be taken into account when planning the program for the development of sports performance and skills. To illustrate, various association and review articles have accepted that resistance training is an appropriate method for increasing muscular strength under the supervision of a qualified instructor for adolescent in order to advance physical performance [38]. Just like resistance training, core stability training might be one of these methods. The popularity of resistance training took attentions on this issue and provided solid significant experimental basis for implenting different kinds of resistance training methods by both researchers and instructors. For improving other functional compounds of performance such as balance and endurance [39] and decreasing injury risks for adolescent [40]. Researchers has started to conduct studies on different exercise methods such as core stabilization, core endurance and balance training [41].

Most of the instructors are not intent to use resistance training for their adolescent or early adolescent players to avoid injury and not to stop their growth rate. Therefore, it has become important to discover other exercise techniques which are used to improve performance for adolescent population. One of them, core stability trainings that activates trunk muscles, has been documented to increase muscular strength in mature sedentary populations [42].

Compared with adults, adolescent are prone to overuse injuries, as their skeletal system is immature [43]. When the core stability exercises are examined in the perspetive of injury, two distinct elements appears; first one is prevention of injury, second is strengthening players for refraining them injuries. Literature has huge number of researches related to occurrence of injuries among young players and some review collected them up and compared comprehensively [44]. According to these researches, there are some common risk factors such as immature skeletal system, decreased flexibility with growth, training in inadequate environment, excessive loading. In comparison, similar to adults injuries seen among children due to two causes; jump-landing mechanism and contacts [45].

Another important point is that poor trunk stability might cause severe injuries in both lower and upper extremity [46], explaining that the stability and mobility are the two base factor that players should built at first for improving their performance and abilities. In addition, a good functional movement is important to refrain from injuries. Sports such as taekwondo, gymnastic, dance and soccer involve repetitive flexion, extension and rotation highly which movement patterns directly related to stabilizer muscles around trunk [47]. As it was emphasized once again the constant exposure to repetitive athletic movements might cause an injury in different parts of body. It has become important issue to focus on core strengthening the physical structure of adolescent to refrain them from injuries and advance their performance. Because of this reason, it might be important to build good functional base at adolescent taekwondo players.

2.2.3. Core Musculature

The core concept in sport performance, it is crucial to explain the musculo-skeletal structure of core region which is described in the sport medicine literature as the lumbopelvic region within abdominals anteriorly, paraspinals and gluteal posteriorly, pelvic floor musculature inferiorly, hip abductors and rotators laterally, and diaphragm superiorly [41]. Core muscles play a vital role in postural stabilization [48]. If the extremities are strong and the core muscles are weak, the force production decreases because the muscle strength in the core region is not sufficient. And because of this, unproductive movement patterns arise. [49].

The core region muscles are divided into two as local and global muscles according to their functions [50].

Table 2.1: Classification of Core Region Muscles [50]

LOCAL MUSCLES (STABILIZATION SYSTEM)		GLOBAL MUSCLES (MOVEMENT SYSTEM)
Primer muscles	Seconder muscles	Rectus Abdominis
Transversus Abdominis Multifidus	Internal Oblique External Oblique (Medial part) Quadratus Lumborum Diaphragm Pelvic Floor Muscles Iliocostalis and Longissimus (Lumbar part)	External Oblique (Lateral part) Psoas Major Erector Spina Iliocostalis (Thorax part)

Local muscles: Transversus abdominis, multifidus, internal oblique, external oblique (medial part), quadratus lumborum, diaphragm, pelvic floor muscles, iliocostalis and longissimus(lumbar part).

Global muscles: Rectus abdominis, external oblique (lateral part), psoas major, erector spina and thorax part of the iliocostalis [Table 2.1].

According to Berkmarg, the features of the core region muscles are as follows.

Table 2.2: The Features of Core Region Muscles [50]

Features of Lokal Muscles	Features of Global Muscles
• Deep • They contract slowly • They have high endurance • They are low powered • They are active at low resistances. (Less than %40 density) • Duration-dependent muscle activation	• Superficial • They contract fast • They are effective at high powers. • They are high powered • They are active at high resistances. (More than %40 density) • Strength-dependent muscle activation

Local and global muscles contain two types of muscle fibers. These are fast-twitches and slow-twitches muscle fibers. The muscle fibers of the local muscular system (deep muscles) consist of slow-twitch muscle fibers. The length of these muscles is shorter than the global muscles. The primary tasks of these muscles are to control inter-regional movements, correcting posture changes, responding to external loads and ensuring coordination. The muscle fibers of the global muscular system (superficial muscles) consist of fast-twitch muscle fibers. These muscles are long and have large branches. In this way, they generate large movements and high amounts torque movements [51].

2.2.4. Core Stabilization Exercises

Core stabilization exercises are exercises that the player performs with his own body weight, and these exercises aims to strengthen the muscles responsible for its stabilization. Thanks to these exercises trunk and back muscles, learn to control and protect the spine during movement [52]. The purpose of the exercises is to improve the function of the important trunk muscles to protect the spine from damage [51].

Core stabilization exercises reduce pain, injury, and risk of injury. It also enhances muscle function and maintains stability [53]. Despite limited evidence, core stabilization exercises integrated into anti-injury exercise programs show that the rate of injury decreases, especially in the lower extremity. Core stabilization exercises are supported in preventing and reshaping the lower limb injuries. In order to train core stabilization, it is recommended to strengthen the local muscles first, and then to create a progressive program by combining exercises with whole body dynamic movements in various positions [54].

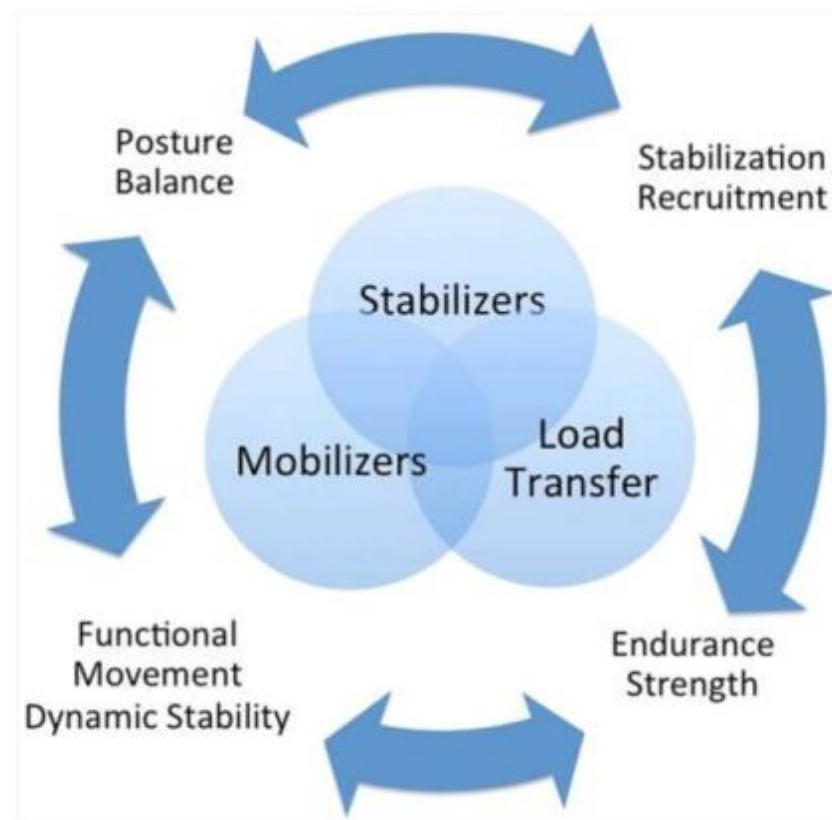


Figure 2.3 : Functional Core Stability [54]

As seen in Figure 2.3, exercise programs aiming to create core stabilization, aims to improve and develop the muscles that make up load transfer, stabilizer muscles (local and global) and mobilizer muscles [54]

This exercise program provides the development of muscle strength and endurance. In addition, thanks to the regulation of the neuromuscular control system, it also provides the development of balance and posture [54]. In addition, core stabilization exercises are also used to improve static balance, dynamic balance, flexibility, stability and functionality [55].

In the core exercise program, the body works as a whole. If the body balance is disturbed during movement and therefore if unwanted movements and loads occur in the body, core region muscles and muscles outside this region they compensate for the imbalance interchangeably. However, if the core region muscles are weak, the muscles in the other region have more duties. Because they are also take on the duties of core region muscles. This causes wear on the body and movement cannot be done desired quality. The movement is done inefficiently and fatigue occurs with loss of energy in the body. Core exercises are created to balance, strengthen and maintain stability of the body for a healthy and energetic life [56].

Core stabilization exercises should be done in pain-free, neutral position of the spine. This position is between lumbar extension and flexion movement. It is the balance and strength position in sports activities and exercise [57]. Players get help from manual repositioning exercises while finding the neutral position of the spine. During these exercises, anterior and posterior tilt are performed to the neutral spine and the player is asked to return to the neutral position. Over time, players gain kinesthetic and proprioceptive awareness of the neutral position [54]. There are numerous exercises that target core muscles. In recent years, several different exercise approaches and variations have been developed to increase core muscle activation. Fast-twitch muscle fibers must work for high muscle activation. Approaches to core stabilization exercises can be divided in two ways. They are divided into isometric and isolated training of muscles or dynamic and holistic training [58].

After ensuring voluntary contraction and proprioceptive awareness of core stabilizers, core stabilization exercises aims to improve muscle strength, muscle

endurance and neuromuscular control. The most accurate core training is to work separately for each muscle and customize it [59].

2.3. Balance

Balance is the ability to maintain a posture while maintaining the center of gravity within the base of support and through connections between the musculoskeletal system and the nervous system. [60]. Balance is the ability of the body to maintain a stable position or to make stable movements by resisting the force of gravity[61]. Balance is achieved through a complex process. Respectively, the movements of body are defined through the sense organs, entered into the central nervous system, sent to the musculoskeletal system after sensory integration, and then the reaction is realized. Balance is an indispensable element in all activities of our daily life (like standing up, sitting, walking) [62]. Balance is a high-level integration process involving musculoskeletal elements (muscle strength, spinal flexibility and joint range of motion) and the proprioceptive sense, vestibular organ, and visual organ [60]. Adopting correct or balanced posture through balance is crucial because it prevents injury or progressive disability and preserves the structure, function and health of the body of the individuals [63].

2.3.1. Balance Systems

Maintaining balance requires coordination of signals from multiple sensory systems. These sensory systems are vestibular, somatosensory and visual systems.

- a) Vestibular System: It includes the sense organs that maintain balance (equilibrioception): directional information as it relation to head position (internal gravity, linear and angular acceleration). Vestibular system, consists of nerve fibers that provide connection between; peripheral, vestibular organ, vestibular nerve, vestibular nuclei, nuclei located in the cerebellum associated with the vestibular system, cerebellum, brainstem, spinal cord and high centers. The vestibular system provides stable visual perception during the movement of the body or the environment and gives information about spatial position, movement of the head, linear and angular acceleration [64].

b) Somatosensory System: It includes the senses of proprioception and kinesthesia of the joints, information from the skin and joints (pressure and vibration senses), spatial position and movement relative to the supporting surface, and the relative movement and position of different body parts. Somatosensory system and balance, work together and uses sensory information related to posture and movement from sensory receptors for postural control. Somatosensory inputs obtained from mechanoreceptors, cutaneous receptors and joint receptors that send afferent signals to the brain. Also, these receptors helps the postural control mechanism directly to regulate balance. It is a combination that provides the sense of touch, pressure and vibration. Sensormotor system; sensory stimulation reception, the transformation of the stimulation into the neural signal, the transfer of the signal to the central nervous system through afferent means, the processing of the signal in the central nervous system, performing movement and functional tasks, and joint stabilization [64].

c) Visual System: It includes its relation to verticality of body and head movement, its spatial position relative to objects. More information about the movement of the body in space is provided by vision. Even if the entire vestibular system is deactivated, the person can balance with stable posture and even slow movements by making use of the sense of vision. There are two different visual systems in people:

1. Specialized focal system (focusing vision) for recognizing objects. The focal system helps consciously perceive objects. If the light is insufficient, this system is broken.

2. Specialized ambient system (environmental vision) for motion control. The ambient system monitors all central and peripheral areas for motion control. The ambient system helps to control movements unknowingly. If the lighting is insufficient, there is no distortion. It is an example of getting used to the light-free environment and walking [64].

Balance is divided into two as static and dynamic.

2.3.2. Static Balance

Maintaining a posture in the same position is known as static balance, but without assistance, eg for 10 seconds standing on one leg.; sitting upright while reading or writing. Static balance is also termed a state of static balance and can best be demonstrated by the level of the spirit [65]. Static balance is defined as the balance that is automatically created to hold and maintain the general stance or body in position on a stationary (fixed) ground without the need for any external force [66]. Force development is very important to achieve static balance. Static balance skill increases as the force develops [67].

Static balance is controlled by maculae receptors within the vestibular system membrane. These are responsible for recording the position of the head relative to gravity when the body is stationary [68]. Every macula is a patch of receptor cells whose hairs located in the otolithic membrane. This membrane is composed of a jelly like substance and includes small particles made of calcium salts known as otoliths. During the turning of the heart, the otoliths turn in response to changes in the gravity. This force slides over the hair cells and pulls the membrane that bends the hairs. The hair cells are stimulated and transmit an impulse along the vestibular nerve (a part of the cranial nerve VIII) to the cerebellum of the brain, reminding the place of the head in space [65,69].

2.3.3. Dynamic Balance

Maintaining a posture while moving in a coordinated manner using exactly the right muscles to perform a task with minimum effort and maximum impact is defined as dynamic balance [68]. Dynamic balance occurs during movement that neutralize the body with the help of external and internal forces acting on the body [66]. In addition to daily activities like walking, running and climbing stairs, dynamic balance is also decisive in sports branches such as rapid response to changing conditions , sudden changes in direction and sprints [70].

Dynamic balance is also called a state of dynamic equilibrium and is controlled by receptors in the semicircular canals that lead to rotational motions of the head. This can be demonstrated by a snow globe, where the snow gets disturbed every time the

head turns. Since these canals are positioned in the three planes of space - forward/backward; up/down; left/right, any movement of the head will be observed by the direction in which the 'snow' moves [68].

Dynamic balance is regulated by the maculae receptors within the membrane of the vestibular system [65] which are liable for sensing the head position to the gravity when the body moves in a linear manner [69].

One of the important aspects in dynamic equilibrium is motor control skill. There are many unstable and dynamic types of exercises to improve movement performance in different situations and conditions such as sudden acceleration or slowing down, changing the direction of the body [71].

2.3.4. The Importance of Balance in Taekwondo Sport

Balance affects performance in taekwondo as in every sports branch. Due to the nature of Taekwondo sport, both static and dynamic balance properties must be well developed.

Due to the difficulties in developing and maintaining functional strength and stability, it is important to utilize an approach that will include activities that promote improvement in each region. Martial arts are traditional types of combat that have been modified for competition, self-defense and leisure [72]. Taekwondo is a defensive art that incorporates foot tactics for self-defense. Sliding on the heels of the feet, and rapidly sliding (in all directions) helps to keep the adversary at a point. It also helps to balance the body while extremities are punching or kicking. Choreographed movements practice involves moving between long and wide stances causing players to move beyond base of support. Taekwondo does not often use upper body tactics that allow competitors to be near to each other. Upper body is mainly used for blocking, but only recently were punches to the body considered scoring in taekwondo sport [73].

2.4. Endurance

Endurance described as performance during full-body, dynamic exercise which requires continuous effort and lasts for 75 seconds or longer [74]. That sort of endurance performance, also named as cardiorespiratory or aerobic endurance. Performance during activities requiring prolonged or repeated submaximal contractions of a single muscle or group of muscle is called as muscular endurance (e.g., sit-ups, weight carrying, hand holding tasks, and leg raising tasks) [75]. As any other type of physical performance, endurance performance can be evaluated from various

disciplinary viewpoints, the primary ones being physiological, biomechanical and psychological [76].

Endurance sports are activities which need muscle endurance to a high level of. This is mainly accomplished through aerobic activities. The muscles are trained in contracting repeatedly without fatiguing at a submaximal level. Some endurance training programs rely almost entirely on aerobic training, using a approach is “more is better”. This approach often excludes other aspects of fitness, because players and coaches think they don't have time to divide into other parts [77].

Most people who involved in endurance sports are recreational players, so general physical fitness is an important part of keeping a high quality of life. As a individual ages, muscle strength (ability to produce force) and muscle power (the ability to produce rapid force) decrease. Endurance training maximizes the ability to generate repeated submaximal muscle contractions but it does little to preserve or increase muscle strength or power [77].

The contraction and endurance levels of different muscles in the body are different. The strength and endurance of the muscles used continuously is higher than the other muscles. Force and endurance, plays an important role in daily work, maintaining the appropriate posture and counteracting fatigue [78].

Endurance is two types according to the energy requirement of the muscles [79]:

2.4.1. Aerobic Endurance

Aerobic capacity is defined as the ability to continue training for a long time and is used synonymously with endurance. Aerobic capacity can also be defined as the carrying maximum oxygen and utilization oxygen capacity of the muscles and is a valuable index of the cardiovascular system capacity [80]. Aerobic fitness is essential for most sports. In many sports, aerobic fitness determines the speed of recovery of the player between high-intensity parts and the distance player takes in the competition [81].

2.4.3. Endurance According to Sport Branch

Considering the needs of training, the endurance of the muscles involved in the movement is examined in two ways:

- General endurance
- Special endurance

General endurance is the endurance feature that should be present in every sport and player [83]. General endurance to be the capacity to perform a kind of activity that involves many muscle groups and systems (Central nervous system, cardiorespiratory system, and neuromuscular) over a long period of time. Regardless of the expertise of the sport, a good level of general endurance, promotes success in different types of training activities. Players engaged in sports in which endurance, and especially aerobic endurance, dominates do have a high level of general endurance. This indicates a strong relationship between general and specific endurance. On the other hand, players participating in sports of short duration or of high technical versatility do not have a good level of general endurance. Each player needs to have general endurance. It helps to achieve a high volume of work, overcome fatigue in long term competitions and recover faster after training or competitions [84].

Special endurance is determined according to the characteristics of each sport branch and it is combined with technical tactical application of the sport branch [83]. Specific endurance often is called the endurance of playing and sprinting depends on the characteristics of each sport or the many repetitions of the motor movements of each sport. Although specific endurance is imprinted in the features of certain sports, it may be influenced by the excitement of competitions, the performance of difficult athletic tasks or the kind of training conducted. Furthermore, a challenging tactical game often affects specific endurance of an player; therefore, the player may be exposed to technical and tactical errors in the second part of the competition.

As a result, the stronger the specific endurance built by the player from a solid base of general endurance, the faster players can resolve training and competition stressors [84].

2.4.4. Muscular Endurance

While muscle fatigue is defined as a decrease in the ability of a muscle to produce strength as a result of activity [85], muscular endurance, refers to the ability of the muscle to perform repeated contractions against a load over a long period of time [86].

Muscular endurance is also one of the health-related components of physical fitness. When the player has sufficient muscular endurance, player also has the ability to resist fatigue while maintaining a position, carrying something over a long period of time, or repeating a movement without getting tired. The inability to maintain the required or expected strength after repeated muscle activity is due to a large number of biological and motivational factors. Fatigue occurs in muscle fibril itself, apart from motivational and psychological factors in healthy individuals. It has been proven that the central nervous system process is not a major factor in loss of skeletal muscle strength during ongoing activity in well motivated individuals [85].

Sport is important in terms of skeletal muscle function. Therefore, endurance players need to provide both mechanical (power output) and metabolic adaptations. Due to the fatigue caused by endurance activities, the goals of physical condition are to delay fatigue and allow the player to work tirelessly at high intensity levels. These adaptations can be achieved if the training sessions are dense enough to produce sufficient fatigue [87].

Muscular endurance training provides muscular adaptation as a result of changes in slow-twitch fibrils. Although these fibrils have slow contractions, they have the ability to contract continuously over a long period of time. Lifting heavy loads with short rest intervals improves force. Dynamic muscular endurance is the opposite of this situation. More repetitions should be used with low resistances. Dynamic muscle endurance is related to the ability of muscle to contract and relax over and over again. While activities in daily life require muscular strength, they also require muscular endurance. Muscle strength and endurance are enhanced by increased resistance of movement , frequency or time of activity. A training intensity of about 40-60% of a maximum repetition was found to be sufficient for the development of muscular strength and muscular endurance in normal active individuals [88].

2.4.5. The Importance of Endurance in Taekwondo Sport

Endurance affects performance in taekwondo as in every sports branch. Due to the nature of Taekwondo sport, both aerobic and anaerobic endurance properties must be well developed.

Aerobic endurance; High aerobic endurance is an important factor for not to get tired during the competition and better performance for a good taekwondo player. Especially the last seconds of the last round of Taekwondo competitions determine whether the player wins the match or not. Therefore, an error due to fatigue, especially in the last seconds, may cause the player to lose the competition. Therefore, a good taekwondo should definitely develop aerobic endurance sufficiently and increasing is an important situation [6].

Anaerobic endurance; It includes sudden acceleration and speedy loads that can be done in a very short time and can be continued without fatigue. Anaerobic endurance is very important in the struggles with the opponent, which lasts 15-30 seconds, in technical combinations applied consecutive in taekwondo sport [89]. Taekwondo players have high peak anaerobic power characteristics in the lower limbs. Power output of the lower limb in eccentric and concentric muscle contractions and the ability to maintain this strength is an important factor in supporting technical and tactical applications in the competition. Anaerobic endurance feature is a very important feature that determines the performance in taekwondo sport. For this reason, a taekwondo player should have high anaerobic capacity in order to maintain his performance from the beginning of the competition to the last minutes and to apply effective techniques [6].

3.MATERIAL AND METHOD

3.1. Subjects

The sample of the study consists of adolescent taekwondo players at İbrahim Öztüfek Sport Club. Many of the players in İbrahim Oztufek Sports Club were male, so we conducted our study with male taekwondo players.

The study included 30 taekwondo players. While calculating the sample size, G power 3.1.9.4 (power analysis) program was used. As a result of the calculations, the sample consisted of 30 male taekwondo players between the ages of 10 and 16. The groups are determined to be random selection method. The randomization for groups was conducted by using statistical computing web programming. The type of the research is Randomized Controlled Research.

Players in first group are involved in the Core Stabilization Group (CSG) and players in second group were included in Control Group (CG).The control group was involved in our study to eliminate the bias and learning effects of the tests which would be applied.

3.1.1. Inclusion Criteria

Players who met the inclusion criteria below participated in the study.

- Being in the 10-16 age range
- Having participated in taekwondo competitions under license for at least one year
- Taekwondo training twice a week

3.1.2. Exclusion Criteria

Players with the following exclusion criteria did not participate in the study.

- Players who previously had an operation on the lower extremity
- Players who experienced muscle and joint injuries in the lower limbs in the previous three months in the study

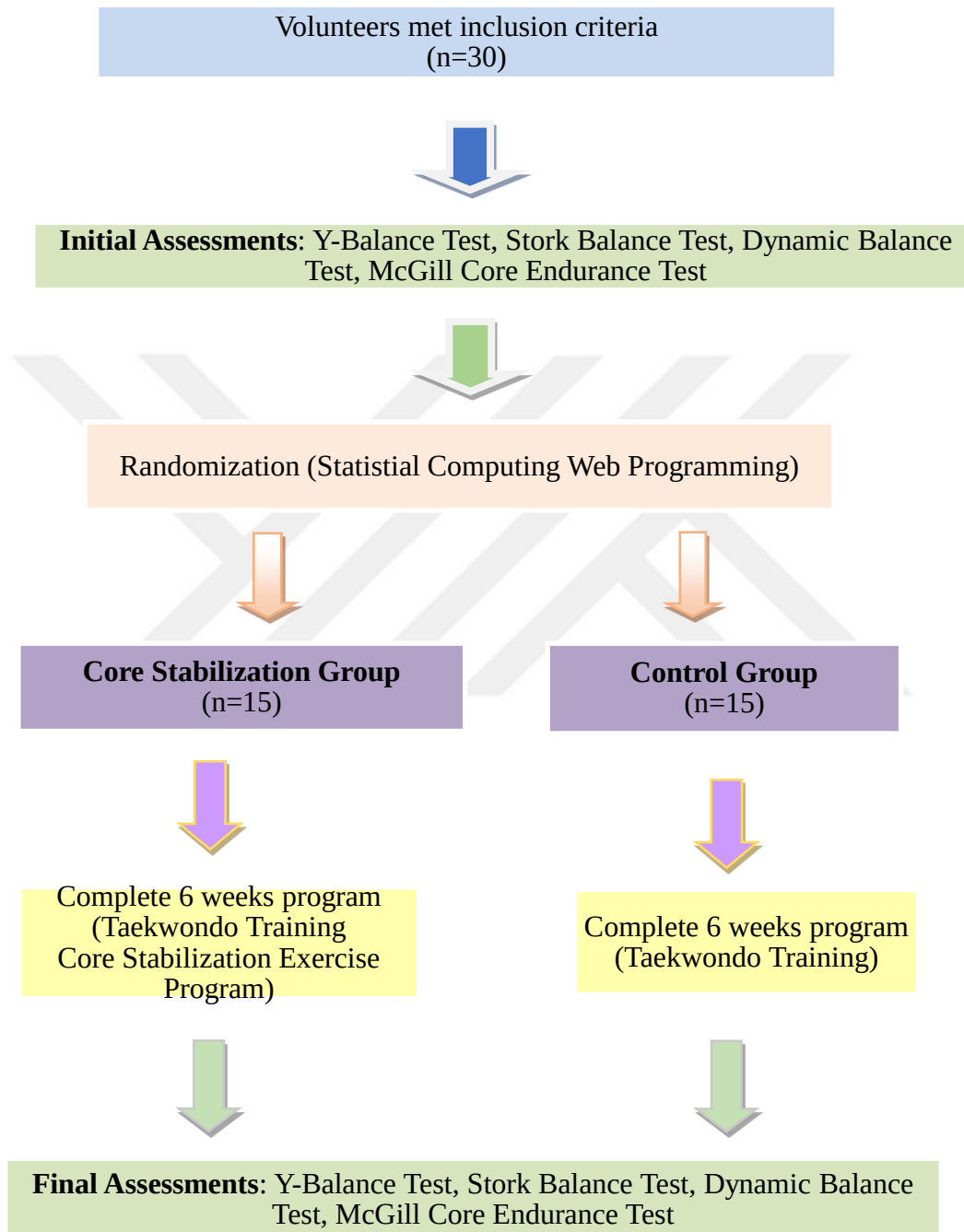
The study protocol was approved by theMarmara University Ethical Committee at the date of 17.02.2020 and issue number was 25 (APPENDIX 1). Participants involved in the study on a voluntary basis. The aim and plan of the study was explained and informed written consent was obtained from each player and parent (APPENDIX 2). The study was conducted according to Declaration of Helsinki.

3.1.3. Flow Chart: Study Process

A totally 30 adolescent taekwondo players for CSG and CG were participated to the study according to inclusion criteria. We asked our players and their parents whether they were willing to be volunteer in our study. Players who met inclusion criteria (n=30) were involved our study. When initial assessment was completed, patients were randomly divided into Core Stabilization Group (CSG) (n=15) and Control Group (CG) (n=15).

After the end of the first assessment, the CSG performed taekwondo training together with the 6 weeks core stabilization exercise program. The CG performed only taekwondo training. After the exercise programs, the second assessment was completed.

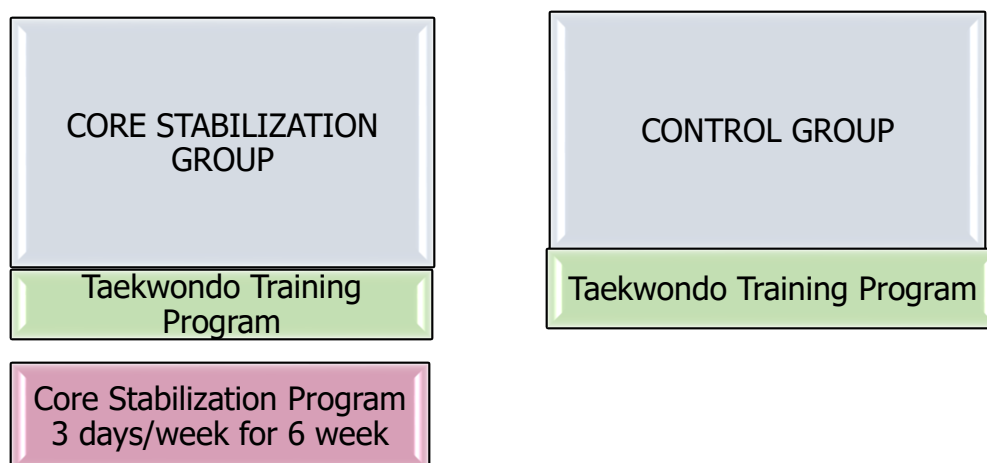
Table 3.1: FlowChart of Study



3.1.4. Study Protocol

The participants of CSG applied core stabilization exercise program in addition to taekwondo training. This program lasted for 6 weeks, 18 sessions were applied 3 times a week. Each training session took about 30 minutes. The training started with a 10-minute warm-up program and ended with a 5-minute cool-down. First of all, we taught all participants to activate the abdominal wall muscles, which is the first stage of core stability. The exercises in the program were applied as 3 sets, 12-20 repetitions and contractions for 20-40 seconds. Rest intervals were applied as 30 seconds between the sets and 2–3 minutes between the exercises. The core stabilization program was continued for 6 weeks, 3 sessions per week, under the supervision of a physiotherapist. The CG continued only taekwondo training for 6 weeks. The interventions of CSG and CG are as follows (Table 3.2.):

Table 3.2. Interventions of Core Stabilization Group and Control Group



3.2. Evaluation

3.2.1. Structured Questionnaire

The structured questionnaire prepared the researchers and to be applied face to face; includes questions about the age, gender, socio-demographic conditions, existing chronic diseases, surgical conditions, injuries and type of sport, performance level, training (APPENDIX 3).

3.2.2. Y-Balance Test(YBT)

Dynamic balance of the players was evaluated by using the Y-Balance Test which is improved to modify Star Excursion Balance Test (SEBT). This test performed for both feet. First, the foot of the dominant leg (the leg used for kicking in taekwondo, defined as the dominant leg) was placed in the middle of the test. There are 3 directions of reaching in the Y Balance Test. Directions are anterior, posteromedial, posterolateral. The test apparatus was pulled with three tape measures between 90° and 135° in these 3 directions. We asked the participants to reach as far as possible along the determined line, touch the line on the ground with the most distal part of the reaching foot, and return the reaching leg to the double-leg stance while maintaining the single-leg stance (Figure 3.1.). We asked them to do the test clockwise or counterclockwise, depending on whether the dominant leg was right or left, respectively. Participants were required to keep their hands on the iliac crest. The heels of the legs they were standing on had to be kept on the ground at all times. Before the test, the participants performed two practice trials to warm up and avoid any learning effects. During testing, the maximum access point was marked on the tape line and measured from the center of the test. Leg length was measured from the anterior superior iliac spine (ASIS) to the medial malleolus tibia (APPENDIX 4)[90].



a. Anterior

b. Posteromedial

c. Posterolateral

Figure 3.1. Y-Balance Test (a, b, c)

3.2.3. Stork Balance Test(SBT)

Stork Balance Test was used to measure the static balance of the participants. The test was carried out on a hard and flat surface. This test performed for both feet. First, the participants were asked to put their hands on their hips. The dominant foot was then placed on the ground and the other foot on the knee of the grounded leg. After taking the position, we asked the participant to rise to the tip of the finger with the instruction of "rise" and stay in this position as much as possible. We started the stopwatch when the heel of participant was lifted off the ground. We recorded the time in seconds (Appendix 4). Then the other foot was assessed. The stopwatch is stopped when:

- If the hands of participant leave the hips
- If the foot on the ground of participant turns or slips in any direction
- If the other foot of participants loses contact with the knee
- If the heel of participant touches the ground [91].



Figure 3.2. Stork Balance Test

3.2.4. Dynamic Balance Test(DBT)

ProKin PK 200 (PK), Italy dynamic balance instrument was used for dynamic balance measurements of the participants. PK 200 is mobile platform for balance assesment and postural training with a wireless transmitter and a proprioceptive system. The PK 200 transmits data from the platform to the computer via a wireless transmitter. And the device detects all angular movements with a chip inside the platform. The device calculates five different parameters. There parameters are as follows: the average movement of the centre of pressure (COP) in the frontal plane (cm), the average movement of the centre of pressure in the sagittal plane (cm), the average speed in anterior-posterior (AP) direction (m/s), the average speed in medio-lateral direction (ML) (m/s), the 90% ellipse area (mm²), and the sway path (SP) (mm) described by COP position during the test. Participants also tested wearing their usual clothes and without shoes. PK 200 has four different applicator to place under the mobile platform: easy, medium, hard and rectangular. We used bipedal and 30 second instructions with easy applicator of mobile platform. To obtain the results, the PK 200 is connected to a computer. The participant is barefoot during the test. The heels and metatarsal phalangeal joints of participant must be in contact with the device. The screen of the computer shows a circle, and a synchronized system for the following shifts. As the measure was being performed, physiotherapist instructs the participants to " keep indicator as much as possible in the midpoint of the circle" and this allows participants and physiotherapist input on the measured outcomes either positive or negative.

Positive results in the AP measure indicate that the participant is mainly moving anterior and positive results in the ML measure imply that the participant is mainly leans on the right foot. In addition, negative results in the AP test means that participant mostly goes to posterior and the negative outcome in the ML test indicates that participant leans on left foot. The results obtained are recorded (APPENDIX 4) [92].



Figure 3.3. ProKin PK 200

3.2.5. McGill's Core Endurance Test (MCET)

McGill's Core Endurance Test used to measure the core endurance of the participants. These test are compose of four movements. These are the trunk anterior flexor test, the right and left lateral plank and trunk posterior extensor test. 30 participants performed several seconds of trials to ensure correct positioning, followed by a static position to measure the maximum time (seconds). Visually, the physiotherapist was the one to decide that the tests were complete. In this way, the reliability of the tests was ensured. Participants completed the test with the "start" and "end" commands of physiotherapist. The assistant recorded the times with a stopwatch.. During the trunk posterior extensor test, the assistant held the legs of participant to stabilize the lower trunk. And again, the physiotherapist determined the beginning and the end of the test. The positions of these four tests are as follows.

The first test is the trunk anterior flexor test. The participant sat with the trunk flexed to 60°, both knees flexed to 90°, and hands on their chest. The physiotherapist measured the angles of trunk and knee flexion by an electronic goniometer. Time was started when the participants took the correct position (Figure 3.4.a.). Time was stopped when the participant's body deviated forward or backward from the 60° angle. The duration was recorded as seconds (APPENDIX 4).

The second and third tests are the left and right lateral musculature plank test. For the left side, the participants placed their feet together, left arm perpendicular to the floor, elbow resting on the mat, right hand on the waist (Figure 3.4. b.). The same position was maintained for the right side with the right arm of participant perpendicular to the floor (Figure 3.4. c). Time was stopped when the physiotherapist determined that the line between the torso or lower body parts of participant were not maintained. The duration was recorded as seconds (APPENDIX 4).

The fourth test is the trunk posterior extensor test. Participants lie prone on a table with both ASIS's hands on a chair in front of them at the edge of the table (Figure 3.4. d). The assistant held the lower extremities above the knees of the participants to stabilize the lower part of the body. Time was initiated when participants took their torso into a horizontal position, lifted their hands from the chair, and then placed them on their chest. When the participants were unable to stay in this position, time was stopped. The duration was recorded as seconds (APPENDIX 4) [93].



(a)



(b)



(c)



(d)

Figure 3.4. McGill's Core Endurance Tests a. Anterior Trunk Flexor Test, b. Left Lateral Musculature Plank Test, c. Right Lateral Musculature Plank Test, d. Posterior Trunk Extensor Test.

3.3. Intervention

The participants who met inclusion criteria were included in either CSG or CG. All participants were assessed with Y-Balance Test, Stork Balance Test , Dynamic Test and McGill's Core Endurance Test. All of the participants continued their taekwondo training. In addition, CSG joined core stabilization exercise program..

3.3.1. Exercise Program

The exercise program is programmed according to the weeks as written in the table below. It is prepared progressively from easy to difficult. It was regulated in the following weeks by modifying it or increasing its intensity (duration or repetition). The 6-weeks exercise program is written in the table below with detailed time and repetitions.

1st and 2nd week exercises: Supine bridge with core stabilization , upper and lower extremity exercises in crawling position with core stabilization (each extremity), modified plank exercise (in knees flexed, modified push up position), modified plank exercise on side lying (knees flexed), curl up exercise.

3rd and 4th week exercises: Single leg supine pelvic bridging, upper and lower extremity exercises in crawling position with core stabilization (opposite extremities) each side, plank exercise (knees extended), plank exercise on the side lying (knees extended), curl up exercise.

5th and 6th week exercises: Single leg supine pelvic bridging, upper and lower extremity exercises in crawling position with core stabilization (opposite extremities) each side, plank exercise (knees extended), plank exercise on the side lying (knees extended), curl up exercise [94,95].

The duration or repetitions of the exercises are written under the exercises in the table below.

Table 3.3. Exercise Program [94,95]

Week 1-2	Week 3-4	Week 5-6
Supine bridge with core stabilization (3x20 s) (Figure 3.5.a.)	Single leg supine pelvic bridging (3x20 s) (Figure 3.5.b.)	Single leg supine pelvic bridging (3x30 s) (Figure 3.5.b.)
Upper and lower extremity exercises in crawling position with core stabilization (each extremities)(3x20 s) (Figure 3.6.a.)	Upper and lower extremity exercises in crawling position with core stabilization (opposite extremities) each side(3x20 s) (Figure 3.6.b.)	Upper and lower extremity exercises in crawling position with core stabilization (opposite extremities) each side(3x30 s) (Figure 3.6.b.)
Modified plank exercise (in knees flexed, modified push up position) (3x40 s) (Figure 3.7.a.)	Plank exercise (knees extended) (3x30 s) (Figure 3.7.b.)	Plank exercise (knees extended) (3x40 s) (Figure 3.7.b.)
Modified plank exercise on side lying (knees flexed) (3x40s) (Figure 3.8.a.)	Plank exercise on the side lying (knees extended) (3x30 s) (Figure 3.8.b.)	Plank exercise on the side lying (knees extended) (3x40 s) (Figure 3.8.b.)
Curl up exercise (3x12 rep.) (Figure 3.9.)	Curl up exercise (3x15 rep.) (Figure 3.9.)	Curl up exercise (3x 20 rep.) (Figure 3.9.)

Table 3.4. Definition of Exercises [54,96,97]

Exercise	Description of Exercise	Primary Muscles
Supine Bridge	With the supine, feet straight and on the floor, the knees are flexed at 90 degrees; the hip is lifted upwards to form a straight line between the shoulder and knee.	Gluteus maximus Gluteus medius Longissimus thoracis Lumbar multifidus
Crawling position with core stabilization	In the crawling position, the neutral is at the level of the spine; unilateral arm, leg extension and contralateral arm, leg extension.	External oblique Gluteus maximus Gluteus medius Hamstring Longissimus thoracis Lumbar multifidus
Plank	Carrying the trunk to create a straight line between the shoulders and feet while on the wrists in the prone position.	External oblique Gluteus medius Rectus abdominis
Side Plank	Performing by propping up on the ipsilateral elbow to the side that is on the mat, then raising the hips up off of the mat extending either to the knees or to the lateral aspect of the ipsilateral foot.	Quadratus lumborum Transversus abdominis External obliques Multifidus Longissimus thoracis Gluteus medius
Curl Up	Started from a lying supine position with the trunk on a force plate, knees flexed at 90° and feet resting on the floor. Shoulders and elbows were flexed at 90° with the hands placed on the opposite elbow. Curl-ups consisted of a head, arms and upper trunk lift to the point where the scapula was lifted from the force plate, then returning to the starting position.	Rectus abdominis Internal and external oblique Transverse abdominis Psoas muscle



(a)



(b)

Figure 3.5. Supine Bridge Exercises (a,b)



(a)



(b)

Figure 3.6. Crawling Position with Core Stabilization (a,b)



(a)



(b)

Figure 3.7. Plank Exercises (a,b)



(a)



(b)



Figure 3.8. Side Plank Exercises (a,b)



Figure 3.9. Curl Up Exercise

3.4. Statistical Analysis

Statistical Package Analyze for Social Sciences (SPSS) version 22.0 was used to analyze the data obtained from the study and to create the tables. Data on variables such as age, height, body weight, body mass index of the participants will be analyzed descriptively. The Kolmogorov-Smirnov test was used to test the numerical variables for normality. The tests used for the difference between the pre and post measurements taken by players in groups, Paired Sample T-Test for parametric variables and Wilcoxon Test for non-parametric variables. Each of the differences (delta) between these groups (CSG and CG) was determined by Independent Samples T-Test for parametric variables and Mann Whitney-U test for non-parametric variables. The level of significance was accepted $p < 0.05$.

4. RESULTS

The study included 30 taekwondo players ($13,07 \pm 2,2$ years old) who applied to İbrahim Öztüfek Sport Club, Istanbul, Turkey between January 2021 and March 2021.

The physical features (age, weight, height and body mass index (BMI)) of CSG and CG are presented in Table 4.1. The physical features of participants comparing two groups showed that there were no significant differences in age, weight, height and BMI according to independent samples t-test results ($p > 0.05$).

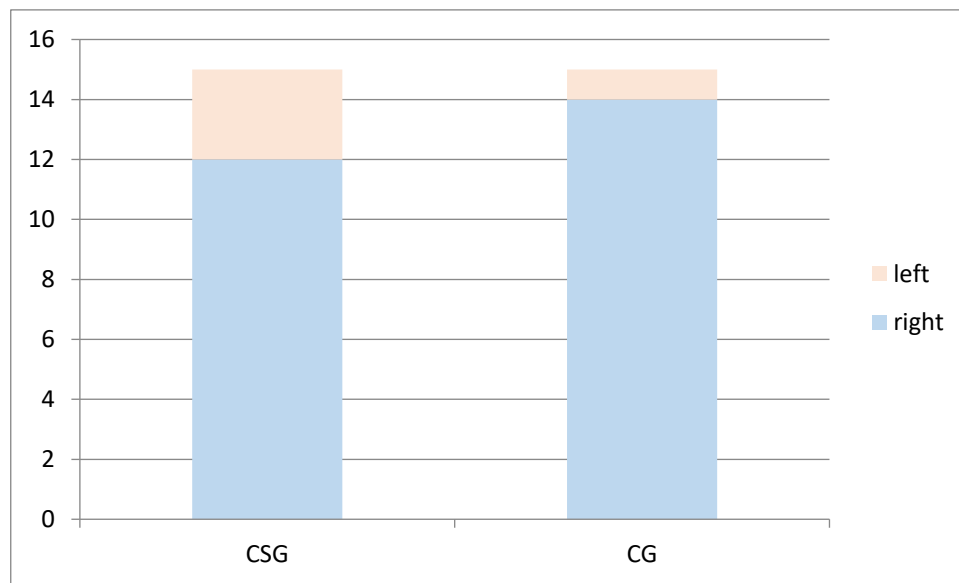
Table 4.1. Physical Features of Participants

	CSG (n=15) mean$\pm$SD	CG (n=15) mean$\pm$SD	p value t
Age (year)	13.4 $\pm$ 1.99	12.73 $\pm$ 2.4	0.41 0.82
Sports Age(year)	4.2 $\pm$ 0.46	4.1 $\pm$ 1.6	0.83 0.21
Weight (kg)	45.8 $\pm$ 12.62	48.67 $\pm$ 16.36	0.59 -0.53
Height (m)	1.53 $\pm$ 0.15	1.57 $\pm$ 0.17	0.48 -0.70
BMI (kg/ m²)	19.36 $\pm$ 3.62	19.22 $\pm$ 3.37	0.90 0.12

Data expressed as mean $\pm$ standart deviation. SD: Standart deviation. n: number of participations. kg:kilogram. m:meter. BMI: Body mass index. CSG: Core Stabilization Group, CG: Control Group.

Dominant leg distribution of study groups were shown in Graphic 1. Of the 30 participants included in study, 26 participants (86,67 %) right leg dominant and 4 participants (13,3 %) left leg dominant. In the CSG , the dominant leg of 12 participants is right and the dominant leg of 3 participants is left. In the CG , the dominant leg of 14 participants is right and the dominant leg of 1 participant is left.

Graphic 1: The Number of Dominant Leg of The Participants



Graphic 1 shows the number of dominant leg of the participants. CSG: Core Stabilization Group, CG: Control Group.

When the distribution of the data was examined using the Kolmogorov-Smirnov test for CSG and CG before interventions, it was observed that there was a normal distribution. Therefore the independent t-test was used for the values of CSG and CG before interventions. The data underlined that only four values had high difference. These values are Stork Balance Test (right and left side), Dynamic Balance Test (Medium Speed, Perimeter Length)($p < 0.05$)(Table 4.2.).

Table 4.2. Comparison of Variables between CSG and CG before Interventions

			CSG (n=15) mean±SD	CG (n=15) mean±SD	p value t
Y-Balance Test	A ¹ (%cm)	Right	84.21±8.64	84.61±7.86	0.90 -0.13
		Left	84.05±8.09	85.41±9.62	0.35 0.95
	PM ² (%cm)	Right	82.53±8.83	79.66±7.71	0.87 -0.18
		Left	80.83±7.88	80.91±8.82	0.70 -0.42
	PL ³ (%cm)	Right	87.64±7.98	88.20±8.64	0.98 -0.027
		Left	88.19±7.25	87.37±10.03	0.80 0.26
Stork Balance Test	Right		1.35±0.55	2.55±1.90	0.026 -2.34
	Left		1.43±0.31	2.26±0.86	0.002 -3.49
Dynamic Balance Test	AP (cm)	Equilibrium	-0.37±1.24	-0.12±1.98	0.68 -0.42
	ML (cm)	Equilibrium	0.00±1.94	-0.59±1.44	0.35 0.95
	Medium (m/s)	Speed	18.23±4.53	14.36±3.49	0.014 2.62
	Perimeter Length (°)		440.90±206.94	273.05±185.84	0.027 2.33
	Area Gap Percentage (%)		21.45±9.48	20.41±11.90	0.79 0.26
McGill's Core Endurance Test	Anterior Trunk Flexor Test (s)		41.30±22.23	56.68±32.70	0.14 -1.51
	Left Lateral Musculature Plank Test (s)		37.76±12.46	37.97±24.88	0.98 -0.03
	Right Lateral Musculature Plank Test (s)		31.22±11.46	45.30±24.44	0.053 -2.02
	Posterior Trunk Extensor Test (s)		45.66±15.36	41.19±20.93	0.51 0.67

Data expressed as mean ± standart deviation. SD: Standart deviation. n: number of participations. 1: A=Anterior ,2: PM=Posteromedial , 3 :PL=Posterolateral m:meter. cm:centimeter. s:second. °:degree. CSG: Core Stabilization Group, CG: Control Group.

The Kolmogorov-Smirnov test was used to test the numerical variables for normality and it was determined that the distribution of test results was normal. For this reason, Paired Sample T- Test was used for parametric values.

The Relative (normalized) reach distance (%cm) used for the Y-Balance Test was calculated as follows:

$$\text{The Relative(normalized) reach distance(\%cm)} = \left(\frac{\text{Absolute reach distance}}{\text{Leg length}} \right) \times 100$$

[98].

Comparing before and after measurement findings of Y-Balance Test were showed that both group had difference in A¹-Right, PM²-Right and Left, PL³-Right parameters (p<0.05). It means that all participants had improvement in this results. Furthermore, while there were differences in before and after test results in A¹-Left and PL³-Left of CSG (p<0.05), there was no statistical change among CG (p>0.05). It appears that participants of CSG showed enhancement outcomes of A¹-Left and PL³-Left (Table 4.2).

Table 4.3. Intragroup Comparison of Pre and Post Intervention Measurements of Y-Balance Test

Y-Balance Test				CSG (n=15) mean±SD	p value t	CG (n=15) mean±SD	p value t
	A ¹ (% cm)	Right	Before	84.21±8.64	0.002 -3.84	84.61±7.86	0.003 -3.58
			After	96.77±7.95		89.31±9.79	
		Left	Before	84.05±8.09	0.000 -6.75	85.41±9.62	0.333 -1.003
			After	95.81±6.15		87.31±10.10	
	PM ² (% cm)	Right	Before	82.53±8.83	0.000 -4.88	79.66±7.71	0.027 -2.48
			After	93.68±7.27		84.67±11.38	
		Left	Before	80.83±7.88	0.000 -6.25	80.91±8.82	0.011 -2.90
			After	92.71±7.46		87.19±10.92	
	PL ³ (% cm)	Right	Before	87.64±7.98	0.005 -3.36	88.20±8.64	0.011 -2.91
			After	95.94±8.19		91.22±9.74	
		Left	Before	88.19±7.25	0.000 -4.81	87.37±10.03	0.51 -0.68
			After	98.37±4.46		88.23±10.53	

Data expressed as mean ±standard deviation. 1: A=Anterior ,2: PM=Posteromedial , 3 :PL=Posterolateral SD: Standart deviation. n: number of participations. cm:centimeter. CSG: Core Stabilization Group, CG: Control Group.

The Kolmogorov-Sminov test was used to test the numerical variables for normality and it was determined that the distribution of test results was not normal. Therefore, Related-Samples Wilcoxon Signed Rank Test was used for nonparametric variables.

When comparing the results of before and after measurement of Stork Balance Test, it was discovered that CSG group had statistical significance in values of Right and Left side ($p < 0.05$), but there was no statistical change among CG in this results ($p > 0.05$). The participants of CSG seemed to have improved Right and Left side values (Table 4.3).

Table 4.4. Intragroup Comparison of Pre and Post Intervention Measurements of Stork Balance Test

Stork Balance Test			CSG (n=15) mean±SD	p value	CG (n=15) mean±SD	p value
	Right (s)	Before	1.35±0.55	0.001	2.55±1.90	0.078
		After	2.65±1.49		2.76±1.05	
	Left (s)	Before	1.43±0.31	0.012	2.26±0.86	0.256
		After	2.45±1.30		2.67±1.24	

Data expressed as mean ± standard deviation. SD: Standard deviation. n: number of participations. s: second. CSG: Core Stabilization Group, CG: Control Group.

The Kolmogorov-Smirnov test was used to test the numerical variables for normality and it was determined that the distribution of test results was normal. Consequently, Paired Sample T- Test was used for parametric values.

Comparing before and after measurement findings of Dynamic Balance Test were showed that CSG had difference in Medium Speed and Area Gap Percentage parameters ($p < 0.05$). It means that the participants of CSG had improvement in this results, but there was no statistical change among CG in Medium Speed and Area Gap Percentage values ($p > 0.05$). When AP Equilibrium, ML Equilibrium and Perimeter Length values were examined, it was seen that there was no significant difference in both groups ($p > 0.05$) (Table 4.4).

Table 4.5. Comparison of Dynamic Balance Measurements for Intragroup variables

Dynamic Balance			CSG (n=15) mean±SD	p value	CG (n=15) mean±SD	p value
	AP Equilibrium (cm)	Before	-0.37±1.24	0.57	-0.12±1.98	0.65
		After	-0.03±1.65	-0.58	-0.36±1.68	0.46
	ML Equilibrium (cm)	Before	0.002±1.94	0.54	-0.59±1.44	0.59
		After	-0.45±1.18	0.64	-0.32±1.31	-0.56
	Medium Speed (m/s)	Before	18.23±4.53	0.008 3.11	14.36±3.49	0.12
		After	14.59±3.11		16.08±3.62	-1.64
	Perimeter Lenght (°)	Before	440.90±206. 94	0.092 1.81	273.05±185. 84	0.799 0.26
		After	332.22±151. 07		264.38±167. 28	
	Area Gap Percentage (%)	Before	21.45±9.48	0.027 2.47	20.41±11.90	0.176
After		14.52±9.28	16.32±9.97		1.42	

Data expressed as mean ± standard deviation. . SD: Standard deviation. n: number of participations. cm: centimeter. m: meter. s: second. °: degree. CSG: Core Stabilization Group, CG: Control Group.

The Kolmogorov-Smirnov test was used to test the numerical variables for normality and it was determined that the distribution of test results was normal. For this reason, Paired Sample T-Test was used for parametric values.

When comparing the results of before and after measurement of McGill's Core Endurance Test, it was discovered that both groups had statistical significance in Posterior Trunk Extensor Test results ($p < 0.05$). In addition, CSG had difference in Anterior Trunk Flexor Test, Left Lateral Musculature Plank Test and Right Lateral Musculature Plank Test parameters ($p < 0.05$). However there was no statistical difference among CG in this value ($p > 0.05$) (Table 4.5).

Table 4.6. Intragroup Comparison of Pre and Post Intervention Measurements of McGill's Core Endurance Test

McGill's Core Endurance Test			CSG (n=15) mean±SD	p value	CG (n=15) mean±SD	p value
	Anterior Trunk Flexor Test (s)	Before	41.30±22.23	0.000 -5.97	56.68±32.70	0.134 -1.59
		After	88.57±31.46		60.86±27.26	
	Left Lateral Musculature Plank Test (s)	Before	37.76±12.46	0.000 -5.60	37.97±24.88	0.160 -1.49
		After	69.34±17.18		43.64±15.71	
	Right Lateral Musculature Plank Test (s)	Before	31.22±11.46	0.000 -5.17	45.30±24.44	0.124 -1.64
		After	63.15±23.62		50.16±18.49	
	Posterior Trunk Extensor Test (s)	Before	45.66±15.36	0.000 -4.99	41.19±20.93	0.17 -2.71
		After	81.30±15.5		47.87±18.26	

Data expressed as mean ± standard deviation. SD: Standard deviation. n: number of participants. s: second. CSG: Core Stabilization Group, CG: Control Group.

To examine differences between CSG and CG after measuring intergroup differences before and after intervention, Independent Samples t-tests and Mann Whitney U-tests were used. Independent Samples t-test was used for normally distributed data and Mann Whitney U-test was used for data without normal distribution. In other words, Mann Whitney U-test is used only for Stork Balance Test. There were changes anterior direction(right and left side), posterolateral direction(left side) values in Y-Balance Test, right and left side values in Stork Balance Test, Medium Speed values in Dynamic Balance Test and all of Mc Gill's Core Endurance Test values ($p < 0.05$). The data revealed that CSG improved these parameters as compared to CG (Table 4.6).



Table 4.7. Comparison of difference between Before and After Measurements of Intergroup Variables

			CSG (n=15) mean±SD	CG (n=15) mean±SD	p t value
Y-Balance Test	ΔA^1 (%cm)	Right	12.56±12.67	4.70±4.09	0.03
		Left	11.76±6.74	1.90±7.34	0.001
	ΔPM^2 (%cm)	Right	11.14±8.85	5.01±7.82	0.054
		Left	11.88±7.36	6.28±8.37	0.062
	ΔPL^3 (%cm)	Right	8.30±9.56	3.02±4.02	0.058
		Left	10.18±8.19	0.86±4.92	0.001
Stork Balance Test	$\Delta Right$ (s)		1.30±1.30	0.21±1.15	0.03 z:-2.12
	$\Delta Left$ (s)		1.28±1.30	0.41±1.17	0.05 z:-1.22
Dynamic Balance Test	ΔAP (cm)	Equilibrium	0.34±2.28	0.23±1.97	0.47 0.74
	ΔML (cm)	Equilibrium	0.45±2.76	30.27±1.86	0.41 -0.84
	$\Delta Medium$ (m/s)	Speed	3.64±4.54	1.72±4.07	0.002 -3.41
	$\Delta Perimeter$ Length (°)		108.67±232.87	8.67±129.08	0.16 -1.46
	$\Delta Area$ Gap Percentage (%)		6.93±10.88	4.09±11.13	0.49 -0.70
McGill's Core Endurance Test	$\Delta Anterior$ Trunk Flexor Test (s)		47.27±30.68	4.18±10.19	0.000 5.16
	$\Delta Left$ Lateral Musculature Plank Test (s)		31.58±21.82	5.67±14.79	0.001 3.81
	$\Delta Right$ Lateral Musculature Plank Test (s)		31.94±23.94	4.87±22.53	0.000 3.95
	$\Delta Posterior$ Trunk Extensor Test (s)		35.64±27.68	6.68±9.55	0.001 3.83

Data expressed as mean ± standart deviation. SD: Standart deviation. n: number of participations. 1: A=Anterior ,2: PM=Posteromedial , 3 :PL=Posterolateral m:meter. cm:centimeter. s:second. °:degree. CSG: Core Stabilization Group, CG: Control Group.

The Spearman's Rank Correlation Test was used to examine the relationship between tests used for measurements. The Spearman's Rank Correlation Coefficient R_s value is used as a statistical measure of the strength of a relationship between two data sets (99).

The strength of correlation for the value of R_s is interpreted as in the table below:

The strength of a correlation;	
<u>Value of coefficient R_s (positive or negative)</u>	<u>Meaning</u>
0.00 to 0.19	A very weak correlation
0.20 to 0.39	A weak correlation
0.40 to 0.69	A moderate correlation
0.70 to 0.89	A strong correlation
0.90 to 1.00	A very strong correlation

(100)

Table 4.8. Correlation of the relationship between the Y-Balance Test and the Stork Balance Test

		Stork Balance Test	
		Right Side (s)	Left Side (s)
Y-Balance Test	Right Side average (%cm)	R: 0.15 p: 0.44	R: 0.13 p: 0.50
	Left Side average (%cm)	R: 0.12 p: 0.52	R: 0.07 p: 0.71

R: Spearman's Rank Correlation Coefficient

When the relationship between the Y-Balance Test and the Stork Balance Test was examined, it was seen that there was a very weak correlation between them.

Table 4.9. Correlation of the relationship between the Y-Balance Test and Dynamic Balance Test

		Dynamic Balance Test				
		AP Equilibrium (cm)	ML Equilibrium (cm)	Medium Speed (m/s)	Perimeter Length (°)	Area Gap Percentage (%)
Y-Balance Test	Right Side average (%cm)	R: -0.79 p: 0.68	R: 0.29 p: 0.13	R: -0.21 p: 0.28	R: 0.21 p: 0.26	R: -0.01 p: 0.94
	Left Side average (%cm)	R:-0.06 p: 0.77	R: 0.35 p: 0.06	R: -0.21 p: 0.27	R: 0.22 p: 0.25	R: -0.04 p: 0.84

R: Spearman's Rank Correlation Coefficient

When the relationship between the Y-Balance Test and the Dynamic Balance Test is examined, the correlation between parameters is in Table 4.9. as in. When the correlation average was taken, it was seen that the correlation between the two tests was weak (Table 4.9).

Table 4.10. Correlation of the relationship between the Y-Balance Test and McGill's Core Endurance Test

		McGill's Core Endurance Test			
		Anterior Trunk Flexor Test (s)	Left Lateral Musculature Plank Test (s)	Right Lateral Musculature Plank Test (s)	Posterior Trunk Extensor Test (s)
Y-Balance Test	Right Side average (%cm)	R: 0.34 p: 0.07	R: 0.42* p: 0.02	R: 0.24 p: 0.20	R: 0.47* p: 0.02
	Left Side average (%cm)	R: 0.29 p: 0.13	R: 0.41* p: 0.02	R: 0.22 p: 0.24	R: 0.39* p: 0.03

R: Spearman's Rank Correlation Coefficient

*. Correlation is significant at the 0.05 level.

When the relationship between the Y-Balance Test and the McGill's Core Endurance Test was examined, the correlation in 4 parameters yielded significant results ($p < 0.05$). When all the results were averaged, the relationship between the two tests was found to be weak correlated (Table 4.10).

Table 4.11. Correlation of the relationship between the Stork Balance Test and Dynamic Balance Test

		Dynamic Balance Test				
		AP Equilibrium (cm)	ML Equilibrium (cm)	Medium Speed (m/s)	Perimeter Length (°)	Area Gap Percentage (%)
Stork Balance Test	Right Side (s)	R: 0.14 p: 0.46	R: 0.09 p: 0.62	R: -0.03 p: 0.87	R: -0.33 p: 0.08	R: -0.14 p: 0.48
	Left Side (s)	R: 0.21 p: 0.27	R: -0.14 p: 0.45	R: -0.08 p: 0.69	R: -0.25 p: 0.19	R: -0.24 p: 0.20

R: Spearman's Rank Correlation Coefficient

When the relationship between the Stork Balance Test and the Dynamic Balance Test was evaluated, it was seen that there was a very weak correlation between the two tests when the average of the results was examined (Table 4.11).

Table 4.12. Correlation of the relationship between the Stork Balance Test and McGill's Core Endurance Test

		McGill's Core Endurance Test			
		Anterior Trunk Flexor Test (s)	Left Lateral Musculature Plank Test (s)	Right Lateral Musculature Plank Test (s)	Posterior Trunk Extensor Test (s)
Stork Balance Test	Right Side (s)	R: -0.20 p: 0.30	R: 0.23 p: 0.23	R: 0.21 p: 0.26	R: 0.04 p: 0.83
	Left Side (s)	R: -0.01 p: 0.97	R: -0.001 p: 0.99	R: 0.00 p: 0.99	R: 0.006 p: 0.97

R: Spearman's Rank Correlation Coefficient

When the relationship between the Stork Balance Test and the McGill's Core Endurance Test was evaluated, it was seen that there was a very weak correlation between the two tests when the average of the results was examined (Table 4.12).

Table 4.13. Correlation of the relationship between the Dynamic Balance Test and McGill's Core Endurance Test

		Dynamic Balance Test				
		AP Equilibrium (cm)	ML Equilibrium (cm)	Medium Speed (m/s)	Perimeter Length (°)	Area Gap Percentage (%)
McGill's Core Endurance Test	Anterior Trunk Flexor Test (s)	R: -0.16 p: 0.39	R: -0.21 p: 0.26	R:-0.36* p: 0.05	R: -0.33 p: 0.08	R: -0.16 p: 0.39
	Left Lateral Musculature Plank Test (s)	R: 0.25 p: 0.19	R: -0.09 p: 0.65	R: -0.18 p: 0.34	R: 0.33 p: 0.08	R: 0.03 p: 0.87
	Right Lateral Musculature Plank Test (s)	R: -0.16 p: 0.41	R: -0.10 p: 0.60	R: -0.05 p: 0.79	R: 0.18 p: 0.35	R: 0.14 p: 0.47
	Posterior Trunk Extensor Test (s)	R: 0.20 p: 0.30	R: 0.03 p: 0.89	R: -0.18 p: 0.35	R: 0.28 p: 0.14	R: 0.12 p: 0.54

R: Spearman's Rank Correlation Coefficient

*. Correlation is significant at the 0.05 level.

When the relationship between the McGill's Core Endurance Test and Dynamic Balance Test was examined, the correlation in 1 parameter yielded significant results ($p < 0.05$). When all the results were averaged, the relationship between the two tests was found to be very weak correlated. (Table 4.13)

5.DISCUSSION AND CONCLUSION

The purpose of our study is to investigate the effects of core stabilization exercises on balance and endurance in adolescent taekwondo players for who groups(Core Stabilization and Control Groups) using tests to measure each variable.

5.1. Y-Balance Test

The overall conclusions of our study is that, when the values of CSG and CG measurements were compared, CSG showed a better improvement in anterior direction(right and left side) posterolateral direction(left side) values in Y-Balance Test, right and left side values in Stork Balance Test, Medium Speed values in Dynamic Balance Test and all of Mc Gill's Core Endurance Test values compared to the CG according to statistical analyzsis ($p < 0.05$) (Table 4.7.). The following results have emerged supporting the hypothesis of our study, CSG achieved more successful results than CG in the values of Stork Balance Test and McGill's Endurance Tests(Table 4.7.).

First of all, when we examine the Y-Balance Test evaluations, there is no significant difference between the CSG and CG data before interventions ($p > 0.05$) (Table 4.2.) Comparing intragroup before and after measurement findings of Y-Balance Test were showed that both group had sdifferences in A¹-Right, PM²-Right and Left, PL³-Right parameters ($p < 0.05$).Furthermore, while there was a significant variety in before and after test conclusions in A¹-Left and PL³-Left of CSG ($p < 0.05$) (Table 4.3.).

When the other studies in the literature were analyzed, it was seen that a similar study was conducted with basketball players. Saki et al. reported that the purpose of this study was to analysis the relationship between core stabilization muscle endurance and static, dynamic balance in basketball players.100 basketball players joined in this study. (50 female and 50 male players). The basketball players were evaluated with the tests before and after the core stabilization exercises. Static balance was measured by Bass Stick. Dynamic balance was measured by Y-Balance Test. The results of analysis indicated a significant relationship between core stabilization and dynamic balance ($p = 0.000$). But, there is no significant relationship between core stabilization and static balance ($p = 0.45$). The conclusion of this study is that it is possible to infer that core stabilization exercises can improve balance(101).

Another study in the literature was achieved with the participation of Kabaddi athletes as follows. Torbatinezhad et al. reported that this study purposed to search the effects of core stabilization of body and hopping exercises on trunk strength and balance of female Kabaddi athletes. The 24 female Kabaddi players joined this study. The participants were randomly selected and separated to two groups. Experimental Group(12 participants) and Control Group (12 participants). The Experimental Group participated a 3 sessions a week for 6 weeks program, 40 minutes session of core stabilization exercises. Static Balance measured with Stork Balance Test. Dynamic Balance measured with Y-Balance Test. The results of this study showed significant difference between the mean after test scores of static and dynamic balance in both groups($p<0.001$). Namely, the participants of experimental group had better results in these test. The results of this study show that core stabilization exercises can improve the balance of the Kabaddi athletes (102).

When the other studies in the literature were analyzed, it was seen that another similar study was conducted with basketball players. Doğan et al. purposed that to examine the effects of core training program on general strength, balance and psychomotor development level. Each sessions of the core stability training program lasted 45-60 minutes and was implemented 3 sessions a week for 8 weeks. 30 male basketball players between the ages of 12-14 were joined in the study. The participants were randomly separated into two groups. (Experimental group (EG)($n=16$) and Control group (CG)($n=14$)). In addition to the basketball program, an 8-weeks core program was continued to the EG. The CG applied only to the basketball program. After 8-weeks of the trainings, tests were repeated. Y-Balance Test was used for dynamic balance measurements. Intragroup, results were assessed by using Paired Samples T-test. Intergroup Tests were evaluated by Independent Samples T-test analysis at before and after tests parameters. As a result, there is significant difference in Y-Balance Test between groups after 8-weeks core training program (103).

Similar results were obtained when the effect of core stabilization was investigated in players in the near age range in studies related to our study in the literature. The results of our study and the studies investigated in the literature review show that the improvement in the CSG group is better when the Y-Balance Test parameters of the CSG and CG groups are examined. The differences were observed in some parameters of the dynamic balance measurements (Y-Balance Test) of the CSG group in both intragroup and intergroup evaluations. There was no difference between the two groups in PM² direction parameters, but in taekwondo, balance is more important in the A¹ and PL³ direction in kicking movement. In this case, it is concluded that core stabilization exercises can be applied for the development of dynamic balance parameters of adolescent taekwondo players.

5.2. Stork Balance Test

According to our results, comparing intragroup before and after measurements values of Stork Balance Test were revealed that a significant difference was observed in right and left side values of CSG ($p < 0.05$) (Table 4.4.). Differences of means between before and after measurements, the value for both side values of Stork Balance Test highly recovered in CSG ($p < 0.05$) (Table 4.7.).

When the other studies in the literature were investigated, it was seen that a similar study was conducted with children who participate in various sports in primary schoolage. Lengkana et al. purposed that to search the effects of core stability exercise(CSE) on balance, either static and dynamic. The participants of this research were 60 children who participate in various sports in primary schoolage. 60 primary school students with average age of 10-11 years in this study were chosen using random cluster sampling. Before and after CSE program, the participants were evaluated with Stork Balance Test. The results revealed that CSE significantly affected the improvement of the balance in primary school students(104).

Another study in the literature was carried out with the participation of young basketball players as follows. Göktepe et al. reported that this study purposed to search the effects of core stabilization training on the agility and balance performances of young basketball players. 20 volunteer males with an average age of 14.05 ± 0.76 (year) were included in the study. For static balance measurement, Stork Balance Test was used. The Wilcoxon signed test was used to define the difference between the results of the before and after tests. It was determined that core stabilization

training applied to young basketball players participating in the study significantly improved the parameters of the Stork Balance Test ($p < 0.05$) (105).

When the other studies in the literature were investigated, it was seen that another similar study was conducted with swimmers. Gül et al. purposed that to investigate the effects of core stabilization training at male swimmers in 10-13 ages on some tests. Their tests were 50 m backstroke swimming time (ST), Biering Sorenson (BS) test, Flexor (FE) and Lateral Endurance test (LE) and Stork (SD) balance test. 14 volunteers male swimmers were randomized to Experiment1 (D1) ($n=7$) and Experiment2 (D2) ($n=7$). After first measurements 7 male volunteers were divided into the control group (K). They included in the study. Core stabilization training was continued the D1 group athletes before swimming program 3 days per week for 8 weeks. The D2 group continued only swimming program. The K group had no training. The data were analyzed using by Paired-Samples T Test and ANOVA tests in SPSS 22.0 program. The significance level was determined as $p < 0.05$. When the data before and after the Stork balance test are analyzed, there was no significant difference within the 3 groups. As a result, it can be stated that 8-week core and swimming training have a positive effect on endurance parameters. In addition, it can be said that performance increase can be achieved by applying it to swimmers between the ages of 10-13 (106).

When studies similar to our study in the literature were examined, it was seen that core stabilization exercises had a positive effect on static balance (Stork Balance Test) except one study. In this study conducted with 21 swimmers, it was thought that the result was obtained in this way due to the small number of participants. As a result, when the Stork balance Test values of CSG and CG are analyzed, it is seen that a high difference was observed in the results of the measurements of the CSG group. In the results of the Stork Balance Test measurement, CSG showed significant differences both intra-group and inter-group measurements. As a result, core stabilization exercises can be applied for the development of static balance parameters in adolescent taekwondo players.

5.3. Dynamic Balance Test

When the results of the Dynamic Balance Test were compared before and after, it was discovered that CSG had statistical significance in Medium Speed and Area Gap Percentage parameter($p<0.05$) (Table 4.5.). Differences of means between before and after results, the measurement of Medium Speed of Dynamic Balance Test significantly developed in CSG($p<0.05$)(Table 4.7.).

When the other studies in the literature were investigated, it was seen that a similar study was conducted with male tennis athletes the ages of 8-14. Gür et al. purposed that to research the effects of core program, which is applied for 12 weeks with male tennis athletes between the ages of 8-14, on the core strength, static and dynamic balance values of the participants. The 19 young male tennis athletes participating in the study were randomly divided into two groups. (The experimental group (EG)($n = 10$) and the Control group (CG)($n = 9$)). While the EG applied the core program for 12 weeks 3 days per week for 30 minutes in addition to the tennis program. The CG applied only tennis program. Core strength, static and dynamic balance test evaluations of the participants were made twice, before and after the training programs. ProKin 252 device was used for the measurement of dynamic balance test. No significant difference was found between the means of the static and dynamic balance data of the EG and CG before and after programs ($p> 0.05$). However, although there was no significant difference between the EG and CG values, it was seen that core training exercises had a positive effect on balance (107).

There are not many studies in the literature regarding the dynamic balance test (ProKin PK 200). As in a similar study in the literature, EG showed better improvement in some parameters of the dynamic balance test. However, it is thought that better results will be obtained when this study is conducted with a longer duration and with a larger number of participants. In our study, only the medium speed parameter differed between the two groups. There was no difference in the AP and ML Equilibrium values, which are more important in taekwondo sports.

5.4. McGill's Core Endurance Test

When we examine the McGill's Core Endurance Test evaluations, there is no significant difference between the CSG and CG groups data before interventions ($p > 0.05$) (Table 4.2.). When we compare intragroup before and after measurement findings of McGill's Core Endurance Test, both group had difference in Posterior Trunk Extensor Test parameters ($p < 0.05$). Moreover, while there was a significance difference in before and after results in Anterior Trunk Flexor Test, Left Lateral Musculature Plank Test, Right Lateral Musculature Plank Test of CSG ($p < 0.05$) (Table 4.6.). Differences of means between before and after measurements, the value for all values of McGill's Core Endurance Test highly recovered in CSG ($p < 0.05$) (Table 4.7.).

When the other studies in the literature were investigated, it was seen that a similar study was conducted with adolescent male basketball players. Kafa et al. purposed that to investigate the effects of core program on muscle endurance, balance, agility and anaerobic power parameters in adolescent male basketball players. 13 male players applied a core exercise program for 3 days a week for 6 weeks, 40 minutes duration a session. McGill's Core Endurance Test was used for evaluation of core muscle endurance before and after the six week program. When the evaluations were analyzed, there was a significant difference in McGill's Core Endurance Test results ($p < 0.05$). It has been defined that when core stabilization exercises are added to the training of athletes, the core endurance of the athletes is positively affected. (108).

Another study in the literature was carried out with the participants of badminton players as follows. Özmen et al. reported that to investigate the effects of core stability program on endurance, dynamic balance and agility in adolescent badminton players. 20 participants (age = 10.8 ± 0.3 years) were randomly separated into two as training group (TG) and control group (CG). All participants were measured with McGill Core Endurance Test for endurance measurements. The TG completed core stability training twice a week for 6 weeks. As a result, there was a significant difference in McGill Core Endurance Test results (109).

Another study in the literature was carried out with the participants of high school track and field athletes. Sandrey et al. purposed that to search the effects of a 6 weeks core stabilization program for high school track and field athletes on dynamic balance and endurance. 13 participants from the track and field team for this study. Participants continued a 6 weeks core stabilization program designed for track

and field athletes. The program lasted 30 minutes each session 3 times per week. After 6 weeks, final test was conducted. McGill Core Endurance Test was used for endurance measurement. Post-test results significantly improved for McGill Core Endurance Test. After the 6 weeks core stabilization program, values of the endurance test developed. Therefore, it can be recommended to use this stabilization program for track and field athletes (110).

When similar studies were examined in the literature, it was seen that Core Stabilization exercises had a positive effect on endurance (McGill's Core Endurance Test). In the results of our study, significant differences were seen in the measurements of CSG in both intragroup and intergroup examinations. In other words, we can explain that core stabilization exercises have a positive effect on endurance for adolescent taekwondo players.

As a result, according to the information obtained from the literature, it has been found that core strength has many benefits. Considering the importance of balance and endurance in taekwondo sport investigation of the relationship between core stabilization and balance, endurance results are thought to contribute to the improvement of sportive performance. In literature, there are very few study of effects of core stabilization exercises on balance and endurance in adolescent taekwondo players. Differences were seen in the other test results except for the dynamic test parameters. Therefore, as a result of our study, it has been observed that the core stabilization exercise program, which is done in addition to taekwondo training, has a positive effect on the parameters of static balance and endurance. In other words, the parameters of static balance and endurance of CSG are more developed compared to

CG. When the statistical results are examined, it can be said that if it is desired to achieve improvement in taekwondo technique, the core stabilization exercise programs to be planned in addition to the technical studies will contribute to the development.

5.5. Conclusion and Recommendations

1. The main conclusion of this study is that the Core Stabilization Exercise program has a positive effect on Stork Balance Test and McGill's Core Endurance Test parameters.
2. There is also improvement in some of the parameters of the Y-Balance Test and Dynamic Balance Test, but we cannot say that they have a completely positive effect.
3. Differences were seen in the static balance and endurance parameters results except for the dynamic test parameters.
4. Although no difference was observed in dynamic balance parameters, differences were observed in static balance and endurance parameters.
5. The same study can be applied to different sports branches.
6. Applying a core stabilization program at least two days a week and providing continuity throughout the year can positively affect the performance of the players.
7. Similar studies can be carried out by increasing the number of participants.
8. The study can also be carried out with female participants.
9. Measurement results can be shared with coaches, training methods can be reviewed, and appropriate training programs can be developed.
10. Trainers can be made aware of the importance of core stabilization exercises in coaching seminars.

5.6. Limitations

The biggest limitation in our study was that there were restrictions during the measurements due to the Covid-19 epidemic. As a precaution, individual exercises were used to avoid contact in taekwondo training. In the Core Stabilization exercise program, while the participants were doing the exercises, the warnings for the correct movements could not be made by contact. Participants were verbally warned of the recommended distance.

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7.APPENDIXES

7.1. Appendix 1. Ethical Committee Approval



T.C.
MARMARA ÜNİVERSİTESİ
Sağlık Bilimleri Enstitüsü
Etik Kurulu

PROJENİN ADI: Adölesan Tekvando Oyuncularında Kor Stabilizasyon Egzersizlerinin Denge ve Endurans Üzerine Etkisi
PROJE YÜRÜTÜCÜSÜ: Prof.Dr. Rasmi MUAMMER
PROJEDEKİ ARAŞTIRICILAR : Fzt.Aysel Buse BARUT
ONAY TARİHİ VE ONAY SAYISI: 17.02.2020-25

Sayın Prof.Dr. Rasmi MUAMMER

25 protokol nolu “Adölesan Tekvando Oyuncularında Kor Stabilizasyon Egzersizlerinin Denge ve Endurans Üzerine Etkisi” isimli projeniz Enstitümüz Etik Kurulu tarafından incelenmiş ve etik yönden uygunluğuna karar verilmiştir.

Prof. Dr. Feyza ARICIOĞLU

Doç.Dr. İlkşan DEMİRBÜKEN

Prof.Dr. Dilşad SAVE

Prof.Dr. Hülya AŞÇI

Prof.Dr. Tuğba TUNALI AKBAN

Prof.Dr. Nefise BAHÇECİK

Doç.Dr. Ümit UĞURLU

Doç.Dr. Betül OKUYAN

Av. Öncel Onur AKBAŞ



Marmara Üniversitesi Göztepe
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<http://saglik.marmara.edu.tr>

Ayrıntılı bilgi için
Süleyman
TÜRKMEÑOĞLU

7.2. Appendix 2. Informed Written Consent For Parents

Siz velilerimizi Fzt.Aysel Buse Barut tarafından yürütülen “Adölesan tekvando oyuncularında kor stabilizasyon egzersizlerinin denge ve endurans üzerine etkisi” başlıklı araştırmaya davet ediyoruz. Bu araştırmaya çocuğunuzun katılıp katılmama kararını vermeden önce, araştırmanın neden ve nasıl yapılacağını bilmeniz gerekmektedir. Bu nedenle bu formun okunup anlaşılması büyük önem taşımaktadır. Eğer anlayamadığınız ve sizin için açık olmayan şeyler varsa bize sorunuz.

Çocuklarınız çalışmaya katılmama veya katıldıktan sonra herhangi bir anda çalışmadan çıkma hakkına sahiptirler. Size verilen formlardaki soruları yanıtlarken kimsenin baskısı veya telkini altında olmayın. Bu formlardan elde edilecek bilgiler tamamen araştırma amacı ile kullanılacaktır.

Araştırmayla İlgili Bilgiler:

- a. Araştırmanın Amacı: Bu çalışmanın amacı, kor stabilizasyon egzersizlerini yapan ve yapmayan adölesan tekvando oyuncularının denge ve endurans parametrelerinin karşılaştırmaktır.
- b. Araştırmanın İçeriği: Katılımcıların denge ve endurans parametreleri 4 test ile değerlendirilir. 30 adölesan tekvando oyuncusu rastgele seçim yöntemi olacak şekilde iki gruba ayrılır. İlk grup(kor stabilizasyon grubu) tekvando antrenmanlarına ek olarak 6 hafta boyunca haftada 3 gün totalde 18 seans kor stabilizasyon egzersizlerini uygular. İkinci grup(kontrol grubu) 6 hafta boyunca sadece tekvando antrenmanına devam eder. Egzersiz programlarından sonra katılımcılar tekrar aynı testlerle değerlendirilir ve iki grup arasındaki değişiklikler değerlendirilir ve karşılaştırılır.
- c. Araştırmanın Nedeni: Yüksek Lisans Tez Çalışması
- d. Araştırmanın Öngörülen Süresi: 6 hafta
- e. Araştırmaya Katılması Beklenen Katılımcı/Gönüllü Sayısı: 30
- f. Araştırmanın Yapılacağı Yer: İbrahim Öztüfek Spor Kulübü

For Parents of CSG

Çalışmaya Katılım Onayı:

Yukarıda yer alan ve araştırmadan önce katılımcıya/gönüllüye verilmesi gereken bilgileri okudum ve katılmam istenen çalışmanın kapsamını ve amacını, gönüllü olarak üzerime düşen sorumlulukları tamamen anladım. Çalışma hakkında yazılı ve sözlü açıklama aşağıda adı belirtilen araştırmacı tarafından yapıldı, soru sorma ve tartışma imkanı buldum ve tatmin edici yanıtlar aldım. Bana, çalışmanın muhtemel riskleri ve faydaları sözlü olarak da anlatıldı. Bu çalışmayı istediğim zaman ve herhangi bir neden belirtmek zorunda kalmadan bırakabileceğimi ve bıraktığım takdirde herhangi bir olumsuzluk ile karşılaşmayacağımı anladım.

Bu koşullarda söz konusu araştırmaya kendi isteğimle, hiçbir baskı ve zorlama olmaksızın çocuğumun testlere katılmasını ve verilecek olan egzersizleri uygulamasını kabul ediyorum.

Veli veya Vasisinin (kendi el yazısı ile)

Adı-Soyadı:

İmzası:

Araştırmacının

Adı-Soyadı: Fzt.Aysel Buse Barut

Danışmanın

Adı-Soyadı: Prof.Dr. Rasmi Muammer

For Parents of CG

Çalışmaya Katılım Onayı:

Yukarıda yer alan ve araştırmadan önce katılımcıya/gönüllüye verilmesi gereken bilgileri okudum ve katılmam istenen çalışmanın kapsamını ve amacını, gönüllü olarak üzerime düşen sorumlulukları tamamen anladım. Çalışma hakkında yazılı ve sözlü açıklama aşağıda adı belirtilen araştırmacı tarafından yapıldı, soru sorma ve tartışma imkanı buldum ve tatmin edici yanıtlar aldım. Bana, çalışmanın muhtemel riskleri ve faydaları sözlü olarak da anlatıldı. Bu çalışmayı istediğim zaman ve herhangi bir neden belirtmek zorunda kalmadan bırakabileceğimi ve bıraktığım takdirde herhangi bir olumsuzluk ile karşılaşmayacağımı anladım.

Bu koşullarda söz konusu araştırmaya kendi isteğimle, hiçbir baskı ve zorlama olmaksızın çocuğumun testlere katılmasını kabul ediyorum.

Veli veya Vasisinin (kendi el yazısı ile)

Adı-Soyadı:

İmzası:

Araştırmacının

Adı-Soyadı: Fzt.Aysel Buse Barut

Danışmanın

Adı-Soyadı: Prof.Dr. Rasmi Muammer

For Adolescent

Siz katılımcılarımızı Fzt.Aysel Buse Barut tarafından yürütölen “Adölesan tekvando oyuncularında kor stabilizasyon egzersizlerinin denge ve endurans üzerine etkisi” başlıklı araştırmaya davet ediyoruz. Bu araştırmaya katılıp katılmama kararını vermeden önce, araştırmanın neden ve nasıl yapılacağını bilmeniz gerekmektedir. Bu nedenle bu formun okunup anlaşılması büyük önem taşımaktadır. Eğer anlayamadığınız ve sizin için açık olmayan şeyler varsa bize sorunuz.

Sizler çalışmaya katılmama veya katıldıktan sonra herhangi bir anda çalışmadan çıkma hakkına sahipsiniz. Size verilen formlardaki soruları yanıtlarken kimsenin baskısı veya telkini altında olmayın. Bu formlardan elde edilecek bilgiler tamamen araştırma amacı ile kullanılacaktır.

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- b. Araştırmanın İçeriği: Katılımcıların denge ve endurans parametreleri 4 test ile değerlendirilir. 30 adölesan tekvando oyuncusu rastgele seçim yöntemi olacak şekilde iki gruba ayrılır. İlk grup(kor stabilizasyon grubu) tekvando antrenmanlarına ek olarak 6 hafta boyunca haftada 3 gün totalde 18 seans kor stabilizasyon egzersizlerini uygular. İkinci grup(kontrol grubu) 6 hafta boyunca sadece tekvando antrenmanına devam eder. Egzersiz programlarından sonra katılımcılar tekrar aynı testlerle değerlendirilir ve iki grup arasındaki değişiklikler değerlendirilir ve karşılaştırılır.
- c. Araştırmanın Nedeni: Yüksek Lisans Tez Çalışması
- d. Araştırmanın Öngörölen Süresi: 6 hafta
- e. Araştırmaya Katılması Beklenen Katılımcı/Gönüllü Sayısı: 30
- f. Araştırmanın Yapılacağı Yer: İbrahim Öztüfek Spor Kulübü

For Adolescent of CSG

Çalışmaya Katılım Onayı:

Yukarıda yer alan ve araştırmadan önce katılımcıya/gönüllüye verilmesi gereken bilgileri okudum ve katılmam istenen çalışmanın kapsamını ve amacını, gönüllü olarak üzerime düşen sorumlulukları tamamen anladım. Çalışma hakkında yazılı ve sözlü açıklama aşağıda adı belirtilen araştırmacı tarafından yapıldı, soru sorma ve tartışma imkanı buldum ve tatmin edici yanıtlar aldım. Bana, çalışmanın muhtemel riskleri ve faydaları sözlü olarak da anlatıldı. Bu çalışmayı istediğim zaman ve herhangi bir neden belirtmek zorunda kalmadan bırakabileceğimi ve bıraktığım takdirde herhangi bir olumsuzluk ile karşılaşmayacağımı anladım.

Bu koşullarda söz konusu araştırmaya kendi isteğimle, hiçbir baskı ve zorlama olmaksızın testlere katılmayı ve verilecek olan egzersizleri uygulamayı kabul ediyorum.

Katılımcının (Kendi el yazısı ile)

Adı-Soyadı:

İmzası:

Araştırmacının

Adı-Soyadı: Fzt.Aysel Buse Barut

Danışmanın

Adı-Soyadı: Prof.Dr. Rasmi Muammer

For Adolescent of CG

Çalışmaya Katılım Onayı:

Yukarıda yer alan ve araştırmadan önce katılımcıya/gönüllüye verilmesi gereken bilgileri okudum ve katılmam istenen çalışmanın kapsamını ve amacını, gönüllü olarak üzerime düşen sorumlulukları tamamen anladım. Çalışma hakkında yazılı ve sözlü açıklama aşağıda adı belirtilen araştırmacı tarafından yapıldı, soru sorma ve tartışma imkanı buldum ve tatmin edici yanıtlar aldım. Bana, çalışmanın muhtemel riskleri ve faydaları sözlü olarak da anlatıldı. Bu çalışmayı istediğim zaman ve herhangi bir neden belirtmek zorunda kalmadan bırakabileceğimi ve bıraktığım takdirde herhangi bir olumsuzluk ile karşılaşmayacağımı anladım.

Bu koşullarda söz konusu araştırmaya kendi isteğimle, hiçbir baskı ve zorlama olmaksızın testlere katılmayı kabul ediyorum.

Katılımcının (Kendi el yazısı ile)

Adı-Soyadı:

İmzası:

Araştırmacının

Adı-Soyadı: Fzt.Aysel Buse Barut

Danışmanın

Adı-Soyadı: Prof.Dr. Rasmi Muammer

7.3. Appendix 3. Structured Questionnaire



Yeditepe Üniversitesi

Sağlık Bilimleri Enstitüsü

Fizyoterapi ve Rehabilitasyon Anabilim Dalı

Demografik Özellikler

Tarih :.../.../.....

1) Sporcunun Adı Soyadı:

2) Doğum Tarihi:

3) Cinsiyet: () Kadın () Erkek

4) Boy uzunluğu (cm):

5) Vücut ağırlığı (kg) :

6) Dominant taraf:

Ayak () sağ () sol

7) Kaç yıldır bu sporu yapmaktasınız? Amatör..... Profesyonel.....

8) Herhangi bir sürekli hastalığınız var mı? Varsa belirtiniz.

() Sürekli bir hastalığım yok()

9) Herhangi bir ameliyat geçirdiniz mi? () Evet..... Belirtiniz () Hayır

10) Hiç kaza geçirdiniz mi ? () Evet.....Belirtiniz () Hayır

11) Son 3 ayda bir sakatlanma geçirdiniz mi? () Evet () Hayır

12) Evet ise, ne tarz bir sakatlanma geçirdiniz?.....



7.4. Appendix 4. Evaluation Form

Adı Soyadı:

Grup:

Doğum

Tarihi:

Boy:

Kilo:

Bacak Boyu:

Dominant taraf:

1.Ölçüm

Y Denge Testi	Sağ	Sol
Anterior		
Posterolateral		
Posteromedial		

Stork Balance Test	Sağ	Sol

ProKin	
Medium equilibrium – AP(cm)	
Medium equilibrium – ML(cm)	
Medium Speed (m/s)	
Perimeter Length	
Area gap percentage	

McGill Kor Endurans Testi	
Flexor Endurance	
Left Side Plank	
Right Side Plank	
Extensor Endurance	

2.Ölçüm

Y Denge Testi	Sağ	Sol
Anterior		
Posterolateral		
Posteromedial		
Stork Balance Test	Sağ	Sol

ProKin	
Medium equilibrium – AP(cm)	
Medium equilibrium – ML(cm)	
Medium Speed (m/s)	
Perimeter Length	
Area gap percentage	

McGill Kor Endurans Testi	
Flexor Endurance	
Left Side Plank	
Right Side Plank	
Extensor Endurance	