

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

**EXAMINATION OF THE RELATIONSHIP BETWEEN FUNCTIONAL  
MOVEMENT SCREENING TEST SCORES AND LOWER EXTREMITY  
INJURY RISK OF THE ELITE CANDIDATE MALE FOOTBALLERS  
PLAYING IN U19 AND U13 GROUPS**

MASTER THESIS

OZAN ÖZTÜRK, PT

İstanbul-2022

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## THESIS APPROVAL FORM

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### APPROVAL

This thesis has been deemed by the jury in accordance with the relevant articles of Yeditepe University Graduate Education and Examinations Regulation and has been approved by Administrative Board of Institute with decision dated 16.06.2022 and numbered 2022/06.16

Prof. Dr. Bayram YILMAZ  
Director of Institute of Health Sciences

## **DECLARATION**

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

05.07.2022

Ozan ÖZTÜRK



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## ABBREVIATIONS

AT	: Anaerobic Threshold
ATP	: Adenosine Triphosphate
FIFA	: Fédération Internationale de Football Association
FMS	: Functional Movement Screening
LT	: Lactate Threshold
TFF	: Turkish Football Federation
TTA	: Turkish Training Associations
UEFA	: Union of European Football Associations
U13	: Under 13
U19	: Under 19
VO <sub>2</sub> max	: Maximal Oxygen Uptake

## ABSTRACT

**ÖZTÜRK, O. (2022). Examination of the relationship between functional movement screening test scores and lower extremity injury risk of the elite candidate male footballers playing in U19 and U13 groups. Yeditepe University, Institute of Health Sciences, Department of Sports Physiotherapy and Rehabilitation, MSc Thesis, İstanbul.**

The aim of this study is to examine the relationship between the functional movement screen test scores of elite male football players playing in the U19 and U13 groups and the risk of lower extremity injury. The study was conducted with the retrospective data of 13-19 age group male elite candidate athletes (n=41) playing football in the development leagues determined by the Turkish Football Federation, affiliated to the Galatasaray Football Academy, in the 2018-2019 season. Functional movement screen (FMS) battery was used to determine the functional movement levels of the football players. The movements in the applied test are, respectively, deep squat, hurdle step, in-line lunge, shoulder mobility, active straight leg raise, trunk stability push-up, rotary stability. Participants were informed about the test before the measurements began, and then demonstrated as a practice. Each movement was repeated three times during the application of the test. The scores that can be obtained from the test range from 0 to 21. In the study, there was a positive and weak correlation between age and deep squat ( $r = .368$ ;  $p < 0.05$ ), positive and moderate correlation between active straight leg raise ( $r = .474$ ;  $p < 0.05$ ), positive and weak correlation between rotary stability ( $r = .363$ ;  $p < 0.05$ ), and a positive and weak ( $r = .400$ ;  $p < 0.05$ ) correlation was detected between total FMS score. When the FMS scores of the U13 football players were examined, it was seen that the highest score was shoulder mobility, the lowest score was the active straight leg raise test, while the U19 footballers got the highest score from shoulder mobility and the lowest score was from the deep squat test. As a result of the study, it was determined that the deep squat, straight forward, active straight leg raising, rotary stability and total FMS score of the U19 football players were significantly higher than the U13 football players ( $p < 0.05$ ). In addition, the total FMS scores of the injured players were found to be lower and below 14 points compared to the players who did not have any injuries.

**Keywords:** Functional Movement Screening Test, Football Player, Injury

## ÖZET (Turkish)

**Öztürk, Ozan (2022). U19 ve U13 Gruplarında Oynayan Elit Adayı Futbolcuların Fonksiyonel Hareket Taraması Test Skorlarının Alt Ekstremitte Sakatlık Riski İle İlişkilerinin İncelenmesi. Yeditepe Üniversitesi, Sağlık Bilimleri Enstitüsü, Spor Fizyoterapisi ve Rehabilitasyon Bölümü, Yüksek Lisans Tezi, İstanbul.**

Bu çalışmanın amacı, U19 ve U13 gruplarında oynayan elit aday erkek futbolcuların fonksiyonel hareket tarama test puanları ile alt ekstremitte yaralanma riski arasındaki ilişkinin incelenmesidir. Çalışma 2018-2019 sezonu Galatasaray Futbol Akademisi'ne bağlı olarak Türkiye Futbol Federasyonu'nun belirlediği gelişim liglerinde futbol oynayan 13-19 yaş grubu erkek elit aday sporcuların (n=41) geçmişe dönük verileri ile yapılmıştır. Futbolcuların fonksiyonel hareket düzeylerini belirlemek için fonksiyonel hareket tarama bataryası kullanıldı. Uygulanan testteki hareketler, derin çömelme, engel adımı, aynı doğrultuda ileri hamle, omuz hareketliliği, aktif düz bacak kaldırma, gövde stabilitesi şınav, gövde rotasyon dengesidir. Katılımcılar, ölçümler başlamadan önce test hakkında bilgilendirildi ve ardından uygulamalı olarak gösterildi. Testin uygulanması sırasında her hareket üç kez tekrarlanmıştır. Testten elde edilebilecek puanlar 0-21 arasında değişmektedir. Elde edilen değerleri SPSS programı ile analiz edildi. Çalışmada yaş ile derin çömelme arasında pozitif yönde ve zayıf ( $r = .368$ ;  $p < 0.05$ ), aktif düz bacak kaldırma ile arasında pozitif yönde ve orta şiddette ( $r = .474$ ;  $p < 0.05$ ), rotasyon stabilitesi ile arasında pozitif yönde ve zayıf ( $r = .363$ ;  $p < 0.05$ ), toplam FMS skoru ile arasında pozitif yönde ve zayıf ( $r = .400$ ;  $p < 0.05$ ) ilişki tespit edildi. Çalışma sonucunda U13 futbolcularının FMS skorları incelendiğinde en yüksek skorun omuz hareketliliği, en düşük skorun ise aktif düz bacak kaldırma testinden, U19 futbolcularının da en yüksek puanı benzer şekilde omuz hareketliliği, en düşük puanı ise derin çömelme testinden elde ettikleri görüldü. U19 futbolcularının derin çömelme, aynı doğrultuda ileri hamle, aktif düz bacak kaldırma, rotasyon stabilitesi ve toplam FMS skorunun, U13 futbolcularından anlamlı şekilde daha yüksek olduğu ( $p < 0.05$ ) tespit edildi. Ayrıca sakatlık geçiren oyuncuların sakatlık geçirmeyen oyunculara göre toplam FMS puanları düşük ve 14 puan altında bulundu.

**Anahtar Kelimeler:** Fonksiyonel Hareket Tarama Testi, Futbolcu, Sakatlık

## 1. INTRODUCTION AND PURPOSE

Football is one of the sports that is played by approximately 270 million people for professional or recreational purposes, and has reached the popularity that no other sports branch can reach (1,2). There is a high risk of injury for both young, amateur and professional football players in which high-intensity activities (jump, sudden change of direction, slip, acceleration) are involved in football (3). Altered neuromuscular control and ineffective movement patterns during these vigorous activities (sudden change of direction, acceleration, jump, and descent) appear to be key factors in increasing the risk of injury in young athletes (4,5). In addition, there is evidence in the literature that muscular imbalance, isokinetic strength imbalance, asymmetry between legs and changes in dynamic stability increase the risk of injury in young football players (6-8).

Young football players can be injured much more frequently than professional football players (9,10). The frequency of injury in young football players, mostly in the lower extremities, varies between 2.0 and 26.6 per thousand hours (10-12). In addition, while the injury rate of a football player is about 0.40 in each season, they stay away from the field for an average of 21.9 days as a result of these injuries (9). As a result of these injuries, young football players staying away from the fields for a long time can negatively affect the skill and physical development of the football players. Studies in the literature mention the importance of effective movement competence for safe and effective long-term physical performance in young athletes (13,14). In addition, sportsmen need balance, core stability and neuromuscular control in order to perform sportive movements safely and effectively (15). Therefore, comprehensive screening methods are needed to determine the risk of injury and to establish preventive strategies to prevent injury (16,17).

Functional Movement Screening (FMS) is a method used to evaluate stability and quality of lower and upper extremity movement patterns in sportsmen because poor neuromuscular control increases the risk of acute injury (18,19). Functional movement analysis is a system based on scoring seven different movement parameters that form the basis of human movement according to certain criteria (20). FMS aims to obtain information about individual movement patterns and to determine movement limitations and limitations by evaluating posture. While evaluating the FMS test it provides an easy

and fast evaluation of features such as movement asymmetry, trunk stabilization, range of motion, balance, neuromuscular coordination, strength and flexibility (21).

The Functional Movement Screening test (FMS) can distinguish functional movement disorders between pubertal groups and can be a useful tool in preventing injuries in the adolescent population (18,21,22).

The aim of this study is the examination of the relationship between functional movement screening test scores and lower extremity injury risk of the elite candidate male footballers playing in U19 and U13 groups. For this purpose, the hypotheses of the research were determined as follows:

H0: There is not a significant relationship between the functional screening test scores of elite male football players playing in the U19 and U13 groups and the risk of lower extremity injury.

H1: There is a significant relationship between the functional screening test scores of elite male football players playing in the U19 and U13 groups and the risk of lower extremity injury.

## **2. THEORETICAL FRAMEWORK AND LITERATURE REVIEW**

### **2.1. Football**

#### **2.1.1. Definition**

Football is a sport whose importance and place is indisputable today. In this sense, millions of people are involved in football. Therefore, today's football has become an industry with coaches and other employees, as well as players and spectators (23).

Football is a team sport in which the two teams try to throw the ball into the opposing team's goal as much as possible within a certain game time and in accordance with the game rules. In the competition where the team that scores more goals wins, aiming for this goal is achieved through different technical behaviors (24).

The requirements of football can be divided into four elements: technical, tactical, social/psychology and physics. The ideal football player should have good tactical thinking, technical skills, mental strength, social and high physical condition in the team. However, a player can compensate for weaknesses on the other side of the game by doing exceptionally well in some areas (25).

It is the application of a technical skill, which is one of the requirements of football. Decisions made such as passing, ball control, jumps and turns show that it includes both physical and mental elements. Today, football is taught as a subject in the school programs of many countries. It affects the physical and mental development of the individual positively and is seen as an educational tool in personality development. In this sense, the individual technique and coordination that constitute the content of the football game, as well as the tactical work required as a group, are an educational tool that affects the mental, physical and educational health of individuals (26).

In addition to the development of various psychological, mental, physiological, technical and tactical features, the development of motoric features also takes an important place in the game of football. In addition to this, it is known that motoric features such as strength, speed, agility, flexibility, endurance, balance and coordination affect sports efficiency in football studies, which are based on scientific foundations as well as specific (27).

Football is a complex sport with its own unique technique and tactic, where aerobic and anaerobic power is used, muscular and cardiorespiratory factors such as speed, agility, flexibility and balance affect performance, and on the other hand, it incorporates mental features. Versatile players interacting with each other, very fast and frequent movements, short sprints, jumps, hitting the ball, changing direction, marking and unpredictable game examples are typical features of sports such as football (28).

Football is a game based on aerobics, combining short-term anaerobic movements for 90 minutes and ball skill. Speed, which is one of the basic features in determining the result and in one-on-one fights, in order to get to the appropriate position in the narrow field and to reduce players, gains more importance in today's football understanding. It is a matter of curiosity whether the speed is an independent determinant of its effect on technical forms, or how much effect these elements in technical elements have on these forms (29).

### **2.1.2. History of Football in Turkey**

The football match, which was known by different names in every civilization when it emerged, was called “tepek” by the Turks. In the first volume of Kaşgarlı Mahmut's famous work, *Divan-ı Lügati't Türk*, it is written that Turks have played ball games for centuries and how they do sports. The way Turks call football game tepuk comes from the word "beat. In a book called *Timur History*, it is written that Tepuk played among the Turks during the Timurid period. The balls used by the Turks in these games were made by wrapping goat hair or felt on a spindle-shaped lead mass poured into oval shapes in the early periods. The ball changed over time and it was preferred to play the ball with softer objects rather than kicking hard objects (30). The tepuk game was played in the form of scoring points by passing the ball between spears planted opposite each other at regular intervals by hitting them with the foot” (31).

According to many documents that went down in history, it was seen that the Sumerian Turks played ball with their feet (32).

The meeting of the Ottoman Empire with football took place during the reign of Sultan Abdulaziz. During this period, students were sent to Paris, they saw that football was very popular in France, they translated a French book about football into Turkish

and published it in Istanbul in 1869. The title of this book was “Football in the Army and Schools” (33).

Playing football in the country became possible with the westernization of the Ottoman Empire. At that time, the game of football did not develop among Muslim Turks with the influence of some religious beliefs. Football was played on the Ottoman lands for the first time by non-Muslims and foreign nationals settled in the country (30). It was first played in Bornova, Izmir in 1890. “Football Club Smyrna” (Izmir Football Club) was established by the British in 1894. This club also has the distinction of being the first football team in Turkey to be formed with the official football regulations and statutes. With the beginning of playing football in Istanbul as of the 1890s, intercity football matches took place, the first of which was in 1897. This first match, played between the mixed teams of İzmir and İstanbul, was won by the İzmir team 2-1 (34).

On the official website of the Turkish Football Federation, the development of football in our country is described as follows: “The love of football, led by the British living in Istanbul and expanding with the participation of the Greeks, has resulted in the establishment of football clubs one after the other. Kadıköy Football Club, founded jointly by the British and the Greeks, is the first club in Istanbul in this sense. However, as a result of the disagreements, the British established the Moda Football Club, and then the Greeks from Kadıköy followed the British by establishing the Elpis and Imogene clubs. After that, the Istanbul Football League was established in 1903 with the participation of the same teams. The establishment of a football league in Istanbul was the first sign that football would become more widespread in this geography. When the interest of Turkish youth in these newly established teams turned into the idea of “Why don't we form a football team” over time, our first official football team emerged. In 1905, 10th grade students of Mekteb-i Sultani founded Galatasaray under the leadership of their friend Ali Sami Yen. Galatasaray joined the Istanbul League in the 1905-1906 season, and with the first championship it won in 1907-1908, it heralded a completely different beginning for the history of Turkish football. Then, when Fenerbahçe and Beşiktaş followed them, Turkish football started to move towards a new dimension” (33).

Unfortunately, in the last period of the Ottoman Empire, which was faced with the negative consequences of the First World War and the danger of collapse, no sports

industry, including the psychology of war and football, could not be built until the end of the War of Independence. With the victory in the War of Independence, a new era began. Of course, football will begin to take shape in the newly established Republic of Turkey. In fact, Alliance of Turkish Training Societies, which is seen as an administratively effective organizational model for sports by sports history researchers. In 1922, the Republic of Turkey was founded on the modern Olympic philosophy and displayed a suitable vision for sports. Then, TFF was established in 1923 and FIFA membership was approved in the same year (35).

On May 22, 1922, when they united and formed the federal structure of the football club, the Turkish Training Associations (TTA) was established. Ali Sami Yen was appointed as the chairman of the association established for football and this formation pioneered Turkish sports from 1922 to 1936. With the establishment of the Football Federation, the start of the national matches and the establishment of the national league, the nationalization phases were completed (23).

Turkey became a member of FIFA on 21 May 1923 and played its first national match with the Romanian national team on 26 October 1923 and drew. In 1937, away league started to be played with the participation of teams from Istanbul-İzmir and Ankara (34).

With its current name, Süper Lig, the highest classification of Turkish football leagues, or with its sponsorship, Spor Toto Süper Lig was established in 1959 under the name of Milli Lig. In the Super League, 18 teams compete in a season, and the last 3 teams in these teams say goodbye to the league and fall into the lower classification. The Super League, formed by the presence of 18 football clubs and their shareholders, is an organization that starts in August and continues until May, lasting up to nine months in total. In the league, 306 matches are played in 34 weeks, when the competitions are held on weekdays and weekends. Süper Lig is affiliated to the Turkish Football Federation (36).

The general sequence of events that contributed to the development of Turkish football history is listed by Ongan et al as follows (37):

- Kadıköy Football Club (Cadikeuy Football Club) was founded in 1902 by J. Lafontaine and H. Armitage in Istanbul. This event marks the transformation of a football team into a football club.
- With the creation of the English teams Moda Football Club and Elpis and the Greek team Imogen, the number of clubs increased to four. When the number of teams reached 4, the Istanbul Football League was formed, and football matches were held within the league in 1904.
- This became possible with the adoption of the “Law of Associations” within the scope of the official opening of the football clubs and the declaration of the Second Constitutional Monarchy, and many teams (Anadolu, Beykoz, Vefa) were formed in addition to Beşiktaş, Galatasaray and Fenerbahçe.
- Expansion abroad within the framework of football took place in 1911. This year, teams traveled from abroad to Turkey and from Turkey to abroad for the match.
- Karşıyaka Club, one of the İzmir teams, was officially founded in 1912, and Altay Club in 1914. Football matches between schools started in Izmir in 1914 with the participation of English, Greek and Turkish teams.
- Activities are carried out in other provinces in the name of football. Altınörs (later Ankaragücü) was founded in 1910 by students of an art school..
- The city of Trabzon did not remain indifferent to football and many clubs were founded in the 1920s. In 1921, Trabzon İdman Ocağı, İdman Yurdu, Sebat Genç and Birlikspor became Trabzon's newly established clubs.
- In 1922, the Turkish Training Associations Alliance was established. Although this organization is the continuation of previous organizations (Istanbul Football Federation, Istanbul Football Clubs League, Friday League, Sunday League), the organization has moved its sports structure from Istanbul to other cities.
- He became a member of Turkey's International Football Federation on May 21, 1923 and Turkey played the first international match against Romania. The

Alliance of Turkish Sports Associations increased the weight of the state in this field and changed its name to "Turkish Sports Association" in 1936.

- An important turning point in football was the reorganization of the football league, with the official recognition of professionalism in 1951. Professional leagues were established in Istanbul, Ankara and Izmir. While Turkey brought football players and coaches from abroad, footballers came from Turkey to abroad. Turkey competed in the World Cup final in the Asian qualifying group (38).

Donuk and Chenduran described the historical development of the national football team in the 1900s as follows: The international football struggle of the Turkish national team, which started three days before the proclamation of the Republic, was full of failures until the 1950s. The Turkish National Team, which won the right to go to the World Cup for the first time in 1950 and 1954, did not go to the World Cup in Brazil in 1950 due to the distance from Brazil and the fear of failure. The following years continued until the early 1990s with unstable results and one-game victories (39).

As the 2000s approached, the national team led by Şenol Güneş achieved the best success in its history by finishing third in the 2002 World Cup. The national team, which could not participate in the World and European Championships for six years, was eliminated in the semi-finals of the German national team in the 2008 European Championship under the leadership of Fatih Terim and came in second. The national team achieved the most successful result in its 100-year history.

### **2.1.3. Physical Characteristics of Footballers**

Football is a game structure in which thousands of different movements take place and the movements can change quickly one after another. The game consisted of two forty-five-minute phases: basic aerobic structure, speed, strength, continuity and strength continuity, explosive ability, coordination acceleration, agility, quickness; Depending on the nature of the game and the characteristics of the skill of the football, the balance and stability in technique and tactics are repeatedly demonstrated (41). Many training scientists state that the physical condition of the football player is a complex process. Because it is considered as the basis of high success in both female

and male football players (42). The general demands of football are handled as skill, speed, acceleration, agility, quickness and strength (43).

### **Skill**

The player is to be in the right place at the right time on the field of play. It is the ability to use appropriate solutions and the right technique with less effort against the game situations that may occur and vary (44). Hughes (1980) examined skill in football differently in terms of technique and decision making. A football player with high skill decides very quickly what to do in variable situations and can successfully fulfill his decision (45).

### **Speed**

Speed is the ability of an organism to move from one place to another at the highest speed. It is defined as the execution of movements as quickly as possible. Speed is an inherited feature, but it can be developed and brought to the desired level with a correct and conscious training. Speed is the distance traveled per unit time and speed is the distance traveled per unit time (46). Among the specified physical and technical skills, speed and related competencies are the leading features of the football player's performance. Although speed is presented as a very important fitness component for a football player, it should be taken into account which component of speed is effective. Acceleration (ascent velocity) is probably more important in this context. Because, in football, sprints are basically applied in short distance under maximal intensity. However, over longer distances, such as about 40 m, it generally involves a few changes of direction (46).

### **Acceleration**

The rate of change in speed that allows an athlete to reach top speed in the shortest time (47).

### **Agility**

It is the ability to change direction quickly, smoothly and accurately, and it is confused with quickness. In agility, it is aimed to bring the whole or a certain part of the body to the ideal angular value required for the movement to be performed. A stimulus,

situation, event result or position that reveals agility is the ability to quickly coordinate the movements that have been learned or not learned before, from the angular value of the whole organism or a few parts of the organism to the ideal angular value required by the emerging situation. Agility is a motor skill that is developed and trained with the help of some regular exercises (48). Agility is a good distinguishing feature that has an effect on successful performance in football (47).

### **Quickness**

The ability of the body, or a part of the body, to move the joints in the shortest possible time despite external resistance. Agility and quickness determine the quality of all motor behaviors (49). That is, a quick and smooth change of direction, explosive acceleration of the body can be considered as part of speed, agility (50).

### **Strength**

According to Hollmann, strength is the ability of muscles to contract or withstand resistance and the ability to apply force and repeat submaximal efforts at short-term maximal efforts. Strength is the power generation feature of the neuromuscular system. In biomechanics, it is the capacity to do work (51).

The concept of strength in sports sciences has been defined and classified in many areas and in different ways (52). In today's football, it is seen that the physical characteristics and strength of the athletes come to the fore. With the developing football, the football player needs the necessary amount of muscle development in order to display his technical skills rather than being very strong. In addition to technical skill, it is strengthened especially in double fights and shots taken to the goal (53).

### **Endurance**

The endurance of people to dynamic-static loading and fatigue and the duration of this resistance is called endurance (54). Physical endurance means that the player can begin to endure as long as possible, and mental resilience refers to the ability of the whole organism or individual systems to resist fatigue (55).

Endurance is the body's ability to resist fatigue during prolonged exercise and to maintain high-intensity loads for long periods of time (56). Endurance means you can

sustain your workout without getting tired at the workout intensity. Durability is one of the most important performance elements. In general, studies involving long-term or low-intensity training and training practices are related to endurance (57). In general, runs and movements between 400 m and 100 km are considered within the scope of endurance. In other words, resistance is a concept with biomechanical, energy, coordination and psychological dimensions. Accordingly, it is the ability to regenerate quickly after a psychological and physical load and to resist long-term physical and psychological loads that cause fatigue (58).

### **Flexibility**

Distance is a term describing the width of movement or movement mechanism in multiple and single participations (59). The ability to perform movements is largely defined as flexibility and often mobility (60). In order for the players to move on balls moving in different directions and at different speeds, they must have developed but flexible, strong but aesthetic muscles and joints that can perform the desired movements. Flexibility is a prerequisite for good ball handling. (61). Flexibility affects the techniques and coordinative skills of the athletes. Therefore, flexibility training is an indispensable part of the training process (62). In a football game, the athlete may encounter sudden and uncontrollable forces originating from himself, the opponent player or the ball. This may force the joint and surrounding structures into positions (areas of motion) beyond their normal limits. In such cases, injuries may occur in athletes who do not have sufficient flexibility. For this reason, coaches and athletes in many sports branches, including football, believe that maintaining flexibility is an important factor in protecting tendons and muscles from injuries (63).

### **Balance**

Balance is the effort required to keep the body in the desired form during “static and dynamic” activity. Balance is one of the engine components; The vestibular systems emerge through the relationship between vision and hearing, "proprioception and motor systems". A disturbance in the body system, which serves to receive visual stimuli and create a balance system, causes deterioration in the movements performed in coordination between actions. The vestibular apparatus is very important in systems. The shape of the head provides balance in the body system with visual stimuli. Balance

is a term that prevents the whole body from falling to the ground and expresses the vitality of the body. Balance is very important for the human body. Gravity is the absorption of all kinds of forces acting on the body in order to maintain the vitality of the body under the influence of internal and external forces. It is usually the result of a complex event involving actions combined through the coordination of sensory and biomotor components. This is the effect that distributes the athlete's body to the area of contact with the body, where he can resist gravity, internal and external forces (64). These environmental factors combine with the central nervous system in metabolism and determine the most effective muscle response to control body position and body position in the resistance zone (65). In fact, balance is a dynamic process involving various nervous systems (66). It is very important to establish a system of balance, such as a standing and standing position of the body, the surface of the abutment must be kept within controlled limits or controlled movement, as is done while running and walking (67).

#### **2.1.4. Physiological Requirements in Football**

Football is a team sport that includes repetitive high-intensity sprints, jogging and walking and physical-physiological relationship (68). Physical fitness is the individual's ability to work and work. This capacity depends on the individual's quickness, endurance levels, strength and coordination level, and the interplay of all these factors. The factors that create physical fitness in football are aerobic capacity, anaerobic power, strength, speed, flexibility, agility, balance and coordination. For this reason, studies aiming to both improve and increase the physical qualities of the players are carried out and their performances are examined through periodic tests (69).

While some studies evaluate football players individually according to the positions they play, others examine all positions together. With the content of the trainings, it is aimed to develop the physical capacities of the players at the same time. Different methods are used to increase physical capacity. Coaches are required to frequently test players' skill and level (70).

Every sport needs a specific structure that requires unique skills and abilities. Football is a sport that is based on aerobic endurance, requires anaerobic power, can be very strong from time to time, at indefinite intervals, running in different directions,

sudden jumps back and forth, repetitive jumps, double combat and stealing. The effort associated with this type of performance is mainly dependent on the neuromuscular structure of the lower extremity and the power it produces there. The quadriceps muscle plays an important role in hitting and jumping, while the hamstring muscle provides control over running movements (69).

Today's football has become a very demanding game in which players are subjected to many actions such as strength, speed, agility, balance, stability, flexibility and high endurance to meet the demands of the position and position they play. Physiologically, football is a sport in which physical characteristics such as technical and tactical skills, abilities, power, agility and endurance are at the forefront, as well as long-term, variable, variable intensity, very sudden changes in direction (71).

The physiological requirements of the football game require the aerobic, anaerobic, strength, flexibility and quickness capacities of the football players to be at a high level. These physiological requirements vary from athlete to athlete, the position and position played, and the game tactic of the team (72).

The data obtained for studies on physiological factors in football also show that players must have a highly developed physical fitness in order to cope with the physiological requirements of football (for example, aerobic and anaerobic power, muscle strength and agility). Although most of the studies, reports and performance tests on the physical and physiological characteristics of the players are basically self-explanatory, studies over a whole season are needed to get an idea about the factors that determine the success in the game (73).

Players also need to have a well-developed neuromuscular system in order to cope with football-specific activities that have a high level of competitive performance and competitiveness. In addition to the individual neuromuscular performance levels of the players (eg, sprinting and jumping, agility abilities), the physical capacity profile according to the position played during the competition is also important (74). In order for players to perform high-intensity and high-quality movements specific to football movements, it is necessary to develop anaerobic endurance and improve aerobic endurance in order to be able to repeat these movements with the same quality (recovery) without fatigue (75).

Different studies indicate that professional football players show an endurance performance covering 8 to 13 km at an average intensity close to the anaerobic threshold (AT) during competitions. Also, energy expenditure during a competition is between 70-75% of maximum oxygen consumption (VO<sub>2</sub>max), suggesting that this high level of performance can be determined in part by aerobic fitness. The component of aerobic endurance has been extensively evaluated in a laboratory setting applying valid and reliable protocols. In this context, VO<sub>2</sub>max and anaerobic threshold (AT), evaluated by lactate threshold (LT), are two of the most frequently used parameters for monitoring the aerobic fitness of football players in the laboratory (76). Determining the VO<sub>2</sub>max of football players is important for the oxygen carrying capacity to strengthen their ability to exercise for 90 minutes and for the high-intensity exercise of the game to recover in a short time (75).

In a football match, professional players run an average of 10 km at a maximum heart rate of 80-90% and at an intensity close to the anaerobic threshold. Explosive elements such as jumping, hitting the ball and running are also included in this resistance formation. Therefore, instead of having a high level on one pitch, players should have adequate opportunities on all football-related pitches(76). Therefore, the player's performance in football depends on his capacity to regularly perform consecutive intense exercises in a repetitive manner. The concept of quality in football is related to the amount and repetition of high-intensity runs performed throughout the game. Players need to do aerobic and anaerobic training to cope with high-intensity activities (77).

Regardless of the past research and studies, and the physiological and functional characteristics of the players are an undeniable topic of interest, it is important for coaches, sports science faculties and researchers to understand how these characteristics change throughout the season, because the football training period and the entire development of the player throughout the season. there may be valuable information to follow (78). It is important for the player and the coach to collect the most detailed data on the performance of the player as soon as possible, to define the short and long-term training programs clearly, to give objective feedback to the player and to motivate the player to train better (79).

It is a type of sport that includes the ability to take the components that can be coordinated by the athlete and the coach, such as technique and tactics, which affect success in the competition, in the most accurate way and to put them into practice (80).

While the energy during the fight in football is realized from oxygen metabolism, the most obvious activities are carried out thanks to oxygen-free metabolism. Oxygen-free energy is the determining factor for better performance of short-distance running, ball grabbing, ascent, etc. This situation is very essential in terms of the result of the competition (81). Oxygen-based exercises, rapid acceleration, short-distance running, sliding intervention, are exercises that require a lot of power, or they contribute to making the components of continuous shooting more efficient during the competition (82). There have been many differences in football compared to the past. This expression can be exemplified as follows:

- Athletes travel a distance of almost ten to twelve kilometers during the competition.
- In football, the competition is played very quickly.
- The number of goals scored per game has increased.
- The time played with the ball and the duration of the ball in play have increased.

All the qualities mentioned are the main differences that occur in modern football. Therefore, the responsibilities imposed on football players and coaches have increased (83). Optimizing the physiological capacity of the person can only be achieved by preparing a good training plan based on scientific methods (84).

As seen in most sports branches, efficiency is provided when technical and motoric abilities are combined in football. On the basis of the work, if technical ability is indispensable, it is present in all sports branches together with football. It is also one of the most basic requirements of sports (85).

Technical capacity requirements vary according to sports branches. In order for an individual's sportive success to climb to higher levels, his technical ability must also be at a high level, and he must follow a sequence. Long-term and technical exercise planning is needed to complete this developmental stage (86).

The basic technical ability is the ability to perform sportive movements at a certain level, accompanied by the materials of the branch applied at the beginner level. Psychomotor development, on the other hand, is the level of psychomotor development at the best level for the stage in which talent development develops at the optimum level after the birth of the individual (87).

Coordination has an important place in the emergence of basic skills in the football branch. Coordination is essential in talent development. For this reason, talent training should be applied together with psychomotor studies. Another necessary element for football player candidates is to be physiologically appropriate (88).

### **2.1.5. Energy Systems in Football**

In team sports, differences such as the position of the athlete in the game and body weight cause the energy needs of the athletes to be different from each other. For example, football is a team sport that requires intermittent high-intensity speed consisting of running, walking, and repetitive movements during the match. Although the average energy requirement for football players is determined as ~3800-4000 kcal/day, the actual requirement varies according to the personal characteristics of the athlete and his position in the game. A player in the midfield is both chasing the ball (9-10 km on average) and defending. The nutrition plan should be prepared individually (89).

Football training is a planned and programmed continuous work aimed at increasing the specific performance level, sometimes gradually decreasing it or maintaining the same level of performance (90).

However, anatomical fitness, physiological strength and conditioning complement the team's cooperation and tactics, as well as exhibit technical skills and abilities, and are an important factor in resisting injuries and injuries. In order to keep up with today's high-tempo football and to be successful, superior structural compatibility and physical strength are required.

Anthropometric features affect the performance of football players. Especially performance; strength formation is closely related to height, body weight, length of arms, legs and other body organs, joint mobility and flexibility levels (91). The stride

length reduces the number of steps in long-legged athletes, allowing them to run faster. Even if height and weight are not an important problem for the body, football players with standard height and normal weight are more successful. The minimum level of fat in football is considered sufficient for a high level of performance. In vertical jumps and sprints, the high fat percentage of football players has a negative effect on their ability to perform these movements, their resistance to fatigue, and superior performance (92).

It is possible to examine the energy systems in football in two groups:

- Aerobic Energy System
- Anaerobic Energy System

### **Aerobic Energy System**

Endurance is a conditioning feature that emerges entirely based on the organism's aerobic energy production. In other words, uninterrupted workouts for more than 3 minutes are developed based entirely on the aerobic energy system as time gets longer. Physiologically, the maximal endurance of the person is called the maximal aerobic capacity of the person. Endurance means being able to continue the activity at a given exercise intensity without muscular fatigue or despite the intensity (93).

According to a different definition, endurance is defined as the ability to resist fatigue. However, some authors define this term in different ways. While Harre defines it as "the ability to resist fatigue in long-term sportive exercises", Schmolinsky describes endurance as performance at a relative level per unit time (94).

Endurance ability plays an important role in almost all types of sports with its various forms, it is very important both in competition power and in the ability to resist the fatigue of long-term dynamic or static work (95).

According to the type of sport, endurance is divided into two (96):

- General Endurance: It is the endurance feature that should be found in every sport and every athlete.

- **Special Endurance:** It is a combined endurance revealed by the technical tactical application required by the sport according to the characteristics of each sport.

Developing resilience depends on a number of factors. These factors are as follows (93):

- Genetic structure
- Training
- Personal training
- Working level
- Type of work
- Working feature
- Training principles
- Ability to adapt to training

Stamina and strength are very important in football players. In this sense, a professional football player should ideally be able to maintain high-intensity activities (sprint, dribbling, passing, jumping, etc.) throughout the match (97). For this reason, endurance training practices in football should be an important part of training programs.

In the literature on professional football players, it is concluded that football players have high aerobic capacity. The level of this aerobic capacity is determined by maximal oxygen uptake ( $VO_{2max}$ ) (98).

It was determined that the football players covered more than 10 km during the match and there was a significant relationship between this distance and  $VO_{2max}$ . In this period, the intensity of the exercise is very close to the lactate threshold rate or 80-90% of the heart rate (25). On the other hand, it is reported that the anaerobic threshold level is highly dependent on  $VO_{2max}$ .  $VO_{2max}$  was determined as 55-68 ml/kg/min in

international level male football players and VO<sub>2</sub>max's were measured above 70 ml/kg/min in individual values. It has been determined that the footballers with high VO<sub>2</sub>max perform the highest number of sprints during the match and decide to direct the game. It has been determined that fatigue in the match worsens the quality of technical and tactical elements and the high lactate accumulation that occurs causes this (98).

A minimum of two units of VO<sub>2</sub>max training per week is required for an increase in VO<sub>2</sub>max. Applications made once a week will be aimed at maintaining VO<sub>2</sub>max. Under theoretical and practical applications, it is predicted that 4x4 minutes of training at 90-95% of the heart rate, with 3-minute intervals (slow jogging-for lactate excretion) will be sufficient for VO<sub>2</sub>max increase in football. It is considered appropriate to carry out VO<sub>2</sub>max tests to be applied to football players in field conditions or on a treadmill.

### **Aerobic Endurance**

Aerobic endurance is the time during which an effort that stimulates the highest possible percentage of VO<sub>2</sub>max can be supported. In other words, it is the capacity to sustain a high percentage of maximal aerobic power for a long time.

In aerobic endurance training, fat metabolism is activated, increasing energy production. With this study, it is aimed to increase the vital capacity by activating the respiratory system due to the economicization of biochemical studies as well as energy metabolism, strengthening of the cardiovascular system (99).

Aerobic endurance, that is, the ability to perform a task for a long time (endurance), can be measured by various exercise tests. The most widely used of these is maximal oxygen use. However, in recent years, various lactate threshold concepts (determined by lactate tests) have been used as criteria of endurance performance, especially of runners and swimmers (100).

Aerobic and anaerobic energy pathways are not completely independent of each other during an exercise (96).

The aerobic system is a more efficient energy system than the anaerobic system in terms of energy production. But in this system, oxygen is important. In low-intensity and long-term work, the aerobic energy system is in the foreground.

As a result of supporting both energy systems with training, an increase is observed in the performances associated with these systems (101).

Improving endurance consists of the following biological functions with the improvement of aerobic capacity (95):

- Safety of energy preparation and improvement of muscle cells
- Confidence for anaerobic performance capability applications in alactasia
- Safety of motoric functions in the skeleton structure
- During and after loading, the organism can recover itself very quickly and return to its original state.
- Reducing the possibility of injury
- Ensuring psychological and psychophysiological functions,
- Tactical discipline
- Technical
- Game understanding,
- Self-check

The higher the aerobic power of the athlete, the higher the anaerobic power, and the later fatigue occurs in the athlete. This interaction explains the significant relationship between speed and VO<sub>2</sub>max (aerobic endurance) (101). Aerobic training can be divided into 3 interrelated areas (95):

#### 1. Back to normal training

2. Aerobic low-intensity training

3. Aerobic high-intensity training

Aerobic exercise, on the other hand, is long-term exercises that exceed 10 minutes, in which most of the energy is provided by aerobic energy metabolism. Aerobic energy metabolism is the system in which the energy required for the organism is obtained by a series of chemical reactions in an oxygenated environment. Therefore, the quality and level of aerobic exercises are closely related to VO<sub>2</sub>max (102).

### **Aerobic Performance**

Performance in many sports is a combination of factors including an individual's health status, training status and genetic ability. Sports scientists can use the information and analyze these factors to provide individual profiles of individual strengths and weaknesses among physiological test participants. This information can form the basis for the development of optimal training strategies (103).

Sportive performance can be defined as the whole of the efforts put forward for success during the fulfillment of an athletic task. In a sense, performance should be seen and evaluated as a whole in a relatively short time during the competition or match, together with the factors affecting the result (104). In this sense, there are various opinions in the literature regarding aerobic endurance, which closely affects sportive performance.

In aerobic endurance, the work done and the energy expended are balanced. Generally, it is the endurance revealed in an adequate oxygen environment without the organism going into oxygen debt. Energy in aerobic endurance is provided by combustion (oxidation) by utilizing oxygen and energy sources. In terms of obtaining aerobic energy, endurance is a type of endurance that is completely based on the aerobic energy production of the organism. In other words, it is developed completely depending on the aerobic energy system, as the time gets longer, in non-stop workouts over a period of 10 minutes. It is the maximum amount of oxygen that a person can use during a work with a maximum load.

In aerobic endurance, the organism provides endurance in an adequate oxygen environment without going into oxygen debt. An example of this is chess. Aerobic

endurance is the most important determinant of performance, especially in long-term training, and at this stage, there is oxidation of energy substances with sufficient oxygen. In this case, if enough oxygen is available for the oxidation of energy-providing substances, aerobic endurance is established (105).

Studies on the concept of aerobic endurance cause the following changes in the body (105):

- Lung capacity is increasing
- The heart is getting stronger
- The number of active capillaries is increasing

The reason for all these changes in the organism is to develop the muscle tissue and to ensure that the energy (glucose and oxygen) required for the muscle tissue to work more goes to the muscle tissue. These formations provide better overall durability.

### **Aerobic Capacity and Maximum Aerobic Power (Maximum Oxygen Consumption-VO<sub>2</sub>max)**

Aerobic capacity is the distribution of blood and O<sub>2</sub> to active muscles by the cardiopulmonary system and the ability of these muscles to use O<sub>2</sub> and energy substrates during maximum physical work. Aerobic capacity is reached by measuring the maximal oxygen use achieved during physical work. VO<sub>2</sub>max is the upper limit of O<sub>2</sub> consumed during exercise requiring a maximal effort and is associated with height, body surface area, lean mass, and various measurements of diameter (106).

For non-athletes, the average oxygen use per minute is 3 to 4 liters. For endurance athletes, 5-6 liters are reported. The amount of oxygen per minute that an individual uses is his aerobic capacity. This score gives useful information about the capacity of the cardiorespiratory system. This value is related to body weight. Larger individuals tend to use more oxygen. To eliminate the effect of body weight, the maximum amount of oxygen is divided by body weight.

With endurance exercises, maximal oxygen use increases with both an increase in arterio-venous O<sub>2</sub> difference and an increase in cardiac output. In both sexes, the

peak value is reached between the ages of 18-20 and  $VO_{2max}$  begins to decrease as muscle mass begins to decrease with age. If the  $VO_{2max}$  is less than 15 ml/kg/min, a disorder is usually considered, whereas  $VO_{2max}$  must be at least 13 ml/kg/min for life to continue (107). Cardiac output, known as the amount of blood pumped by the heart to the periphery per minute, is determined by stroke volume and heart rate (HR). The Fick method, which includes the estimation of the venous  $CO_2$  content by using the rebreathing technique, is used to determine the cardiac output of the person, especially during exercise. At the end of an effective training, cardiac output increases in maximal exercise. While breathing is only a part of aerobic capacity, cardiac output is usually the biggest limiter of aerobic exercise. To do a job, obese people need an increased metabolic rate ( $VO_2$  and  $VCO_2$ ) compared to non-obese people. The increased metabolic rate results in an increase in cardiac output and minute ventilation (VE) at a given job in obese compared to normal weights (108).

Aerobic capacity ( $VO_{2max}$ ) is the maximum amount of oxygen ( $O_2$ ) a person uses per minute. The more  $O_2$  is used in a given unit of time, the more ATP (energy) can be produced. Aerobic capacity can usually be determined by measuring the maximum oxygen consumption capacity ( $VO_{2max}$ ). The improvement in aerobic capacity ( $O_2$  utilization capacity) achieved by training also results in an increase in ATP production. Therefore, there is a difference in  $VO_{2max}$  capacity between a person who trains and a person who does not train; The untrained person has a lower capacity.  $VO_{2max}$  is accepted as the best predictor of endurance (101).

Maximal Oxygen Consumption ( $VO_{2max}$ ), one of the most important physiological criteria of endurance, is considered the best indicator of aerobic endurance. Performance in endurance activities depends on the use of high percentages of  $VO_{2max}$  and  $VO_{2max}$  to be sustained for a long time during exercise.  $VO_{2max}$  refers to the use of  $O_2$ , which reaches a certain maximal level with an increase in workload or active muscle mass participating in exercises and cannot be increased further. Wagner defined  $VO_{2max}$  as the highest amount of oxygen that large muscle groups can consume in dynamic exercises (109).

Generally, aerobic training with regular and gradually increasing weight increases aerobic power ( $VO_{2max}$ ). In addition, the resting heart rate of athletes

decreases with regular exercises. Aerobic power is defined as the uptake, transport and use of oxygen (96).

Performance in endurance type exercises depends on a high energy production per unit time and the continuous production of this energy. Generally VO<sub>2</sub>max is accepted as a determining criterion of aerobic performance capacity in endurance sports.

If endurance is not developed enough, enough oxygen cannot be supplied to the body. Low oxygen uptake causes earlier onset of fatigue and lactic acid production. Tired muscles produce less muscle force than non-fatiguing muscles, and the player is slower (101).

Those with a low body fat percentage have higher VO<sub>2</sub>max. The use of VO<sub>2</sub>max can be improved with training. In order to increase VO<sub>2</sub>max, aerobic exercises such as running, cycling, swimming and similar exercises that work large muscle groups are performed (110).

Aerobic capacity is defined by measuring the highest value of oxygen use (maximal oxygen volume = VO<sub>2</sub>max) that can be reached and measured at a maximum load with a progressively increasing exercise test, applying a predetermined "Exercise Test Protocol". VO<sub>2</sub>max is the best, easily applicable and reliable indicator of aerobic capacity. The VO<sub>2</sub>max measurement test is performed by metabolic analysis of exhaled gases, using predetermined "exercise test protocols" and applying an exercise test with gradually increasing intensity to the person/athlete. VO<sub>2</sub>max measurement is made by two methods (111):

- Measurement with the direct method: It is based on the principle of measuring the oxygen-carbon dioxide amount in the expiratory air with oxygen and carbon dioxide gas analyzers at maximum loading under laboratory conditions. Douglas bags and the "Breath by Breath" method are used.
- Indirect method measurement: Heart rate, load, time, distance etc. with submaximal loading. It is calculated from the parameter change. This method can also be used in field tests with pre-prepared test protocols.

## **Aerobic Endurance in Football**

Considering the distances they run during the match and the movements they perform during the game, the players are asked to perform high-intensity activities at maximum capacity and not to make mistakes in technique and tactics by coping with fatigue. In other words, it is desired that their ability to cope with fatigue is developed in high-intensity activities that may affect the outcome of the game. Although it is the aerobic energy system that contributes to almost all of a competition, many features need to come into play. Football alone is not an endurance sport.

Football is a team game in which short-term very intense activities are interspersed in a game that takes a long time at low speed and intensity. For this reason, in order for elite football players to respond to the physiological demands of the game, their aerobic fitness must be sufficient (112). Although activities of high intensity in football for a few seconds are supported by anaerobic systems, it is known that continuous endurance is supported by aerobic metabolism throughout the duration of the match. Football requires enhanced aerobic endurance. The advanced aerobic endurance of the football player shows that he is trained against fatigue, and that he recovers quickly after a high-intensity position.

Professional football players should ideally prepare themselves for high-intensity movements in all parts of the game. The metabolism of a football player with advanced aerobic endurance does not have as much difficulty as undeveloped players in providing and delivering the oxygen needed by the muscles in competitions and contributing to energy production (113,114).

One of the determinants of aerobic endurance performance in football is the "Lactate Threshold". In soccer, the lactate threshold marks the transition to a high-intensity position. As the intensity and intensity of exercise increases, there is an increase in the level of lactate in the blood. Sports scientists indicate the first serious level of this increase as 2 mmol/L and consider it to be the aerobic threshold (115). A level of 4mmol/L is also considered as the anaerobic threshold. The 4mmol/L level is now defined as a breaking point when lactate begins to increase significantly and anaerobic metabolism begins to strain. In addition, both references are seen as important references for the endurance status of professional football players (116).

One of the most important indicators of aerobic endurance performance in football is VO<sub>2</sub>max, in other words Aerobic Power. It is measured in milliliters of oxygen consumed per minute per kilogram of body weight. The player with the higher VO<sub>2</sub>max level is more effective against his opponent on the field to win a successful result in football.

It wants to be widely known by coaches as it is an indicator of the carrying and utilization capacity of oxygen required for energy production and recovery, VO<sub>2</sub>max, the highest level of oxygen used by the football player's body, in other words the optimal state of the functional limit level of the cardiovascular system or the body during extensive exercise. It is explained as the amount of oxygen that can be used (116,117).

In football, the VO<sub>2</sub>max levels of elite football players are shown as 60-70 ml/kg/min (118). Professional football players whose VO<sub>2</sub>max levels have reached the desired levels have glycogen levels that can produce the energy necessary to perform high-intensity activities during the competition. In this case, he will meet the aerobic power required to win the match in the second half.

It is sensitive to the VO<sub>2</sub>max training regimen, it is thought that the planned revs at 80-95% of the heart rate girl can have a positive effect on the aerobic power of the football player. This positive development directly affects the performance that will determine the outcome of the competition (117).

Players with a good level of aerobic endurance with developed MaxVO<sub>2</sub> capacity will be able to perform well in competitions. On the contrary, players who do not have good stamina will not be able to display their technical skills and tactics at the maximum level (119).

### **Anaerobic Energy System**

This energy system is to meet the energy needs of the body in short-term work as a result of producing energy thanks to the ATP-PC and lactic acid system without oxygen. Therefore, the contribution of each energy system is based on exercise parameters such as time, intensity and rest intervals. Generally, short rest intervals, long-term and low-intensity exercises are based on the glycolytic system. On the other

hand; It is based on exercises with short duration, high intensity and long rest intervals, lactic anaerobic, that is, phosphate system. These energy systems mentioned provide most of the energy needed in anaerobic activities (120).

The ATP-CP system plays a fundamental role as an energy source in sudden ascents and accelerations, diving, weightlifting, jumping, throwing and sudden jumps. The ATP-CP system plays an important role in the sudden reactions of the goalkeepers in football, in their attempts to hit the ball and rise to the head, and in defensive and offensive attempts by making sudden explosive outbursts. This feature is valid for other team sports such as volleyball, basketball and handball. The ATP-CP system is of great importance in sudden dunks, blocks, rollovers, jumps, and throwing the ball (121).

Exercise load or oxygen use ( $VO_2$ ) at the point where there is a second sharp exponential increase following the first nonlinear increase in blood lactic acid level during a progressive exercise is called aerobic - anaerobic threshold or anaerobic threshold, or OBLA (onset of blood lactate accumulation) according to some. They have given. The phase between about 2 and 4 mM LA is called aerobic-anaerobic transition.

### **Anaerobic Performance**

It has been stated that body weight has a positive effect on the development of anaerobic performance and the ratio of fat has a negative effect on the development of anaerobic performance, however, regardless of these variables, the age factor has a positive effect on the development of anaerobic performance (122).

Although anaerobic performance is important for all kinds of sportive activities, its importance increases even more in sports branches such as football, basketball and American football, where anaerobic performance is predominantly used (123).

In studies, it is frequently stated that age, gender, muscle type, muscle mass and muscle cross-sectional area, heredity, training and body composition affect anaerobic performance. In addition to these features, muscle fiber length, leg volume and muscle mass are stated as features that play an important role in the power produced by the muscle in sports branches with anaerobic content (124).

## **Anaerobic Power and Capacity**

Anaerobic power and capacity express the working performance of the organism at the highest possible oxygen borrowing during activity. According to another definition, it is also known as anaerobic energy reserves in the organism. Anaerobic power and capacity differ according to the muscle fiber structure and training level during the exercise of the athlete. On the other hand, it is also considered as the ability of the athlete to convert his energy into power in a certain unit of time. In general, it is the value that appears within the first 5 seconds. In some cases, it can occur in the second 5 seconds (125).

On the other hand, it is defined as the most anaerobic power required for the anaerobic systems (ATP-PC and Lactic Acid) to produce energy.

As stated above, anaerobic power is the situation of converting the existing energy of the athlete into power at a certain time. For example, it is the ability to jump, throw, throw or make sudden movements (125).

Anaerobic power and capacity is a power source used in many sports and positively affects performance in sports activities. For example, as stated above, the organism needs anaerobic power in sudden exits. However, aerobic power and capacity are very important factors in exercises that require 3 minutes or longer. In addition, determining the aerobic power and capacity of the organism allows shaping the training program, following the changes that occur as a result of the training applied, and evaluating these changes, as well as comparing the athletes that make up the team (126).

## **Anaerobic Endurance in Football**

Anaerobic training consists of sprint training, sustained sprint training, which can then be divided into development training and maintenance training.

Speed in football is not only dependent on physical fitness, but also involves quick decision making, which should have translated into quick action later on. Therefore, the purpose of speed training also improves a player's ability to perceive, evaluate and act quickly in match conditions where speed is required. To get this effect, speed training should basically be done with the ball. Continuity training in sprint increases the muscle's ability to generate power quickly and improves the muscle's

capacity to maintain a high power output. This type of training can enable a player to exercise at high intensity more frequently and for longer periods of time. This ability is especially important for high-level players (25).

## **2.2. Functional Movement**

### **2.2.1. Definition of Functional Movement**

Functional movements play an important role throughout each person's life and contribute to our full development. It is influenced by the development of the musculoskeletal, nervous and cardiopulmonary systems and is defined as the ability to move changes throughout life (127).

### **2.2.2. Functional Movement Screening (FMS)**

Functional Movement Screening (FMS) is a comprehensive term that evaluates the quality of basic movement patterns to identify an individual's limitations or asymmetries. A basic movement pattern is a basic movement used to simultaneously test range of motion, stability, and balance (128). When used together, observation of movement and performance tests create a more complete evaluation perspective than they can provide alone (129).

Functional movement screening requires muscle strength, flexibility, range of motion, coordination, balance, and proprioception to successfully complete the seven basic movement patterns. Participants in the study are scored between 0 and 3 points for each of the seven movement patterns. Three points is considered normal. The scores from the seven movement models are added together and a composite score is obtained (130). The FMS identifies movement problems in a rating and ranking system and determines what is and isn't acceptable before recommending remedies or fixes (129).

As FMS is related to exercise, sport and increased activity, it offers different approaches such as screening for movement risk, injury prevention and performance predictability. When used as part of a comprehensive assessment, FMS leads to personalized, specific, functional recommendations for physical fitness protocols in athletic and active individuals (128).

Composite scores obtained with FMS provide useful information to predict some injuries (131). Movement scanning tools are widely used in fitness, professional sports, and as methods of assessing participants to identify susceptibility to injuries or underlying weaknesses (132).

The FMS was designed to assess quality of movement (functional movement) and to determine susceptibility to injury by assigning a score to describe global mobility competence (128). The main purpose of pre-season FMS tests is to reduce the risk factors that may cause injuries, prevent the recurrence of injuries, increase performance and improve quality of life (133).

The moves in this test are Deep Squat, High Stepping, Single Line lunge, Shoulder Mobility, Active Straight Leg Raise, Trunk Stability Pushup, Rotation Stability.

### **Deep Squat**

It is a basic movement pattern required for numerous activities of daily life such as deep squatting, sitting, lifting, and many sportive activities (134). The deep squat is part of many functional movements. The deep squat movement demonstrates fully coordinated limb mobility and core stability. Hips and shoulders should be in symmetrical positions. Mobility and core stability are important in the test. Tests the reciprocal mobility of the ankle, hip and knee. The stick is held in a standing position with the shoulders in abduction, flexion and elbows in full extension. If the athlete can perform the movement without any compensation, deserves three points. If athlete does not get a three, asked to squat again with support under the heel. If the athlete does, gets two, if doesn't, gets one. In modern daily life, although full deep squats are not usually necessary for general exercise and sports movements, active individuals still need the basic components for deep squatting (129).

### **Hurdle Step**

It requires single-leg stance stability in addition to proper coordination and stability between the hips and trunk during the high-stepping motion. Bilateral functional mobility and stability of the high-stepping hips, knees, and ankles are assessed (128). For this test, the participant aligns their feet with their toes to touch the

base of the obstacle, and the obstacle height is adjusted by measuring the length of the tibia. The stick will be placed just below the neck, facing the shoulders. The participant is asked to walk slowly over the obstacle while the stance foot is extended and the participant to touch the ground with his/her heel. The movable leg is then returned to the starting position (135).

### **In Line Lunge**

The length of the patient's tibia is measured from the floor to the tibial tuberosity. The participant is then instructed to place the tip of the heel of the foot at the end of the board. Using the length of the tibia, a mark is made on the board from the tip of the participant's toes. The stick is held back in contact with the head, thoracic spine and coccyx. The hand opposite the front foot grasps the stick at the nape of the neck, and the other hand grasps the stick at the waist. The participant then places the heel of the other foot on the measured mark on the board and the back knee is lowered enough to touch the board behind the heel of the front foot. Three points are awarded for a successfully completed repetition, two points for a compromised movement, and one point for deficiency and loss of balance (135).

### **Shoulder Mobility**

This movement includes adduction, abduction, internal rotation and external rotation of both shoulders. After measuring the distance between the fist and the back, fist distance and shoulder mobility are examined according to the length of the palm (136).

The participant's hand is first measured from the wrist to the tip of the middle finger. The participant is then asked to make a fist with both hands. The participant is asked to assume a maximally extended and internally rotated position with one shoulder and a maximally bent and externally rotated position with the other shoulder. The distance between the two fists on the back is measured at the nearest point. Three points are awarded if the fists are one hand long, two if the fists are one and a half hands long, and one point if the fists go beyond this length (135).

### **Active Straight Leg Raise**

The starting position for active straight leg raise requires the participant to lie on their back with their arms in an anatomical position and their head flat on the floor. The kit is placed under the knees and the midpoint of the anterior superior iliac spine and patella is determined. Using these two marks, a midpoint is found on the thigh. The stick is placed perpendicular to the ground. The participant raises the test foot with a dorsiflexed ankle and extended knee while keeping one knee in contact with the board. If the ankle lateral bone of the raised leg extends beyond the club, three points are awarded. If it lags behind, the stick is brought to the level of the kneecap and if it passes the stick while the foot bone is like this, one point is given if it cannot exceed two points (135).

### **Trunk Stability Push-Up**

Push-ups are a widely used exercise to assess upper body function and strength (137).

In the trunk stability push-up, the participant takes a prone position with their feet. Then, the hands are placed shoulder-width apart in the appropriate position according to the application criteria. The knees are then fully extended and the ankles dorsiflexed. The person is asked to do a push-up in this position. The body is lifted as a whole. There should be no "lag" in the spine when doing this push-up. If the person cannot do push-ups in this position, the hands are lowered to the appropriate position according to the determined criteria (128).

### **Rotary Stability**

Rotatory stability is a complex movement that requires proper neuromuscular coordination and is the transfer of energy from one part of the body to another part of the body through the trunk. Rotation stability assesses multi-plane trunk stability during a combined upper and lower extremity movement (128).

In rotational stability, he moves to the quadrupedal position with the FMS kit between his hands and knees. The plank should be parallel to the spine, the shoulders and hips should be at 90 degrees to the torso, the ankles should be neutral, and the soles of the feet should be perpendicular to the floor. Before the movement begins, the hands,

thumbs, knees and feet should be open to touch the board. The individual should flex the shoulder while extending the same hip and knee, and then bring the elbow to the knee while staying level with the board. Spinal flexion is allowed while the participant brings the knee and elbow together. The movement is performed bilaterally (129).

### **2.3. Injuries in Football**

The term sports injuries cover the situations that occur when the strength of the tissue or tissues is exceeded, as a result of the whole body or a part of it being met with an abnormal force. Classical sports injury occurs with the effect of certain techniques and tools, depending on certain types of sports. Many different injuries can be encountered during sports activities (138).

Sports injuries are the damages that occur as a result of the damages caused by traumas in the body (139). Sports injuries are no different from other injuries, they only require the athlete to take a break from training and competitions. Since the athlete will experience many physical and psychological losses during the injury process, he wants to recover as soon as possible and return to training again. Minimizing this passing process requires a well-programmed treatment and rehabilitation program (140).

Sports injuries are injuries that occur in our body during sports. In other words, they are situations that occur as a result of exceeding the endurance limits as a result of our body encountering more resistance than normal (141). Exercise-induced damage to our bodies can occur for many reasons. Various factors need to be examined in detail to determine the severity of a sports injury.

As a result of the researches made among the most injured sports, football ranks first with 10%, and wrestling takes the second place with 6%. Afterwards, handball and boxing continue with 3%, athletics 1% and skiing 0.5% (142). In wrestling matches with severe injuries, athletes use intense power to dominate their opponents. In this process, it is seen that the resistance of the athletes to each other increases the risk of injury and causes damage to various parts of the body (143).

Proper diagnosis and treatment are essential to minimize sports injuries and restore the athlete's health as quickly as possible. Athletes who regain their health can be successful in sports once again (144).

### **2.3.1. Factors Causing Injury**

In sportive activity, athletes perform their activities under certain risks. While some of these risks negatively affect the performance of the athletes, some of them cause sports injuries and injuries. There are many factors that facilitate the formation of these, which athletes do not pay attention to. These are as follows (145,146);

- Living an irregular private life
- Excess fatigue and overload
- Insufficient rest after training and match
- Presence of past injuries and lack of treatment
- Inadequate and unbalanced nutrition.

Many athletes or non-athletes think that injuries are due to physical conditions, and this approach is generally correct. However, many physical, social, psychological, personal, stress and environmental factors are effective in the formation of injury (147).

Physiologically, there are differences between men and women in terms of exercise compliance and the level of performance achieved. Women experience fewer injuries than men due to their higher body fat ratio, low oxygen capacity, greater flexibility, less sweating and not pushing their physiological limits too much (148).

The age of the athlete carries risks that vary according to the sport he is doing. Since the epiphyseal plates in the bones of the athlete, who are in the age of growth and development, do not ossify, the growth of the individual continues. Unconscious weight lifting exercises or contact sports at this age affect the individual negatively. Being young will reduce the risk of injury in non-contact sports and conscious activities (148).

Joint instability is when the joint becomes open to non-physiological movements and is exposed to repeated traumas as a result of elongation in the ligaments and joint

capsule (149). It is seen that joint problems, especially in the knee region, contribute to injury (150).

The weakness of the muscles, which are one of the parts of the musculoskeletal system, the loss of agonist antagonist muscle power balance (151) and the deterioration of muscle elasticity (152) negatively affect the risk of injury and performance of the individual (148).

The level of motivation determines the behavior of a person to survive in the biological and social environment in which he lives. The motivation needed in sports provides a biological contribution with the application of training programs that will contribute to physical development, and a social contribution thanks to the athlete's desire to gain economic income and status. Insufficient or excessive motivation is a factor in sports injuries. The person becomes vulnerable to injury due to a reluctant and reckless attitude in lack of motivation, and not paying attention to risks in excessive motivation (153).

Social factors are among the main causes of sports injuries. The desire of the athletes to continue the competition in the presence of pain, fatigue or injury triggers injuries. It can be thought that the environment created by the social environment, colleagues or managers responsible for the athlete triggers this (154).

Considering the intensity of the played matches, the increase in the number of matches played per week increases the frequency of injury (155). Increasing the rest period between the matches in the increasing number of matches reduces the risk of injuries other than acute injuries (156). The reasons such as loss of smoothness of the ground on the field where the competition is played, being wet or frozen, presence of foreign materials on it, lighting and bad weather conditions increase the risk of injury (148).

All of the health problems that occur within the scope of sports activities are considered as athlete's injuries. In order for a health problem to be included in the scope of sports injury, the following must be present; If it is not possible to participate in sports activities within the day following the occurrence of the said problem, this is considered as a sports injury. There are many factors that cause the formation of a

sports injury. It is possible to evaluate these factors under the subtitles of internal and external factors (157).

### **Intrinsic Factors**

In addition to injuries caused by external causes during sports, injuries caused by athletes are considered sports injuries. Injuries related to this activity can occur for many reasons (142).

Women can use less oxygen than men. Body fat percentage is higher in women than in men. Men's joints and ligaments are thicker than women's. This delicacy makes women more flexible than men. Women lose less water due to perspiration than men. As you can see, due to these differences between men and women, there are differences in the ability to adapt to sports and reach the desired level. Because of these differences, men can push themselves harder than women when it comes to asserting themselves. Therefore, men are more likely to get sports injuries. The age of a person who plays sports is important depending on the type of sport. Since the elongation zones of the bones are not fully developed in athletes in the developing age, growth continues. These athletes can negatively affect their development as a result of unconscious exercises (148).

If the disparity between the two leg lengths exceeds 20 mm, it causes a biomechanical disturbance. This prevents the rotation and adductors of the thigh from performing their duties. These problems cause injury, trauma and poor performance for the athlete (158).

Athletes must have flexibility that varies according to the sport they are involved in. If the muscles do not have this elasticity, sports injuries are inevitable. Muscle stiffness causes a decrease in performance (148).

Defects in the athlete's body bring him closer to exposure to sports injuries and injuries. Muscular and bone structure defects, posture defects negatively affect the performance of the athlete and increase the risk of injury or injury (148).

In order to perform a physical activity in a healthy way, the muscular systems must have a certain level of flexibility. The lack of flexibility in question brings with it the risk of injury. So much so that muscle stiffness is among the causes of muscle

injuries. For example; tendonitis and patello femoral problems in the hamstring stiffness group; Achilles tendinitis (inflammation of the tendons that attach the muscles to the bones) in the upper triceps muscle can occur when the iliotibial band creep syndrome is stiff. At the same time, flexibility deficiencies negatively affect the performance of athletes (148).

The reasons underlying the actions that individuals exhibit in order to maintain their existence in the biological and sociological environment they are in constitute the motivation elements. At this stage, it is possible to evaluate motivation on two separate factors. These; social motivation and biological motivation. Within the scope of sports activities, individuals trying to improve themselves physically is considered as a biological motivation source. Athletes' search for a certain income within the scope of sports activities and their desire to achieve social position are expressed as sociological motivation sources (157). An athlete may face the risk of injury due to low or very high motivation. Due to the low motivation of the athletes, reluctant behaviors and reckless behaviors increase the risk of injury. This situation is referred to as "start laziness". The fact that the athletes are highly motivated is expressed as "start rush".

An athlete, who is motivated above what he should be, can take much more risks within the scope of the competition, does not protect himself and may be injured as a result (159).

### **Extrinsic Factors**

According to the nature of the sport branch and type, contact and fighting styles, risk taking time, the situation of teammates and opponents play an active role in injury (134). In terms of human health, exercise is associated with asthma and shortness of breath. It is known that exercise triggers bronchial spasm and shortness of breath in many people, and this is more common especially in elite athletes (160).

To give an example from some sports branches, basketball is played with a ball of certain weights according to its categories. Depending on the speed of the ball and the way it comes, dislocations and connective tissue injuries can be seen due to the excessive bending of the fingers at various levels due to the ball hitting the ball in passing for the positions in the game. Again, due to the nature of the branch, sudden stops and turns, falls after jumping, and intense body movements while the foot is

stationary can cause an increase in the risk of injury in the relevant regions as a result of strain on the knees (159).

The most obvious injuries specific to the volleyball branch are ankle sprains, shoulder and knee injuries, leg cramps, the opponent's foot after the block, the damage to the connective tissues and joint capsule as a result of the ball hitting the fingers, but rarely, injuries such as finger bone and cartilage ruptures (159).

Football is one of the sports with the most injuries. Injuries related to the opponent, the floor and the ball are seen. At the beginning of the branch-specific injuries, sprains, muscle strains, crushes, fractures, meniscus, internal-external lateral ligament and cruciate ligament injuries in the knee are frequently seen in the lower extremity region. In goalkeepers, finger and arm dislocations and fractures are most common in the upper extremity region. They are also faced with injuries such as shoulder dislocations, facial injuries, concussions and hemorrhage, and internal organ ruptures. While 48% of injuries are caused by double combat and 29% by falling, 79% of these injuries are seen in competitions and 21% in training (159).

Injuries in swimming generally occur as a result of jumping into the water and colliding with other athletes. Chronic injuries, on the other hand, result from overloading and incorrect techniques. For example, pain and limitation of movement are seen in breaststroke style due to groin strain and meniscus injury with special movement of the legs, back strain in butterfly style, and swimmer's shoulder in freestyle. Again, injury and health problems such as concussion due to slipping and falling due to the floor, eye infections due to chlorine, ear infections and fungal infections also appear as branch-specific conditions (159).

Asthma, which triggers the increase of undesirable and problematic crises in many types of sports, shows some differences in swimming. To summarize, it has been reported that bronchial spasm, crisis and severity triggered by exercise are less common in swimming, it is beneficial by increasing the capacity of the heart and respiratory system in children and reduces the severity of symptoms, and it can be effective in non-drug treatment. However, in some studies on elite athletes, it is thought that asthma is more common in swimmers, and this may be due to the fact that asthmatics prefer this branch more. Again, although it is thought that chlorine gas in pools will trigger asthma

and bronchial spasm with exercise in allergic and asthmatic athletes, it is thought that exposure to pool chlorine in childhood may cause asthma in the initial stage (160).

The main motif of the athletics branch is running. Running injuries are often caused by overuse and biomechanical defects. Athletics branch is grouped under three main branches as running (short, middle, long distance and hurdles), jumping (long, triple, high and pole vault), throwing (shot, javelin, hammer, discus throw). Considering these branches, middle and long distance runners usually have tendon problems, stress fractures, bone pain and tenderness in the tendon and bone membrane (periosteum), and heat stroke in long-distance runners. Short-distance runners, on the other hand, have more muscle tears. Muscle tears in long jump, tension in the back muscles in hurdles, strain on the neck, heel crushes, sprains and meniscus injuries in long and triple jumps, muscle and ligament tears in the shoulder region in pole vault, low back problems, knee pain and heel crush are seen. Breaking the jumping stick can also cause serious injury. In throws, arm muscle injuries, pain in the inner part of the elbow, arm bone fractures in hammer throw, and rupture fractures in the spine protrusions are also seen (159).

Competition times in sports branches were determined according to the energy use of the organism and the characteristics of the branch. The branches that require aerobic energy are long-term, while in speed sports where anaerobic energy is used, the times are limited to seconds and minutes. The longer the competition and the longer the race, the higher the risk of injury. For these reasons, training intensity is more intense and longer-lasting than competitions. Accordingly, when looking at all sports branches in general, 7% are seen during competitions and 29% are seen during training (159).

The game rules are the rules that determine the duration of the game according to the characteristics of the sports branch, how many people are played, approved by the relevant organizations and for which the relevant parties are responsible. The main purpose of the referee and the rules of the game is to ensure that the athlete performs well, to prevent the athlete, opponent and spectators from being harmed, and to provide viewing satisfaction by keeping the viewing pleasure and excitement at a high level (159). Allowing the referees to set the set will increase the risk of injury (139).

Since factors such as temperature, humidity, wind, altitude, air pollution affect the health of athletes, climatic and environmental conditions are included in the rules of

the game in sports branches (159). Competition should not be held in environments where the environment is very hot and accompanied by excessive humidity. The organizers should pay attention to this. Heat stroke due to heat and humidity can be fatal. In cold weather, especially with the effect of the wind, body temperature will drop, so undesirable situations and injuries can be encountered. Another point is that a good planning should be done considering the geographical features of the place where the competition will be held and the time difference between the place where the competition will be held, and the geographical differences will change the physiological characteristics (139).

The human body, like all systems, produces energy by consuming fuel. However, as it cannot use 100% of this energy, all the energy cannot be converted into work. Some of it is used for heating the tissues. This undesirable heating is reduced by contact and evaporation (thermoregulation). The body also loses heat with the infrared radiation it emits. These are controlled by the clothes used. Again, heat loss is experienced by the evaporation of water in the body from the lungs through the skin and respiration. Excess energy produced in an extremely hot environment and with exercise comes into play for heat loss. In order for the water in the body to pass from the lungs and skin to the air, the humidity in the air must be low. As the humidity in the air increases, the evaporation rate decreases, which makes heat loss more difficult. All these events are controlled from a region of the brain located in the hypothalamus. This area is also called the hypothalamic thermostat. All systems will force the body to lose heat due to exercise in an extremely hot environment, and if there is not enough water intake, the body will become dehydrated and increase in body temperature. The humidity in the environment also affects this situation. In cold environments, since a part of the energy source will be used to heat the body, since it will cause the body to lose heat, all these situations can lead to injury as they will adversely affect the performance and the health of the athlete unless precautions are taken (160).

Sport is a collaborative and disciplined style of play based on competition and competition, formed by warrior forces. Although sportive activities have emerged with military and religious rituals, they have gained a new dimension with concepts such as peace, brotherhood and common humanity values. Whatever the causes of violence in sports, although it includes psychological and socio-economic reasons, it has become a

necessity to prevent this trend with continuous training and safety measures developed in accordance with today's sports understanding. At the Munich Olympics (1972), the first act of political violence was committed against athletes, and many athletes lost their lives in the rescue of Israeli athletes taken hostage by Arab guerrillas. The war between El-Salvador and Honduras started with the events of a football match played in 1974. Again in 1985, as a result of the events in the Heysel stadium by British hooligans, 38 people lost their lives (159).

Since these and similar events mentioned above affect some, if not the majority, of the masses, measures that impose sanctions are taken and continue to be taken by the relevant organizations so that the sport does not go beyond its purpose. It should not be forgotten that sports are common human values in order to reinforce peace and brotherhood in today's understanding of non-violence.

### **2.3.2. Injury Types in Football**

Injuries affect not only the player's performance and participation in the game, but also the success of teams and clubs due to long recovery intervals. Most of the injuries are due to trauma; 9-34% are injuries from overuse. 12-28% of injuries are foul injuries caused by contact. Non-contact injuries constitute a rate ranging from 26 to 59%. Non-contact injuries are usually seen during running and turning. Approximately 20-25% of injuries are recurrent injuries of the same type and in the same location (161). The incidence of injury in professional football ranges from 2.48 (162) to 9.4 (163) injuries per thousand hours of observation. Extrand et al (162) reported that 53% of 2098 muscle injuries occurred during competition and 47% during training. The most common types of injuries are strains, sprains and crushes. The most frequently injured extremity is the thigh. The hamstrings are the most affected muscles. However, quadriceps injuries cause being away from the field for longer than hamstring injuries. Other frequently injured areas are the groin, knees and ankles. Fractures account for a very small proportion of total injuries, but many fractures fall into the category of serious injury.

Injuries in football can be listed as follows:

- Head and Neck Injuries

- Nose injuries
- Nosebleeds
- Lacerations (tears)
- Nose fractures
- Shoulder Injuries
- Rotator Cuff Inflammation
- Impingement Syndrome
- Elbow Injuries
- Back Injuries
- Knee Injuries
- Thigh Injuries
- Muscle Injuries
- Tendon Injuries
- Groin Injuries
- Foot and Ankle Injuries

### **3. MATERIAL AND METHOD**

#### **3.1. Participants**

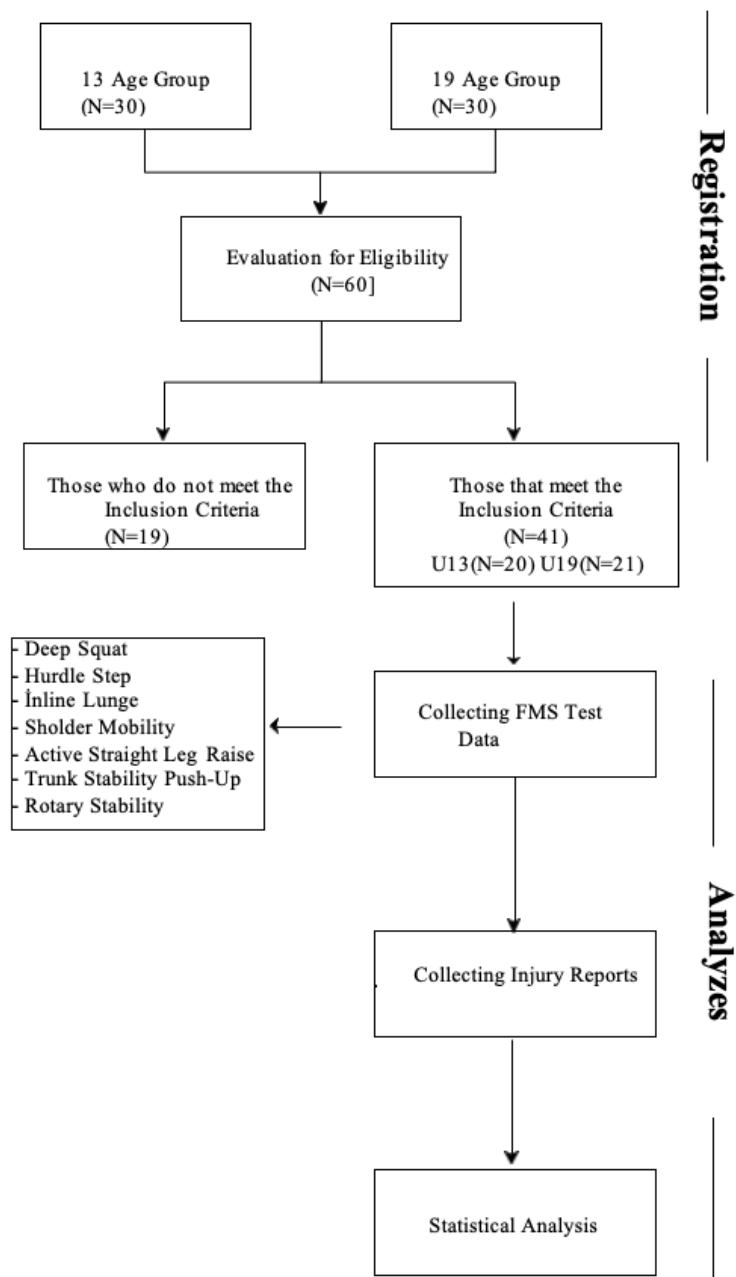
The sample of the study consists with the retrospective data of the elite male football player candidates playing in the Galatasaray Sports Club U19 and U13 groups in the 2018-2019 football season. A total of 41 elite candidate football players were included in the study. The ages of the participants were between 13-20 and the mean age was  $15.95 \pm 2.85$ . Before the study, each of the participants was given detailed information about the study and signed the Informed Voluntary Consent Form and Parent Permission Document (Appendix 1). Written permission was obtained from Yeditepe University Ethics Committee for the study (Appendix 2). Before the start of the football season, the players' Functional Movement Screen scores and lower extremity injuries (lower extremity muscle injuries, ankle injuries, knee injuries, tendon injuries...) that they have experienced during the season and training was prepared as a report.

#### **Inclusion Criteria**

- To play football on the 2018-2019 football season in Galatasaray Football Academy,
- Not having any lower extremity sports injury within the last 1 year. Injury risk was determined by the injury follow-up form. (Appendix 3)
- To be an elite candidate athlete,
- Being male,
- Volunteering for research.

#### **Exclusion Criteria**

- Having had any lower extremity sports injury within the last 1 year.
- Contact injury presence



**Figure 3. 1.** Flowchart

## **3.2. Data Collection Tools**

### **3.2.1. Height and Weight Measurement**

The heights of the football player candidates participating in the study were measured with a stadiometer device measuring with 0.1 cm precision in the anatomical stance position, with bare feet, the heels of the feet together, the head in the frontal plane, the headboard in contact with the vertex. The body weights of the participants in the study were measured with a body analysis system (Tanita BC-418 Segmental, Tokyo, Japan) measuring with an accuracy of 0.1 kg, while standing in the anatomical position with bare feet.

### **3.2.2. Functional Movement Screening Test (FMS)**

The Functional Movement Screening test was determined by using the Functional Movement Screening Test battery developed by Gray Cook in 1997. The movements in the applied test are, respectively, deep squat, hurdle step, in-line lunge, shoulder mobility, active straight leg raise, trunk stability push-up, rotary stability. Measurements were made by considering the basal state of the body without warming up the participants. Participants were informed about the test before the measurements began, and then demonstrated as a practice. Each movement was repeated three times during the application of the test. Participants were asked to report any pain or discomfort that may occur during the implementation of the movements to the measurement specialist.

The FMS assessment was done as follows:

- The movements (deep squat, push-up test), which were evaluated unilaterally by taking the test first, were measured.
- Tests measured on both sides (hurdle step, in line lunge, shoulder mobility, active straight leg raise and rotary stability) were scored separately as right and left.
- During scoring, the scores of the participants' bodies from both sides were recorded. However, the lowest score obtained from the movement was accepted as the test result. For example, in shoulder mobility, the

score of the athlete with a left shoulder score of 1 and a right shoulder score of 2 was recorded as 1.

- This rule was applied for two-sided movements. Each test is given a score between 0 and 3 in itself. The highest FMS test score is 21. It is known that participants with a FMS total score below 14 points have a higher risk of injury than those with a total FMS score above 14 points. The test values of each participant were recorded separately in the FMS scoring table (Appendix 4).

**Deep Squat:** In the squat movement, participants were asked to flex their hips, dorsiflex their ankles, and flex their knees for deep squatting. While performing the deep squat correctly, the middle region was stable and movement was observed in the symmetrical position of the hips and shoulders (Figure 3.2)



**Figure 3. 2. Deep squat**

**Hurdle Step:** With an asymmetrical fit that divides the body into two, the participants were asked to put their feet on the obstacle and bring their feet to the starting position by touching the heel to the ground without losing their balance. Tibia length was measured and injury step was made according to this evaluation (Figure 3.3).



**Figure 3. 3. Hurdle step**

In Line Lunge: Participants were instructed to place the tip of the heel of the foot at the end of the board. A mark was made on the board from the tip of the participant's toes using the length of the tibia. The rod was kept in contact with the head, thoracic spine and coccyx. The hand opposite the front foot was asked to grasp the stick at the nape of the neck and the other hand to grasp the stick at the waist. The participant was then asked to place the heel of the other foot on the measured marks on the board and lower the back knee until the heel of the front foot touched the board behind it (Figure 3.4).



**Figure 3. 4. In Line Lunge**

Shoulder Mobility: The participant's hand was first measured from the wrist to the middle fingertip. The participant was then asked to make a fist with both hands. The participant was asked to take a position with one shoulder maximally extended and turned inward, and the other shoulder maximally bent, externally rotated. The distance between the two fists on the back was measured from the nearest point.



**Figure 3. 5. Shoulder Mobility**

Active Straight Leg Raise: The participant was asked to lie on his back with his arms in an anatomical position and his head flat on the ground. The FMS kit was placed under the knees and the midpoint of the anterior superior iliac spine and patella were determined. Using these two marks, keep a midpoint on the thigh. The stick was placed perpendicular to the ground. The participant was asked to raise the test foot with the ankle dorsiflexed and the knee extended while keeping one knee in contact with the board assessment. (Figure 3.6).



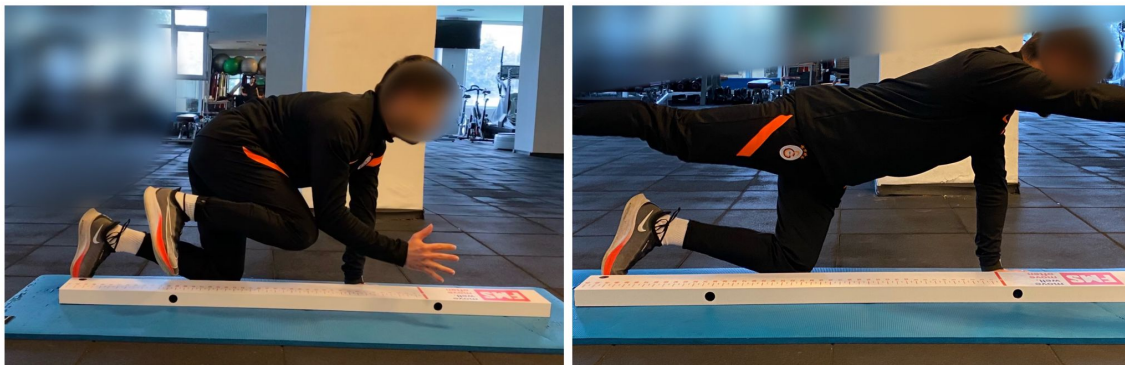
**Figure 3. 6. Active Straight Leg Raise**

Trunk Stability Push-Up: The participant was asked to take a prone position with their feet. Then, the hands were placed in a suitable position at shoulder width apart from each other according to the application criteria of the movement. Then the knees were fully extended and the ankles were dorsiflexed. The participant was asked to do push-ups in this position. The body was asked to be lifted as a whole. While doing this push-up, attention was paid to avoid any delay in the spine (Figure 3.7).



**Figure 3. 7. Trunk Stability Push-Up**

Rotary Stability: The participant was asked to take a quadrupedal position with one hand between the knees with the FMS kit. The FMS kit was placed parallel to the spine. Shoulders and hips are set at 90 degrees to the body, ankles are neutral, and soles are perpendicular to the floor. Before starting the movement, attention was paid that the hands, thumbs, knees and feet were open to touch the board. The participant was asked to flex his shoulder while extending the same hip and knee, and then to bring his elbow to the knee while standing straight on the board. Spinal flexion was allowed while the participant brought the knee and elbow together. The movement was performed bilaterally (Fig. 3.8).



**Figure 3. 8. Rotatory Stability**

### **3.2.3. Detection of Injury Risk**

Due to the differences in definitions and methodologies significant differences in results and discussions were seen in studies conducted on sports injury.

For this reason, after disagreements at the 1st World Sports Injury Prevention Congress held in Oslo in June 2005, the FIFA Medical Evaluation and Research Center (Federation Internationale de Football Association) adopted a nominal group consensus model approach. As a result, an appropriate football player injury follow-up form was created. In our study, the Injury Follow-up Form was used to determine the injury risk of football players (Appendix 3). In this form, the participant's injury was followed up for 1 season. The form was used by using questions such as in injured body part, when did the injury occur, the type of injury, causes of the injury and is the injury a recurrence.

### **3.3. Statistical Analysis**

The data obtained from the study were analyzed with the SPSS 21.0 Package Program. Mean and standard deviation values were given as descriptive statistics. Whether the data fit the normal distribution was analyzed with the Shapiro Wilk test. Spearman's correlation analysis was used to determine the correlation between continuous variables. The Mann Whitney U test was used to determine whether there was a difference between the injured and non-injured players in terms of FMS scores. Obtained results were evaluated at 95% ( $p < 0.05$ ) significance level.

#### 4. RESULTS

The mean height of U13 football players was  $158.30 \pm 9.71$  cm, body weight was  $45.75 \pm 7.04$  kg, and BMI was  $18.15 \pm 1.13$  kg/m<sup>2</sup> (Table 4.1). The mean height of U19 football players was  $178.04 \pm 6.72$  cm, body weight was  $70.19 \pm 7.01$  kg, and BMI was  $22.11 \pm 1.45$  kg/m<sup>2</sup> (Table 4.1).

**Table 4. 1.** Height, weight and BMI values of U13 and U19 football players

	Group	N	Mean	Std. Deviation
Height	U13	20	158,30	9,71
	U19	21	178,04	6,72
Weight	U13	20	45,75	7,04
	U19	21	70,19	7,01
BMI	U13	20	18,15	1,13
	U19	21	22,11	1,45

While 12 (60%) of the U13 football players had been injured before, 8 of them did not. 12 (57.1%) of the U19 football players had been injured before, 9 of them (42.9%) did not (Table 4.2).

**Table 4. 2.** Distribution of U13 and U19 players by injury status

			Injury		Total
			Yes	No	
Group	U13	n	12	8	20
		%	60,0	40,0	100,0
	U19	n	12	9	21
		%	57.1	42.9	100,0

The FMS test results of the participants are presented in (Table 4.3). Considering the average FMS score, it can be said that the participants have a risk of injury.

**Table 4. 3.** FMS test results of the participants

	N	Mean	Std. Deviation
Deep Squat	41	1,75	0,53
Hurdle Step	41	2,09	0,49
Inline Lunge	41	2,39	0,54
Shoulder Mobility	41	2,65	0,48
Active Straight Leg Rise	41	1,97	0,82
Trunk Stability Pushup	41	2,48	0,55
Rotary Stability	41	2,09	0,30
FMS TOTAL	41	15,68	1,98

As a result of the Mann Whitney U test performed to determine whether there is a difference in terms of FMS scores in U13 and U19 footballers, it was seen that the U19 footballers' deep squat, inline lunge, active straight leg rise, rotatory stability and total FMS scores were significantly higher ( $p < 0.05$ ) (Table 4.4).

**Table 4. 4.** Comparison of FMS scores according to study group

	Group	N	Mean	Std. Deviation	U	p
Deep Squat	U13	20	1,60	0,59	140.000	<b>0.018*</b>
	U19	21	1,90	0,43		
Hurdle Step	U13	20	1,95	0,51	157.000	0.065
	U19	21	2,23	0,43		
Inline Lunge	U13	20	2,20	0,52	138.000	<b>0.030*</b>
	U19	21	2,57	0,50		
Shoulder Mobility	U13	20	2,70	0,47	193.000	0.589
	U19	21	2,61	0,49		
Active Straight Leg Rise	U13	20	1,55	0,82	95.000	<b>0.001*</b>
	U19	21	2,38	0,58		
Trunk Stability Pushup	U13	20	2,45	0,60	200.000	0.766
	U19	21	2,52	0,51		
Rotary Stability	U13	20	2,00	0,00	170.000	<b>0.042*</b>
	U19	21	2,19	0,40		
FMS Total	U13	20	14,75	1,65	102.000	<b>0.004*</b>
	U19	21	16,5	1,88		

As a result of Spearman's correlation analysis performed to determine whether there is a relationship between the age of the participants and FMS scores, it has been found that there was a positive and moderate correlation between the age and active straight leg rise ( $r = 0.474$ ;  $p < 0.05$ ), positive and weak correlation between rotary ( $r = .363$ ;  $p < 0.05$ ), positive, weak and significant correlation between FMS ( $r = .400$ ;  $p < 0.05$ ). As a result of Spearman's correlation analysis performed to determine whether there is a relationship between BMI values and FMS scores of the participants, there was a positive, weak ( $r = .321$ ;  $p < 0.05$ ) correlation between BMI and deep squat; it was positive and moderate ( $r = .432$ ;  $p < 0.05$ ) correlation between active straight leg rise; positive, weak ( $r = .339$ ;  $p < 0.05$ ) and significant relationship was found between FMS (Table 4.5).

**Table 4. 5.** The correlation between the age, BMI and FMS scores

		Deep Squat	Hurdle Step	Inline Lunge	Shoulder Mobility	Active Straight Leg Rise	Trunk Stability Pushup	Rotary Stability	FMS
Age	r	,368*	,253	,290	-,011	,474**	-,044	,363*	,400**
	p	<b>,018</b>	,111	,065	,944	<b>,002</b>	,786	<b>,020</b>	<b>,010</b>
BMI	r	,321*	,166	,155	-,061	,432**	,092	,271	,337*
	p	<b>,041</b>	,300	,332	,705	<b>,005</b>	,569	,087	<b>,031</b>

As a result of the statistical analysis performed to determine whether there is a difference in FMS scores in terms of whether there is a history of injury according to the groups, the "Active Straight Leg Rise" score in the U13 category was found to be significantly higher in the U13 category than in those with a history of injury ( $p = .001$ ). In the U19 category, the "shoulder mobility" ( $p = .031$ ) and total FMS score ( $p = .009$ ) were found to be significantly higher than those with a history of injury (Table 4.6).

**Table 4. 6.** Comparison of FMS scores according to injury status

	U13			U19		
	Mean Rank		p	Mean Rank		p
	Injury (No)	Injury (Yes)		Injury (No)	Injury (Yes)	
Deep Squat	11,63	9,75	.433	11,50	10,63	.388
Hurdle Step	11,00	10,17	.684	13,17	9,38	.061
Inline Lunge	9,69	11,04	.532	13,17	9,38	.106
Shoulder Mobility	11,00	10,17	.698	13,83	8,88	<b>.031</b>
Active Straight Leg Rise	15,38	7,25	<b>.001</b>	13,67	9,00	.053
Trunk Stability Pushup	10,13	10,75	.794	12,50	9,88	.268
Rotary Stability	10,50	10,50	1.000	11,33	10,75	.754
FMS Total	13,00	8,83	.114	15,00	8,00	<b>.009</b>

## 5. DISCUSSION AND CONCLUSIONS

Today, the increase in participation in sports has led to an increase in the frequency of musculoskeletal injuries (164). Especially in professional athletes, musculoskeletal injuries cause many negative consequences. Interruption of individual performance, negative impact on team performance, economic loss of the team and the athlete, and the distress it creates in the athlete are some of these results. Difficulties in the management of negative outcomes have also increased efforts to prevent the occurrence of musculoskeletal injuries. In this direction, methods that only deal with a part of the body such as isolated muscle stretching and strengthening and increasing isolated joint movement have been tried (165,166).

However, it has been demonstrated that the effectiveness of isolated rehabilitation approaches is limited (167). Instead, methods that evaluate the components of human movement (such as muscle strength, range of motion, balance) together became more prominent (167). Computer-based motion analysis systems and electromyographic motion analyzes are methods developed for this purpose. The results from these systems are extremely useful in terms of revealing the kinesiological deficits in human movement. However, disadvantages such as high cost and laboratory environment requirements limit the use of these systems (168).

Discussions about the effectiveness of isolated methods and the disadvantages of advanced technological systems have increased the tendency to develop methods that evaluate the components of human movement in the field, simply, quickly and accurately. The most popular of the methods designed for this purpose; Its basic philosophy is Functional Movement Screening (FMS), which is structured on the assumption that strength, movement, flexibility and stability are prerequisites for sportive performance (169,170). The reliability of FMS among the scores of trained testers is high (171,172).

In our study, the relationship between FMS and injury risk was investigated in elite football player candidates in the U19 and U13 categories of Galatasaray Sports Club. In our study, a positive correlation was found between age and FMS. In the study conducted by Portas et al (173) to examine the relationship between FMS scores of adolescent male football players and maturation, it was reported that FMS scores

increase depending on the increase in age. However, in football, young football players can be injured much more frequently than professionals (174). The frequency of injury, usually lower extremity, in young football players varies between 2-26.6 per thousand hours (10-12). In addition, while the injury rate of a football player is about 0.40 in each season, they stay away from the field for an average of 21.9 days as a result of these injuries (9). As a result of these injuries, young football players staying away from the fields for a long time can negatively affect the skill and physical development of the football players. Studies in the literature mention the importance of effective movement competence for safe and effective long-term physical performance in young athletes (13,14). In addition, athletes need balance, core stability and neuromuscular control in order to perform sportive movements safely and effectively (15). Therefore, comprehensive screening methods are needed to determine the risk of injury and to establish preventive strategies to prevent injury (17,173).

As a result of the study it was seen that the active straight leg rise score of the injured football players was significantly lower. In addition to the mean total FMS score of the injured players was found to be significantly lower than those without injury. This result shows that the risk of injury decreases as the total FMS score increases. When a functional movement pattern cannot be applied correctly, functional impairments in movements may occur. Dysfunctions in functional movement patterns are caused by imbalance in muscle strength, deficiencies or asymmetries in neuromuscular control, and this may lead to losses in physical performance (170,174). In the current literature, it is accepted that the strengths and weaknesses in functional movement patterns are defined and the risks of injury are determined with the FMS test battery (129,170,174). In many studies evaluating functional movements, it is stated that low scores and asymmetries in FMS subtests and total scores limit performance and increase the possibility of injury in athletes (135,175,176).

Functional movement scores increase with age in football players. Accordingly, younger football players can be considered to be vulnerable to injury. In addition, as the total FMS score increases, the risk of injury decreases. The effects of exercise programs to be performed according to the FMS system on the FMS score of young football players and their relationship with injuries are subjects that need to be investigated.

As can be understood from the studies, it is seen that football players with high functional movement scores face fewer injuries during the season. With the aim of preventing injury, it helps to reduce the potential for injuries and sports injuries with an appropriate exercise prescription for adolescent football players with low functional movement scores.

As a result of this study, it was determined that there is a relationship between the FMS test scores of young football players and the injuries not related to the impact they experienced in a football season. In the literature, there are conflicting results regarding whether FMS score is associated with non-impact injuries (135,177,179) or not (180).

Chorba et al. (177) found statistical significance between total FMS scores and lower extremity injuries in the study they conducted with 38 female athletes with an average age of 19. In the same study, it was reported that an FMS score of 14 and below was associated with 69% of injury, and the risk of experiencing injury was four times higher (177). In another study involving professional American football players, it was determined that a FMS score of 14 or below was associated with serious injuries (135). In addition to these, in a study in which 160 athletes from various sports branches (swimming, rugby and football) participated, the FMS test was applied to the athletes and their injuries not related to impact within a season were followed. According to the results of the study, it was determined that the probability of experiencing an injury is twice as high in athletes with an FMS test score of 14 and below (179). Contrary to these studies, Smith et al. (180) reported that there was no significant relationship between FMS score and injury in their study on professional football players. Similarly, Rusling et al. (181) reported in a study conducted with young football players that there was no relationship between FMS total score and composite score and injuries experienced. However, in the same study, it was reported that there is a relationship between the deep squat and trunk stability (push-up) movement score and the number of injuries. According to the study, it was determined that young football players with low scores for deep squats or trunk stability (push-ups) were injured more frequently.

The limitations of our study are as follows :

1. All the participants in the analysis were male.

## 2. The sport branch of all the participants were football

The fact that young football players stay away from the field after injury negatively affects their physical and technical development. For this reason, before young football players get injured, risk factors should be determined and necessary preventive exercises should be applied. It is recommended that sports physiotherapists evaluate functional mobility at the beginning of the season and train football players with corrective exercises for asymmetry or stability problems.



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## 7. APPENDICES

### Appendix 1 . Voluntary Consent Form

Bu bilgilendirilmiş gönüllü onam formu, "U19 ve U13 gruplarında oynayan seçkin erkek futbolcuların fonksiyonel hareket tarama testi puanları ile alt ekstremitte yaralanma riski arasındaki ilişkinin incelenmesi" adlı çalışmaya davet etmek için hazırlandı. Bu çalışma, elit futbol adaylarında yaralanma riski ile fonksiyonel hareket tarama testi arasındaki ilişkiyi incelemeyi amaçlamaktadır. Fonksiyonel hareket tarama testi, 7 temel hareketten oluşan bir testtir. Bir futbol sezonu boyunca katılımcıların sakatlık durumları takip edilecek ve kayıt edilecektir. Sezon öncesi katılımcıların Fonksiyonel Hareket Taraması testleri alınacaktır. Toplanan veriler analiz edilecektir. Amacımız, bu test ile yaralanma riski arasındaki ilişkiyi incelemek ve sporcunun olası yaralanma riskini belirlemek ve en aza indirmektir. Katılımcıların verileri gizli tutulacaktır. Bu çalışmaya klinik tanısı olmayan 42 katılımcıyı kaydetmeyi hedefliyoruz.

Bu araştırma Fizyoterapist OZAN ÖZTÜRK (Tel: [REDACTED]) tarafından yürütülecek ve Yeditepe Üniversitesi Sağlık Bilimleri Enstitüsü Fizyoterapi ve Rehabilitasyon Anabilim Dalı'nda Dr. Çiğdem YAZICI MUTLU gözetiminde yapılacaktır.

Çocuğunuz bir araştırma projesine davet ediliyor. Karar vermeden önce bu araştırmanın neden ve nasıl yapılacağını anlamanız çok önemlidir. Lütfen biraz zaman ayırın ve aşağıdaki bilgileri dikkatlice okuyun, derseniz başkalarıyla tartışın. Net olmayan bir bölümünüz varsa veya daha detaylı bilgiye ihtiyaç duyuyorsanız bizden bilgi alabilirsiniz. Araştırmamıza davetlisiniz çünkü çocuğunuzun dahil edilecek kriterlere uyduğunu düşünüyoruz. Katılımın isteğe bağlı olduğunu ve katılmayı reddetmenin herhangi bir cezaya veya herhangi bir menfaat kaybına yol açmayacağını belirtmek isteriz. Aynı şekilde istediğiniz zaman araştırmadan çekilebilirsiniz.

Araştırmamızda katılımcılara uygulanan değerlendirmelerin bilinen herhangi bir zararı bulunmamaktadır. Değerlendirme sürecinde herhangi bir beklenmedik hasar olması durumunda, bilgiler size anında verilecektir. Katılımcıların herhangi bir zarar görmesi durumunda gerekli başvurular herhangi bir rücu olmaksızın araştırmacılar tarafından

karşılacaktır. Bunun için ne sizden ne de sosyal güvenlik sigortanızdan herhangi bir ücret alınmayacaktır. Araştırmaya katılmak size hemen yardımcı olmamakla birlikte, araştırma sonuçlarımızın gelecekte kuruluşa, topluma veya bilime fayda sağlayacağı umulmaktadır.

Araştırma amacıyla veya bağlı olduğunuz sosyal güvenlik kurumu için sizden herhangi bir ücret alınmayacaktır.

### **Katılımcının Onayı**

Bilgi formunun tamamını açıkça okudum ve anladım veya bana okunduğu veya tercüme edildiği dili nasıl okuyacağımı / okuyamadığımı veya anlamadığım için. Sağlık durumumu hem başvurum sırasında hem de sonrasında ve bu formu doldururken sorma, değerlendirme ve karar verme fırsatı verildi.

### **Katılımcı ve Yasal Temsilcinin Adı Soyadı:**

**Telefon numarası:** **Adresi:** **Tarih:** **İmza:**

### **Tanık Adı ve Soyadı:**

**Telefon numarası:** **Adresi:** **Tarih:** **İmza:**

### **Fizyoterapist Beyanı**

Katılımcıya çalışma ve yapılacak işlemler hakkında gerekli bilgileri verdim. Hastanın bu bilgileri anladığına, sormak istediği soruları sorduğuna, özgür iradesiyle süreci kabul ettiğine inanıyorum.

**Araştırmacı:** Fizyoterapist Ozan ÖZTÜRK

**Adres:** [REDACTED]  
[REDACTED]

**Cep Telefonu:** [REDACTED] **E-mail:** [REDACTED]

**Tarih :**

**İmza:**

**Katılımcı / Yasal Temsilci Beyanı**

Sayın Ozan ÖZTÜRK tıbbi bir araştırma yapılacağını ifade etmiş ve bu araştırma ile ilgili yukarıdaki bilgiler bana anlatılmıştır. Çocuğumun bu araştırmaya katılımcı olarak davet edildiğini biliyorum. Bu araştırmaya katılırsam, araştırma sırasında çocuğumun bilgilerinin gizliliğinin büyük bir özen ve saygı ile ele alınacağına inanıyorum. Araştırmanın kullanımını sırasında çocuğumun kişisel bilgilerinin özenle korunacağına ve sonuçların yalnızca eğitim ve bilimsel amaçlarla kullanılacağına dair yeterli bilgi verildi. Araştırma sırasında herhangi bir sebep olmaksızın çocuğumu çalışmadan istediğim zaman çekebilirim. Araştırma masrafları için herhangi bir mali sorumluluk almıyorum. Benim için ödeme olmayacak. Araştırma sırasında oluşabilecek herhangi bir sağlık sorunu doğrudan, dolaylı olarak ortaya çıkmış olsun, herhangi bir parasal yüke maruz kalmayacağım. Araştırma sırasında herhangi bir sağlık sorunu ile karşılaştığımızda; Herhangi bir saatte fizyoterapist Ozan Öztürk'ü [REDACTED] (mobil) 'den arayabileceğimi biliyorum.

Bana yapılan tüm açıklamaları detaylı olarak anladım. Belirli bir süre tek başıma düşünmenin sonunda çocuğumun bu araştırma projesinde katılımcı olarak yer almasına karar verdim. Çocuğum adına bu daveti gönüllü olarak kabul ediyorum. Gönüllü Onay Formu, araştırmadan önce gönüllüye verilmesi gereken bilgileri gösteren yukarıdaki metni okudum. Bunlar yazılı ve sözlü olarak açıklandı. Bu şartlarla, kendim ve çocuğum üzerinde herhangi bir baskı veya zorlama olmaksızın bu araştırmaya katılmayı kabul ediyorum. 4 sayfadan oluşan bu formun imzalı 2 nüshası, belgelerin bir nüshası tarafıma verilecektir.

**Katılımcı ve Yasal Temsilcinin Adı Soyadı:**

**Telefon numarası:**

**Adresi:**

**Tarih:**

**İmza:**

**Tanık Adı ve Soyadı:**

**Telefon numarası:**

**Adresi:**

**Tarih:**

**İmza:**

Açıklamaları yapan arařtırmacı,

**Arařtırmacı:** Fizyoterapist Ozan ÖZTÜRK

**Adres:** [REDACTED]  
[REDACTED]

**Cep Telefonu:** [REDACTED] **Email:** [REDACTED]

**Tarih :**

**İmza:**

[REDACTED]

## Appendix 2 . Ethical Committee Approval



**YEDİTEPE ÜNİVERSİTESİ**  
**GİRİŞİMSEL OLMAYAN KLİNİK ARAŞTIRMALAR**  
**ETİK KURULU**

Versiyon No 2.0  
13.02.2022  
Sayfa 1 / 2

### KARAR FORMU

14.03.2022

ETİK KURUL BİLGİLERİ	Etik Kurulun Adı	Yeditepe Üniversitesi Girişimsel Olmayan Klinik Araştırmalar Etik Kurulu
	Açık Adres	Yeditepe Üniversitesi Kayışdağı Kampüsü, Tıp-Mühendislik Binası, Sağlık Bilimleri Enstitüsü, İnönü Mah. Kayışdağı Cad. 326A, 26 Ağustos Yerleşimi 34755 Ataşehir, İstanbul
	İnternet Sayfası	<a href="http://goetik.yeditepe.edu.tr/">http://goetik.yeditepe.edu.tr/</a>
	Telefon	0216 578 00 00
	E-posta	<a href="mailto:goetik@yeditepe.edu.tr">goetik@yeditepe.edu.tr</a>

DEĞERLENDİRİLEN BELGELER	Islak imzalı başvuru dosyası, CD'si ve elektronik başvuru	<input checked="" type="checkbox"/>
	Araştırma başlığı ve araştırmacıların isimleri	<input checked="" type="checkbox"/>
	Başvuru dilekçesi	<input checked="" type="checkbox"/>
	Başvuru Formu- Araştırmanın;	<input checked="" type="checkbox"/>
	• Niteliği	<input checked="" type="checkbox"/>
	• Önemi ve özgün değeri	<input checked="" type="checkbox"/>
	• Amaç ve hedefleri	<input checked="" type="checkbox"/>
	• Yöntemi	<input checked="" type="checkbox"/>
	• Yönetimi	<input checked="" type="checkbox"/>
	• Yaygın etkisi	<input checked="" type="checkbox"/>
	• Araştırma bütçesi (Mevcutsa)	<input checked="" type="checkbox"/>
	• Süresi ve uygunluğu (Zaman cetveli)	<input checked="" type="checkbox"/>
	• Kaynakları	<input checked="" type="checkbox"/>
	Bilgilendirilmiş Gönüllü Olur Formu (yapılan araştırmaya özel olarak hazırlanmış)	<input checked="" type="checkbox"/>
	Taahhütname-1 Araştırmanın yapılacağı kurumdan izin alma sorumluluğunun araştırmacılara ait olduğuna dair taahhüt	<input checked="" type="checkbox"/>
	Taahhütname-2 Dünya Tıp Birliği Helsinki Bildirgesinin son versiyonunun ve Sağlık Bakanlığı'nın ilgili tüm kılavuzlarının okunmasına dair taahhüt	<input checked="" type="checkbox"/>
	Taahhütname-3 Daha önce yapılmış etik kurul başvuruları mevcut olup olmadığına dair taahhüt	<input checked="" type="checkbox"/>
	Taahhütname-4 Araştırma sırasında araştırma bütçesinde yer almayan ve gönüllünün kendisine veya Sosyal Güvenlik Kurumuna ek yük getirecek hiçbir işlem uygulanmayacağına dair taahhüt	<input checked="" type="checkbox"/>
	Taahhütname-5 COVID-19 hastalarında tedavi yaklaşımları ve bilimsel araştırmalar genelgesi okunmasına dair taahhüt	<input checked="" type="checkbox"/>
	Taahhütname-6 Milli Eğitim Bakanlığı Araştırma Uygulama izinleri konulu yazının okunmasına dair taahhüt	<input checked="" type="checkbox"/>
Araştırmacıların her birisine ait özgeçmiş formu	<input checked="" type="checkbox"/>	
Ek belgeler (Varsa kullanılan ölçek izinleri vb.)	<input checked="" type="checkbox"/>	

KARAR BİLGİLERİ	Başvuru Numarası	20211113
	Toplantı Tarihi	17.12.2021
	Toplantı Yeri	Çevirim içi (Google Meet)
	Karar No	6

Araştırmanın Başlığı U19 ve U13 Gruplarında Oynayan Elit Adayı Erkek Futbolcuların Fonksiyonel Hareket Taraması Test Skorlarının Alt Ekstremitte Sakatlık Riski ile İlişkilerinin İncelenmesi

Araştırmacılar Ozturk O,Yazıcı-Mutlu Ç.



BAŞVURU NUMARASI: 202111113

14.03.2022


**KARAR**

<input checked="" type="checkbox"/> <b>KABUL</b>	<input type="checkbox"/> <b>RET</b> <input type="checkbox"/> KAPSAM DIŞI (GİRİŞİMSEL) <input type="checkbox"/> BİLİMSEL VE/VEYA ETİK KURALLARA AYKIRI <input type="checkbox"/> BİR SORUMLU ARAŞTIRMACININ (TEZ İSE TEZ DANIŞMANI), BİR TOPLANTIYA İKİ (2) <b>ADETTEN FAZLA ÇALIŞMA BAŞVURUSUNDA BULUNMASI</b> <input type="checkbox"/> KURUM İÇİ BAŞVURULARINDA <b>KURUMSAL E-POSTA HESABI İLE GİRİŞ YAPILMAMIŞ OLMASI</b> <input type="checkbox"/> ŞARTLI KABULDE BELİRTİLEN REVİZYONLARIN ZAMANINDA VE/VEYA İSTENİLDİĞİ ŞEKİLDE YAPILMAMIŞ OLMASI
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Yeditepe Üniversitesi'Girişimsel Olmayan Klinik Araştırmalar Etik Kurulu adına  
Prof.Dr.Didem Özdemir ÖZENEN  
Başkan

Araştırmanın Başlığı U19 ve U13 Gruplarında Oynayan Elit Adayı Erkek Futbolcuların Fonksiyonel Hareket Taraması  
Test Skorlarının Alt Ekstremitte Sakatlık Riski ile İlişkilerinin İncelenmesi  
Araştırmacılar Ozturk O,Yazıcı-Mutlu Ç.

## Appendix 3 . Injury Follow-Up Form

 <p><b>FIFA</b> F-MARC MEDICAL ASSESSMENT AND REHABILITATION CENTRE <i>For the Good of the Game</i></p>	<h3 style="margin: 0;">Injury Report Form</h3> <p>(Team) Player-code: _____ Date: _____</p>	<h3 style="margin: 0;">LOGO</h3>																																				
<p><b>1A Date of injury:</b> _____ <b>1B Date of return to full participation:</b> _____</p> <p><b>2A Injured body part</b></p> <table style="width: 100%; border: none;"> <tr> <td><input type="checkbox"/> head / face</td> <td><input type="checkbox"/> shoulder / clavícula</td> <td><input type="checkbox"/> hip / groin</td> </tr> <tr> <td><input type="checkbox"/> neck / cervical spine</td> <td><input type="checkbox"/> upper arm</td> <td><input type="checkbox"/> thigh</td> </tr> <tr> <td><input type="checkbox"/> sternum / ribs / upper back</td> <td><input type="checkbox"/> elbow</td> <td><input type="checkbox"/> knee</td> </tr> <tr> <td><input type="checkbox"/> abdomen</td> <td><input type="checkbox"/> forearm</td> <td><input type="checkbox"/> lower leg / Achilles tendon</td> </tr> <tr> <td><input type="checkbox"/> low back / sacrum / pelvis</td> <td><input type="checkbox"/> wrist</td> <td><input type="checkbox"/> ankle</td> </tr> <tr> <td></td> <td><input type="checkbox"/> hand / finger / thumb</td> <td><input type="checkbox"/> foot / toe</td> </tr> </table> <p><b>2B Injured body part</b></p> <table style="width: 100%; border: none;"> <tr> <td><input type="checkbox"/> right</td> <td><input type="checkbox"/> left</td> <td><input type="checkbox"/> not applicable</td> </tr> </table> <p><b>3 Type of injury</b></p> <table style="width: 100%; border: none;"> <tr> <td><input type="checkbox"/> concussion with or without loss of consciousness</td> <td><input type="checkbox"/> lesion of meniscus or cartilage</td> <td><input type="checkbox"/> haematoma / contusion / bruise</td> </tr> <tr> <td><input type="checkbox"/> fracture</td> <td><input type="checkbox"/> muscle rupture / strain / tear / cramps</td> <td><input type="checkbox"/> abrasion</td> </tr> <tr> <td><input type="checkbox"/> dislocation / subluxation</td> <td><input type="checkbox"/> tendon injury / rupture / tendinosis / bursitis</td> <td><input type="checkbox"/> laceration</td> </tr> <tr> <td><input type="checkbox"/> sprain / ligament injury</td> <td></td> <td><input type="checkbox"/> nerve injury</td> </tr> <tr> <td><input type="checkbox"/> other injury (please specify): _____</td> <td></td> <td><input type="checkbox"/> dental injury</td> </tr> </table> <p><b>4 Diagnosis</b> (text or Orchard code): _____</p> <p><b>5</b> Has the player had a <b>previous injury</b> of the same type at the same site (i.e. this injury is a recurrence)?</p> <p><input type="checkbox"/> no <span style="margin-left: 150px;"><input type="checkbox"/> yes</span></p> <p>If <b>YES</b>, specify date of player's return to full participation from the previous injury: _____</p> <p><b>6</b> Was the injury caused by <b>overuse</b> or <b>trauma</b>?</p> <p><input type="checkbox"/> overuse <span style="margin-left: 150px;"><input type="checkbox"/> trauma</span></p> <p><b>7</b> <b>When</b> did the injury occur?</p> <p><input type="checkbox"/> training <span style="margin-left: 150px;"><input type="checkbox"/> match</span></p> <p><b>8</b> Was the injury caused by <b>contact</b> or <b>collision</b>?</p> <p><input type="checkbox"/> no <span style="margin-left: 100px;"><input type="checkbox"/> yes, with another player</span></p> <p><span style="margin-left: 100px;"><input type="checkbox"/> yes, with the ball</span></p> <p><span style="margin-left: 100px;"><input type="checkbox"/> yes, with other object (specify) _____</span></p> <p><b>9</b> Did the referee indicate that the action leading to the injury was a <b>violation of the Laws</b>?</p> <p><input type="checkbox"/> no <span style="margin-left: 20px;"><input type="checkbox"/> yes, free kick / penalty</span> <span style="margin-left: 40px;"><input type="checkbox"/> yes, yellow card</span> <span style="margin-left: 40px;"><input type="checkbox"/> yes, red card</span></p> <p>If <b>YES</b>, was the referee's sanction against: <span style="margin-left: 40px;"><input type="checkbox"/> injured player</span> <span style="margin-left: 40px;"><input type="checkbox"/> opponent</span></p>			<input type="checkbox"/> head / face	<input type="checkbox"/> shoulder / clavícula	<input type="checkbox"/> hip / groin	<input type="checkbox"/> neck / cervical spine	<input type="checkbox"/> upper arm	<input type="checkbox"/> thigh	<input type="checkbox"/> sternum / ribs / upper back	<input type="checkbox"/> elbow	<input type="checkbox"/> knee	<input type="checkbox"/> abdomen	<input type="checkbox"/> forearm	<input type="checkbox"/> lower leg / Achilles tendon	<input type="checkbox"/> low back / sacrum / pelvis	<input type="checkbox"/> wrist	<input type="checkbox"/> ankle		<input type="checkbox"/> hand / finger / thumb	<input type="checkbox"/> foot / toe	<input type="checkbox"/> right	<input type="checkbox"/> left	<input type="checkbox"/> not applicable	<input type="checkbox"/> concussion with or without loss of consciousness	<input type="checkbox"/> lesion of meniscus or cartilage	<input type="checkbox"/> haematoma / contusion / bruise	<input type="checkbox"/> fracture	<input type="checkbox"/> muscle rupture / strain / tear / cramps	<input type="checkbox"/> abrasion	<input type="checkbox"/> dislocation / subluxation	<input type="checkbox"/> tendon injury / rupture / tendinosis / bursitis	<input type="checkbox"/> laceration	<input type="checkbox"/> sprain / ligament injury		<input type="checkbox"/> nerve injury	<input type="checkbox"/> other injury (please specify): _____		<input type="checkbox"/> dental injury
<input type="checkbox"/> head / face	<input type="checkbox"/> shoulder / clavícula	<input type="checkbox"/> hip / groin																																				
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<input type="checkbox"/> sternum / ribs / upper back	<input type="checkbox"/> elbow	<input type="checkbox"/> knee																																				
<input type="checkbox"/> abdomen	<input type="checkbox"/> forearm	<input type="checkbox"/> lower leg / Achilles tendon																																				
<input type="checkbox"/> low back / sacrum / pelvis	<input type="checkbox"/> wrist	<input type="checkbox"/> ankle																																				
	<input type="checkbox"/> hand / finger / thumb	<input type="checkbox"/> foot / toe																																				
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<input type="checkbox"/> sprain / ligament injury		<input type="checkbox"/> nerve injury																																				
<input type="checkbox"/> other injury (please specify): _____		<input type="checkbox"/> dental injury																																				
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## Appendix 4. FMS Scoring Table

FMS

### THE FUNCTIONAL MOVEMENT SCREEN

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#### SCORING SHEET

NAME \_\_\_\_\_ DATE \_\_\_\_\_ DOB \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY, STATE, ZIP \_\_\_\_\_ PHONE \_\_\_\_\_

SCHOOL/AFFILIATION \_\_\_\_\_

SSN \_\_\_\_\_ HEIGHT \_\_\_\_\_ WEIGHT \_\_\_\_\_ AGE \_\_\_\_\_ GENDER \_\_\_\_\_

PRIMARY SPORT \_\_\_\_\_ PRIMARY POSITION \_\_\_\_\_

HAND/LEG DOMINANCE \_\_\_\_\_ PREVIOUS TEST SCORE \_\_\_\_\_

TEST	RAW SCORE	FINAL SCORE	COMMENTS
DEEP SQUAT			
HURDLE STEP	L		
	R		
INLINE LUNGE	L		
	R		
SHOULDER MOBILITY	L		
	R		
IMPINGEMENT CLEARING TEST	L		
	R		
ACTIVE STRAIGHT-LEG RAISE	L		
	R		
TRUNK STABILITY PUSHUP			
PRESS-UP CLEARING TEST			
ROTARY STABILITY	L		
	R		
POSTERIOR ROCKING CLEARING TEST			
TOTAL			

**Raw Score:** This score is used to denote right and left side scoring. The right and left sides are scored in five of the seven tests and both are documented in this space.

**Final Score:** This score is used to denote the overall score for the test. The lowest score for the raw score (each side) is carried over to give a final score for the test. A person who scores a three on the right and a two on the left would receive a final score of two. The final score is then summarized and used as a total score.