T.C.
YEDİTEPE UNIVERSITY
INSTITUTE OF HEALTH SCIENCES
DEPARTMENT OF SPORTS PHYSIOTHERAPY

COMPARISON OF UPPER AND LOWER EXTREMITY FUNCTIONS AFTER PROGRESSIVE ROPE SKIP TRAINING IN ADOLESCENT ATHLETES PLAYING BASKETBALL

Master Thesis

Murat ERDEM, PT

İSTANBUL
2019

T.C.
YEDİTEPE UNIVERSITY
INSTITUTE OF HEALTH SCIENCES
DEPARTMENT OF SPORTS PHYSIOTHERAPY

COMPARISON OF UPPER AND LOWER EXTREMITY FUNCTIONS AFTER PROGRESSIVE ROPE SKIP TRAINING IN ADOLESCENT ATHLETES PLAYING BASKETBALL

Master Thesis

Murat ERDEM, PT

ADVISER

Prof. Dr. FERYAL SUBASI, PT

İSTANBUL

2019

THESIS APPROVAL FORM

TEZ ONAYI FORMU

Kurum : Yeditepe Üniversitesi Sağlık Bilimleri Enstitüsü

Program : Spor Fizyoterapisi

Tez Başlığı : Basketbol Oynayan Adolesan Atletlerde Progresif İp Atlama Eğitimi Sonrası Üst Ve Alt Ekstremite Fonksiyonlarının Karşılaştırılması

Tez Sahibi : Murat ERDEM

Sınav Tarihi : 10.10.2019

Bu çalışma jurimiz tarafından kapsam ve kalite yönünden Yüksek Lisans Tezi olarak kabul edilmiştir.

	Unvanı, Adı-Soyadı (Kurumu)	İmza
Jüri Başkanı:	Prof. Dr. Feryal SUBAŞI (Yeditepe Üniversitesi)	
Tez danışmanı:	Prof. Dr. Feryal SUBAŞI (Yeditepe Üniversitesi)	
Üye:	Dr. Öğr. Üyesi Çiğdem YAZICI MUTLU (Yeditepe Üniversitesi)	
Üye:	Dr. Öğr. Üyesi Emre Serdar ATALAY (Sağlık Bilimleri Üniversitesi)	

ONAY

Bu tez Yeditepe Üniversitesi Lisansüstü Eğitim-Öğretim ve Sınav Yönetmeliğinin ilgili maddeleri uyarınca yukarıdaki jüri tarafından uygun görülmüş ve Enstitü Yönetim Kurulu'nun 16/07/2019 tarih ve 2019/12-08 sayılı kararı ile onaylanmıştır.

Prof. Dr. Bayram YILMAZ
Sağlık Bilimleri Enstitüsü Müdürü

ii

DECLARATİON

DECLARATİON

This thesis is my own work, I have no unethical behavior at any stage from planning to writing, I have obtained all the information in the thesis within the academic and ethical rules, I have cited all the information and comments not obtained by the thesis work and I have included these sources in the list of sources, and that I do not infringe any copyright.

01. 07. 2019

Murat Erdem

iii

ACKNOWLEDGEMENT

I would like to express deepest appreciation to Professor Feryal SUBAŞI who continually provide us all support and guidance which makes this project possible.

My dear friend and colleague Pt. Ayça YAĞCİOĞLU has been with me at every stage of my thesis and I sincerely thank her for her help and support.

Finally, I would like to thank my dear friend Pt. Seda Nur CİMEN, her support, motivation and strong friendship and my dear family for giving me strength and supporting me in every period of my life.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SYMBOLS / ABBREVIATIONS LIST

CG	Control group
TG	Training Group
SMBT	Seated Medicine Ball Throw
SSPT	Seated Shot Put Test
CKCUEST	Closed Kinetic Chain Upper Extremity Stability Test
YBUET	Y-Balance Upper Extremity Test
Fig8	Figure8 Hop Test
HJ	Horizontal Jump
YLET	Y-Balance Lower Extremity Test

ABSTRACT

Erdem, M. Comparison of Lower and upper extremity functions after progressive skipping training in adolescent athletes playing basketball. Yeditepe University Institute of Health Sciences, Sports Physiotherapy, Master Thesis. Istanbul (2019).

The aim of this study; to compare the lower and upper extremity performance parameters of basketball players after this training program. Thirty-seven (N: 37) athletes with a mean age of 14.71 years playing basketball at the Galatasaray Sports Club were included in the study. In the first stage of the study, the demographic characteristics, training information and position of the athletes were questioned. The athletes were randomly divided into two groups as training group (n: 19; F / M: 6/13) and control group (n: 18; F / M; 6/12). All subjects underwent lower and upper extremity performance tests before progressive skipping training. Seated Medicine Ball Throw (SMBT), Seated Shot Put Test (SSPT) and Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST) were used for upper extremity strength assessment and Y-Balance Test Upper Extremity (YBTUE) was used for balance assessment. Horizontal Jump (HJ) test was used to evaluate the lower extremity. In addition, agility and balance assessments Figure 8 Hop Test (Fig8) and Y-Balance Test Lower Extremity (YBTLE) test were used. All subjects continued their normal training programs in the middle of the season after the first evaluation. The athletes in the training group, unlike the control group athletes, were included in the skipping program three times a week for eight weeks. At the end of 8 weeks, all athletes were evaluated by SMBT, SSPT, CKCUEST, YBTUE, YBTLE, HJ and Fig8 tests. SSPT, CKCUE, Fig8 and HJ tests performed in the training group showed a statistically positive difference between the athletes in the training group. ($P \leq 0,05$). There was no statistically significant difference between the two groups in the Y-Balance tests performed for lower and upper extremity for balance evaluation ($p > 0.05$). In basketball athletes who played in infrastructure teams, we thought that rope skipping training for pliometric exercise could improve strength and stabilization of upper extremity, agility in lower extremity and jump to yacht parameters

Key Words: rope Jump , basketball, Agility, strength, balance, upper extremity, lower extremity.

ÖZET

Erdem, M. Basketbol oynayan adolesan sporcularda progresif ip atlama eğitimi sonrası alt ve üst ekstremite fonksiyonlarının karşılaştırılması. Yeditepe Üniversitesi Sağlık Bilimleri Enstitüsü, Spor Fizyoterapisi ABD, Master Tez. İstanbul (2019).

Bu çalışmanın amacı; basketbol oyuncularının progresif ip atlama antrenman programı sonrasında alt ve üst ekstremite performans parametrelerini karşılaştırmaktır. Çalışmaya Galatasaray Spor Kulübü'nde altyapıda basketbol oynayan yaş ortalaması 14,71 yıl olan otuz yedi (N:37) sporcu dahil edilmiştir. Çalışmanın ilk aşamasında sporcuların demografik özellikleri, antrenman bilgileri ve oynadıkları pozisyon sorgulandı. Sporcular randomize olarak, eğitim grubu (n:19; K/E:6/13) ve kontrol grubu (n:18; K/E;6/12) olmak üzere iki gruba ayrıldı. Çalışmada tüm olgulara progresif ip atlama eğitimi öncesinde alt ve üst ekstremite performans testleri uygulandı. Üst ekstremite kuvvet değerlendirmesi için Seated Medicine Ball Throw (SMBT), Seated Shot Put Test (SSPT) ve Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST) ve denge değerlendirmesi için Y-Balance Test Upper Extremity (YBTUE) kullanıldı. Horizontal Jump (HJ) testi alt ekstremitenin değerlendirilmesinde kullanıldı. Ayrıca çalışmada çeviklik ve denge değerlendirmeleri Figure 8 Hop Test (Fig8) ve Y-Balance Test Lower Extremity (YBTLE) testi kullanıldı. Tüm olgular ilk değerlendirmeye alındıktan sonra sezon ortası normal antrenman programlarına devam ettiler. Eğitim grubundaki sporcular ise kontrol grubunda olan sporculardan farklı olarak sekiz hafta boyunca, haftada üç kez ip atlama programına alındı. Sekiz hafta sonunda tüm sporcular tekrar SMBT, SSPT, CKCUEST, YBTUE, YBTLE, HJ ve Fig8 testleri ile değerlendirildi. Eğitim grubunda yapılan SSPT, CKCUE, Fig8 ve HJ testlerinde eğitim grubundaki sporcularda istatistiksel olarak olumlu yönde bir farklılık görülmüştür. ($p \leq 0,05$). Denge değerlendirmesi için alt ve üst ekstremiteye yönelik olarak yapılan Y-Balance testlerinde iki grup arasında istatiksel olarak anlamlı bir farklılık yoktur ($p>0,05$). Altyapı takımlarında oynayan basketbol sporcularında pliometrik egzersiz amaçlı verirken ip atlama eğitiminin üst ekstremitede kuvvet ve stabilizasyonu, alt ekstremitede çeviklik ve yatay sıçrama parametrelerinde gelişme sağlayabildiğini düşündüldü.

Anahtar Kelimeler: ip atlama, basketbol, çeviklik, kuvvet, denge, alt ekstremite, üst ekstremite

1. INTRODUCTION

Basketball is one of the most popular field games in the world, played with an average of more than 450 million athletes in 213 countries at both competition and recreation levels (1,2). Athletes playing in professional basketball leagues play on average every 2.5 days in national and international competitions (2).

Basketball is considered to be predominantly anaerobic exercise involving specific movements, including jumps (for rebounds, blocks and shots), sprint runs, sudden acceleration / deceleration, and direction changes and high intensity activity action (3,4). Sport performance in basketball is associated with anthropometric (height, weight) and motoric skill (jump height, agility, strength) values (5). Compared to other team sports, the duration of the contest and the small playing field and the necessity of fast play are taken into consideration while the main motoric features such as strength, speed, endurance, coordination and agility are at the forefront (3,6,7). In order for athletes to have good running and jumping performances, upper and lower extremity muscle strength force and sudden direction change capabilities should be good (8). However, the players are often in contact with rival team athletes are exposed to situations that disrupt their balance (8, 9). For this reason, basketball players need to be able to control their body positions and maintain their balance well when jumping, changing direction or contacting competing athletes (8, 9). In order to improve these qualities and to improve performance, training programs suitable for the motoric characteristics of the athlete are needed (7).

In the literature, pliometric exercises have been suggested to improve muscle strength, explosive strength and agility in basketball players (10). Pliometric exercises can help the muscles to be exposed more efficiently by providing eccentric contraction in the muscle with the rapid, sudden change of direction and jump movements. So; It also contributes to the storage of more energy in the concentric phase. Since pliometric training is also performed rapidly, the exercises have neuromuscular adaptation effect (11). In summary, pliometric exercises are designed to store elastic energy in muscle, increase mechanical stimuli, and improve dynamic muscle performance and athletic performance (12, 13, 14). Studies have shown that pre-season pliometric exercise training, especially in the lower and upper extremities of young basketball players improve coordination, but also improve muscle strength (8,15,16). Moran et al. In his study in athletes between the ages of 10 and 18, it was reported that there was an increase in the jump values of the male athletes before and after the pliometric training as a result of pliometric training (17,18). However, Asadi et al. found a decrease in jump height scores in his study (18). However, the effect of pliometric training in athletes has generally been examined on male athletes, and not much research has been done on female athletes (18). Recently, Moran et al. reported in their study that pliometric training increases the jump performance on female athletes between 8-18 years of age playing basketball (19). Bavli et al. In their study on 24 male athletes playing basketball athletes in addition to in-season training pliometric exercise training for 6 weeks found that increase in lower extremity muscle strength and jump performance (20). In their study, Asadi et al. (2017) investigated the effects of age on agility. They investigated the effect of age factor on the agility parameter after a pliometric exercise program applied to 30 athletes for 7 weeks, 2 days a week, and showed that there was a statistically positive difference in the agility values of younger athletes (21).

It has been reported in the literature that rope skipping exercise is the most suitable exercise to improve anaerobic capacity. In the studies, it has been tried to explain the effects of skipping on performance and when the goal is to improve physical performance parameters, it has been reported that rope skipping, which is an anaerobic activity, is the most suitable choice (22, 23). it can be used for pre-training warm-up as well as for improving agility (24), strength and anaerobic performance (25) parameters (23). Rope jumping studies are effective in strengthening body coordination, general athletic position and development of foot movements (23,25). One of the most important features of skipping rope exercise is the muscle groups used in skipping rope. Upper extremity muscle groups are used to hold the rope, rotate at a certain speed and control the rope, and lower extremity muscle groups and hip muscles are used for jumping (23). There are many studies investigating the effects of jump rope exercises on the frequency of jump, contribution to training and physiological parameters (22). In their study in Masterson and Brown, they divided the athletes into 3 groups: the weight-skipping group, the core / pliometric group, and the only stretching group, and evaluated the strength, jump and strength parameters of the subjects. After 10 weeks of skipping training, wingate peak power test (anaerobic capacity), bench press and jump parameters were significantly increased. Changes in the other two groups were not significant (22). Trecroci et al. In 2015, they gave an 8-week skipping program to the athletes. As the athletes continued their training during the season, a group also joined the jump rope exercise program. In addition, a significant increase in overall coordination and balance parameters was observed in the group performing rope skipping exercises in addition to the training program (26).

Duzgun et al. (2010), in their study with 24 adolescents playing volleyball, evaluated shoulder isokinetic muscle strength in the 12-week rope training group. showed significant increase in isokinetic muscle strength parameters (60 ° / s and 180 ° / s) in this group. To the best of our knowledge, the number of studies on the effects of rope skipping training in basketball players is limited. The effects of upper and lower extremity strength, agility and balance parameters of skipping programs combined with skipping training are not available in the literature.

In addition, according to the knowledge of the effect of this training program on the strength, agility and balance parameters of the athletes who received the program combined with pliometric exercises, there is no literature in our knowledge. Therefore, the purpose of our study; The aim of this study was to compare the effects of progressive skipping exercise on lower and upper extremity jump, balance and strength parameters in adolescent athletes playing basketball.

The hypotheses of the study can be listed as follows.

Hypothesis 0: Progressive skipping training has an impact on the development of upper extremity functions.

Hypothesis 1: Progressive skipping training has no effect on the development of upper extremity functions.

Hypothesis 2: Progressive skipping training has an impact on the development of lower extremity functions.

Hypothesis 3: Progressive skipping training has no effect on the development of lower extremity functions.

2. GENERAL INFORMATION

2.1. Definition and History of Basketball

Basketball was introduced in 1891 by James Naismith, a physical education teacher in Massachusetts, USA. When it occurs, the first goal is to train athletes and baseball players in the gym. The match in the game is to pass the ball through a wooden basket. The game is called basketball because it means basket ball.

The aim of both teams; to score points in the opponent's pot and to prevent the opponent from scoring. Basketball is played with two teams and each team has 5 players. At the end of the match, the superior side wins the match (29).

The competition starts with a throw. One player from both teams participates in the aerial throw. The ball must be bounced during the step. When the ball is held, no step is taken, the game continues by passing. In the competition, a team has 24 seconds to score. You must cross your own halffield within 8 seconds of this 24 seconds. Otherwise, the right to attack passes to the other team. In the event that the regular time of the match ends in a draw, the match is played for an additional 5 minutes until the equality at the end of the match is broken (29).

The first basketball game was held on January 20, 1892 in Springfield, Massachusetts. There are two teams in the game and a total of 18 players with 9 players per team. The first game was played for only 30 minutes and the match was 1-0. Later matches were played in New York, Philadelphia and Boston (30). The game then began to spread to other countries. More people wanted to watch and play this game (30). FIBA (International Basketball Federation) was founded on 18 June 1932 in Geneva, Switzerland. When it was founded, Argentina, Italy, Switzerland, Romania, Greece, Portugal, Czechoslovakia and Latvian Basketball Federations cooperated with FIBA (29). For the first time in 1936, basketball was one of the games at the Berlin Olympics (30). FIBA has been responsible for world basketball since its establishment. In the city where the Olympics will be held, it meets every four years and makes the changes that they deem necessary to make basketball a better game (29).

Figure 2.1. Drop ball of basketball

2.2. Physiology and Biomechanics of Basketball

Basketball sport includes skills that require athletes to move at high speed and change direction under dynamic conditions. Therefore, athletes should have sufficient strength, strength and agility in lower and upper extremity muscle groups (31). At the same time, the endurance level of the athletes is also important in order to ensure adequate performance during the competition (31).

In basketball games, the duration of a game lasts an average of 12-20 seconds, but in a 48-minute match a player travels approximately 4500-5000 meters. In a study, it was found that the average play of the players playing basketball in adolescent period was 34.1% playing with the ball, 56.8% walking on foot, and 9% waiting (31, 32, 33).

Basketball athletes were defined in three basic game positions: guard, forward and center according to their rules and tactics. For each of the three positions, the playing fields were determined to play effectively. The tallest players, called centers, play in the area close to the circle so that they can make the most of the score (Area A, Figure 2). Athletes who play guard usually play in the area far from the circle as they are responsible for bringing the ball to the opposing team's halfcourt and determining the game plan to be played during the attack (Area B, Figure 2). Athletes who play in the forward position usually play in the middle part of the attack zone in order to set up the game plan on the offense and to get the balls rotating during the defense (Area C, Figure 2) (34).

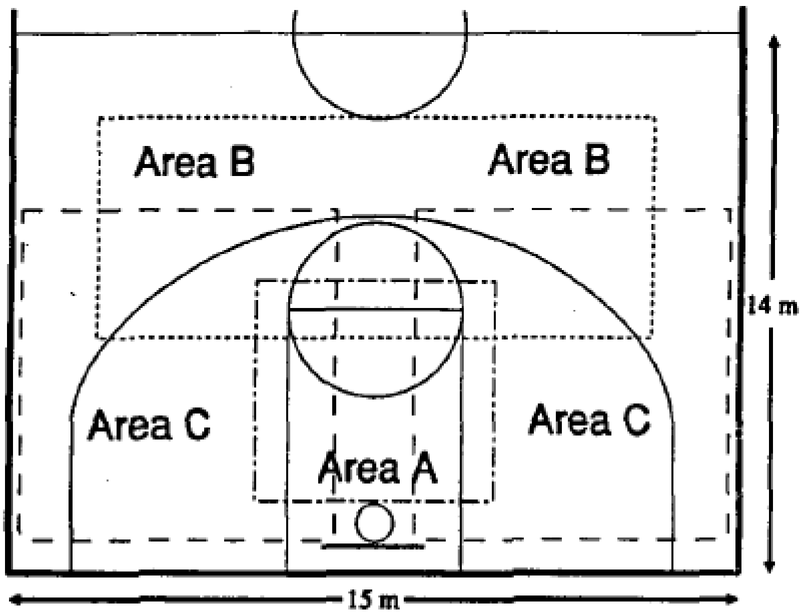

Figure 2.2. Places where athletes mainly play according to their positions

The main goal of each athlete in basketball is to score. To do so, the athlete may shoot, turnstile or score a free throw. As the discipline of sports developed and the number of athletic athletes increased, the defense performance of the athletes developed. As a result, the athletes jumped more and started shooting and this shot accounted for 70% of all shots during the match (35). The jumping shot is a complex and technically challenging movement pattern in which the athletes stay in the air with the ball (Figure 3). Accuracy of firing mechanics for successful shooting is not the only determining factor but a combination of various factors (ball drop angle, drop angle and drop height) (35,36). Shooting action can be influenced by several factors: distance to the circle, position of the opponent's position, body posture at the time of the ball release, other movements completed before the shot, weight and width of the ball, level of expertise of the athlete, field of vision and physical characteristics of the athlete (37).

This movement should be automated with multiple repetitions, so that the shot can be influenced to a minimum by external influences, allowing an efficient shot (35).

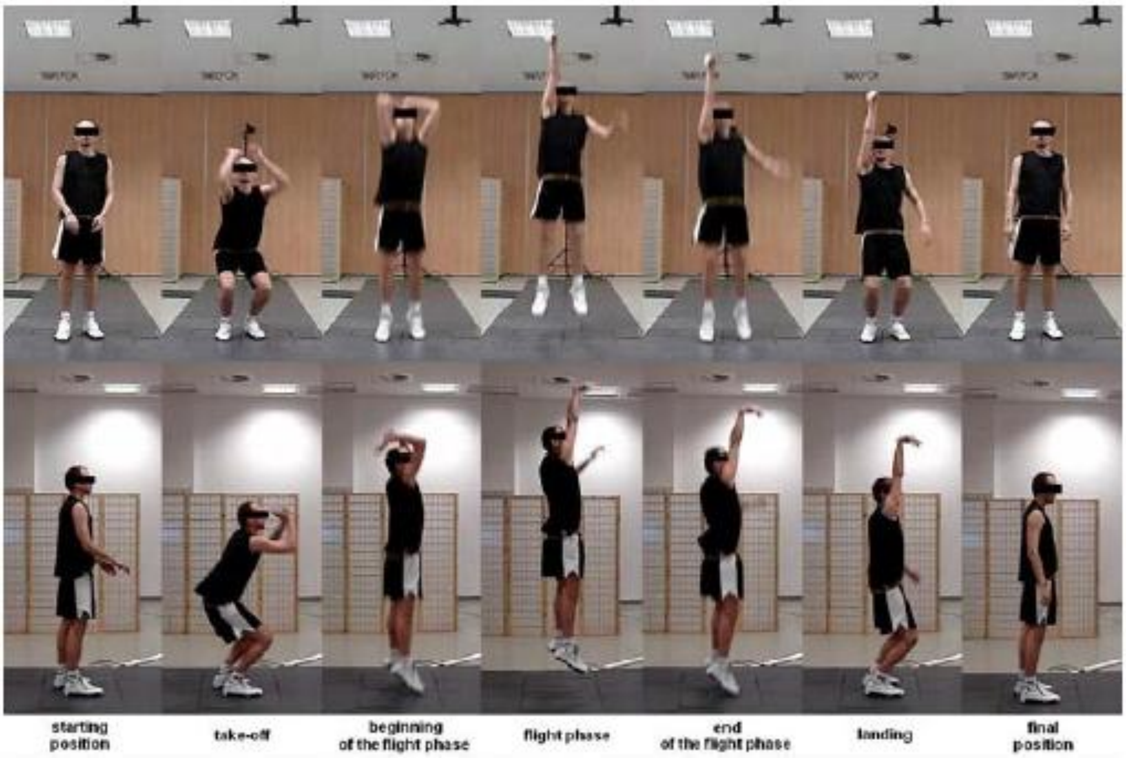

Figure 2.3. Movement Patterns When shooting, From Start Position To End Position

The mechanical process of changing the direction of a moving body is based on Newton's classical laws of motion. The athlete must apply force to the ground to make a change of direction and the side on which he wishes to move is in the opposite direction to the direction in which he applies force (Figure 4). The more force the athlete initially produces, the faster the direction change can take place. Therefore, an athlete who wants to increase his agility will want to increase the lateral forces in the opposite direction to the direction he wants to change direction (38).

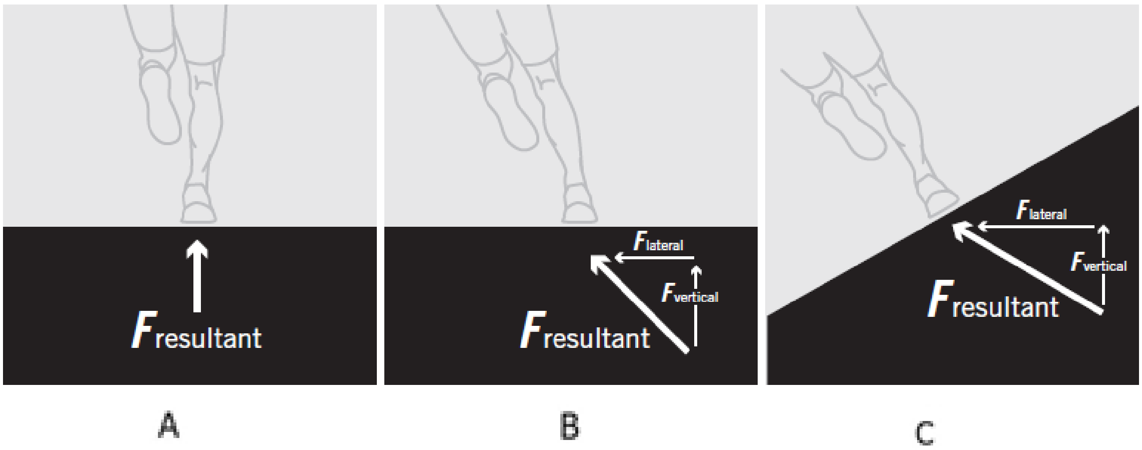

Figure 2.4. Motion Diagram During Shifting. A, When running forward on a flat ground, the forces applied to the ground are perpendicular to the ground. B, Lateral and vertical forces are generated during deflection on a flat surface. Horizontal forces are transferred to the floor by traction between the shoe and the floor. C, Since the lateral forces that will occur on a horizontal surface will be greater, the resultant force required for deflection will be greater (38).

Basic Motoric Characteristics of Basketball Players

Basketball sport requires certain skills that can be completed when moving at high speed and changing direction under dynamic conditions (31). Basketball is a team sport based on repetitive transitions and movements between offense and defense. Basketball matches are defined as low-medium intensity activities, but generally high intensity activities. These activities vary in order of movement (sprint, jump, change direction). The jump takes place approximately every minute in the basketball branch. In addition, they frequently perform sprint and sudden direction changes in matches and training sessions (39). Basketball athletes tend to have high strength, force and agility skills while maintaining low fat percentages. In addition to these skills, the endurance level of the athlete is also important during competition times (31).

Strength, force and agility are important determinants of basketball performance. Lower extremity muscle strength was a preliminary data for the duration of the game, and it was observed that the upper body muscle strength score enabled the sub-pot movements to be performed successfully (31).

Research has shown that dynamic balance is associated with athletic performance characteristics as part of coordination ability. The balance also protects players from injury. The results showed that special balance training reduced knee and hamstring injuries, ankle sprains, tendinopathies and rehabilitation after disability.

Many lower extremity injuries have been shown to cause impaired balance during descent after a jump (40).

There is a relationship between balance and basketball as basketball involves sudden change of direction, sprinting, sudden stopping and physical contact. The importance of assessing balance ability in basketball is related to injury frequency, sporting performance and coordination ability. Therefore, considering the necessary motor skills and balance definition related to high performance levels, dynamic balance has been shown great importance in basketball (40). The distribution of motor skills in basketball is as follows;

- 20% Speed; action and reaction time,
- 30% Durability; splashes and anaerobic Resistance,
- 15% Balance - coordination (Skill),
- 10% Flexibility,
- 25% Force; Special jump and firing force (41).

In general, in order to meet the demands of the game and to leave the competition, basketball athletes should focus on improving strength, agility, balance and strength performance and protecting them from disability by using short and intensive exercise programs (31).

2.3. Performance

Performance can be defined as the action required to do a concrete job. Sportive performance, on the other hand, is all the effort required to achieve success and achieve the highest level of athletic duty in any sport branch. In a sense, during the competition, it is a whole formed by the factors that will affect the result in a short period of time. Therefore, it will be necessary to think of sporting performance as a combination of athletic skills, athletic performance producing skills and quality “despite all positive and negative factors (42).

Today, there are many psychic and physical mechanisms that influence athletes' ability to produce athletic performance. Therefore, internal and external factors can affect the performance of the athlete in a positive or negative way (43).

2.3.1. Internal Factors

When internal factors are mentioned, they are generally differentiated factors that are present in the human being, partly inherited and with small changes over time. Internal factors are almost non-existent. Many factors reach a more stable structure with adolescence and become much more difficult to change (42). The age, sex, anatomical structure, balance system, autonomic nervous system, glandular functions, intelligence, state of the locomotor system, neuromuscular conduction rate, energy usage mechanisms, cardiovascular structure of the individual are some of these internal factors and these factors are difficult to be objective objectively. it is almost impossible to calculate the positive and negative effects it will generate (43).

2.3.2. External Factors

These are factors that do not originate from the structure of the human body, come from outside, and may indirectly affect sporting performance. We are able to influence many of these external factors externally through physical and psychic ways. Therefore, it can contribute to the increase of sporting performance by making a positive effect on these factors (43). Temperature, material worn during the competition, past disabilities, doping, time difference, negative words coming from outside, leisure time methods, determined role models, quality of training, quantity, flexibility, sleep order and quality of the athlete, rest between performance activities range is one of the main external factors (42).

2.4. Some Factors Affecting Basketball Performance

Basketball; It is a sport that requires high endurance, speed, agility and strength (44). The elite athletes cover a distance of approximately 991 meters in each competition and are required to change their movement patterns in the match by 50-60 direction changes and 40-50 times the maximum level of jump. These activities require maximum effort for athletes. Basketball is a sport that includes sudden runs, changes of direction, acceleration and different types of jumps, and as a game it is necessary to be able to do them in ball and without ball. These features are required for activities with the upper extremity (dribbling, different passes, shots). These features play an important role in the technical and tactical structure of basketball (43).

Today, there is an increase in physical competition due to the development and change of rules and strategies in basketball. The basic physical characteristics of a basketball player need to run faster than competitors, to have the strength and balance to balance physical contact and rigidity in the game, to run faster and jump faster than competitors and to make them less tiring during the competition (45).

Developing factors that change physical factors such as speed, endurance, strength and agility have been included in training programs and have been recognized as an important determinant of achieving sport superiority in most athletics, including basketball (46).

2.4.1. Strenght

The most powerful of the basic motoric features in basketball is strength. The concept of force has been expressed by many scientists in various definitions and meaning. The concept of force, which is accepted as a motoric feature, can be defined as resisting and dominating any different resistance that may occur in sports science (47).

Muscle strength development is supported as a combination of various morphological and neural factors. However, mechanisms that increase muscle strength can be considered multifaceted and may be affected by the athlete's initial strength, exercise status and genetics (48).

Athlete's height, weight, characteristics, age, sex, muscle structure, body fat percentage, lower and upper extremity length, muscle contraction rate, muscle fiber layout, psychological life and stress factors such as factors affecting muscle strength (47). Studies have shown that muscle strength decreases with age. According to the results of isokinetic knee extension / flexion muscle strength test performed in different age categories, a decrease in performance values regarding both strength and endurance was observed. Strength value shows a faster decrease compared to durability (49).

Espenschade and Eckert, in their research on the strength development of men between 9-24 years of age, 9-14 years of age in men between the period of a continuous increase in muscle strength, 15-24 years of age, there is a decrease in the development of strength and the highest level of muscle strength development in adolescence . The muscle strength of a child during adolescence was found to be higher than the muscle strength of a child who did not enter puberty at a young age (50).

The maximum level of force generation in basketball in the shortest time has been accepted as the basis for achieving high sports performance. Therefore, strength training has been indispensable for pre-basketball training as it increases sporting performance and reduces injury rate and provides high motivation for the athlete (51).

2.4.2. Speed

The ability of the athlete to transfer himself from one place to another at the highest speed and sudden changes in the direction of basketball can be defined as the fastest possible way (43). According to Gundlach, speed can be defined as bil progression at the highest speed ". Grosser, in a study, defined speed as the "ability to react to the stimulus as soon as possible 52 (52).

Speed is one of the most important components in basketball. One of the most important factors of success in all field sports is the short running speed (53).

Speed and quickness are two different terms. The difference between them is related to the frequency of the movement. The higher the frequency of movement of the athlete, the faster the athlete. In basketball, the difference between these two terms should be as small as possible in order to make the opponent's defense difficult (42). During the basketball game, the player must change suddenly, run forward for the offense, run back for the defense and jump in order to get a rebound. In order for the athlete to perform these activities at the right technical and right time during the match and to obtain efficiency from the performance of the athlete, it is necessary to have a good speed ability (43).

There are anatomical and physiological factors affecting speed. The size and frequency of muscle contraction in the athlete is one of the most important characteristics. Rapid stimulation of the musculoskeletal system results in a dynamic, strong movement. This requires movement coordination. The realization of intra-muscular and inter-muscular coordination makes it possible to perform in a coordinated manner in the resulting movement (42).

Muscle contraction rates depend on the structure of the muscle fiber. Athletes with Type 2 fibers, called white fibers, are faster. Excessive ATP-CP reserve leads to maximal force. Speed depends on maximal muscle strength and muscle coordination ability. Movement time can be reduced by increasing the maximal force value. Flexibility allows the muscles to move over a wider range, which indirectly improves the athlete's speed performance. The warm-up time before the competition positively affects 20% (42).

2.4.3. Explosive Force

Explosive force; it is the maximum force required to be used to displace the body or an object at the highest possible speed (54). As in most sports, basketball is an explosive act of good performance. Anaerobic performance is of great importance in the formation of explosive action in a short time with high intensity (55). The main purpose of explosive strength training is to shorten the reaction time of the athlete and to make the movement faster. Therefore, strength, speed and technical elements should not be ignored when performing these training programs (52).

In explosive strength training, the muscle length increases and large contractions occur. In addition, tension increases in the beam and explosive force is generated by contractions in the form of stress-shortening. In the jumping activities when the muscle is stretched, there is more mobility than the movement in voluntary contractions. At the same time as the beam tension increases, a stronger thrust occurs with nerve stimulation in the concentric phase (54).

Explosive strength training;

- Can be organized into stations.
- Lighter or moderate weights should be chosen compared to other strength training.
- Load intensity in training should be 40-60% intensity.
- Rest periods should be adjusted according to training intensity.
- For sets, 3 or 5 repeatable operations can be performed (52).

There are many factors that affect explosive force performance. Dawson et al. (1998) showed that the magnitude of muscle strength during dynamic movements is related to the sprint performance and the anaerobic performance capacity of the athlete. It can be said that the explosive power created by knee extensors is an important factor on anaerobic performance as muscle strength (55).

In another study, Özkan and Sarol (2008) observed that there was an increase in anaerobic performance and muscle strength values of the people engaged in mountaineering sport due to the increase in muscle volume of the leg around the calf and thigh. This study shows that the muscles in the leg area, volume, cross-sectional area and mass affect the explosive force that the muscle will generate (55).

In the evaluation tests for explosive strength, it was assumed that athletes with high muscle fiber conduction velocity performed more successfully in the tests and muscle fiber conduction velocity was better than isometric muscle strength (56).

2.4.4. Agility

Although there is no clear definition of agility, it can often be defined as an athlete's ability to change direction effectively with the lowest possible loss of speed and control. Within movement patterns involving agility, there is sudden deceleration, shifting and sudden acceleration while providing horizontal and vertical postural control (42, 57). Agility movements are used in basketball to get rid of the opposing player, to defend the player during the defender, or to make sudden moves to the ball when he wants to grab the ball (58).

Agility is a term commonly used in the field of strength and fitness and is thought to be an important element on performance in many sports as in basketball (59). There are many studies in the literature investigating the relationship with other physical parameters that can be developed to improve agility. It is seen that these studies are mainly investigating the relationship between lower extremity muscle strength and strength and agility. Because, in many studies, it is known that pliometric exercises improve lower extremity muscle strength and indirectly have a positive effect on agility (57).

2.4.5. Flexibility

Flexibility; It is related to the geometry of joint surfaces, soft tissues around the joint and joint capsule laxity. The joint can be defined as the maximum range of motion that can occur in the joint (42).

Especially in competitive sports, the effect of warming on pre-competition speed and power parameters during the warm-up period is an important issue and different results have been observed in studies conducted on this subject in the world. Stretching exercises were generally part of warming to increase range of motion and reduce the risk of disability (60). Various studies have shown that it reduces the risk of disability and provides a positive effect on performance (61). Flexibility; factors such as joint structure, joint type, age, sex, general body temperature, lack of muscle strength and fatigue may affect (47). Recommended flexibility tests in basketball (42).

- Standing Lateral Flexion
- Quadriceps Flexibility Test
- Achilles Flexibility
- Flexibility of hip flexors

2.4.6. Balance

Balance is a general term that defines body posture dynamics to prevent falls (62). At the same time, it is associated with physical factors such as running, walking, turning, sitting and not falling down by processing environmental factors. In addition to being a motor skill, balance is divided into static and dynamic balance (43).

All changes in balance are made by sensory receptors in the semicicular and vestibular canals. This is why the sense of balance is different from other senses (seeing, hearing, touching). The balance receptors in the inner ear, called the vestibular system, are responsible for providing the static balance and dynamic balance system. Static and dynamic equilibrium can be demonstrated between the limiting factors of sporting performance (43).

The central nervous system is responsible for stability, postural control and maintenance of balance. It works with the central nervous system, vestibular system, somatosensor system and visual system to provide balance and postural control (63).

Static balance is the ability to hold the body in static balance or within the support base (64). Static balance can be defined as ene the ability to provide support base with minimum movement, and dynamic equilibrium can be defined as yerine performing a task while maintaining the mobile state (65). Dynamic balance is supported by surrounding structures as it is more difficult to achieve stability during the transition from dynamic to static. Both static and dynamic balance require the integration of visual, vestibular and proprioceptive inputs to produce a response that is efferent to control the body within the support base. There are studies showing that players should have the ability to pay attention to proprioceptive and visual stimuli in order to have better balance ability (64).

In basketball, athletes perform physical contact, such as jumping, fast dribbling, box-out to defend the rival player, in order to receive sudden direction changes, offensive and defensive rebounds. These activities consistently occur in a limited space and high coordination, strength and balance are required to perform these movements (66). Although a weak balance is seen as a risk factor for injury, few studies have been conducted on this, and some studies have reported no association between balance and disability risk. Therefore, the relationship between balance and lower extremity injury risk could not be determined well (67).

Since balance and coordination are not fully developed in athletes for both genders, it is important to include balance training in adolescent athletes. Some studies have shown a positive relationship between balance training and balance-related test parameters. Gandevia in a study that can increase proprioceptive feedback and balance training can help to improve a better neuromuscular activation (66).

In a study by Behm and Colado, they observed an average increase of 31.4% in performance tests in the summary of balance training studies measuring vertical jump, shuttle running and other functional performances. Therefore, developing only the balance without additional resistance training can improve explosive power (68).

2.5. Plyometric

2.5.1. Pliometric Definition

The term pliometric is an unknown word in terms of origin, although there is no equivalent in the dictionary. It is thought to have come from the word “pleythyern”, which means to “increase” in Greek, and it may also be derived from the word “plio”, which means to “measure” in Greek (41).

Pliometric training is popular among people who perform dynamic sports and includes exercise programs such as jump, sprint, sudden direction changes to improve dynamic muscle performance. In pliometric exercises, muscles enter an elongation phase rapidly after the stretching phase using the elastic energy stored during the stretching phase (41). For this cycle, as in the countries of Norway, Italy and the Soviet Union, the term Strech - Shortening Cycle (SSC), which means the Short Tension Cycle (SSD), has been used in recent years (41). Physiologists prefer to use the term Strech - Shortening Cycle (SSC) developed by Komi instead of the pliometric term, which means the elongation of muscle length (69). As a synonym for this word; the terms myotenic strech reflex, pre-stress loop or stress reflex can be seen in the literature (41).

The aim of pliometric training is to increase the relationship between explosive force and maximal force. Nowadays, pliometric exercises have a widespread use in power generation and training methods to quickly use maximum muscle strength (69). In addition to the many training methods available, pliometric exercises help to improve the sports skill of the athlete (70).

2.5.2. Pliometric Trainings

Pliometric exercises are exercises parallel to the movement patterns used by athletes in jump and sprint activities in competition and training. These exercises work on the principle of short-tension cycle (SCC), which is the result of the muscle being subjected to a rapid eccentric elongation before rapid contraction. The muscle is actually stretched in its active state, and with the subsequent contraction, more force is generated than the force it produces in the static position. In order for the muscle to adapt to this cycle, exercises that provide more power production should be performed in the athlete and in many studies, pliometric training has been shown to be effective in increasing power generation and jump performance (71).

2.5.3. Physiological Characteristics of Pliometric Training

Pliometric exercises are a popular form of training used to improve athletic performance (72). When exercise programming is done correctly, there are studies showing that plyometric exercise has a positive effect on increasing muscle strength and power production. This increased muscle strength production is best explained by the mechanical and neurophysiological model. The function of each model can be explained by the term Strech - Shortening Cycle (SCC) (70).

In the mechanical model, the elastic energy is stored quickly in the muscle after a rapid stretching, and then energy is released with a concentric muscle movement. Thus, an increase in the total force production is provided (70). This model significantly increases the maximum force generation of the muscle junction in the shortest possible time and can also be used as part of plyometric exercise (72).

This common model presents the function between the contractile structures and the series and elastic components, the three mechanical components of the muscle-tendon unit. The series of elastic component structures with primary effect on energy production during plyometric exercise are mainly composed of tendons. When the muscle-tendon unit is stretched, as in the eccentric contraction mechanism, the series of elastic components act as springs and the elastic energy is stored. If the concentric muscle movement starts immediately after the eccentric contraction, the stored energy is released. This contributes to the total force production of muscles and tendons (70). Tendons and, to a lesser extent, muscles, bones and other tissues are predominantly influenced by storage and energy release (73). After the eccentric contraction, if an immediate concentric contraction does not occur, or if the eccentric phase lasts too long, the stored energy dissipates as heat (70).

During muscle contraction, skipping rope is considered a kind of strain-shortening cycle. Because the muscle groups in the thigh circumference and posterior crulal region, rope shortening and lengthening during exercise (74).

Physiological investigations supporting the efficacy of pliometric exercises on the SCC cycle on muscle tissue have been reviewed by many authors. Most researchers point out the importance of two factors (72).

A series of elastic components including actin and myosin tendons that form muscle fibers and cross-bridging properties. Proprioceptors that play a role in producing sensory inputs with rapid muscle tension. The myotatic reflex responds to the stretching rate of the muscle and is one of the fastest reflexes in the human body. This is due directly to the sensory receptors in the muscle and spinal cord cells and muscle fibers responsible for the action (72). Other reflexes are slower than myotatic reflexes, which are stretch reflexes. This is because they do not transmit directly, but through different channels. That is, before an action occurs, the stimulus must be transmitted to the central nervous system via interneurons (54).

2.5.4. Stages of Pliometric Exercises

Two different naming can be used for the stages of pliometric exercise. While some sources call these three phases as loading, binding and discharging phases, in some studies they have been named as eccentric, amortization and concentric (70, 72).

Pliometric exercises consist of three phases. The first phase is the phase in which the length of the muscle, known as the eccentric phase, grows rapidly. The second phase comprises a short rest period. In the third phase, an explosive shortening occurs concentrically in the muscle. The athlete completes this three-phase cycle as quickly as possible and the goal is to reduce the time between eccentric and concentric contraction (75).

2.5.4.1. Eccentric Phase

The phase of pliometric movement, which includes a rapid muscle extension, is called the eccentric phase. According to our definition, the eccentric phase of a pliometric movement occurs when the primary moving muscle-tendon units and synergist muscle groups are stretched as a result of joint-applied loading (72).

The eccentric phase is also defined as readiness, preloading, pre-setting, preparation, counter-motion phase (70).

The eccentric phase of a pliometric activity allows for stretching of non-contractile tissues with series elastic components and parallel elastic components. Stimulation of the components of the muscle is often referred to as a neurophysiological and biomechanical response. Many researchers have reported that the concentric contraction after stretching will increase the strength. This stress stage affects the magnitude of the stress, the speed of the stress and the duration of the stress (70).

2.5.4.2. Amortization Phase

It can be defined as the transition phase between the eccentric phase and the concentric phase of a pliometric exercise. This phase is generally called the depreciation phase (72).

Often this stage of pliometric exercises is also called electro-mechanical delay phase. Because this stage is the time lag between the muscles to produce force production, accelerate muscle contraction and pliometric movement (70). The longer this period, the more the benefits of a short-tensioned cycle will be lost (72).

This phase should not exceed 25 milliseconds to prevent the dissipation of stored energy as heat and to generate maximum force. The average time for this phase was calculated as 23 milliseconds. For optimal performance, the duration of this phase can be less than 15 milliseconds (72).

2.5.4.3. Concentric phase

This last stage of pliometric activity is called the concentric stage. It can also be called recoil, push, shortening phase. It comes immediately after the amortization phase and includes shortening of the muscle (72). This stage is the performance stage of the obtained energy production (70).

In order to complete the pliometric movement and release the force of the muscle, these three phases must be realized (70).

3. MATERIAL - METHOD

3.1. Individuals

The aim of this study was to investigate the effect of progressive skipping training on lower and upper extremity functions in adolescent athletes playing basketball at Galatasaray Sports Club. Thirty-seven athletes (25 male and 12 female) who met the inclusion criteria were included in the study.

Inclusion criteria were;

- Not having any surgical operation in the last 6 months,
- Not having patellafemoral pain syndrome or Jumper’s Knee pathology in the lower extremity and impingement syndrome in the upper extremity,
- To be between the ages of 16-18,
- Have played basketball for at least 4 years.

Exclusion criteria were;

- Having serious orthopedic (Trauma, Over use injuries, etc.) and systemic discomfort during exercise training program,
- Absence of 3 sessions or more in a 24-session training program.

Ethics committee approval was received by Yeditepe University Clinical Research Ethics Committee on 27.03.2019 and written informed consent form was obtained from all patients who accepted this study.

The study was completed with 37 athletes between the ages of 15-16. In the first stage, 25 male athletes and 12 female athletes were randomly divided into two groups. In the next stage, the training group that will perform in-season basketball training with progressive jump rope exercise and the control group that will continue only basketball training during the season were formed. The flowchart of the patients included in the study is shown in Figure 3.1.

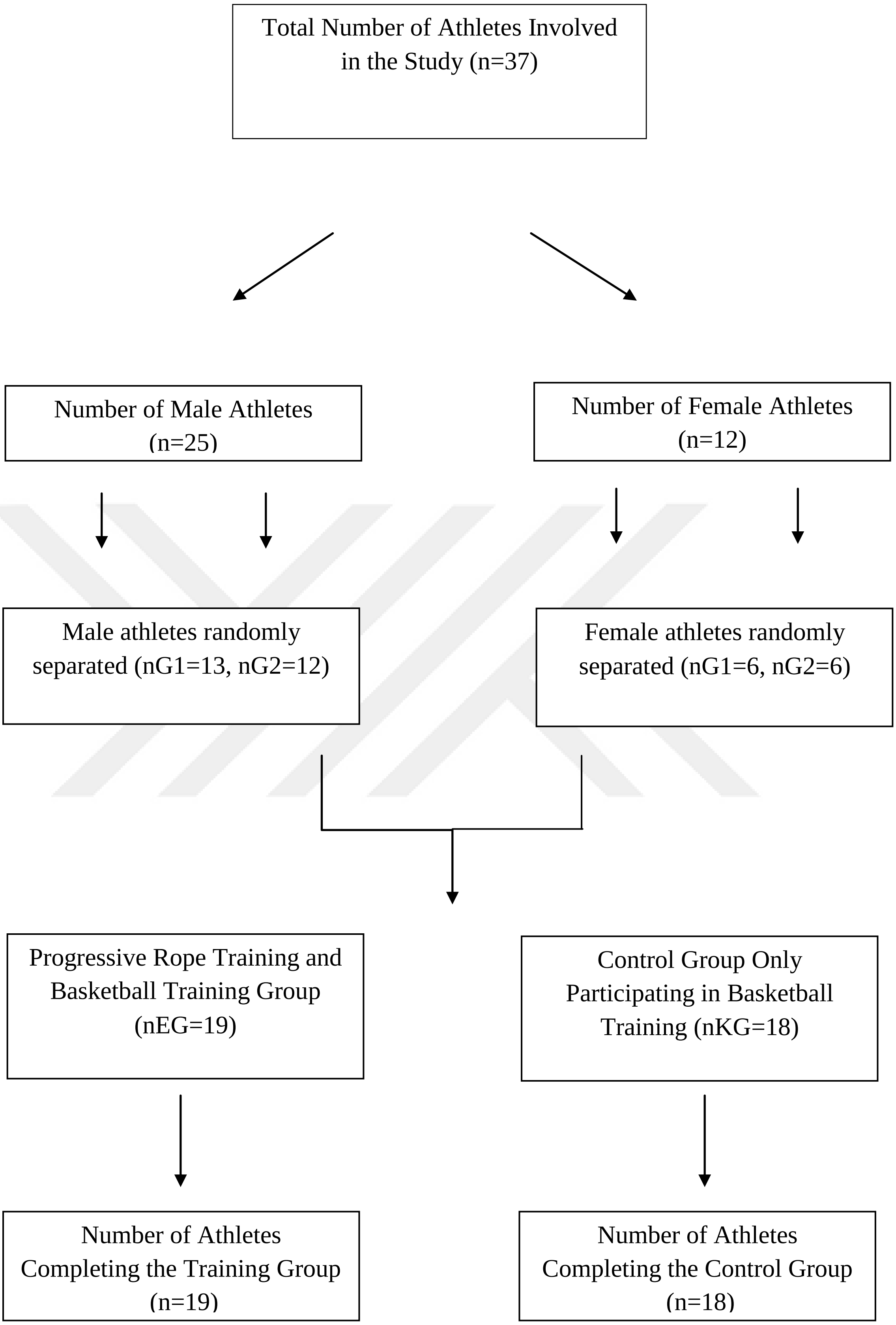

Figure 3.2. Flow Chart

3.2. Method

3.2.1. The work plan

Before starting the study, permission was obtained from the families of the athletes (Appendix A) and an oral presentation was made to inform the athletes. In this study, demographic information questionnaire, field tests and progressive jump rope training program were explained to athletes.

Demographic data of the volunteer athletes were questioned and field tests were evaluated (Annex B and Annex C). Then the athletes were given training on the correct jump rope exercise.

After the evaluations, the athletes in the training group performed progressive skipping exercise three times a week in addition to basketball training for 8 weeks. The athletes in the control group continued their basketball training only during the season.

3.2.2. Evaluation

3.2.2.1. Evalation of Demographic Characteristics

The information such as name, surname, gender, age, height, body mass index, disability history, club and position of the participants were recorded on the "Demographic Characteristics" form

3.2.2.2. Evaluation of Physical Performance Parameters

Physical performance tests were classified under two headings as upper extremity and lower extremity function tests.

3.2.2.2.1 Upper Extremity Function Tests

Seated Medicine Ball Throw

Open kinetic chain is a functional screening test. The aim is to evaluate bilateral upper body strength and strength. The athletes are asked to sit on the floor with their head, shoulders and back against the wall and stretch their legs. 90 kg shoulder abduction and elbow flexed, 2 kg weight ball is held with both hands. A measuring tape (tape measure) is placed on the ground and stretched over a distance of 10 m. The athletes throw the weightball forward in a knee line, with full wall contact with the head, shoulder and back. Three test shots are fired. A resting time of 1 minute is given between the test shots and the farthest distance to which the ball is thrown is noted in centimeters (76).

Figure 3.3. Seated Medicine Ball Throw

Seated Shot Put Test

An open kinetic chain functional screening test used to assess unilateral upper body strength and strength. The athletes are asked to sit on the floor with their head, shoulders and back against the wall and stretch their legs. Hold the 2 kg weight ball with one hand and throw it as far forward as possible, with the shoulder in the neutral position, adjacent to the wall and the elbow flexed. Three test shots are fired. A resting time of 1 minute is given between sighting shots and the farthest distance to which the ball is thrown is noted in centimeters. The test is repeated with the contralateral arm (77).

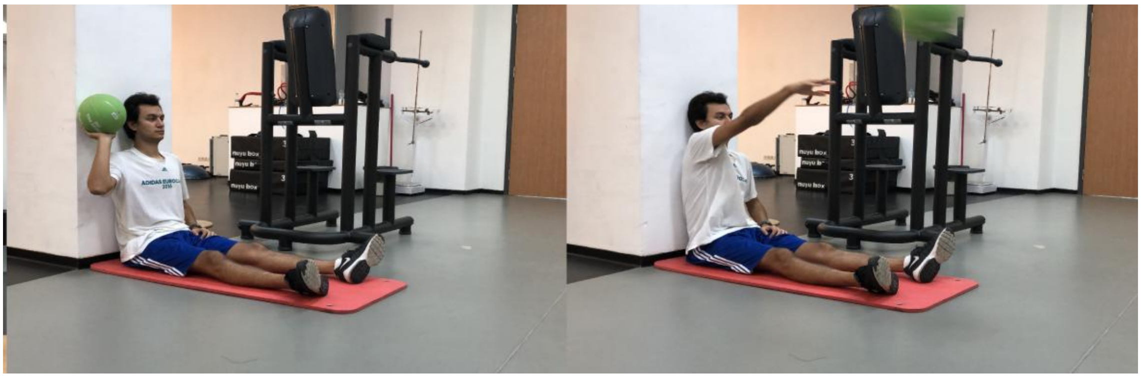

Figure 3.4. Seated Shot Put Test

Closed Kinetic Chain Upper Extremity Stability Test

The test starts in the push-up position for male athletes and in the modified push-up position for female athletes. The distance between the arms was 91.5 cm. The aim is to touch the shoulders with the opposite hand respectively for 15 seconds. Each athlete was first told the test and allowed to try submaximally. The assessor will hold for 15 seconds and note the number of repetitions performed within 15 seconds. The test is repeated three times and the score is written by taking the arithmetic average of the results of the three tests (78).

Figure 3.5. Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST)

Y-Balance Upper Extremity Test

The test was evaluated using rigid tape and tape measure. The Y-Balance Upper Extremity Test is a closed kinetic chain functional screening test (79).

According to previously published articles, the Y-Balance Upper Extremity test was first measured with the non-dominant side and then with the dominant side. The athletes stand in a three-board position with feet wide, shoulder elbows, and hands on the ground. The test hand is placed on the posture platform. In this position, the free hand extends to the maximum point where it can extend in the lateral, inferomedial and superomedial directions, and then returns to the starting position in a controlled manner. Each rest interval was given for 30 seconds and three test runs were performed. The test is repeated when the athlete breaks the starting position and makes a push to reach the distance. The maximum distance it can reach is calculated and noted (80).

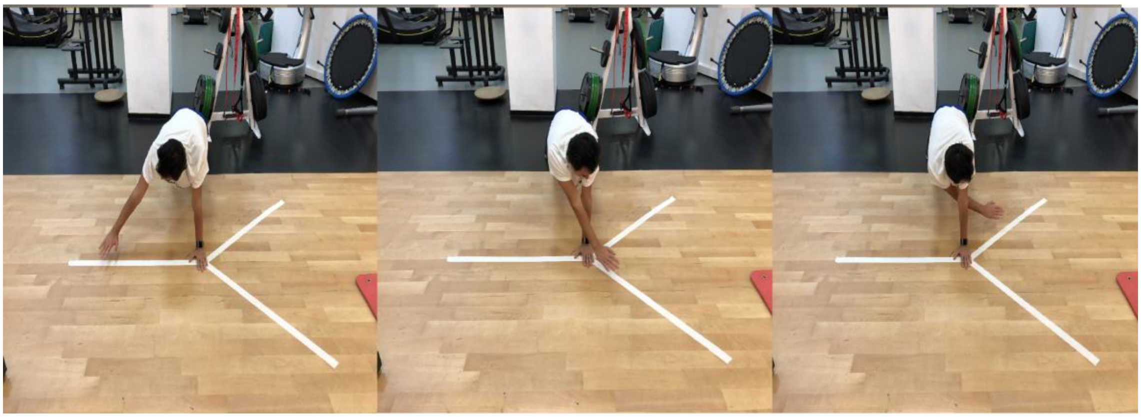

Figure 3.6. Y-Balance Upper Extremity Test

3.2.2.2.2. Lower Extremity Function Tests

Figure 8 Hop Test

Training funnels were placed in an area of 5 meters to form the shape of 8. The assessor keeps time with the stopwatch. The athlete draws eight around the funnels on one leg, the stopwatch is stopped when the course is completed. The test is repeated twice and the best score is noted (81).

Figure 3.7. Figure 8 Hop Test

Horizontal Jump

The starting point is specified. The athletes jump forward from the starting point by taking maximum force with the pair of feet and fall evenly onto the pair of feet. The test is repeated three times. 20 sec rest is given between each trial. After three attempts, the farthest distance is noted in centimeters (82).

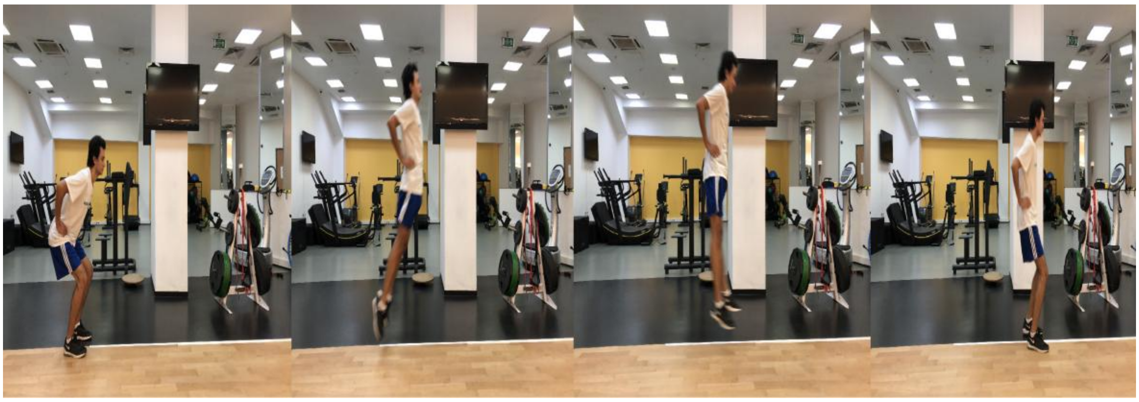

Figure 3.8. Horizontal Jump

Y-Balance Lower Extremity Test

YBLET consists of a three-part test used to assess neuromuscular control to predict lower extremity balance and lower extremity injury. Y-Balance Lower Extremity Test, which is one of the balance tests for the lower extremities, was evaluated using the Y Balance Test Kit (79).

The test was performed by examining the maximum reach of the free leg in the anterior, posteromedial and posterolateral directions of the athlete. This procedure was repeated after the athlete moved to the contralateral foot. According to the standardized protocol, the trial was considered unsuccessful when the subject was unable to maintain a posture on one foot, the free foot touched the floor, the hands were disengaged from the hip, or the test kit was disrupted and the test was repeated. Three attempts were made for each direction and the maximum reached distance was recorded at the end of three attempts (83).

Figure 3.9. Y Balance Upper Extremity Test

3.2.3. Training program

25 male and 12 female athletes playing in Galatasaray Sports Club Infrastructure Teams participated in the study voluntarily. The athletes were randomly divided into two groups. 13 male and 6 female athletes were selected for the first group and 12 male and 6 female athletes were selected for the second group. After the evaluation of the athletes, exercise program was started for the training group and no exercise program was applied after the evaluation for the control group.

Training Period: 8 Weeks, 3 Sessions / Week, Total 24 Sessions

Session Duration: 10 minutes warm-up + skipping exercise (Duration will vary according to set and repetition number.)

Phases:

Phase 1: Teaching correct skipping (1 week)

Phase 2: Progressive skipping exercise program (1-8 Weeks)

Table 3.1. Progressive skipping exercise program (27)

Week	Number of Sets	Exercise (Rope Jump / Rest Time)
1.	2	30 Second / 30 Second
2.	2	40 Second / 40 Second
3.	2	50 Second / 50 Second
4.	2	60 Second / 60 Second
5.	3	30 Second / 30 Second
6.	3	40 Second / 40 Second
7.	3	50 Second / 50 Second
8.	3	60 Second / 60 Second

3.3. Statistical analysis

Data obtained from the athletes were analyzed using SPSS for IBM Version 21 statistical package program.

Wilcoxon Test was used to analyze pre- and post-training findings of the study and control groups. The means of the variances are shown as arithmetic mean ± standard deviation (mean ± SD).

Mann - Whitney U Test was used to compare the differences between the study and control groups before and after training. The means of the variances are shown as arithmetic mean ± standard deviation (mean ± SD). In all statistics, p value of significance was taken as $p < 0.05$ and expressed as.

4. RESULTS

4.1. Descriptive Data and Evaluation Results

The aim of this study was to investigate the effects of eight-week progressive skipping exercises on lower and upper extremity functions of 37 athletes with a median age of 14.56 ± 0.55. The age, height, weight and BMI characteristics of the athletes in the control group (CG) (n = 18) and the training group (EG) (n = 15) are shown in Table 4.1. There was no statistically significant difference between two groups in terms of age and physical characteristics (height, body weight and BMI) ($p > 0.05$).

Table 4.1. Demographic Information of Training and Control Group Athletes

Demographic Information	CG	TG		
	Mean±SD Min - Max	**Mean±SD Min - Max**	**t**	**P**
Age (years)	14,66±0,59 (14-16)	14,47±0,51 (14-15)	1,05	0,29
Height (m)	1,88±0,10 (1,66-2,03)	1,84±0,93 (1,66-2,01)	1,06	0,29
Weight (kg)	74,83±10,46 (57,5-93)	70,23±10,41 (52-85,5)	1,33	0,18
Body Mass İndex (BMİ)	20,5±1,20 (19-22)	20,0±1,56 (18-23)	1,08	0,28

Pre-intervention values in lower and upper extremity function tests between groups Table 4.2, Table 4.3, Table 4.4. and Table 4.5. There was a statistically significant difference between the two groups in terms of double-handed throwing ball, right and left hand throwing ball, Fig8 Hop Test and upper extremity left superomedial Y balance test values ($p < 0.05$).

Table 4.2. Upper extremity function tests between groups before trainig

Test	CG	TG		
	Mean±SD	Mean±SD	t	p
Seated Medicine Ball Throw (m)	5,64±1,09	4,99±0,27	2,51	0,17
Seated Shot Put Test (Sağ) (m)	4,97±1,00	4,36±0,38	2,49	0,17
Seated Shot Put Test (Sol) (m)	4,72±0,75	4,25±0,33	2,47	0,18
CKCUEST (sn)	41,66±6,00	41,00±4,76	0,37	0,71

Table 4.3. Upper extremity Y balance test values between groups before training

Y-Balance Test		CG	TG		
		Mean±SD	Mean±SD	t	p
Right (Dominant) (cm)	**Medial**	91,55±7,57	93,5±9,21	-0,73	0,47
	Superolateral	82,44±8,14	82,0±8,84	0,15	0,87
	İnferolateral	78,44±9,26	75,63±9,79	0,89	0,37
Left (Non dominant) (cm)	**Medial**	90,0±7,20	91,15±8,42	-0,45	0,65
	Superolateral	82,6±6,98	77,89±10,91	1,57	0,12
	İnferolateral	81,88±6,73	77,42±6,06	2,12	**0,04**

Table 4.4. Lower extremity function tests between groups before training

Test	CG	TG		
	Mean±SD	Mean±SD	T	P
Fig8 Hop Test (Sağ) (sn)	5,94±0,55	6,28±0,74	-1,55	0,13
Fig8 Hop Test (Sol) (sn)	5,85±0,57	6,51±0,60	-3,35	**0,02**
Horizontal Jump (cm)	218,5±23,2	210,15±25,6	1,04	0,30

Table 4.5. Lower extremity Y balance test values between groups before training

Y-Balance Test		CG	TG		
		Mean±SD	Mean±SD	t	p
Right (Dominant) (cm)	**Anterior**	76,27±6,43	79,47±6,90	-1,45	0,15
	Postero medial	89,55±14,96	86,31±13,84	0,68	0,49
	Postero lateral	96,94±13,21	92,73±14,85	0,91	0,37
Left (Non dominant) (cm)	**Anterior**	79,55±6,60	79,89±5,80	-0,16	0,86
	Postero medial	90,33±11,95	86,89±15,59	-0,75	0,45
	Postero lateral	93,05±14,35	96,05±16,65	-0,58	0,56

The results of the lower and upper extremity function tests before and after the progressive skipping exercise of the training group are shown in Table 4.6, Table 4.7, Table 4.8, and Table 4.9. There was a statistically significant difference in left and right hand throwing, Closed Kinetic Chain Upper Extremity Stability Test (CKCUEST), Y balance test Inferolateral and Posterolateral direction, right and left Fig8 Hop test and horizontal jump values of the athletes in the training group (p. <0.05).

Table 4.6. Upper extremity function tests results before and after exercise of the training group in pre-training assessment

Test	TG			
	Pre Mean±SD	**Post Mean±SD**	**t**	**p**
Seated Medicine Ball Throw (m)	4,99±0,27	5,22±0,40	-2,85	0,05
Seated Shot Put Test (Sağ) (m)	4,36±0,38	4,66±0,48	-3,46	**0,02**
Seated Shot Put Test (Sol) (m)	4,25±0,33	4,55±0,36	4,38	**0,00**
CKCUEST (sn)	41,00±4,76	46,21±4,35	-3,83	**0,00**

Table 4.7. Upper extremity Y balance test results before and after exercise of the training group

Y Balance Test		TG			
		Pre Mean±SD	Post Mean±SD	t	p
Sağ (Dominant) (cm)	**Medial**	93,5±9,21	94,15±9,92	0,67	0,50
	Superolateral	82,0±8,84	78,36±12,27	-1,68	0,10
	İnferolateral	75,63±9,79	78,63±7.47	-1,25	0,20
Sol (Nondominant) (cm)	**Medial**	91,15±8,42	90,57±7,86	-0,71	0,48
	Superolateral	77,89±10,91	78,68±11,01	1,564	0,13
	İnferolateral	93,5±9,21	79,57±6.81	3,52	**0,02**

Table 4.8. Intra-group evaluation of the training group before and after exercise with lower extremity function test results

Test	TG			
	Pre Mean±SD	Post Mean±SD	t	p
Fig8 Hop Test (Sağ) (sn)	6,28±0,74	5,96±0,75	2,79	**0,01**
Fig8 Hop Test (Sol) (sn)	6,51±0,60	6,06±0,66	-4,35	**0,00**
Horizontal Jump (cm)	210,15±25,6	216,36±21,63	4,33	**0,00**

Table 4.9. Lower extremity Y balance test results before and after exercise of the training group

Y Balance Test		TG			
		Pre Mean±SD	Post Mean±SD	t	p
Right (Dominant) (cm)	**Anterior**	79,47±6,90	80,84±6,62	1,68	0,10
	Posteromedial	86,31±13,84	85,21±13,20	-0,837	0,41
	Posterolateral	92,73±14,85	94,31±15,98	1,358	0,19
Left (Non dominant) (cm)	**Anterior**	80,42±5,54	90,57±7,86	-0,93	0,36
	Posteromedial	86,89±15,59	86,26±6,62	-0,59	0,55
	Posterolateral	96,05±16,65	98,89±17.26	3,25	**0,04**

The results of the lower and upper extremity function tests of the control group before and after progressive skipping exercise are shown in Table 4.10, Table 4.11, Table 4.12, and Table 4.13. There was a statistically significant difference in right superolateral, right inferolateral, left medial and inferolateral direction in the upper extremity Y balance test and right posteromedial and left anterior direction values in the CKCUEST test of the athletes in the training group ($p<0.05$).

Table 4.10. Intra-group evaluation results of control group before and after exercise and upper extremity function tests

Test	**CG**			
	Pre Mean±SD	**Post Mean±SD**	**t**	**p**
Seated Medicine Ball Throw (m)	5,64±1,09	5,23±0,99	-2,85	0,05
Seated Shot Put Test (Sağ) (m)	4,97±1,00	4,88±0,87	-0,02	0,98
Seated Shot Put Test (Sol) (m)	4,72±0,75	4,71±0,86	-0,02	0,97
CKCUEST (sn)	41,66±6,00	44,21±4,55	-3,28	**0,01**

Table 4.11. Upper extremity Y balance test results before and after exercise of control group

Y Balance Test		CG			
		Pre Mean±SD	**Post Mean±SD**	**t**	**p**
Right (Dominant) (cm)	**Medial**	91,55±7,57	90,94±7,75	-0,55	0,58
	Superolateral	82,44±8,14	85,33±5,81	3,61	**0,02**
	İnferolateral	78,44±9,26	82,38±8,99	-3,07	**0,02**
Left (Nondominant) (cm)	**Medial**	90,0±7,20	92,66±7,74	4,15	**0,04**
	Superolateral	82,6±6,98	85,22±6,80	-1,85	0,06
	İnferolateral	91,55±7,57	92,66±7,74	3,52	**0,00**

Table 4.12. Intra-group evaluation of the training group before and after exercise with lower extremity function test results

Test	CG			
	Pre Mean±SD	**Post Mean±SD**	**t**	**p**
Fig8 Hop Test (Sağ) (sn)	5,94±0,55	5,93±0,63	-0,33	0,73
Fig8 Hop Test (Sol) (sn)	5,85±0,57	5,83±0,51	-0,73	0,47
Horizontal Jump (cm)	218,5±23,2	217,16±21,09	-0,56	0,57

Table 4.13. Lower extremity Y balance test results before and after exercise of control group

Y Balance Test		CG			
		Pre Mean±SD	**Post Mean±SD**	**t**	**p**
Right (Dominant) (cm)	**Anterior**	76,27±6,43	77,88±6,33	3,18	0,05
	Posteromedial	89,55±14,96	90,61±14,87	2,49	**0,02**
	Posterolateral	96,94±13,21	96,72±10,17	-0,14	0,88
Left (Nondominant) (cm)	**Anterior**	79,55±6,60	83,88±6,76	4,30	**0,00**
	Posteromedial	90,33±11,95	90,61±10,41	-0,52	0,60
	Posterolateral	76,27±6,43	95,22±11.25	1,47	0,74

The comparison of lower and upper extremity function tests are shown in Table 4.14, Table 4.15, Table 4.16 and Table 4.17. While the results of the athletes in the training group increased with double handed ball throwing, right-handed weight throwing, Fig8 Hop test, horizontal jump and CKCUEST tests compared to the results of the athletes in the control group ($p < 0.05$), training of left hand throwing and Y balance tests were compared. There was no statistically significant difference in favor of the group.

Tablo 4.14. Comparison of differences in upper extremity function tests before and after exercise program

Test	CG	TG		
	Mean±SD	**Mean±SD**	**t**	**P**
∆Seated Medicine Ball Throw (m)	-0,40±0,83	0,23±0,31	-3,09	**0,00**
∆Seated Shot Put Test (Sağ) (m)	-0,09±0,74	0,30±0,35	-2,09	**0,04**
∆Seated Shot Put Test (Sol) (m)	-0,00±0,67	0,30±0,29	-1,80	0,08
∆CKCUEST (sn)	2,38±2,35	5,21±3,44	-2,89	**0,00**

Tablo 4.15. Comparison of the difference between the upper extremity Y balance test before and after the exercise program

Y Balance Test		CG	TG		
		Mean±SD	**Mean±SD**	**u**	**P**
∆Right (Dominant) (cm)	**Medial**	-0,61±4,67	-0,57±3,73	-0,85	0,40
	Superolateral	2,88±3,39	-3,63±9,39	2,77	**0,00**
	İnferolateral	3,94±4,58	3,00±9,45	-0,38	0,70
∆Left (Non – dominant) (cm)	**Medial**	2,66±2,72	-0,57±3,51	3,14	**0,00**
	Superolateral	2,61±6,39	0,78±2,20	1,17	0,24
	İnferolateral	3,16±2,99	2,15±2,67	1,07	0,28

Tablo 4.16. Comparison of the difference between lower and lower extremity function tests before and after exercise program

Test	CG	TG		
	Mean±SD	Mean±SD	u	P
ΔFig8 Hop Test (Sağ) (sn)	-0,01±0,15	-0,31±0,49	2,49	**0,01**
ΔFig8 Hop Test (Sol) (sn)	0,02±0,14	-0,44±0,44	3,18	**0,00**
ΔHorizontal Jump (cm)	-1,38±10,38	6,21±6,25	-2,67	**0,01**

Tablo 4.17. Comparison of the difference between the lower extremity Y balance test before and after the exercise program

Y Balance Test		CG	TG		
		Mean±SD	Mean±SD	u	p
ΔRight (Dominant) (cm)	**Anterior**	1,61±2,14	1,36±3,53	0,25	0,80
	Posteromedial	1,05±1,79	-1,10±5,75	1,52	0,13
	Posterolateral	-0,22±6,44	0,52±2,45	-0,94	0,35
ΔLeft (Non – dominant) (cm)	**Anterior**	4,33±4,27	0,52±2,45	3,30	**0,03**
	Posteromedial	2,61±6,39	0,78±2,20	1,17	0,24
	Posterolateral	2,16±6,22	2,84±3,80	-0,39	0,69

5. DISCUSSION

In this study, adolescent basketball players' explosive, balance, agility capacities for lower extremity functions after 8 weeks of progressive skipping exercise; The changes in strength and balance capacities for upper extremity functions before and after training were investigated. After progressive skipping training, there were significant differences in strength and agility for lower extremity and strength values for upper extremity in the training group. In the Y-Balance balance evaluation for both extremities, there were no significant differences in the values of superolateral and left side medial direction for the upper extremity and medial direction for the left extremity and only the anterior direction for the lower extremity.

The study was conducted with a total of 37 volunteer basketball athletes (15 girls and 25 boys). There were no significant differences in physical characteristics (height, body weight and body mass index) parameters of training and control group before and after training.

In our study, after 8 weeks of progressive skipping exercise program, statistically significant differences were found between two handed ball throwing, right / left single hand throwing, CKCUEST, right / left Fig8 Hop test and horizontal jump values before and after the training group.

Many studies in the literature have suggested that skipping and pliometric exercises are effective on performance development (22, 24, 25, 26, 27, 31). Sahin, in 2017 in his study of the effect of different speeds of jump rope exercise on vertical jump and anaerobic force in women athletes. The athletes were divided into two groups: slow jumping (n: 10) and fast jumping (n: 10). While there was no statistically significant difference in vertical jump values in slow jump group, vertical jump values were statistically significant in fast jump group ($p<0.05$) (22).

Agar (2006), in his study on 29 male athletes in the 9-11 age range investigated the effect of vertical jump jump and interval running training. The athletes were divided into three groups as rope jumping group (n: 10), interval jogging group (n: 10) and control group (n: 9). The athletes who applied the training programs 3 days a week were re-evaluated at the end of 6 weeks. While there was a statistically significant difference in vertical jump values in the skipping rope group, no statistically significant difference was found on the vertical jump value in the group running interval running training (24).

Orhan et al. (2008) investigated the effect of vertical and horizontal jump strength, two-handed ball throwing and right / left one-handed ball throwing tests on 39 male athletes aged 17-19 years. Athletes were divided into two groups as rope jumping group (n: 12) and predominantly rope jumping group (n: 12). The athletes were asked to do jump rope exercises for 3 weeks and 8 weeks. They observed that there was a statistically significant difference in horizontal / vertical jump, two-hand medicine ball throwing and right / left single-handed ball throwing tests in rope skipping exercise at the end of 8 weeks, but the increase in weighted rope athletes was higher in these values (25). In our study, this study, which was conducted according to the results of double hand medicine ball throwing test, right / left single hand medicine ball throwing and horizontal leap, supports our study.

Trecroci et al. (2015), 24 adolescent footballers in their study on the effects of jump rope exercise on balance and agility in athletes. They found a significant difference in agility and Y balance test values after 8 weeks, 2 days a week, 15 minutes rope exercise. In our study we found a statistically significant difference in agility values ($p < 0.05$), but we did not find a statistically significant difference in terms of Y balance test. Although the study by Trecroci et al. supports our study in terms of agility assessment, different results were found in terms of Y balance test evaluation applied to the lower extremity compared to our study (26).

In the study of Duzgun et al. (2010) investigated the effects of rope skipping exercise on isokinetic muscle strength in their study on 24 volleyball athletes aged 13-16 years. The athletes were divided into 3 groups as rope jumping group (n: 9), weighted rope jumping group (n: 8) and control group (n: 8). The athletes were evaluated in both empty-can and full-can positions at 60 ° / s and 180 ° / s after 12 weeks of skipping exercise program and it was shown that there was a statistically significant difference in full-can position at only 180 ° / s (27).

In the studies conducted in the literature, weight ball throwing in upper extremity, closed kinetic stabilization test and increase in Y-Balance values in the lower extremity in the control group, the athletes should be trained during the season and to maintain individual performance values, leap, agility, strength exercises in basketball-specific technical training. and to prevent injury, training and pre-match balance studies can be said to be effective in the evaluation criteria. With the idea that basketball-specific activities performed by coaches in different clubs and the exercises to prevent disability were different, the number of people was kept small and work was conducted in a single club.

Limitations of our study;

- After the progressive skipping training, the results of the training and control group did not differ in the Closed Kinetic Chain Upper Extremity (CKCUET) test for upper extremity stabilization assessment.
- As a result of statistical analyzes performed before progressive skipping training, upper extremity Y balance test was not similar between the groups in the inferolateral direction and Figure 8 Hop Test left extremity parameter.
- Since the basketball training program implemented by different coaches of different clubs will affect the work, the number of players was kept very low.

6. CONCLUSIONS AND RECOMMENDATIONS

The study was carried out with a total of 37 athletes (25 male, 12 female) to investigate the effect of progressive skipping exercise program on lower and upper extremity functions. The athletes were taken to the jump rope exercise program three times a week for eight weeks before the training.

The results of the study are as follows;

1. The Seated Medicine Ball Throw, Seated Shot Put Test (Right) and Closed Kinetic Stabilization Tests for upper extremity muscle strength showed more improvement in the education group compared to the control group.

2. In the Y-Balance balance test used for upper extremity balance assessment, a statistically significant difference was found in the evaluation of the right extremity superolateral and the left extremity in the training group compared to the control group.

3. In the Y-Balance balance test used for the evaluation of the lower extremity balance, a statistically significant difference was found in the evaluation of the left extremity in the anterior direction compared to the control group in the training group.

4. In the Figure 8 Hop Test, which we used for agility assessment of the lower extremities, there was more improvement in the right and left extremities in the training group than in the control group.

5. In the Horizontal Jump test for lower extremity explosive force assessment, more improvement was observed in the training group compared to the control group.

Nowadays, training techniques and improvements in physical fitness parameters increase the performance of athletes and increase its importance in sports world. Emphasizing that progressive skipping training increases strength, agility and explosive strength on basketball athletes, this study can be added to training programs applied to athletes to maintain performance during pre-season preparation and mid-season, and can bring a new perspective to training schemes for performance improvement.

REFERENCES

1. Delextrat, A. Trochym, E. & Calleja-Gonzalez, J. Effect of a typical in-season week on strength jump and sprint performances in national-level female basketball players. Journal of Sports Medicine and Physical Fitness, (2012). 52(2), 128.

2. Calleja-González J, Terrados N, Mielgo-Ayuso J, et al. Evidence-based post-exercise recovery strategies in basketball. Phys Sportsmed. 2016;44(1):74-78.

3. Scanlan A, Humphries B, Tucker PS, et al. The influence of physical and cognitive factors on reactive agility performance in men basketball players performance in men basketball players. 2013;(January 2014):37-41.

4. Ángel P, Román L, Javier F, Macias V, García F. Effects of a contrast training programme on jumping , sprinting and agility performance of prepubertal basketball players performance of prepubertal basketball players. J Sports Sci. 2017;00(00):1-7.

5. Nikolic A. Plyometric basketball training. Turkish J Kinesiol. 2018;4(4):101-105.

6. Calleja-González, J., Terrados, N., Mielgo-Ayuso, J., Delextrat, A., Jukic, I., Vaquera, A. Ostojic, S. M. Evidence-based post-exercise recovery strategies in basketball. The Physician and sportsmedicine, (2016) 44(1), 74-78

7. Okur, F., Tetik, S., & Koç, H. Basketbolcularda dikey sıçrama performansı ile müsabaka performansı arasındaki ilişkinin incelenmesi. (2013).

8. Cherni Y, Jlid MC, Mehrez H, Shephard RJ. Eight Weeks of Plyometric Training Improves Ability to Change Direction and Dynamic Postural Control in Female Basketball Players. 2019;10(June).

9. Objectives C, Terms K. Speed, Agility, and Speed-Endurance Development. :1-25.

10. Strength N. Research Unit, Sport Performance, Health & Society, Higher Institute of Sport and Physical Education of Ksar Said, University of La Manouba, Tunis, Tunisia.

11. Meszler B, Váczi M. Effects of short-term in-season plyometric training in adolescent female basketball players. 2019;106(2):168-179.

12. Potteıger JA, Lockwood RH, Haub MD et al. Muscle Power and Fiber Characteristics Following 8 Weeks of Plyometric Training. J Strength Cond Res. 2004;13(3):275.

13. Chaouachi A, Othman A Ben, Hammami R, Drinkwater EJ, Behm DG. The Combination of Plyometric and Balance Training Improves Sprint and Shuttle Run Performances More Often than Plyometriconly Training with Children. Vol 28.; 2014.

14. Gonzalo-skok O, Sánchez-sabaté J, Izquierdo-lupón L. Influence of force-vector and force application plyometric training in young elite basketball players. Eur J Sport Sci. 2018;0(0):1-10.

15. Attene, G., Iuliano, E., Di Cagno, A., Calcagno, G., Moalla, W., Aquino, G., & Padulo, J. Improving neuromuscular performance in young basketball players: plyometric vs. technique training. J Sports Med Phys Fitness, (2015) 55(1-2), 1-8.

16. Hernández S, Ramirez-campillo R, Álvarez C, Sanchez-sanchez J, Pereira LA, Loturco I. Effects of Plyometric Training on Neuromuscular Performance in Youth Basketball Players : A Pilot Study on the Influence of Drill Randomization. 2018;(May):372-378.

17. Moran, J. J., Sandercock, G. R., Ramírez-Campillo, R., Meylan, C. M., Collison, J. A., & Parry, D. A. Age-related variation in male youth athletes' countermovement jump after plyometric training: a meta-analysis of controlled trials. The Journal of Strength & Conditioning Research,(2017) 31(2), 552-565..

18. Bogdanis GC, Donti O, Papia A, Donti A, Apostolidis N, Sands WA. E ff ect of Plyometric Training on Jumping , Sprinting and Change of Direction Speed in Child Female Athletes. 2019:1-10.

19. Moran J, Clark CCT, Ramirez-campillo R. A Meta-Analysis of Plyometric Training in Female Youth: Its Efficacy and Shortcomings in the Literature. 2018;(August).

20. Bavli, O. a. Investigation the effects of combined plyometrics with basketball training on some biomotorical performance. Pamukkale Journal of Sport Sciences, (2012). 3(2), 90-100.

21. Asadi, A., Arazi, H., Ramirez-Campillo, R., Moran, J., & Izquierdo, M. Influence of maturation stage on agility performance gains after plyometric training: a systematic review and meta-analysis. The Journal of Strength & Conditioning Research, (2017). 31(9), 2609-2617.

22. Şahin G, Farklı Hızlarda İp Atlama Antrenmanlarının Anaerobik Güce Etkisi. Spor ve Performans Araştırmaları Dergisi, 8(2), 75-86.

23. Orhan S. Basketbolcularda İp ve Ağırlık İpi Çalışmalarının Vücut Yağ Oranı, Vücut Yağ Yüzdesi ve Çevre Ölçümlerine Etkisi. Sport Sciences, (2008). 3(2), 43-51.

24. Ağar, E. 9-11 Yaş erkek çocuklarda ip atlama ve interval koşu egzersizlerinin performans ile etkileşimi. ABÜ Sağlık Bilimler Enstitüsü Antrenörlük Eğitimi Anabilim Dal (2006). ı (Doctoral dissertation, Yüksek Lisans Tezi, ss. 47. Bolu).

25. Orhan, S., Pulur, A., & Erol, A. E. İp ve Ağırlıklı İp Çalışmalarının Basketbolcularda Bazı Fiziksel ve Fizyolojik Parametrelere Etkisi. Fırat Üniversitesi Sağlık Bilimleri Dergisi, (2008). 22(4), 205-210.

26. Trecroci, A., Cavaggioni, L., Caccia, R., & Alberti, G. Jump rope training: Balance and motor coordination in preadolescent soccer players. Journal of sports science & medicine, (2015). 14(4), 792.

27. Duzgun, I., Baltaci, G., Colakoglu, F., Tunay, V. B., & Ozer, D. The effects of jump-rope training on shoulder isokinetic strength in adolescent volleyball players. Journal of sport rehabilitation, (2010). 19(2), 184-199.

28. Parlak, O. 14-17 yaş genç erkek basketbol ve hentbolcuların bazı fizyolojik ve motorik özelliklerinin karşılaştırılması (Master's thesis, Adnan Menderes Üniversitesi Sağlık Bilimleri Enstitüsü). (2018).

29. FIBA. 2018 Official Basketball Rules; Basketball Equıpment. 2018;(October):98.

30. Fiete RD. The Story of. Model Imaging Chain Digit Cameras. 2010:109-126.

31. Ransone J. Physiologic profile of basketball athletes. Sport Sci Excange. 2016;28(163):1-4.

32. Crisafulli, A., Melis, F., Tocco, F., & Laconi, P. External mechanical work versus oxidative energy consumption ratio during a basketball field test. Journal of sports medicine and physical fitness, (2002). 42(4), 409.

33. Narazaki, K., Berg, K., Stergiou, N., & Chen, B. Physiological demands of competitive basketball. Scandinavian journal of medicine & science in sports, (2009). 19(3), 425-432.

34. Miller, S., & Bartlett, R. The relationship between basketball shooting kinematics, distance and playing position. Journal of sports sciences, (1996). 14(3), 243-253.

35. Struzik, A., Pietraszewski, B., & Zawadzki, J. Biomechanical analysis of the jump shot in basketball. Journal of human kinetics (2014)., 42(1), 73-79.

36. Podmenik, N., Supej, M., Čoh, M., & Erčulj, F. The effect of shooting range on the dynamics of limbs angular velocities of the basketball shot. Kinesiology: International journal of fundamental and applied kinesiology, (2017). 49(1), 92-100.

37. Okazaki, V. H., Rodacki, A. L., & Satern, M. N. A review on the basketball jump shot. Sports biomechanics, (2015). 14(2), 190-205.

38. Conrad, B. R. Y. A. N. The biomechanics of basketball agility. Sport Research Review, (2014). 1, 1-8.

39. Stojanović, E., Stojiljković, N., Scanlan, A. T., Dalbo, V. J., Berkelmans, D. M., & Milanović, Z. The activity demands and physiological responses encountered during basketball match-play: a systematic review. Sports Medicine, (2018). 48(1), 111-135.

40. Nikolaos, K. Anthropometric and fitness profiles of young basketball players according to their playing position and time. Journal of Physical Education and Sport, (2015). 15(1), 82.

41. Kızılet, A., Atılan, O., & Erdemir, İ. 12-14 yaş grubu basketbol oyuncularının çabukluk ve sıçrama yetilerine farklı kuvvet antrenmanlarının etkisi. (2010).

42. Usgu, S. Profesyonel basketbol oyuncularında fonksiyonel eğitimin performansla ilişkili fiziksel uygunluk parametrelerine etkisi. (2015).

43. Tedavi UF, Program R, Tez D. Basketbol oyuncularinda vibrasyon eşliğindeki pliometrik eğitimin fiziksel performans üzerine etkileri. 2016.

44. Sıegler, J., Gaskıll, S., & Ruby, B. Changes evaluated in soccer-specific power endurance either with or without a 10-week, in-season, intermittent, high-intensity training protocol. The Journal of Strength & Conditioning Research, (2003). 17(2), 379-387.

45. Schelling, X., & Torres-Ronda, L. Conditioning for basketball: Quality and quantity of training. Strength & Conditioning Journal, (2013). 35(6), 89-94.

46. Benzidane, H., Mokrani, D., Mohamed, K. S., Houcine, A., & Sadek, Z. Effect of Usıng Some Plyometric Exercises to Imporve Explosie Power and Digital Achıevement In The Long Jump.. European Journal of Physical Education and Sport Science, (2016). 1(2).

47. Gokdemir S, Ondokuz Mayıs Üniversitesi erkek hentbol ve basketbol takımlarında yer alan oyuncuların fiziksel ve fizyolojik parametrelerinin karşılaştırılması, (1997).

48. Suchomel, T. J., Nimphius, S., Bellon, C. R., & Stone, M. H. (2018). The importance of muscular strength: training considerations. Sports medicine, 48(4), 765-785.

49. Bayraktar, B., & Kurtoğlu, M. (2009). Sporda performans, etkili faktörler, değerlendirilmesi ve artırılması. Klinik Gelişim Dergisi, 22(1), 16-24.

50. Aydos, L., Taş, M., Akyüz, M., & Uzun, A. (2009). Genç Elit Güreşçilerde Kuvvet ve Bazı Antropometrik Parametlerin İlşkisinin İncelemesi Beden Eğitimi ve Spor Bilimleri Dergisi, 11(4).

51. Santos, E. J., & Janeira, M. A. (2008). Effects of complex training on explosive strength in adolescent male basketball players. The Journal of Strength & Conditioning Research, 22(3), 903-909.

52. Tedavi UF, Program R, Tez D. Basketbol oyuncularinda vibrasyon eşliğindeki pliometrik eğitimin fiziksel performans üzerine etkileri. 2016.

53. Tez S, Dem E. Pliometrik Antrenmanın 14-16 yaş Kadın Voleybolcuların Fiziksel Parametreleri Üzerine Etkisi. 2016.

54. Shalfawi, S. A., Sabbah, A., Kailani, G., Tønnessen, E., & Enoksen, E. The relationship between running speed and measures of vertical jump in professional basketball players: a field-test approach. The Journal of Strength & Conditioning Research (2011)., 25(11), 3088-3092.

55. Sağıroğlu, İ. Genç basketbolcularda pliyometrik antrenmanların anaerobik performans ve dikey sıçrama yüksekliğine etkisi (Doctoral dissertation, DEÜ Sağlık Bilimleri Enstitüsü). (2008).

56. Özkan, A., & Kinişler, A. Sporcularda Bacak Hacmi, Kütlesi, Hamstring/Quadriceps Oranı ile Anaerobik Performans ve İzokinetik Bacak Kuvveti Arasındaki İlişki. Spor Bilimleri Dergisi, (2010). 21(3), 90-102.

57. Methenitis, S., Terzis, G., Zaras, N., Stasinaki, A. N., & Karandreas, N. Intramuscular fiber conduction velocity, isometric force and explosive performance. Journal of human kinetics, (2016). 51(1), 93-101.

58. Yıldız, M., Hamdi, A. T. İ. K., Baysal, A., Keleş, G., Kayan, Ö., & Tekın, D. Kort tenisi ve takim sporlarinda siçrama ile çeviklik ilişkisi. Spor ve Performans Araştırmaları Dergisi, (2017). 8(3), 175-182.

59. Young WB. Is Muscle Power Related to Running Speed With Changes of Direction W B Young ; R James ; I Montgomery. 2014;(September 2002).

60. Okur, M. Genç basketbolcularda 8 haftalık hız antrenman programının ivmelenme ve çeviklik üzerine etkisi (Doctoral dissertation, Selçuk Üniversitesi Sağlık Bilimleri Enstitüsü). (2011).

61. Mikolajec, K., Waskiewicz, Z., Maszczyk, A., Bacik, B., & Kurek, P. Effects of stretching and strength exercises on speed and power abilities in male basketball players. Isokinetics and Exercise Science, (2012). 20(1), 61-69.

62. Notarnicola, A., Perroni, F., Campese, A., Maccagnano, G., Monno, A., Moretti, B., & Tafuri, S. Flexibility responses to different stretching methods in young elite basketball players. Muscles, ligaments and tendons journal, (2017). 7(4), 582.

63. Winter, D. A. Human balance and posture control during standing and walking. Gait & posture, (1995). 3(4), 193-214.

64. Sever, O. Comparison of static and dynamic core exercises' effects on Stork balance test in soccer players Futbolcularda statik ve dinamik core egzersizlerin Stork denge testine etkisi. Journal of Human Sciences, (2017). 14(2), 1781-1791.

65. Karadenizli, Z., Erkut, O., Ramazanoğlu, N., Selda, Uzun, Camlıguney, A., Bozkurt, S., ... & Sırmen, B. Comparision of dynamic and static balance in adolescents handball and soccer players. Turkish Journal of Sport and Exercise, (2014). 16(1), 47-54.

66. Cerrah, A. O., Bayram, İ., Yıldızer, G., Uğurlu, O., Şimşek, D., & Ertan, H. Effects of functional balance training on static and dynamic balance

performance of adolescent soccer players. Uluslararası Spor Egzersiz ve Antrenman Bilimi Dergisi, (2016). 2(2), 73-81.

67. Bouteraa, I., Negra, Y., Shephard, R. J., & Chelly, M. S. Effects of combined balance and plyometric training on athletic performance in female basketball players. Journal of strength and conditioning research. . (2018).

68. Plisky, P. J., Rauh, M. J., Kaminski, T. W., & Underwood, F. B. Star Excursion Balance Test as a predictor of lower extremity injury in high school basketball players. Journal of Orthopaedic & Sports Physical Therapy, (2006). 36(12), 911-919.

69. Váczi, M., Tollár, J., Meszler, B., Juhász, I., & Karsai, I. Short-term high intensity plyometric training program improves strength, power and agility in male soccer players. Journal of human kinetics, (2013). 36(1), 17-26.

70. Bayraktar B. Voleybolcularda Sağ ve Sol Bacak Sıçrama Derecesi Farklılıklarına Göre Periyotlanmış Pliometrik Antrenmanın Çift Bacak Sıçrama Performansına Etkisi. 2008;1997:67-83.

71. Davies, G., Riemann, B. L., & Manske, R. Current concepts of plyometric exercise. International journal of sports physical therapy, (2015). 10(6), 760.

72. Potteıger JA, Lockwood RH, Haub MD, et al. Muscle Power and Fiber Characteristics Following 8 Weeks of Plyometric Training. J Strength Cond Res. (1999)2004;13(3):275.

73. Chu DA, Myer GD, Allen Dad, Chu PDA, Myer GD. Chu, Donald. A., Jumping into Plyometrics. Champaign, Illinois: Human Kinetics Pub., 1992.

74. Gruber, M., Kramer, A., Mulder, E., & Rittweger, J. The importance of impact loading and the stretch shortening cycle for spaceflight countermeasures. Frontiers in Physiology, (2019). 10, 311.

75. Miyaguchi, K., Sugiura, H., & Demura, S. Possibility of stretch-shortening cycle movement training using a jump rope. The Journal of Strength & Conditioning Research, (2014). 28(3), 700-705.

76. Davis, K. L., Kang, M., Boswell, B. B., DuBose, K. D., Altman, S. R., & Binkley, H. M. Validity and reliability of the medicine ball throw for kindergarten children. The Journal of Strength & Conditioning Research, (2008). 22(6), 1958-1963.

77. Chmielewski, T. L., Martin, C., Lentz, T. A., Tillman, S. M., Moser, M. W., Farmer, K. W., & Jaric, S. (2014). Normalization considerations for using the unilateral seated shot put test in rehabilitation. journal of orthopaedic & sports physical therapy, 44(7), 518-524.

78. Tucci, H. T., Martins, J., de Carvalho Sposito, G., Camarini, P. M. F., & de Oliveira, A. S. Closed Kinetic Chain Upper Extremity Stability test (CKCUES test): a reliability study in persons with and without shoulder impingement syndrome. BMC musculoskeletal disorders, (2014). 15(1), 1.

79. Shaffer, S. W., Teyhen, D. S., Lorenson, C. L., Warren, R. L., Koreerat, C. M., Straseske, C. A., & Childs, J. D. Y-balance test: a reliability study involving multiple raters. Military medicine, (2013). 178(11), 1264-1270.

80. Westrick, R. B., Miller, J. M., Carow, S. D., & Gerber, J. P. Exploration of the y-balance test for assessment of upper quarter closed kinetic chain performance. International journal of sports physical therapy, (2012). 7(2), 139.

81. Someeh, M., Norasteh, A. A., Daneshmandi, H., & Asadi, A. Influence of Mulligan ankle taping on functional performance tests in healthy athletes and athletes with chronic ankle instability. International Journal of Athletic Therapy and Training, (2015). 20(1), 39-45.a

82. Reina, R., Iturricastillo, A., Sabido, R., Campayo-Piernas, M., & Yanci, J. Vertical and horizontal jump capacity in international cerebral palsy football players. International journal of sports physiology and performance, (2018). 13(5), 597-603.

83. Lai, W. C., Wang, D., Chen, J. B., Vail, J., Rugg, C. M., & Hame, S. L. Lower quarter Y-Balance Test scores and lower extremity injury in NCAA division I athletes. Orthopaedic journal of sports medicine, (2017). 5(8), 2325967117723666.

APPENDİX A

Araştırma Amaçlı Çalışma İçin Aydınlatılmış Onam Formu
Fizyoterapistin Açıklaması

Bu çalışma basketbol oyuncularında ilerleyici ip atlama egzersizlerinin sporcuların egzersiz sonrası alt ve üst ekstremite fonksiyonlarının karşılaştırılması amacıyla yapılacaktır. Elde edilen verilerle basketbol sporcularına ve onların rehabilitasyonlarına katkı sağlanacak, bu alanda çalışan profesyonellere ve öğrencilere yol gösterici olacaktır.

Araştırmanın ismi ''Basketbol oynayan adolesan atletlerde progresif ip atlama eğitimi sonrası alt ve üst ektremite fonksiyonlarının karşılaştırılması''dır. Sizin de ebeveyn olarak çocuğunuzun bu çalışmaya katılmasına izin vermenizi öneriyoruz. Ancak hemen söyleyelim ki bu araştırmaya katılmalarına izin verip vermemekte serbestsiniz. Çalışmaya katılım gönüllülük esasına dayanır. Kararınızdan önce araştırma hakkında sizi bilgilendirmek istiyoruz. Bu bilgileri okuyup anladıktan sonra araştırmaya katılmalarına izin verirseniz formu imzalayınız. Araştırmaya davet edilmenizin sebebi çocuğunnuzun yıldız/genç basketbol takımında oynuyor olmasıdır. Çalışma Galatasaray Spor Kulübü Florya Metin Oktay Tesislerinde yapılacaktır. Eğer çocuğunuzun araştırmaya katılmasını kabul ederseniz, çocuğunuz Fzt. Murat Erdem tarafından fizyoterapi değerlendirme programına alınacaktır. Değerlendirme kayıtlarınız kimliğiniz belirtilmeden sağlık alanında öğrenim gören öğrencilerin eğitiminde veya bilimsel nitelikte yayınlarda kullanılabilir. Bunun dışında bu kayıtlar kullanılmayacak ve başkalarına verilmeyecektir. Bu çalışmayı yapabilmek için çocuğunuzun üst ekstremite ve alt ekstremite kuvvet testleri ve denge testlerinin değerlendirilmesi yapılacaktır. Ayrıca çocuğunuzu boy-kilo-spor yaşı-adet görme yaşı(kız ise)-mevkiisi ve yaralanma geçmişi de sorgulanacaktır. Bu değerlendirmeler sporcuların hangi vücut fonksiyonunda zayıflık olduğunu anlamamızda ve o fonksiyona katkı sağlamamızda yol gösterici olacaktır. Daha sonra 8 hafta süresince sporcular haftada 3 gün antrenman öncesi 10-20 dakika boyunca ip atlama egzersiz eğitimi görecektir. Egzersizlerin şiddeti her seans sporcuların uygunluk kapasitesine göre artış göstererek ilerleyici bir program uygulanacaktır. Eğitim süreci bittikten sonra değerlendirmeler egzersiz eğitiminin etkinliğini anlamak açısından tekrar yapılacaktır. Bu çalışma ile amacımız henüz kas iskelet sistemi gelişimini tamamlamayan ve çoğunlukla doğru sportif tekniği oluşturamayan genç sporcularda yaralanma sıklığını azaltmak ve dahil oldukları basketbol sporu için gerekli altyapıyı kazandırmak ve kuvvetlendirmektir. Sporcular değerlendirmeler esnasında herhangi bir ağrı veya acı hissetmeyecektir. Bu çalışmaya katılmanız için sizden herhangi bir ücret istenmeyecektir. Çalışmaya katıldığınız için size ek bir ödeme de yapılmayacaktır.

Değerlendirmeler sırasında oluşabilecek riskler:
Çalışma kapsamında yapılacak olan değerlendirmeler herhangi bir risk içermemektedir.
Çalışmanın devamı sırasında açığa çıkabilecek sorun ve riskler size iletilecektir. Araştırma esnasında görebileceğiniz olası bir zararda bunun sorumluluğu alınacak ve giderilmesi için her türlü tıbbi müdahale yapılacaktır. Bu konudaki tüm harcamalar üstlenilecektir.

Bu çalışmaya çocuğunuzun katılmasını reddedebilirsiniz. Bu araştırmaya katılmak tamamen isteğe bağlıdır ve reddettiğiniz takdirde çocuğunuzun antrenman programında herhangi bir değişiklik olmayacaktır. Yine çalışmanın herhangi bir aşamasında onayınızı çekmek hakkına da sahipsiniz. Buna rağmen çekilme talebinizi zamanında bildirmeniz uygun olur.

Ebeveynin Beyanı

Sayın Fzt. Murat Erdem tarafından adolesan baskebol oyuncularında ilerleyici ip atlama egzersiz eğitiminin alt ve üst ekstremite fonksiyonlarına etkisinin araştırılması için tıbbi bir araştırma yapılacağı belirtilerek, bu araştırma ile ilgili yukarıdaki bilgiler bana aktarıldı. Bu bilgilerden sonra velisi olduğum çocuğum böyle bir araştırmaya " katılımcı" olarak davet edildi.

Eğer çocuğumun bu araştırmaya katılmasına izin verirsem, bu araştırma sırasında fizyoterapistin çocuğuma ait bilgilerin gizliliğine büyük bir özen ve saygı ile yaklaşılacağına inanıyorum. Araştırma sonuçlarının eğitim ve bilimsel amaçlarla kullanımı sırasında kişisel bilgilerimin ihtimamla korunacağı konusunda bana yeterli güven verildi. Çalışmanın yürütülmesi sırasında herhangi bir sebep göstermeden çocuğumu araştırmadan çekebilirim *(Ancak arastırmacıları zor durumda bırakmamak icin arastırmadan çekileceğimi önceden bildirmemin uygun olacağının bilincindeyim).* Ayrıca çocuğumun sportif durumuna herhangi bir zarar verilmemesi koşuluyla araştırmacı tarafından araştırma dışı tutulabilirim. Araştırma için yapılacak harcamalarla ilgili herhangi bir parasal sorumluluk altına girmiyorum. Bana da bir ödeme yapılmayacaktır. İster doğrudan, ister dolaylı olsun araştırma uygulamasından kaynaklanan nedenlerle çocuğumda meydana gelebilecek herhangi bir sağlık sorununun ortaya çıkması halinde, her türlü tıbbi müdahalenin sağlanacağı konusunda gerekli güvence verildi (bu tıbbi müdahalelerle ilgili olarak da parasal bir yük altına girmeyeceğim). Araştırma sırasında çocuğum bir sağlık sorunu ile karşılaştığında; 24 saat boyunca herhangi bir saatte, Fzt. Murat ERDEM'i 05364842006 no'lu telefondan arayabileceğimi biliyorum.

Bu araştırmaya çocuğumun katılmasına izin vermek zorunda değilim ve katılmasına izin vermeyebilirim. Araştırmaya katılması konusunda zorlayıcı bir davranışla karşılaşmış değilim. Eğer katılmasını reddedersem, bu durumum çocuğumun akındaki durumuna veya fizyoterapist ile olan ilişkisine herhangi bir zarar getirmeyeceğini de biliyorum. Bana yapılan tüm açıklamaları ayrıntılarıyla anlamış bulunmaktayım. Kendi başıma belli bir düşünme süresi sonunda adı geçen bu araştırmada ebeveyni olduğum çocuğumun "katılımcı" (denek) olarak yer alması kararını aldım. Bu konuda yapılan daveti büyük bir memnuniyet ve gönüllülük içerisinde kabul ediyorum. İmzalı bu form kağıdının bir kopyası bana verilecektir.

Katılımcı Velisi
Adı, soyadı:
Adres:
Tel:
İmza:

Katılımcı ile görüşen fizyoterapist
Adı soyadı: Fzt. Murat ERDEM (24 Saat ulaşılabilecek kişi)
Adres: Deli Hüseyin Paşa caddesi Huzur Apt. No:55/10 Bahçelievler İstanbul
Tel: 05364842006
İmza:

APPENDİX B

Basketbol Oynayan Adolesan Atletlerde Progresif İp Atlama Eğitimi Sonrası Üst ve Alt Extremite Fonksiyonlarının Karşılaştırılması

DEMOGRAFİK ÖZELLİKLER

ADI:

SOYADI:

DOĞUM TARİHİ:

BOY: VKİ:

KİLO:

REGL TARİHİ (K):

DOMİNANT TARAF:

AYAKKABI NUMARASI:

KAÇ SENEDİR BASKETBOL OYNUYOR? :

OYNADIĞI KULÜP:

OYNADIĞI POZİSYON:

HAFTADA KAÇ SAAT İDMAN YAPIYORSUNUZ? :

DİŞ -- DİŞ-ETİ PROBLEMLERİ (SON 2 YIL):

DAHA ÖCE BİR SAKATLIK GEÇİRİLMİŞ BİR SAKATLIK VAR MI? :

EVET İSE;

NE ZAMAN:

NEREDE SAKATLANDI (İDMAN/ANTRENMAN):

SAKATLIK OYNAMANA ENGEL OLDU MU?

OLDUYSA KAÇ GÜN? :

Alt Ekstremite Fonksiyonlerının değerlendirilmesi		
		İlk Değerlendirme
Y-Balance Test Lower Quarter	Anterior (Sağ)	
	PosteroMedial (Sağ)	
	PosteroLateral (Sağ)	
Y-Balance Test Lower Quarter	Anterior (Sol)	
	PosteroMedial (Sol)	
	PosteroLateral (Sol)	
Figure 8 Hop Test	Sağ	
	Sol	
Horizontal Jump (m)		

		Son Değerlendirme
Y-Balance Test Lower Quarter	Anterior (Sağ)	
	PosteroMedial (Sağ)	
	PosteroLateral (Sağ)	
Y-Balance Test Lower Quarter	Anterior (Sol)	
	PosteroMedial (Sol)	
	PosteroLateral (Sol)	
Figure 8 Hop Test	Sağ	
	Sol	
Horizontal Jump (m)		

APPENDİX C

Üst Ekstremite Fonksiyonlarının Değerlendirilmesi		
		İlk Değerlendirme
Seated Medicine Ball Throw		
Seated Shot Put test	Sağ	
	Sol	
Closed Kinetic Chain Upper Extremity Stability Test		
Y-Balance Upper Extremity	Lateral (Sağ)	
	İnferomedial (Sağ)	
	İnferolateral (Sağ)	
Y-Balance Upper Extremity	Lateral (Sol)	
	İnferomedial (Sol)	
	İnferolateral (Sol)	

		Son Değerlendirme
Seated Medicine Ball Throw		
Seated Shot Put test	Sağ	
	Sol	
Closed Kinetic Chain Upper Extremity Stability Test		
Y-Balance Upper Extremity	Lateral (Sağ)	
	İnferomedial (Sağ)	
	İnferolateral (Sağ)	
Y-Balance Upper Extremity	Lateral (Sol)	
	İnferomedial (Sol)	
	İnferolateral (Sol)	

Alt Ekstremite Fonksiyonlarının değerlendirilmesi		
		İlk Değerlendirme
Y-Balance Test Lower Quarter	Anterior (Sağ)	
	PosteroMedial (Sağ)	
	PosteroLateral (Sağ)	
Y-Balance Test Lower Quarter	Anterior (Sol)	
	PosteroMedial (Sol)	
	PosteroLateral (Sol)	
Figure 8 Hop Test	Sağ	
	Sol	
Horizontal Jump (m)		

		Son Değerlendirme
Y-Balance Test Lower Quarter	Anterior (Sağ)	
	PosteroMedial (Sağ)	
	PosteroLateral (Sağ)	
Y-Balance Test Lower Quarter	Anterior (Sol)	
	PosteroMedial (Sol)	
	PosteroLateral (Sol)	
Figure 8 Hop Test	Sağ	
	Sol	
Horizontal Jump (m)		