GİZEM KARADENİZ SPORTS PHYSIOTHERAPY MASTER THESIS 2023

T.C.

YEDITEPE UNIVERSITY
INSTITUTE OF HEALTH SCIENCES
DEPARTMENT OF SPORTS PHYSIOTHERAPY

THE EFFECT OF EXERCISE TRAINING AND ARCH SUPPORTED INSOLE ON BALANCE AND VERTICAL JUMP PERFORMANCE IN FOOTBALL PLAYERS WITH FOOT PRONATION DEFORMITY

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İSTANBUL-2023

TEZ ONAYI FORMU

Kurum : Yeditepe Üniversitesi Sağlık Bilimleri Enstitüsü

Program : Spor Fizyoterapisi Yüksek Lisans Programı

Tez Başlığı : The Effect of Exercise Training and Arch Supported Insole On Balance and Vertical Jump Performance In Football Players With Foot Pronation Deformity

Tez Sahibi : Fzt. Gizem Karadeniz

Sınav Tarihi : 25.05.2023

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

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ONAY

Bu tez Yeditepe Üniversitesi Lisansüstü Eğitim-Öğretim ve Sınav Yönetmeliğinin ilgili maddeleri uyarınca yukarıdaki jüri tarafından uygun görülmüş ve Enstitü Yönetim Kurulu’nun …………………tarih ve .... sayılı kararı ile onaylanmıştır.

Prof. Dr. Bayram YILMAZ

Sağlık Bilimleri Enstitüsü Müdür

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 that has been accepted for the award of any other degree except where due acknowledgment has been made in the text.

Gizem Karadeniz, PT.

DEDICATION

I would like to dedicate my thesis to my beloved and loving parents Tülay KARADENİZ and Turgut KARADENİZ, and also I thank to my all dear friend.

ACKNOWLEDGEMENTS

I would like to express my deepest appreciation to all those who provided me the possibility to complete this report. A special gratitude I give to my supervisior, Ass. Prof. Dr. Elif Develi whose contribution in stimulating suggestions and encouragement helped me to coordinate my project especially in writing this thesis.

I would like to appreciate FootBalance Team who provided all the resources to conduct this study.

I would like to extend a special thank you to several people that have been of vital importance to this project. First I would like to thank my parents for their continued support. Additionally, I thank to Ege Umur Er for his support, motivation and strong friendship.

I would like to thank my best friends, who are my lifelong friend and superpower give always positive energy and support.

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LIST OF SYMBOLS AND ABBREVIATIONS

FPI	Foot Posture Index
FIFA	Association of World Football Federation
LCL	Lateral Collateral Ligament
LLA	Lateral Longitudinal Arch
MASI	Medical Arch Supported Insole
MCL	Medial Colleteral Ligament
MPI	Medially Posted Insole
MLA	Medial Longitudinal Arch
MTF	Metatarsofalangeal Joint
NDT	Navicular Drop Test
NRS	Rating Scale
ROM	Range of Motion
SPSS	Statistical Package Analyze for Social Sciences
TA	Transverse Arch
TFF	Turkish Football Federation
VAS	Visual Analog Scale

ABSTRACT

KARADENİZ, G. (2023), The Effect Of Exercise Training And Arch Supported Insole On Balance And Vertical Jump Performance In Football Players With Foot Pronation.

Yeditepe University Institute of Health Sciences, Department of Sports Physiotherapy Master Thesis, Istanbul.

This study aims to investigate the effects of foot pronation exercises and arch support insole on balance and vertical jump test in football players. A total of 30 volunteer football players including this study between March 2022 - August 2022. The athletes who were randomly divided into 2 groups which is the insole (n=15) and insole+exercise group (n=15). Insole groups used customized medial arch supported insole for four weeks. Insole+exercise group did foot core exercises programme twice a week for four weeks and used customized medial arch supported insoled for four weeks.All the volunteers were assessed in term of performance test and foot arch level test, including Navicular Drop Test, Y-Balance Test, Flamingo Test, Vertical Jump Test, VAS questionnaire before and after interventions. The study results showed that with in groups, insole+exercise group differences were (0.8±0.41cm), has more significant difference than the insole group changes (0.4± 0.51 cm) in navicular drop test ($p<0.05$). Moreover, ybalance Within groups demonstrated statistically significant differences ($p<0.05$) there was no significant difference in nondominant flamingo test results. ($p>0.05$).However, there was a significant difference in dominnat flamingo test between groups. ($p<0.05$). In vertical jump test , there was no significant difference in between groups.($p>0.05$) However, there was a significant difference within groups. ($p<0.05$) Lastly, it was observed that insole+exercise groups were higher positively difference (3.0±0.92), than the insole group (2.0±1.06), ($p<0.05$). Thus, we conclude that elite football players should be assessed with a holistic approach and physiotherapists should advise not only performance-enhancing exercises and insoles but also structured exercise programs, including short foot exercises, towel curl exercises, and heel-to-rise exercises to elite football players with foot pronation deformity.

Keywords: Insole, Medial Arch, Football Players, Vertical Jump, Balance, Foot pronation, Foot pronation exercises

ÖZET

KARADENİZ, G. (2023), Ayak Pronasyonu Olan Futbolcularda Egzersiz Eğitimi Ve Ark Destekli Tabanlıkların Denge ve Dikey Sıçrama Performansı Üzerine Etkileri

Yeditepe Üniversitesi Sağlık Bilimleri Enstitüsü, Spor Fizyoterapisi Anabilim Dalı Yüksek Lisans Tezi, İstanbul.

Bu çalışmanın amacı, futbolcularda ayak pronasyon egzersizleri ve medial ark destekli tabanlıkların denge ve dikey sıçrama testine etkisini araştırmasıdır. Mart 2022 - Ağustos 2022 arasında bu çalışmaya dahil edilen toplam 30 gönüllü futbolcu bulunmaktadır. Randomize olarak 2 gruba ayrılan sporcular; tabanlık (n=15) ve tabanlık+egzersiz grubu (n=15) olarak belirlendi. Tabanlık grubu, kişiye özel medial ark destekli tabanlıklar kullanırken, tabanlık+egzersiz grubu 4 hafta boyunca haftada 2 kez ayak pronasyon egzersiz programı yaptı ve 4 hafta boyunca kişiye özel medial ark destekli tabanlık kullandı. Tüm gönüllüler, müdahale öncesi ve sonrasında Naviküler Düşme Testi, Y-Denge Testi, Flamingo Testi, Dikey Sıçrama Testi, VAS anketi de dahil olmak üzere performans testi ve ayak ark seviye testi açısından değerlendirildi. Çalışma sonuçları, gruplar arasında naviküler düşme testinde tabanlık+egzersiz grubunun (0,8±0,41cm) tabanlık grubundan (0,4±0,51cm) daha önemli bir farklılık gösterdiğini ($p<0,05$) ortaya koydu. Ayrıca, gruplar içinde Y-Denge Testi'nde istatistiksel olarak anlamlı farklılıklar ($p<0,05$) görüldü. Nondominant flamingo test sonuçlarında anlamlı bir farklılık yoktu ($p>0,05$). Ancak, dominant flamingo test sonuçlarında gruplar arasında anlamlı bir farklılık vardı ($p<0,05$). Dikey sıçrama testinde gruplar arasında anlamlı bir farklılık yoktu ($p>0,05$). Ancak, gruplar içinde anlamlı bir farklılık vardı ($p<0,05$). Tabanlık+egzersiz grubu (3,0±0,92) tabanlık grubuna (2,0±1,06) göre daha yüksek pozitif farklılık gösterdi ($p<0,05$). Son olarak, ayak pronasyon egzersizlerinin tabanlık kullanımıyla birlikte kullanılması, sadece tabanlık kullanımına kıyasla daha iyi sonuçlar verdiği gözlemlenmiştir. Bu nedenle, elit futbolcuların bütüncül bir yaklaşımla değerlendirilmesi gerektiği ve fizyoterapistlerin yalnızca performans arttırıcı egzersizler ve tabanlık değil, aynı zamanda ayak pronasyon deformitesine sahip elit futbolculara ayak kısaltma egzersizleri(SF), havlu toplama egzersizi, ayak parmak ucuna yükselme gibi spesifik egzersizler verilmesi gerektiği sonucuna varılmıştır.

Anahtar Kelimeler: Tabanlık, medial ark, futbol oyuncuları, ayak pronasyon egzersiz

1. INTRODUCTION AND PURPOSE

Football is a one of most popular sport with over 260 million active players worldwide (1) . This team sport requires aerobic and anaerobic performance, with short bouts of high-intensity activity interspersed with more extended periods of low- to moderate-intensity activity(2) . Moreover, it involves contact and various movements such as running, jumping, passing, shooting, kicking, dribbling, turning, heading, and tackling (3) .Thus, participating in the football can result in both acute and chronic injuries for players of all ages and skill levels (4) . These injuries that occur in football significantly affect the performance and daily life of the football players. The type and location of injuries to football players have been described in many studies (5) . Lower extremity injuries are an ongoing concern for professional football players, and according to the surveillance system reports, football injuries have steadily increased over the years (6) .Most injuries affect the lower extremities, comprising 70-93% of injuries in male players, especially the ankle and foot (7) .

Pronation is one of the most common deformities among football players. In the literature, it has been demonstrated that the foot's position is essential for proper lower limb movement and stability. Specifically, changes in foot posture can lead to proprioception and balance loss in football players, increasing the risk of injuries (8-10) . Repetitive injuries, especially seen in elite football players, may result in improved health expenditures, loss of performance, loss of matches in sports competitions, and a decrease in the athlete's motivation.

Traditionally, cushioned or shock-absorbent Medially Placed Insole (MPI) are advised to reduce the impact forces associated with running and protect against overuse injuries for people with foot pronation deformity (11) . Moreover, resistance exercises for the inner muscles of the foot are also recommended as an effective preventive and therapeutic strategy for foot pronation deformity (12-14) . However, in the literature, studies on foot pronation deformity are focused on sedentary individuals and amateur athletes. In addition, the researchers could not define a consensus statement, including the use of insole or the comprehensive exercise program for foot pronation deformity. Although studies indicated that the performance of football players with foot pronation deformity is affected and the frequency of injury increases, the effectiveness of insole use and foot strengthening exercises have not been demonstrated. Thus, the study aims to investigate the effects of foot pronation exercises and arch support insole on balance and vertical jump tests among football players.

Four hypotheses were identified in the study:

H0: Combination of foot pronation exercises and insole does not improve balance and vertical jump test performance among football players compared to using insole alone.

H1: Combining foot pronation exercises and insole improves balance and vertical jump test performance among football players compared to using insole alone.

H2: Foot pronation exercises improve balance and vertical jump test performance among football players compared to using insole.

H3: Using insole improves balance and vertical jump test performance among football players compared to foot pronation exercises.

2. THEORETICAL INFORMATION AND LITERATURE

2.1. Football

Football is a popular sport all over the world and it has a long past. It became an official sport branch in 1863 in which the first football association was founded in England. In Turkey, football became very popular and became as a sport branch around between the years of 1908 and 1923 [15] . According to the rules of the Association of World Football Federations (FIFA), there are 209 football federations in the world [15-16] . The number of licensed football players in Turkey is 466,445 and this number is increasing day by day (TFF, 2020) [17] .

2.1.1. Players and Game

Football highly complex sport that demands players to have,tactical, technical, and physical capabilities in order to achieve a successful performance and ultimately emerge victorious in a match [18] . In football, the objective is to achieve a higher score than the opposing team within the 90-minute time frame by scoring more goals. A team'sperformanceEach team is composed of 11 players with specific roles and responsibilities determined by their position on the field. The success of the team is often reliant on the ability of players to work together and effectively communicate [19-20] . A team players who are divided into two broad categories: the goalkeeper and the outfield players. The goalkeeper is the sole player permitted to utilize their hands while inside the penalty area and their primary responsibility is to avoid the opposition from scoring. Remaining 10 players are referred to as outfield players and are further divided into defensive, midfield, and attacking positions depending on the tactical formation used by the team [21] .The quantification of physical demands in football play a crucial role in developing accurate conditioning plans and optimizing performance during competitive games and prevent injuries [22] .

2.1.2. Football Injuries

Football players suffer many injuries and illnesses during preparation for and during the competition [23] .Literature reviews report that all players experience an injury that limits their performance at least once a year. The rate of football injuries is ranges from 10 to 35 per 1000 playing hours. [24] It is estimated that the typical expense for medical care for each football injury is be $150 (U.S. dollars). This cost can vary depending The severity of the harm and the kind of medical care needed. However, when considering the a significant amount of football players are currently active globally., the financial and socioeconomic consequences of these injuries can be significantThe global count of football players who regularly participate in the sport, coupled with the significant socioeconomic and financial impact of injuries, indicate the need for an injury prevention initiative aimed at reducing injury incidence rates. [25-27] Generally injury risk factors, both intrinsic and extrinsic have been proposed factors that come from outside the body, such as the level of competition, the skill level of the player, whether ankle tape or braces are used, the type of shoes or braces worn, and the playing surface, all contribute to the risk of injury . [27-28] These factors can contribute to an increased risk of injury if they are not properly managed.Intrinsic risk, on the other hand, are those that come from within the body like factors include previous injury age, sex and aerobic fitness , types of body , flexibility, limb dominance, and nondominant limb girth, muscle strength, ibalance of the body and reaction time, good posture, proper anatomical structure, and foot morphology. [27-30] Overall, it is important to take a comprehensive approach to injury risk assessment, and consider both extrinsic and intrinsic risk factors when developing injury prevention strategies for athletes. [31,32] The injury types that occurred most frequently were ligament sprains, muscle strains, and contusions and most of the injuries occur in the lower limbs, primarily in the ankles and knees because of sudden movements, impact, or overuse. [32]

2.1.3. Lower extremity injuries in football

As anticipated, injuries to the lower limbs mostly prevalent location for an ınjury with a rate of occurrence of 6.8 injuries per 1000 hours of participation. [33-34] Previously research has identified The hip, upper leg, also knee, and mostly ankle are frequently injured body parts in this group, with injuries primarily resulting from contact with other players. [35] Ankle sprains are a prevalent injury in sports, and various studies have been conducted to reduce their incidence in football. [33-36]

Research has shown that there is a strong correlation between biomechanical irregularities and injuries that affect the lower extremities. For instance, the correlation between a rise in subtalar joint inversion and the development of Achill tendinopathy or a foot type characterized by pronation and medial tibial stress syndrome(MTSS) . [37] Foot posture is critical to normal lower limb kinetics and kinematics, and foot pathologies can considerably increases the risk of lower limb injury. [38]

2.2. Foot – Ankle Anatomy

The foot-ankle complex has a similar structure to the hand-wrist complex in the upper extremity. However, the essential role of the foot-ankle is to support the body's weight, and it shows differences from the hand-wrist in order to perform this task effectively. [39]

The stability and mobility of the foot is maintained by the interrelated components of the foot-ankle complex in varying conditions. The foot is capable of accommodating the stress imposed on the joint by the body weight in a variety of terrains and activities. [40] To ensure seamless performance of activities like as walking, running, jumping, and leaping, the foot must role as a rigid support, which is achieved through the stability of the foot. [40-41] Conversely, it must also have a level of mobility to effectively absorb shock, reduce rotational movements originating from adjacent joints, and adapt to irregular surfaces. [42]

The plantar aponeurosis, a flexible tendinous tissue that extends across the bottom of the feet from the part of heel bone to the joints connecting the toe bones., plays a crucial role in maintaining this is a structure through by storing potential energy through stretching when the arch is compressed.. [43-44] This powerful energy is also utilized to transmit pressure applied to the front part of the foot to enable effective forward movement. [43-45] Additionally, the ankle and the foot-ankle complex should not only respond to forces from the ground, but also manage rotational forces originating from the spinal column, pelvis, hip, and knee. [32,33]

The foot composed of 26 bones, 33 joints and 19 muscles, all arranged in a manner that enables it to adapt to the various demand placed upon it. The ankle joint complex has been divided into three functional regions for better understanding. These three functional regions are respectively the front foot, the midfoot, and the hindfoot. [34,35]

The forefoot (front part) is consist of 14 phalangeal bones from five metatarsals and their extensions. The big toe is comprised of distal and proximal phalanges, while the four other toes are comprised of proximal, middle, and distal phalanges. It is considered that the shorter length of the first metatarsal compared to the other four metatarsals enhances the efficiency of the arch of the foot. [36] The sesamoid bones located on the plantar aspect of the first metatarsophalangeal joint serve to provide a mechanical advantage for the flexor tendons and to ensure the distribution of forces during walking and standing. The biomechanical function of the forefoot is to rapidly strike the ground during the propulsive stages of gait. [37]

The midfoot is comprised of the midtarsal joint, which is made up of the lateral calcaneo-cuboid and medial talo-navicular joints. Midfoot participates in the structure of the longitudinal and transverse arch that distribute the weight of the body during movement. [38,39]

The hindfoot is comprised of the subtalar joint, created by the lower part of the talus bone and the upper part of the calcaneus bone . The hindfoot is made up of the calcaneus bone, which is the broadest and most robust bone found in the foot, and the talus, which is the second largest tarsal bone. [40,41]

2.3. Foot Ankle Joint

2.3.1. Ankle Joint

The talocrural joint, also commonly known as the ankle joint, is a joint situated between the distal portions of the fibula an tibia and the trochlea of the talus. It comprises of three individual joints, namely the distal tibiofibular joint, tibiotalar joint, and fibulotalar joint. [42] The ankle joint is structurally configured in a bow-like shape, and is functionally classified as a synovial hinge joint. Its primary movement is that of plantarflexion and dorsiflexion, however, due to the absence of a single axis, rotational movements are also present during these actions. In addition, dorsiflexion of the ankle joint is accompanied by eversion, while plantarflexion is accompanied by inversion. The functional stability and balanced of the ankle joint requires stability in the talofibular joint. However, the mobility of the joint is primarily related to the fibula. It is generally believed that the fibula does not have a weight-bearing function. [43]

2.3.2. Subtalar Joint

The subtalar (talocalcaneal) joint connecting the talus bone and the calcaneus. The most primary movement of the subtalar joint is pronation-supination. The muscles responsible for pronation in the joint are the peroneus longus and peroneus brevis. [44] In addition to these muscles, the extensor digitorium longus muscle also helps with pronation movements. The primary muscles responsible for supination are the tibialis anterior (in dorsiflexion) and tibialis posterior (in plantarflexion), while the auxiliary muscles are the flexor digitorum longus and flexor hallucis longus muscles. In the subtalar joint, the term "varus" is used for supination and "valgus" for pronation. The total joint movement range is considered to be between 40-60 degrees. [45,46]

2.3.3. Midtarsal Joint

The joint in the middle of the foot referred to as the transverse tarsal joint, Chopart joint, or midtarsal joint. is a joint formed by the talonavicular and calcaneocuboid joints. It is a functional joint between the bones that form the hindfoot (talus-calcaneus) and the bones that form the midfoot (navicular-cuboid). Although the midtarsal joint is anatomically composed of two different joints, it is functionally defined as a single unit. [47]

A joint has two movement axes, longitudinal and oblique. The plantarflexion-dorsiflexion movement occurs on the oblique axis, while the eversion-abduction or inversion-adduction movement occurs on the longitudinal axis. [48]

2.3.4. Tarsometatarsal Joint (Lisfrank Joint)

It is a plane-type joint located in the lateral part of the foot located between the cuboid bone and the fourth and fifth metatarsals, and medially between the first three metatarsals and the three cuneiforms. The structures that limit movements in the joint are ligaments. The joint allows for limited movements including extension, flexion, supination, and pronation. It is important for providing stability. [49]

2.3.5. Metatarsofalangeal Joints

Metatarsofalangeal (MTF) joints are joints located between the bases of the heads of the metatarsals and the proximal phalanges and. Each metatarsal forms a joint with its corresponding phalanx. [50] The MTF joints allow for flexion/extension and abduction/adduction movements. It is commonly believed that the muscles controlling the MTF joints are mostly located more distally and actuate the proximal phalanges over the fixed metatarsal bones. However, in closed chain activities of the lower extremity, such as when the fingers are fixed to the ground, it is the metatarsal bones that move. This variability in the MTF joints allows for the heel lift during walking or running as the foot rises off the ground, with the fingers fixed to the ground and the MTF joints providing the motion. [51]

2.3.6. Interphalangeal Joint

The interphalangeal joint is a hinge type joint located between the distal and proximal sections of the toes. It is a ginglymus joint and allows for flexion-extension movements. The muscles responsible for flexion at this joint are the flexor digitorum longus and the flexor hallucis longus muscles. The muscles responsible for extension are the extensor digitorum longus and extensor hallucis longus.During the toe-off phase of walking, the 1st metatarsofalangeal joint is active. The 10° dorsiflexion that occurs at the joint generates the plantarflexor moment necessary for toe-off. [52]

2.4. The Ankle Joint-Ankle Ligaments

2.4.1. Ligaments of the Ankle Joint

Posterior and Anterior Tibiofibular Ligaments

In the distal tibiofibular joint, the distal tibia and fibula are separated by fibroadipose tissue, thus they do not make full contact. The capsule of the ankle joint is also rather delicate and is particularly susceptible to weakness in the anterior and posterior regions. As a result, the anterior and posterior tibiofibular ligaments are primarily responsible for ensuring stability in the continuity of the mortise. [53]

Medial collateral ligament

The medial collateral ligament (MCL) is also known as the deltoid ligament and is Y-shaped. It connects the two sides of the medial malleolus to the anterior and posterior surfaces of the talus and calcaneus, maintaining the stability of the medial-lateral joint and playing a key role in the stability of the subtalar joint. The MCL helps control medial distraction stress on the ankle joint and assists in controlling joint movements that occur at the end points, especially with calcaneal eversion. [54]

Lateral collateral ligament

The lateral collateral ligament (LCL) ,which a band of connective tissue on the outside of the knee joint that helps to stabilize the joint by preventing excessive sideways movement. Also, composed of three separate bands, namely the anterior talofibular, posterior talofibular, and calcaneofibular ligaments. The ligament helps control varus stress and excessive joint movement. In general, the components of the LCL are weaker and more prone to injury than those of the MCL. [55]   The anterior talofibular ligament extends from the anterior of the lateral malleolus to the medial of the talar neck and is the most commonly injured ligament among the lateral ligaments. The calcaneofibular ligament extends from the apex of the lateral malleolus to the lateral surface of the calcaneus, limiting inversion in the talocrural joint and subtalar joint, particularly during full dorsiflexion. The posterior talofibular ligament originates at the back and inner border of the lateral malleolus. and attaches to the lateral tubercle of the talus, primarily stabilizing the talus within the mortise. This ligament is involved in approximately two-thirds of lateral ankle ligament injuries, along with the calcaneofibular and anterior talofibular ligaments. [56]

2.4.2. Ankle ligaments

Talocalcaneal ligaments

The ankle ligaments are the structures that connect the bones in the ankle joint and provide stability to the joint. There are four types of tarsal-calcaneal ligaments, which are the interosseous tarsal-calcaneal ligament, lateral tarsal-calcaneal ligament, medial tarsal-calcaneal ligament, and posterior tarsal-calcaneal ligament. These ligaments contribute to the secondary stability of the subtalar joint and assist the calcaneofibular and deltoid ligaments, which provide the important and primary stability of the subtalar joint. [57]

Plantar and Dorsal calcaneonavicular ligaments

The dorsal and plantar calcaneonavicular ligaments are two separate ligaments that connect the calcaneus bone to the navicular bone in the foot. The plantar calcaneonavicular (spring) ligament is a strong ligament that extends from the sustentaculum tali to the plantar surface of the navicular bone. [58]   The dorsal calcaneonavicular ligament is part of the bifurcate ligament and extends between the distal portion of the calcaneus and the dorsal surface of the navicular bone. [58,59]

Dorsal talonavicular ligaments

The dorsal talonavicular ligament has two components, superficial and deep. It originates from the superomedial edge of the neck of the talus and inserts into the dorsum of the navicular bone. [58,59]

Dorsal and plantar calcaneocuboid ligaments

The dorsal and plantar calcaneocuboid ligaments connect the calcaneus and cuboid bones and assist in stabilizing the calcaneocuboid joint. The dorsal calcaneocuboid ligament is located on the dorsal aspect of the foot, and the plantar calcaneocuboid ligament connects the calcaneus and cuboid bones on the plantar aspect of the foot. [59-60]

Long plantar ligament

The long plantar ligament, originates from the anterior calcaneal tuberosity and inserts into the plantar surface of the base of the lateral three metatarsal bones which are calcaneus bone to the cuboid bone and the metatarsal bone and it is the longest ligament in the foot. It works in conjuction a with the plantar calcaneocuboid ligament to offer stability to the lateral column of the foot. [62]

Dorsal and plantar cuboideonavicular ligaments

The dorsal and plantar cuboideonavicular ligaments connect the cuboid and navicular bones transversely. The dorsal cuboideonavicular ligament is triangular in shape and attaches from the dorsal surface of the navicular to the dorsum of the cuboid. The plantar cuboideonavicular ligament is rectangular in shape and attaches from the inferior surface near the medial edge of the cuboid to the inferior surface of the navicular. [59]

Each cuneiform bone is connected to the navicular bone by both dorsal and plantar ligaments. There are three dorsal and three plantar cuneonavicular ligaments. The dorsal cuneonavicular ligaments originate from the distal portion of the dorsal surface of the navicular and insert into the dorsum of the cuneiform bones. The plantar cuneonavicular ligaments originate from the plantar surface of the navicular and insert into the plantar surface of the cuneiform bones. [60-62]

Kuneokuboid ligaments

The Kuneokuboid ligaments are three ligaments that connect the cuboid bone to the third cuneiform bone in the dorsal, plantar and interosseous directions (Kelikian & Sarrafian, 2011). [63]

Interkuneiform ligaments

The Interkuneiform ligaments are five ligaments, two dorsal, two interosseous and one plantar, that connect the first cuneiform to the second cuneiform and the second cuneiform to the third cuneiform. These ligaments are short and transversely located. [63]

Tarsometatarsal ligaments

The Tarsometatarsal ligaments connect the bases of the metatarsal bones to the kuneokuboid block. These ligaments, located in the plantar and dorsal directions, are responsible for the stability of the tarsometatarsal joints (Kelikian & Sarrafian, 2011). [63]

Intermetatarsal ligaments

The Intermetatarsal ligaments are the ligaments between the metatarsal bones that provide intermetatarsal stability. There are two rows of ligaments in the dorsal and plantar directions, with the plantar ligaments being stronger than the dorsal ligaments. [64]

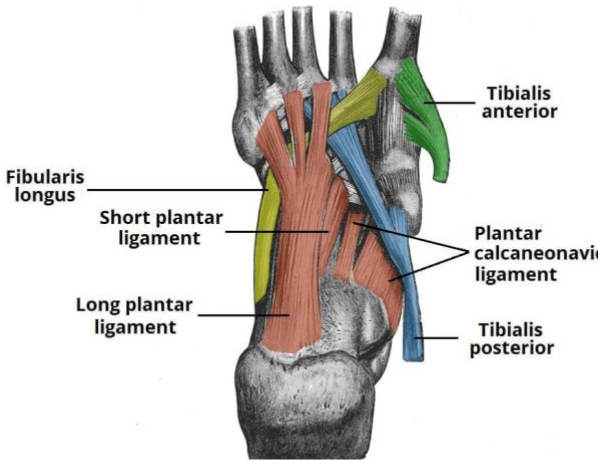

Figure 2.1 Foot Ligaments

2.5. Ankle- Foot Muscles

2.5.1. Extrinsic Muscles

The extrinsic muscles of the foot and ankle have a wide range of movement and allowing for movement of the foot and toes. The movements produced by these muscles are determined by the position of the lines of tension, based on the axis of rotation. [65]

The muscles in the anterior (front) region of the leg

This groups pf muscles include the tibialis anterior, extensor hallucis longus, extensor digitorum longus, and peroneus tertius muscles. These muscles are responsible for dorsiflexion (lifting the foot upwards) and eversion (moving the foot away from the midline of the body).. As a group, they originate from the proximal tibia, the neighboring fibula, and the interosseous membrane. The potential movements of these muscles are determined by their relationships with the rotational axes of the talocrural and subtalar joints. They cause dorsiflexion in the talocrural joint and inversion or eversion in the subtalar joint. The deep peroneal nerve innervates all four muscles, and they all play a role in dorsiflexion as one of their primary movements. [66-67]

The muscles in the lateral region of the leg

The muscles located in the lateral region of the leg include the fibularis longus (also known as peroneus longus) and fibularis brevis (also known as peroneus brevis) muscles. These muscles are responsible for eversion (moving the foot away from the midline of the body) and plantar flexion (pointing the foot downwards). [67,68]

The muscles in the posterior (back) region of the leg

The muscles situated in the back (posterior) region of the leg can be categorized into two groups - superficial and deep. The superficial group comprises the gastrocnemius, soleus, and plantaris muscles. On the other hand, the deep group consists of the tibialis posterior, flexor digitorum longus, and flexor hallucis longus muscles. All the muscles in the posterior region of the leg are stimulated by the tibial nerve, and their primary movement is plantar flexion. [68]

2.5.2. Instrinsic Muscles

The intrinsic muscles are those that are present within the foot. These muscles are primarily active during the propulsion phase of activities like walking and running. They work in coordination to provide support to the elevated Medial Longitudinal Arch (MLA) and aid in stabilizing the foot during the propulsion phase while the plantar flexors are contracting. The only intrinsic muscle located in the top (dorsum) of the foot is the extensor digitorum brevis muscle, which is responsible for extending the toes. In contrast, the intrinsic muscles in the bottom (plantar) surface of the foot are arranged in four different layers. The first layer comprises the flexor digitorum brevis, abductor hallucis, and abductor digiti minimi muscles.. [69-70]

The second layer includes the lumbricals and the quadratus plantae. The third layer includes the abductor hallucis, flexor hallucis brevis, and flexor digiti minimi. The fourth layer consists of dorsal and plantar interosseous muscles. The outermost layer is covered by the plantar fascia. [70]

2.6. Plantar Fascia

The plantar fascia is a thick band of connective tissue that runs along the bottom of the foot, connecting the heel bone to the toes.. Its key function is to assist in the stabilization of the skin on the plantar surface of the foot and to maintain the shape of the foot. The plantar fascia attaches from the connective tissues around the medial tuberosity of the calcaneus and the Achilles tendon, and runs all the way to the joint capsules of the MTF. [70,71]

The tensile strength of the plantar fascia is twice that of the strongest ligament in the ankle, the deltoid ligament. The plantar fascia covers the foot's arches and plays a crucial role in maintaining the foot's alignment by providing support. [72]

2.7. Foot Alignment

The relationship between the ankle, foot, and ground is a critical component of normal walking. Proper foot alignment is important for maintaining stability and balance during movement and preventing injuries. The way the ankle and foot function is influenced by the intricate interplay between anatomy, physics and physiology. However, proper alignment of the ankle and foot is also necessary for optimal function of the hip and knee during walking . [73]

Walking is a cyclical process that begins with the foot contacting the ground, followed by the stance phase, and ending with the swing phase, with each cycle lasting a specific period of time. During the stance phase of the walking cycle, the relationship between the ankle and foot and the ground is described by three "rockers." In normal walking, the first part of the foot to make contact with the ground is the ball of the foot. The ankle then dorsiflexes until the foot is flat on the ground. This movement is controlled by the eccentric activity of the ankle dorsiflexor muscle group. The first rocker or heel rocker occurs from heel strike to foot flat. As the body weight is shifted forward, the tibia moves over the foot with the help of ankle dorsiflexors. The motion is governed by the contraction of ankle plantar flexor muscles during their eccentric phase. The second rocker or ankle rocker occurs as the tibia moves forward over the foot. Just before the other foot makes contact with the ground and during the gait cycle, as the reference foot goes through the swing phase, the heel initially lifts off the ground and the ankle joint dorsiflexes. As a result, there is movement at the metatarsophalangeal joints of the forefoot, which allows the foot to clear the ground. This is necessary to ensure a smooth transition into the subsequent stance phase of the gait cycle. The ankle plantar flexor muscles play a vital role in controlling this motion, as they engage in concentric activity. This results in the third rocker or forefoot rocker, which takes place when the ankle starts to plantarflex. [74]

2.8. Arches of the Foot

The foot contains three arches, namely the transverse, medial longitudinal, and lateral longitudinal arches. The arches of the foot are maintained by a combination of bony and soft tissue structures, including the shape of the bones, ligaments, tendons, and muscles. The medial longitudinal arch (MLA) comprises the calcaneus, talus, navicular, medial cuneiform, and first metatarsal. The lateral longitudinal arch (LLA) is composed of the calcaneus, cuboid, and fifth metatarsal bones. The transverse arch (TA), on the other hand, is formed by the bases of the cuboid, cuneiform bones, and metatarsal bones[75]

These three arches are supported by the foot bones, muscles, and ligaments, and play an key mechanism in foot structure. The arches increase the weight-bearing surface, optimize load distribution, and provide stability to the foot, thereby preserving its alignment and enhancing its functionality. [76]

The arches cushion the impact and reduce vibrations during walking. The height and flexibility of the arches assist in performing various walking styles and activities. Additionally, the proper function of the foot arches helps prevent foot and ankle problems by distributing the weight correctly. [77]

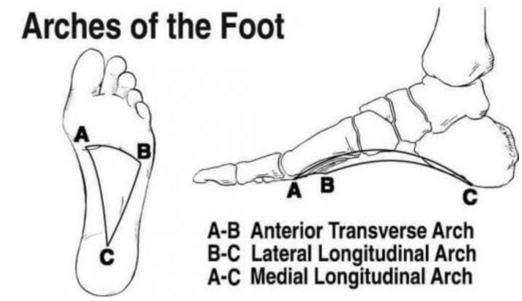

Figure 2.2 Arches of the Foot

2.8.1. Medial Longitudinal Arch

uch as the first three metatarsals, the navicular, cuneiforms, talus, and calcaneus. The hindfoot is formed by the talus and calcaneus bones at the subtalar joint, which features three facets on both bones. The talus bone articulates with the navicular bone to form a ball-and-socket joint. These various components work together to enable the proper functioning of the medial longitudinal arch of the foot. [78]

The medial longitudinal arch is essential for shock absorption and propulsion during walking. During the stance phase of the gait cycle, the arch is lengthened and flattened as the forefoot pronates, and elastic tendons and ligaments become stretched, storing mechanical energy. This energy is then released during the push-off phase of walking to aid in efficient propulsion. A ball and socket joint are between the navicular and talus, with the proximal portion of the navicular forming a concave shape. [79]

2.8.2. Lateral Longitudinal Arch

The calcaneus, cuboid, fourth, and fifth metatarsals come together to create the lateral longitudinal arch of the foot. Unlike the medial longitudinal arch, this arch is less curved and has restricted flexibility.The apex of the cuboid bone is positioned approximately 3-5mm above the ground. The height of the lateral longitudinal arch from the ground is less than that of the medial longitudinal arch, which results in a proportionate load-bearing distribution during movement. [80]

The human foot's longitudinal arch is a sophisticated mechanical system that needs to be adaptable on uneven terrain while also providing enough rigidity to enable the foot to function efficiently during walking and running. The arch's height influences the alignment of the lower limb, with a higher arch leading to supination alignment and a lower arch resulting in pronation. [81]

2.8.3. Transverse Arch

The transverse arch is established through the basis of the metatarsals and the tarsal bone articulation. It can be further divided into three distinct segments, namely, the anterior transverse arch, the posterior transverse arch, and the midtransverse arch. The section situated between the first and fifth metatarsals constitutes the anterior transverse arch.

The intermetatarsal ligaments and the transverse part of the adductor hallucis muscle play a critical role in stabilizing the anterior transverse arch. The navicular and cuboid bones form the posterior transverse arch, and the tibialis posterior muscle stabilizes it. The midtransverse arch is formed by the three cuneiform bones and the cuboid bone. Stabilization is provided by the peroneus longus muscle. [82]

2.9. Foot Posture

The shape of arch which name is MLA commonly used to describe foot posture, which is typically categorized as normal (rectus), low-arched (planus), or highly-arched (cavus). Various methods, such as visual assessment, footprint measurements, and radiographic analysis, have been employed to classify foot posture. However, there is no consensus on the most suitable approach to use. [83] The foot's static posture may not always accurately reflect its functionality. Therefore, foot function is also determined by how the foot moves during walking. In terms of foot biomechanics during gait, the amount of lowering or elevation of the medial longitudinal arch and the location of plantar loading distribution are key factors. A foot with a prominent lowering of the medial longitudinal arch and increased medial plantar loading during gait is termed "pronated," while a foot with a greater elevation of the medial longitudinal arch and more lateral plantar loading distribution during gait is referred to as "supinated." These terms describe the relative position and alignment of the bones, joints, and soft tissues of the foot and their impact on the foot's ability to function efficiently and effectively during gait . [84]

2.10. Foot Pressure in FootBall Players

According to the literature, plantar pressure measurements differ between the non-dominant and dominant foot. [85] In one study, the highest pressure values of young soccer players were reported to be higher in the non-dominant foot, the hallux, the 5th metatarsal, and the medial arch compared to other areas. In the results of foot pressure evaluated in 11 regions in female soccer players, higher pressures were found between the 2nd metatarsal head on the right foot and the 1st and 2nd metatarsal heads on the left foot compared to other areas. [85,86]
Another study conducted on individuals who play soccer and those who do not play soccer found that the soccer players in the study generally had higher peak pressure values on the right foot compared to the left foot. One of the most important reasons for this is thought to be professional soccer players' use of their right leg as the dominant leg. In professional soccer players, lower pressure values were observed on both feet's heel medial and lateral compared to non-

athletic individuals. When compared to non-athletic individuals, only the 5th metatarsal head had higher foot pressure values, particularly on the right foot, when looking at all contact areas. This situation was explained by the greater dominance of the right leg in training and matches, and its more active use in quick turns outward. [87]

2.11. Pronation of Foot

Pronated foot or pronation is a normal movements of the foot that occurs in all activites like walking and running. It involves a combination of motion at the subtalar joint, talonavicular joint, and midtarsal joint, resulting in an inward rolling of the foot and a flattening of the arch. [88] Excessive pronation involves the flattening of the arch on the inside of the foot and increased flexibility of the middle of the foot. However, this movement can also require the neuromuscular system to work harder to stabilize the foot and keep the body upright.. When excessive pronation occurs, also known as overpronation, it can lead to a variety of biomechanical changes that can result in injuries or discomfort. [88]

These changes include increased stress on the foot and lower leg, decreased shock absorption, alterations in gait, and an increased risk of foot and lower leg injuries like plantar fasciitis, shin deformity, and stress fractures. [89]

These biomechanical changes occur because foot pronation deformity can cause the foot to flatten and elongate, increasing stress on the muscles, tendons, and ligaments in the foot and lower leg. The muscles responsible for foot pronation, such as the tibialis posterior and peroneus longus, may become overactive, while other muscles in the foot and lower leg, such as the peroneus brevis or tibialis anterior, may become weaker or tighter than normal. Additionally, the inward rolling of the foot can reduce the foot's ability to absorb shock, leading to increased stress on the joints and bones. This altered movement pattern can also lead to further biomechanical changes and an increased risk of injury. [89,90]

Studies investigating the use of orthotic intervention in individuals with excessive pronation have provided evidence to support the claim. Researchers have observed alterations in muscle activity at the ankle, knee, and hip when the degree of pronation is effectively modified.This movement helps to distribute the forces of impact across the foot and lower leg.

It's important to note that treatment for foot pronation deformity may not always be necessary, as mild cases may be alleviated with simple interventions such as proper footwear or stretching and strengthening exercises. However, in more severe cases, orthotics or other forms of treatment may be necessary to correct the underlying biomechanical changes and reduce the risk of injury. [90]

2.12. Performance Parameters in FootBall

Performance in football, which is the most popular and widespread sport among sports, depends on numerous factors such as technical, biomechanical, tactical, mental, and physiological factors. Football is a highly coordinated team and contact sport where strength, explosive power, speed, agility, flexibility, muscular endurance, balance, cardiorespiratory endurance, coordination, and many other factors contribute to athletic performance. [91] While aerobic energy systems are dominant in football, it is also a sport where anaerobic energy is important.

During a match, elite athletes demonstrate a running performance of approximately 10 km at an intensity close to the anaerobic threshold for about 90 minutes (80-90% of maximum heart pressure). They make sprints lasting 2-4 seconds every 90 seconds while running. In addition to energy systems, good lower extremity muscular strength and endurance are required for a 90-minute match or training. [92]

Explosive movements, such as jumping, kicking, ball interception, running, turning, and changing direction, which can be achieved through strong contractions, are performed to maintain balance during performance in contact football and control the ball during an opponent's attack. [93] Both static and dynamic balance are required to prevent losing control, falling, and the risk of injury. Studies show that balance training with athletes increases agility and vertical jump height. [94] Researchers have also found that improved balance ability and postural control lead to better muscle strength development and can reduce the amount of muscle involved in stabilization by allowing more muscles to contribute to force production during movement. [95] In addition to improving postural control in athletes, studies have shown that it can also help improve technical skills in football.

2.13. Assessment of Food Pronation

2.13.1. Visual inspection

This method involves observing the foot during static or dynamic tasks such as standing, walking, or running. It can provide a qualitative assessment of the degree of pronation and the extent of arch collapse, but it is limited by subjectivity and may not be reliable for clinical or research purposes. [96]

2.13.2 Gait analysis

This method involves analyzing the kinematics and structure of the lower limb during walking or running, using techniques such as motion capture and force plate measurements. It provides a more objective and quantitative assessment of pronation, including the magnitude, timing, and duration of the pronation phase. Gait analysis can also provide information about other gait parameters that may be relevant to injury risk, such as foot strike pattern and joint angles. [97]

2.13.3. Foot posture index (FPI)

The FPI is a standardized measure of foot posture that evaluates different aspects of foot alignment, including the position of the heel, the arch height, and the forefoot position. It provides a quantitative score that can be used to categorize the foot posture as highly pronated, neutral, or highly supinated. The FPI has been shown to be a reliable and valid measure of foot posture, and it can be used in both clinical and research settings. [97]

2.13.4. Foot pressure measurement

This method involves using pressure-sensitive insole or mats to measure the distribution of forces under the foot during different tasks. It provides information about the timing and magnitude of pronation, as well as other aspects of foot function such as pressure distribution and balance. Foot pressure measurement has been shown to be a reliable and valid method for assessing foot function, and it can be used in both clinical and research settings. [98]

2.13.5. Navicular Drop Test

The navicular drop test is a clinical assessment used to evaluate the degree of foot pronation or collapse of the medial longitudinal arch. The test involves measuring the change in position of the navicular bone, which is one of the tarsal bones located in the midfoot, during weight-bearing activities such as standing or walking. [99]

By using a combination of these assessment methods, a more comprehensive and accurate evaluation of pronation can be achieved. This information can be useful for identifying individuals at risk of injury or for developing interventions to improve foot function and reduce injury risk. [100]

2.14. Treatment protocols of Foot Pronation

Treatment protocols for foot pronation typically involve a combination of exercises, footwear modifications, and sometimes orthotics. The main goals of treatment are to improve foot and ankle stability, reduce foot pronation deformity, and relieve pain. [101]

In some cases, surgery may be necessary to correct severe cases of foot pronation. However, this is typically only recommended after other treatment options have been exhausted. [101]

3. MATERIAL AND METHODS

3.1. Subjects

This randomized controlled study consisted of 30 elite male football players having foot pronation deformity approved by the Yeditepe University Faculty of Health Sciences Ethics Committee (No: 202203Y0193) (Appendix A). The study was also registered on ClinicalTrials.gov (NCT05821803). The investigation has been performed following the principles of the Declaration of Helsinki and Good Clinical Practice. The inclusion and exclusion criteria of the study are indicated below.

3.1.1. Inclusion Criteria

- Voluntary participation in research
- To be between the ages of 18-45
- Who has not been exercising regularly in the past three months
- foot pronation deformity (navicular drop test over 10 mm)
- Professional football players at least 5 years

3.1.2. Exclusion Criteria

- Previous surgery for musculoskeletal structures in both lower extremities,
- Prior occurrence of fracture in both lower extremities
- Neurological deficit or disease,
- Acute injury of the musculoskeletal structures of other joints of the lower extremity affected joint function and integrity within the last 3 months,
- Have any other knee pathology,
- Balance or vestibular disorder.

3.1.3. Flow Chart of the Study Process

Elite football players (N=35) who came for foot analysis and insole to FootBalance Center between June 2022–July 2022 were invited in to study. The researchers provided an explanation of the study's purpose and procedures, and each football player was required to provide informed written consent before participating (Appendix B). Once baseline assessments were done, football players who met the inclusion criteria were divided into the Insole Group (n=15) and the Insole+Exercise Group (n=15) using block randomization. Y Balance Test to evaluate dynamic balance, flamingo test to evaluate static balance, vertical jump test for jump performance were applied to all athletes, respectively. These tests were measured before the insole and exercise protocol and the tests were repetead after 4 week later for understand and compare the effects of treatment. None of the athletes participating in the study were excluded from the study for any reason. (Figure 3.1. Flow Chart of The Study)

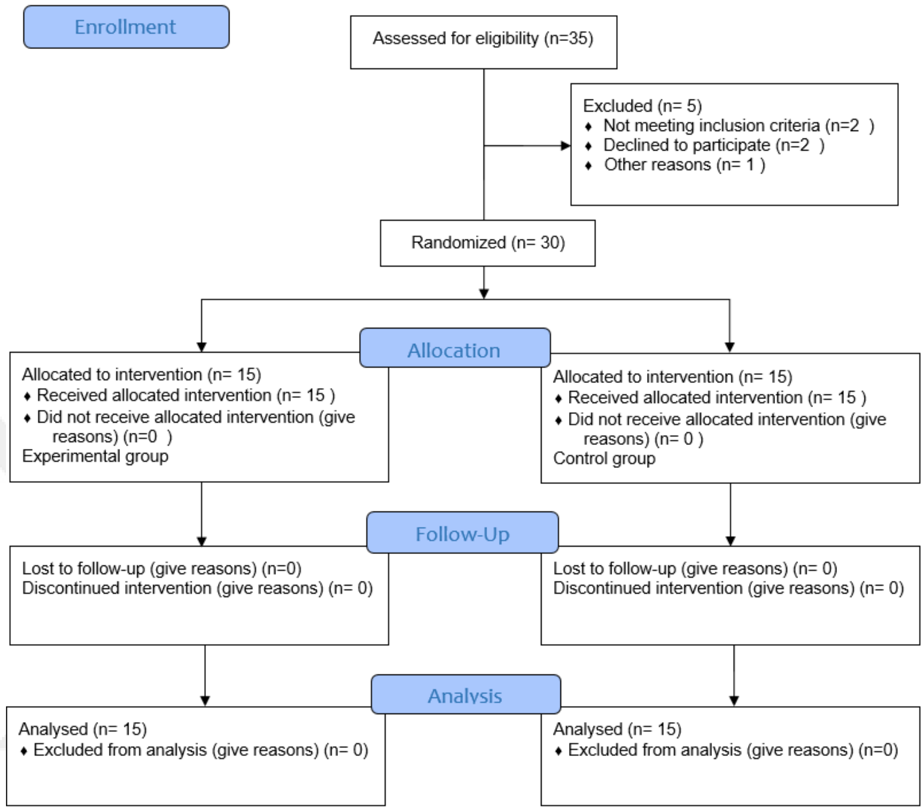

Figure 3.1. Flow Chart of The Study

3.1.4. Study Protocol

The level of foot pronation of all professional football players who participated in the study was determined by conducting a navicular drop test. Performance tests were administered to all football players prior to the intervention. Subsequently, the insole group received personalized insole made at the FootBalance Center for four weeks, while the insole+exercise group received personalized insole and were also instructed to perform foot pronation exercises twice a week for four weeks. At the end of four weeks, performance tests were administered and analyzed for both groups.

3.2. Assessment Methods

3.2.1. Structured Questionnaire for Patient's Demographic Characteristics

A form called "General Information Evaluation Form" prepared to evaluate the demographic characteristics of the participants.

This form, prepared in accordance with the protocol of the study applied to all participants at the beginning of the study. With this form, the participant's demographic characteristics, socio-demographic status, diseases and deficits, past or current traumas, surgical practices, sleep patterns, medications, exercise status, and smoking/alcohol/caffeine use were questioned. (APPENDIX 3)

3.2.2. Navicular Drop Test

In 1982, Brody introduced the Navicular Drop Test (NDT) as a technique for measuring the degree of foot pronation in runners. [102] The navicular drop test is a clinical assessment used to measure the degree of medial longitudinal arch collapse or flattening during weight-bearing activities such as standing or walking. The test involves measuring the vertical displacement of the navicular bone in response to loading. This test is easy to apply in anywhere and inexpensive to apply in practice. To perform the test , we marked the navicular tuberosity of the football players foot while they were in a standing position. Then, we asked them to sit and placed a mark at the level of the navicular tubercle again. We measured the vertical displacement of the navicular tuberosity with a tape measure and recordes as centimeter (cm). The difference between the standing and sitting measurements provided an indication of the degree of medial longitudinal arch collapse or flattening. A greater navicular drop suggested greater pronation of the foot. [103]

Figure 3.2. Navicular Drop Test Assessment

3.2.3. Y Balance Test

We used Y Balance Test as a performance test within the scope of dynamic balance evaluation. The Y-balance test is a functional movement assessment that can be used to evaluate the balance and stability of football players. It involves reaching in three different directions while standing on one foot at the center of a "Y" shaped pattern marked on the ground. The Y-balance test is a functional movement assessment that can be used to evaluate the balance and stability of football players. [104] It involves reaching in three different directions while standing on one foot at the center of a "Y" shaped pattern marked on the ground. There have been many studies in the literature that have used the Y balance test, especially in football players, and we chose to use this test for dynamic balance because it is showed good interrater test-retest reliability football players used to it. Explaining the test was made easy due to football players' frequent use of it during the season.

Before initiating the assessment, we afforded participants the opportunity to perform three trial reaches in each of the three testing directions. The test commenced with participants being instructed to reach their limb as far as possible without losing their balance while maintaining a single-leg stance. We recorded the distances reached by the participant in each direction, with the test being repeated three times for each direction. A 15-second rest period was provided after each direction attempt to ensure sufficient recovery. Normalized reach distances were calculated for each direction by dividing the average of the three measured repetitions by the length of the participant's lower extremity, as measured from the anterior superior iliac spine (ASIS) to the distal apex of the medial malleolus, and multiplying by 100. [105]

The measurements applied respectively in the following aspects:

• Right Anterior, Left Anterior

• Right Posteromedial, Left Posteromedial

• Right Posterolateral, Left Posterolateral

Figure 3.3. Y-Balance Test

3.2.4. Flamingo Balance Evaluation

The Flamingo balance test assesses static balance and dynamic balance, as well as the strength of the leg, pelvic, and trunk muscles. It can be used for mass investigations. The reason for selecting this test is its cost-effective test that assesses static balance and simple.The validity and reliability of the test have been established, with an ICC coefficient of 0.71. [106,107]

To execute the test, we had the participant stand on a narrow and raised beam without wearing shoes, and balance on their dominant leg while flexing the other leg at the knee and bringing the foot close to the buttocks. The evaluator then released contact with the participant, initiated the stopwatch, and measured the duration until the individual lost balance (either by falling off the beam or releasing the held foot). The test was repeated, and the number of falls in 60 seconds of balance maintenance was tallied. If there were more than 15 falls within the first 30 seconds of the test, the assessment was halted, and a score of zero was assigned.

Figure 3.4. Flamingo Test

3.2.5. Vertical Jump Test

The vertical jump test is a method of assessing an athlete's explosive power and physical capabilities in the lower body. We chose this test because it is commonly used in football as well as in return-to-play assessments after injuries.To execute the test, we required the individual to perform a countermovement jump, where the knees were flexed to 90 degrees before being extended, before that the longest position where they raised their arms at the edge of the wall was noted, and the point they touched after the jump was noted. We measured the difference between them using a tape measure. The test involved three repetitions with a five-minute interval between them, and we considered the highest jump for analysis. [108]

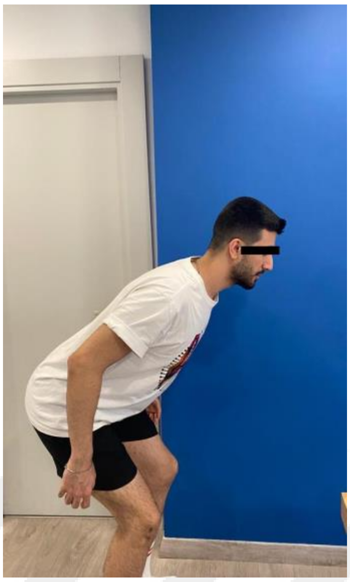

Figure 3.5. Vertical Jump Test

3.2.6. Vas Score for Pain

The Visual Analogue Scale (VAS) is a widely used response format in health research, typically employed to assess pain and other related factors. It is commonly displayed as a solitary line. Alternatively, the Numeric Rating Scale (NRS) presents as a thick line made up of blocks, resembling a row of bricks. This format comprises 11 categories spanning 0 to 10. Research has demonstrated that both the VAS and NRS formats are comparable. The Visual Analog Scale (VAS) is a tool that exhibits good validity and excellent reliability, indicating that it accurately measures what it is intended to measure and produces consistent results. It also displays moderate distribution-based responsiveness, meaning that it can detect meaningful changes in a population over time, and good anchor-based responsiveness when compared to multi-item questionnaires. [109] We assessed the alterations in pain experienced during matches over a four-week intervention period in both the insole group and the insole+exercise group. Participants were asked to rate the changes in both numerical and verbal terms.

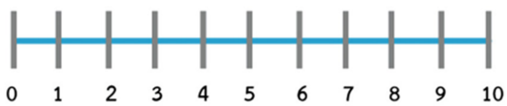

Figure 3.6. VAS Scale

4. INTERVENTION

In our study, participants in two groups used insole moreover, the participants in insole+exercise group performed a four-week structured foot exercises including short foot exercises, towel curl exercises, heel to raise and tennis ball exercises under the guidance of a physiotherapist. The exercise protocol, the exercise group participants performed exercises to activate their plantar short foot muscles.

4.1. Exercise Protocol

The Short Foot Exercise is a technique that involves the contraction of the foot muscles to shorten the foot in the anteroposterior direction, without flexing the toes, and balance the load of the three support points of the foot. [110] The level of difficulty is progressively increased through variations such as sitting, standing, and half-squat positions. [111] The football players started with a 15-minute exercise in the sitting position, then progressed to 7.5 minutes in sitting and standing positions, and eventually to 5 minutes in sitting, standing, and half-squat positions. We asked them to visually follow the movement and provided instructions throughout the exercise. The short foot exercise was the most challenging for the footballers to analyze, understand and apply to their foot muscles. These directions were motivational in nature, encouraging them to continue and to engage their foot muscles.

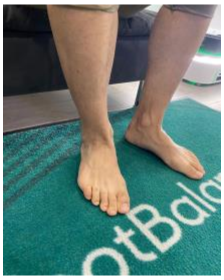

Figure 4.1.1. Short foot exercise standing

Figure 4.1. Short foot exercise sitting

Figure 4.1.2. short foot exercise half-squad

The towel curl exercise requires the individual to bunch up a towel using their toes and is performed on a smooth surface with or without the use of dumbbells. [112] We emphasized the importance of fully stretching their toes and using all the muscles in their feet while picking up the towel in the towel curl exercise. Initially, the exercise is performed without weights while seated for a period of 2 weeks, after which dumbbells weighing 2 kg are added. The exercise is completed three times per week, with three sets per week and each set consisting of 5 minutes.

Figure 4.2. Towel Curl Exercise

Heel to toe raises with tennis ball exercises, participants were 1 set of 12 repetitions using tennis ball with their heelas and keep that constant tension during the whole exercise. [113] Then, push up with toes while raising heels and repeated 3 times for 4 weeks. [114] During the first exercise, some athletes dropped the ball occasionally, but after the first repetition, they managed to keep the ball from falling. As part of the exercise, we instructed the football players to look forward and maintain an upright posture. This exercise works on the "Tibialis posterior" and its adjacent muscle tendons.

Figure 4.3. Heel to raise exercise

The tennis ball roll exercise involved rolling a tennis ball under the feet from toe to heel and applying pressure to the inner arch of the sole. [115] The exercise consisted of everyday per week, and with 5 minutes spent per set. [116] The exercise was very easy to apply and understand, so we were able to complete it easily.During the exercise, we instructed the participants to focus their full attention and consciously feel the massage movements of the ball under their feet. The football players reported feeling both immediate relaxation and the massage effect that came with this exercise

Figure 4.4. Tennis roll exercise

4.2. Insole preparation

Insole preparation involved using heated orthotic blanks (Footbalance Systems Ltd., Vantaa, Finland) to create a mold of the foot with neutral alignment, using the windlass mechanism with slightly flexed knees and dorsiflexed first metatarsophalangeal joint. The subjects were instructed to use their insole every day for approximately four weeks before performance test measurements to get accustomed to them. [117]

Figure 4.5. Insole Preparation

4.3 Molding FootBalance %100 Control Insole

The FootBalance 100% Control insole is designed for high-performance sports that require speed. Its slim and tapered shape is perfect for sports footwear that fits tightly, such as cleats, cycling shoes, ski boots, and skates. This insole offers dynamic support and has a minimalist feel. It includes a shaped balance plate that provides strong support, and a narrow heel cup that relieves pressure, improves energy transfer, and adds space. The insole is extra thin, providing better contact with the ground and a better feel of the shoe on the foot. The toe area is wide enough to fit a variety of shoe widths. The 100% Control insole helps to distribute body weight evenly, which increases traction and accelerates movement [118].

Figure 4.6. FootBalance 100% Control Insole

Data analysis

The data analysis was conducted using Statistical Package Analyze for Social Sciences (SPSS) version 25.0. Quantitative variables were presented using mean, standard deviation, median, minimum, and maximum values, while qualitative variables were presented using frequency and percentage values. The normality of numerical variables was tested using the Kolmogorov-Smirnov test. The pre-post measurements taken by athletes were evaluated using paired sample t-test for parametric variables and Wilcoxon test for non-parametric variables. The differences between the groups were determined using One-way ANOVA and Tukey post hoc test for parametric variables and Kruskal Wallis-H test for non-parametric variables. The level of significance was set at $p<0.05$ for all statistical analyses.

To determine the minimum sample size, the effect size was calculated using the values of the main variables before and after the intervention in the previous study group. G-power version 3.1.9.7 from Heinrich-Heine-Universität in Düsseldorf, Germany was used for this calculation.

4. RESULTS

4.1. Descriptive Characteristics of Participants

The study included 30 professional football players with pronation who divided into two groups. The football players in the Experimental Group (EG; n=15; 24± 4.30years old) used insole and also participated the foot core exercise program twice a week for 4 weeks duration. The football players in the Control Group (CG; n=15 23.67 ±4.37years old) just used the insole.

The main demographic parameters comparing the two study groups showed that there was no significant difference in age, weight, height and professional football time according to the results of the independent sample t-test or chi-square test (p>0.05) (Table 4.1.1).

Table 4.1.1. Comparison the sociodemographic parameters between study groups

Variable	Insole	Insole+exercise	t	p value (sig. (2tailed)
Age (year)	23.67± 4.37	24.00±4.30	-0.21	0.83
Weight (kg)	73.2± 7.22	74.1± 8.53	2.34	0.67
Height (m)	179.47± 7.10	175.20± 5.82	1.80	0.83
Professional football time (year)	9.67± 5.31	9.47± 5.05	0.10	0.91

Data expressed as mean ± standard deviation or number (percentage), M= meter, kg= kilogram.

The primary demographic parameters comparing the two study groups showed that there was no significant difference in terms of using insole and dominant side according to chi-square test results (p>0.05) In ınsole group 13 athletes have never used insole before and ınsole+exercise group 12 football player have never used insole before. In both group 13 athletes use left side for dominant and right side for nondominant part. (Table 5.1.2.).

Table 4.1.2. Comparison the demographic parameters between study groups

Variable		Insole	Insole+exercise	t	P
Have you ever used insole	yes	2(13.3)	3(20)	1.00	0.50
	no	13(86.7)	12(80)		
Dominant side	right	13 (86.7)	13 (86.7)	1.00	0.71
	left	2 (13.3)	2 (13.3)		
Important injury knee or foot	yes	0	0	1.00	0.00
	no	15 (100)	15 (100)		

Data expressed as number (percentage).

4.2. Comparison of Performance Tests in Between Groups

An independent sample t-test was used to compare study variables between the two groups. Navicular Drop Test, Y Balance Test, Flamingo Test and Vertical Jump Test applied to evalute foot pronation, dynamic balance, static balance and jump performace respectively. There was no significantly difference in between groups. ($p>0.05$). (Table 4.2.1.).

Table 4.2.1. Comparison of performance test in between groups

Variable	Insole	Insole+exercise	t	p value (sig. (2tailed)
Navicular drop test right (cm)	13.13±1.55	12.93±1.033	0.41	0.68
Navicular drop test left (cm)	13.33± 1.29	12.60±1.18	1.62	0.11
Y Balance Test Anterior Dominant (cm)	68.07±3.05	68.80±1.61	-0.82	0.418
Y Balance Test Anterior NonDominant (cm)	66.40±3.13	67±33	1.49	0.146
Y Balance Test PostMedial Dominant (cm)	99.67±3.24	97.67±2.76	1.81	0.08
Y Balance Test PostMedial NonDominant (cm)	97.40±3.50	96.27±2.68	0.99	0.328

Y Balance Test PostLateral Dominant (cm)	102.07±3.61	100.20±2.42	1.66	0.108
Y Balance Test PostLateral NonDominant (cm)	100.40±4.08	99.53±2.56	0.69	0.011
Flamingo test dominant	1.53±0.91	0.93±0.704	2.01	0.054
Flamingo test dominant	1.53±0.91	0.93±0.704	2.01	0.054
Vertical jump test (cm)	30.73±2.31	1.53±0.64	-1.76	0.089
VAS	6.07±0.96	5.47±0.83	1.72	0.082

Data expressed as mean ±standard deviation, Cm: Centimeter, VAS: Visual Analog Scale

4.3. Changes in Primary Outcomes

An independent sample t-test was used to compare study variables between the two groups.The data in Navicular test right and left has a statisticially significant difference within groups. With in groups, insole+exercise group differences were (0.8±0.41cm), has more significant difference than the insole group changes (0.4± 0.51 cm). ($p<0.05$) (Table 4.3.1.).

Table 4.3.1. Comparison of navicular drop test within groups

Variables	**Insole**					**Insole+exercise**						
	Before	After	Δ	Z/t	P	Before	After	Δ	Z/t	P	F	P
NTR	13.13±1.55	12.67±1.67	0.4± 0.63	2.82	**0.014**	12.93±1.033	11.87±0.99	1± 0.70	5.870	**0.00**	5.96	**0.021**
NTL	13.33± 1.29	12.87±1.12	0.4± 0.51	-2.64	**0.008**	12.60±1.18	11.80±1.20	0.8±0.41	-3.46	**0.001**	4.36	**0.046**

Data expressed as mean ±standard deviation , p<0.05 = statistically significant different, NTR: Navicular Test Right, NTL: Navicular Test Left

As a result of statiscal analysis, there was no significant difference between groups. (p>0,05) A paired t-test for parametric variables and Wilcoxon test for non-paramatric variables were used to examine for differences in regard to pre-post measurements findings intragroup variables.Within groups demonstrated statistically significant differences (p<0.05) (Table 4.3.2.)

Table 4.3.2. Comparison of y balance test within groups

Variables	Insole					Insole+exercise						
	Before	After	Δ	Z/t	P	Before	After	Δ	Z/t	P	F	P
YBTAD (cm)	68.07±3.05	69.33±2.79	1.26±0.70	-6.971	**0.00**	68.80±1.61	70.07±1.53	1.26±0.96	-5.104	**0.00**	0	1
YBTAND (cm)	66.40±3.13	67.47±2.97	1.0±0.70	-5.87	**0.00**	67.33	68.67	1.33±0.97	-5.292	**0.00**	0.73	0.39
YBTPMD (cm)	99.67±3.24	101.20±3.14	1.53±0.74	-7.990	**0.00**	97.67±2.76	99.13±2.87	1.46±0.91	-6.205	**0.00**	0.04	0.82
YBTPMND (cm)	97.40±3.50	98.93±3.19	1.53±1.87	-5.002	**0.00**	96.27±2.68	97.27±2.96	1.0±2.10	-1.84	0.087	0.73	0.40
YBTPLD (cm)	102.07±3.61	103.67±3.33	1.60±0.82	-7.483	**0.00**	100.20±2.42	102.00±2.44	1.80±1.32	-5.281	**0.00**	0.24	0.62
YBTPLND (cm)	100.40±4.08	101.87±3.75	1.46±0.83	-6.813	**0.00**	99.53±2.56	101.20±2.39	1.66±1.58	-4.06	**0.001**	0.85	0.36

Data expressed as mean ±standard deviation ,YBTAD: Y Balance Test Anterior Dominant, YBTAND: Y Balance Test Anterior NonDominant, YBTPMD: Y Balance Test PostMedial Dominant, YBTPMND: Y Balance Test PostMedial Non Dominant, YBTPLD: Y Balance Test PostLateral Dominant, YBTPLND: Y Balance Test PostLateral Non Dominant cm=centimeter, p<0.05 = statistically significant different, cm: centimeter

As a result of statiscal analysis, there was no significant difference in nondominant flamingo test results. (p>0.05).However, there was a significant difference in dominnat flamingo test between groups. (p<0.05) (Table 4.3.3.)

Table 4.3.3. Comparison of flamingo test within groups

Variables	Insole					Insole+exercise						
	Before	After	Δ	Z	P	Before	After	Δ	Z	P	F	P
Flamingo test dominant	1.53±0.91	0.60±0.82	0.93±0.59	-3.27	**0.001**	0.93±0.704	0.07±0.25	0.86±0.74	-2.91	**0.004**	5.898	**0.022**
Flamingo test non dominant	2.07±1.22	1.20±0.94	0.86±0.63	-3.12	**0.002**	1.53±0.64	0.80±0.41	0.73±0.45	-3.31	**0.001**	2.463	0.128

Data expressed as mean ±standard deviation , p<0.05 = statistically significant different

As a result of statiscal analysis, there was no significant difference in between groups.(p>0.05) However, there was a significant difference within groups. (p<0.05) (Table 4.3.4.)

Table 4.3.4. Comparison of vertical jump test within groups

Variable	Insole					Insole+exercise						
	Before	After	Δ	Z/t	P	Before	After	Δ	Z/t	P	F	P
VJT (cm)	30.73±2.31	32.00±2.33	1.26±0.59	-8.264	**0.00**	32.07±1.79	32.93±1.58	0.86±0.51	-6.500	**0.00**	3.87	0.059

Data expressed as mean ±standard deviation ,VJT: Vertical Jump Test, p<0.05 = statistically significant different, cm: centimeter

As a result of statiscal analysis, there was significant difference in between groups.($p<0.05$) At the same time, it was observed that inosle+exercise groups were higher positively difference (3.0±0.92), than the insole group (2.0±1.06) . ($p<0.05$). (Table 4.3.5.)

Table 4.3.5. Comparison of VAS score quality of life changes within groups

Variables	**Insole**					**Insole+exercise**						
	Before	After	Δ	Z/t	P	Before	After	Δ	Z/t	P	F	P
VAS	6,07±0,96	8,07±0,59	2.0±1.06	-7,24	**0.00**	5,47±0,83	8,47±0,64	3.0±0.92	-12,55	**0.00**	7,50	**0,011**

Data expressed as mean ±standard deviation , p<0.05 = statistically significant, VAS: Visual Analog Scale

5. DISCUSSION

The findings of this study revealed that a combination of structured foot exercise programs and insole decreased the amount of foot pronation and increased quality of life among professional football players having foot pronation deformity. Furthermore, amount of foot pronation, balance, anaerobic performance and pain were improved in football players in insole group and insole plus exercise group after four weeks of intervetion.

The study indicated that navicular drop test results statistically decreased after the four weeks of intervetions in both groups. Moreover, football players in the insole plus exercise group had further improvement in navicular drop test compared to insole group. In the literature, a study conducted on 14 university students showed that a combination of insole and short foot exercises three times per week for five weeks increased navicular drop test distance compared to using arch supported insole [119]. Similar to our study, Park et al. reported that short foot exercise was effective for navicular drop test results among individulas with pes planus [120]. Moreover, Kim et al. found that applying short foot exercises was more effective than applying arch support insole in terms of medial longitudinal arch improvement and dynamic balance ability [121]. Consistent with the literature, combination of insole and exercise education further reduced foot pronation degree in elite football players. Since an increase in pronation angle is associated with an increased risk of injuries in athletes, we may suggest that adding structured exercise training to the insole given to elite football players with pronation deformities may prevent injuries [121].

Another finding of this study showed that the dynamic and static balance of the football players was increased in the insole and insole plus exercise group after four weeks of intervention. Additionally, the static balance score in the dominant lower extremity was higher in the insole group compared to the insole plus exercise group. The study by Moon et al. showed that short-foot exercises could improve Y-balance test scores even after one session in healthy adults with excessively pronated feet [122]. Another study conducted at university students showed that combination of insole and short foot exercises incresed Y-balance test scores compared to using insole [119,123]. The study of Saeb et. al. included 32 healthy cross-fit athletes who were divided into insole and control groups. The participants in the insole group used polyurethane insole for 10 weeks while the control group did not receive any intervention. They demonstrated that static and dynamic balance were increased at the end of the study in female participants in the insole group [124]. Although the number of studies investigating the effects of insole, exercise, or a combination of elite athletes with overpronation deformity is limited, studies showed that increased foot pronation affects static and dynamic balance in football players compared to football players with neutral foot posture [125,126]. Moreover, it is reported that football players use technical skills, such as passing, dribbling, shooting, and controlling the ball, which requires standing on one foot during a sportive performance. Similarly, balance plays a critical role in challenging situations such as when competing against an opponent, experiencing collisions, playing on slippery surfaces, dealing with sudden changes in the ball's direction, and remaining stable while in motion [127,128,129,130] Therefore, in light of the results of our study, we may suggest using insole or insole and exercise to improve performance and prevent sport-specific injuries by increasing the balance during competitions in football players with pronation deformities.

In the present study, we also showed that vertical jump scores were increased in the insole and insole plus exercise group after four weeks of intervention, and there is no statistical difference comparing both groups. In the literature, studies involving athletes with foot deformities mainly focus on how insoles affect vertical jump performance, while studies investigating the effects of exercise on vertical jumping are limited. A study on 20 asymptomatic subjects with pronated feet showed that the six-week intrinsic foot muscle strengthening program did not change the vertical force on force palate assessment during the jump test [131]. However, the study of Lynn et. al. included 24 healthy university age volunteers and divided them into short foot exercise group, towel curl exercise group and no intervention group. While, participants in exercise groups did their exercises for 100 repetetions daily with 4 weeks of duration. They showed that participants in the short foot exercise group improved their dynamic balance much more than participants in the towel curl exercise [132]. Another study conducted on 34 collegiate athletes to examine effects of carbon-fiber shoe insole on athletic performance. They assessed vertical jump performance of the athletes while wearing shoe with insole or without insole. The study demonstrated that wearing carbonfiber insole led to increase vertical jump distance than wearing normal athletic footwear among collegiate atheles [133]. Arastoo et. al. also compared the vertical jump performance on force platform between flatfoot and healthy male amateur soccer players. While athles with flatfoot wear trainer shoe with insole, health ones wear trainer shoes. They showed that use of insole improved the stance time and efficiency of take off during vertical jump test [134]. The vertical jump test is considered essential for football players due to its ability to assess lower body power and explosive strength. Specifically for football, vertical jump height and maximal strength levels have been reported as essential to heading performance in football players [135]. Thus, regular use of insole or combination of insole and exercise training can improve vertical jump performance in elite football players having foot pronation.

The study also showed that pain scores were statistically decreased in both groups, and VAS scores in the insole plus exercise decreased more compared to the insole group. A meta-analyze showed that regular use of the insole and exercises reduces pain in adult flatfoot. Active interventions were more effective in reducing pain than passive ones [136]. Another study conducted on 17 recreational healthy team sports players showed that training insole could reduce pain and improve change of direction performance [137]. Channasanon et al. also found that using three medial arch supports reduced plantar heel pressure in healthy volunteers [138]. Besides that, a study conducted in the military with 1,338 participants showed that the use of shock-absorbing insole reduced lower extremity overuse injuries. [139]. Consistent with the literature our study showed that pain was reduced in both groups but the insole plus exercise group decreased VAS scores more compared to the insole group.

LIMITATIONS

The study included a few limitations. The first limitation is the number of the study sample. Although we had 30 elite football players in the study according to power analysis, we may increase the number. Considering that the most common injuries in football players are lower extremity injuries, we excluded football players who had lower extremity injuries, which was the study's exclusion criterion. Therefore, we could not find more athletes suitable for the study. Additionally, the lack of only an exercise group is another limitation of the study. Thus we could not compare the outcomes from only the exercise group. In addition, we may consider that there is no follow-up period in the study as another limitation. We believe that studies with more elite football players and long-term follow-ups will contribute to the literature for future studies.

CONCLUSION

In conclusion, as far as we know this study is the first study that compared the effects of insole and a combination of structured exercise programs with insole among elite football players. Although pronation degree, balance test scores, vertical jump performance and pain were improved in both groups, elite football players in insole plus exercise group had more decrease in pronation degree and pain. We believe that exercises to promote the foot muscles to retrain dynamically may increase muscle strength and reduces the degree of foot pronation. In addition, we may indicate that the improvement in the degree of foot pronation will continue not only when the athlete is using athletic shoes, but also while wearing a different shoe without insoles in daily life, so this may be the reason for reduced pain more in the exercise plus insole group. Thus, we conclude that elite football players should be assessed with a holistic approach and physiotherapists should advise not only performance-enhancing exercises and insoles but also structured exercise programs, including short foot exercises, towel curl exercises, and heel-to-rise exercises to elite football players with foot pronation deformity.

Funding

No external or internal funding was received for this work.

Conflict of interests

The author declares no conflict of interest.

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APPENDIX A: ETHICAL COMMITTEE APPROVAL

T.C.
YEDİTEPE ÜNİVERSİTESİ REKTÖRLÜĞÜ
Girişimsel Olmayan Klinik Araştırmalar Etik Kurulu

Sayı : E.83321821-805.02.03-40
Konu : Etik Kurul Karar Yazısı

Sayın Dr. Öğr. Üyesi Elif Develi

Yeditepe Üniversitesi Girişimsel Olmayan Klinik Araştırmalar Etik Kuruluna etik onay için başvuru yapılmış olan araştırma önerisinin başlığı, araştırmacılar, başvuru numarası, sunulan belgeler ve toplantı bilgileri aşağıda yer almaktadır. İlgili araştırma önerisi, etik kurulumuz üyeleri tarafından değerlendirilmiş olup, etik ve bilimsel açıdan **UYGUN** olduğuna karar verilmiştir.

Araştırma Başlığı:	**Ayak Pronasyon Deformitesi olan Futbolcularda Egzersiz Eğitimi ve Ark Destekli Tabanlıkların Denge ve Dikey Sıçrama Performansı Üzerine Etkisi**
Araştırmacılar:	**Fzt. Gizem Karadeniz, Dr. Öğr. Üyesi Elif Develi**
Başvuru Numarası:	**202203Y0193**

TOPLANTI BİLGİLERİ			
Toplantı Tarihi:	11 Mart 2022	**Toplantı Yeri:**	Çevirim içi (Google Meet)

SUNULAN BELGELER
Islak imzalı başvuru dosyası, CD veya USB belleğe kaydedilmiş başvuru dosyası ve elektronik başvuru
Araştırma başlığı ve araştırmacıların isimleri
Başvuru dilekçesi
Başvuru formu
Araştırmanın;
• Niteliği
• Önemi ve özgün değeri
• Amaç ve hedefleri
• Yöntemi
• Yönetimi
• Yaygın etkisi
• Araştırma bütçesi (Mevcutsa)
• Süresi ve uygunluğu (Zaman cetveli)
• Kaynakları
Bilgilendirilmiş Gönüllü Olur Formu (yapılan araştırmaya özel olarak hazırlanmış)

Bu belge, güvenli elektronik imza ile imzalanmıştır.

Belge Doğrulama Adresi : http://belgedogrulama.yeditepe.edu.tr/bg.aspx?id=5940A199-EFD7-4848-994F-C541A9FAE124

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Kep Adresi : yeditepeuniversitesi@hs03.kep.tr

Bilgi İçin: Sinem ARI
Unvan: Uzman Yardımcısı
Telefon No:

APPENDIX B: INFORMED WRITTEN CONSENT

Ek 2 : BİLGİLENDİRİLMİŞ GÖNÜLLÜ OLUR FORMU

YEDİTEPE ÜNİVERSİTESİ

Araştırmanın Adı: Futbol Oyuncularında Ayak Pronasyonu Egzersizleri ve Ark Destekli Tabanlıkların Denge ve Dikey Sıçrama Performansına Etkisi

Sayın Katılımcı,

Yukarıda adı yazılı araştırmaya katılmak üzere davet edilmiş bulunmaktasınız. Çalışmaya katılıp katılmama kararı tamamen size aittir. Katılmak isteyip istemediğinize karar vermeden önce araştırmanın neden yapıldığını, bilgilerinizin nasıl kullanılacağını, çalışmanın neler içerdiğini, olası yararları ve risklerini ya da rahatsızlık verebilecek yönlerini anlamanız önemlidir. Lütfen aşağıdaki bilgileri dikkatlice okumak için zaman ayırınız. Sorularınız olursa sorunuz ve açık yanıtlar isteyiniz.

Bu araştırma ile ayak pronasyonu olan futbol oyuncularında tabanlık ve ayak pronasyonu egzersizlerinin denge ve dikey sıçrama performansı üzerindeki etkisinin araştırılması amaçlanmıştır. Ayak pronasyonun belirlenmesinde Navikular Düşme Testi ve FootBalance kiosk cihazındaki ölçüm kullanılacaktır. Ek olarak tabanlık ve egzersiz uygulamasından önce denge ve dikey sıçrama testleri uygulanacak olup 4 hafta sonra bu testler tekrarlanacaktır. Araştırma için Yeditepe Üniversitesi'nden izin alınmıştır. Araştırmaya sizin dışınızda 29 kişi katılacaktır. Sizden bu çalışmaya 4 hafta (haftada 2 saat) ayırmanız istenecektir. Bunun size ve yakınlarınıza hiçbir zararı olmayacaktır. Çalışmaya katılmakta parasal yük altına girmeyeceksiniz ve size de herhangi bir ödeme yapılmayacaktır.

Bu araştırmaya katılıp katılmamakta tümüyle özgürsünüz. Gerek duyduğunuz tüm bilgileri istemeye ve doğru, açık, anlaşılır bilgi almaya hakkınız vardır. Araştırmaya katılmayı istemezseniz burada size verilen hizmet olumu veya olumsuz şekilde etkilenmeyecektir. Gerekli gördüğü takdirde araştırmanın herhangi bir kısmında katılımcı araştırmadan çıkabilir, araştırmacı çalışmayı sonlandırabilir. Araştırmanın tüm aşamalarında kimlik bilgileriniz gizli tutulacaktır. Araştırma kapsamında elde edilen bilgiler bilimsel amaçlarla kullanılabilir, gizlilik kurallarına uyulmak kaydıyla sunulabilir ve yayınlanabilir.

Araştırma ile ilgili daha fazla bilgiye ihtiyaç duyarsanız araştırma yürütücüsüne gizem.karadeniz@std.yeditepe.edu.tr e-posta adresi veya 0534 677 63 83 numaralı telefondan ve sorumlu araştırmacıya elif.ustun@yeditepe.edu.tr e-posta adresi veya 0555 593 62 93 numaralı telefondan ulaşabilirsiniz.

Yukarıda yer alan ve araştırmaya başlanmadan önce katılımcılara verilmesi gereken bilgileri içeren metni okudum (ya da sözlü dinledim). Araştırma kapsamında elde edilen şahsıma ait bilgilerin bilimsel amaçlarla kullanılmasını, gizlilik kurallarına uymak kaydıyla sunulmasını ve yayınlanmasını, hiçbir baskı ve zorlama altında kalmaksızın, kendi özgür irademle kabul ettiğimi beyan ederim.

Katılımcı;	Araştırma Yürütücüsü;
İmza/Tarih:	İmza/Tarih:
Adı-Soyadı:	Adı-Soyadı:
Adres:	Adres:
Telefon No:	Telefon No:
Tanık:	
İmza/Tarih:	Ad-Soyadı:
Adres:	Telefon No:

APPENDIX C: STRUCTURED QUESTIONNAIRE

Ek 11: DEMOGRAFİK VE KLİNİK BİLGİLER

YEDİTEPE ÜNİVERSİTESİ

Demografik Özellikler Tarih:...../...../......

1)Hastanın Adı Soyadı:

2)Doğum tarihi, yaş :

3) Cinsiyet:
☐ Kız ☐ Erkek

4) Boy uzunluğu (cm):

5) Vücut ağırlığı (kg) :

- Vücut Kitle Indexi:

6) Dominant taraf:
El ☐ Sağ ☐ Sol
Ayak ☐ Sağ ☐ Sol

7)Eğitim durumunuz
☐ Okuryazar değilim
☐ Lise
☐ Üniversite ve üzeri

8) Kaç senedir profesyonel olarak futbol oynuyorsunuz? Hangi ligde?

9) Futbol dışında ilgilendiğiniz profesyonel spor branşı var mı?

10) a) Sigara kullanıyor musunuz?
☐Hiç içmedim ☐Sigara içtim ama bıraktım ☐Halen içiyorum

b) Günde kaç adet sigara içiyorsunuz?.........................adet/gün

11) Alkol kullanıyor musunuz?
- ☐ Evet   Hangi sıklıkla?..........
- ☐ Hayır

12) Doktor tarafından teşhisi konulmuş herhangi bir sistemik rahatsızlığınız var mı?
- ☐ Evet
- ☐ Hayır

Cevabınız evet ise teşhis edilen hastalığınız aşağıdakilerden hangisi / hangileridir? (birden fazla seçim yapabilirsiniz.)
- ☐ Kalp damar hastalıkları
- ☐ Şeker hastalığı
- ☐ Yüksek tansiyon
- ☐ Kanser
- ☐ Sindirim sistemi hastalıkları (karaciğer, mide, safra kesesi,...)
- ☐ Solunum sistemi hastalıkları (akciğer)
- ☐ Ruhsal sorunlar (depresyon, aşırı yeme, kusma,...)
- ☐ Endokrin (hormonal) hastalıklar
- ☐ Vitamin ve mineral yetersizlikleri (Demir, B12, D vitamini,...)
- ☐ Diğer : ....

13) Düzenli olarak kullandığınız bir ilaç var mı?
- ☐ Evet   Nedir? ....
- ☐ Hayır

14)Şu an herhangi bir ağrı kesici ilaç kullanıyor musunuz?
- ☐ Evet, Ne zamandır? ....
- ☐ Hayır

15)Herhangi bir ameliyat geçirdiniz mi? Evet ise yıl ile birlikte belirtiniz.
- ☐Evet.............................
- ☐Hayır

16)Herhangi bir sakatlık geçirdiniz mi? Evet ise yıl ile belirtiniz.
- ☐Evet......................
- ☐Hayır

APPENDIX D: PERFOMANCE TEST BEFORE INTERVENTION

Ek 11: DEMOGRAFIK VE KLINIK BILGILER

YEDİTEPE ÜNİVERSİTESİ

17) Şuan da tabanlık kullanıyor musunuz?

18) Daha önce tabanlık kullandınız mı? (Kullanma tarihini de belirtiniz)

Uygulama Öncesi Testler:

1. **NAVİKÜLER DÜŞME TESTİ: (10mm ve üzeri)**

	SAĞ	SOL
Ağırlık Yok (mm)		
Ağırlık Verilerek (mm)		
Fark (mm)		

2. **FLAMİNGO DENGE TESTİ:**

	DOMİNANT	NONDOMİNAT
1 DAKİKA İÇİNDE DENGE SAĞLAMA GİRİŞİMİ		
ELDE EDİLEN PUAN		

3. **Y DENGE TESTİ: (3 deneme, en iyi değeri al)**

	DOMİNANT			NONDOMİNANT		
Anterior (cm)						
Posteromedial (cm)						
Posterolateral (cm)						

4. **DİKEY SIÇRAMA TESTİ: (3 deneme, en iyi değeri al)**

	1.DENEME	2.DENEME	3.DENEME
UZANILAN MESAFE (CM)			

APPENDIX E: PERFOMANCE TEST AFTER INTERVENTION

YEDİTEPE ÜNİVERSİTESİ

Uygulama Sonrası (4 hafta sonra):

1. **NAVİKÜLER DÜŞME TESTİ: (10mm ve üzeri)**

	SAĞ	SOL
Ağırlık Yok (mm)		
Ağırlık Verilerek (mm)		
Fark (mm)		

2. **FLAMİNGO DENGE TESTİ:**

	DOMİNANT NONDOMİNAT
1 DAKİKA İÇİNDE DENGE SAĞLAMA GİRİŞİMİ	
ELDE EDİLEN PUAN	

3. **Y DENGE TESTİ: (3 deneme, en iyi değeri al)**

	DOMİNANT			NONDOMİNANT		
Anterior (cm)						
Posteromedial (cm)						
Posterolateral (cm)						

4. **DİKEY SIÇRAMA TESTİ: (3 deneme, en iyi değeri al)**

	1.DENEME	2.DENEME	3.DENEME
UZANILAN MESAFE (CM)			

APPENDIX F: VAS SCORE

Ek 11: DEMOGRAFİK VE KLİNİK BİLGİLER

YEDİTEPE ÜNİVERSİTESİ

Uygulamalar öncesi/sonrası ağrı seviyesi ? (1-10 üzerinden puan)

Önce::
Sonra:

Sözel soru: Tedavi sonunda hayat kalitesi değişti mi? Nasıl?

APPENDIX H: CURRICULUM VITAE

Kişisel Bilgiler

Adı	Gizem	**Soyadı**	Karadeniz