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YEDITEPE UNIVERSITY
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DEPARTMENT OF GENERAL PHYSIOTHERAPY

EFFECTIVENESS OF FOOT CORE EXERCISES ON PAIN AND FUNCTIONAL PERFORMANCE IN PATIENTS WITH PATELLOFEMORAL PAIN SYNDROME

MASTER OF GENERAL PHYSIOTHERAPY THESIS

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APPROVAL

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DECLARATION

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

Zeynep Budak, PT.

DEDICATION

I dedicate this to my family and my best friend Ruveyda Ak for your constant love, support and encouragement.

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LIST OF SYMBOLS AND ABBREVIATIONS

ROM	Range of Motion
IPAQ	International Physical Activity Questionnaire
CG	Control Group
EG	Experimental Group
PFP	Patellofemoral Pain
PFPS	Patellofemoral Pain Syndrome
ACL	Anterior Cruciate Ligament
PCL	Posterior Cruciate Ligament
MCL	Medial Collateral Ligament
LCL	Lateral Collateral Ligament
EF	Extension Facet
FF	Flexion Facet
TAF	Tibial Articular Facet
M	Medial
L	Lateral
MPFL	Medial Patellofemoral Ligament
ITB	Iliotibial Band
TUG	Time Up and Go
10-MWT	10-Meter Walk Test
MRI	Magnetic Resonance Imaging
CT	Computed Tomography

ABSTRACT

Budak, Z. (2023). Effectiveness of Foot Core Exercises on Pain and Functional Performance in Patients with Patellofemoral Pain Syndrome

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

The aim of the study was to evaluate the effects of Foot Core exercises on pain and functional performance in patients with patellofemoral pain syndrome. A total of 30 patients with patellofemoral pain syndrome including this study between March 2023 - August 2023. The patients who were randomly divided into 2 groups which is the Foot Core Exercise Group (n=15) and Control Group (n=15). All the participants did quadriceps isometric exercises in supine position twice a day, neuromuscular electrical current 20 minutes, soft tissue therapy-patellar mobilization for 4 weeks. All the volunteers were assessed in terms of VAS Questionnaire, the knee flex. and ext. ROM degrees; hip internal and external rot. ROM degrees; ankle dorsiflexion, plantarflexion, inversion and eversion ROM degrees using a goniometer and some strength tests; flexion and extension of the knee, internal and external rotation of the hip, the ankle dorsiflexion, plantarflexion, inversion and eversion, respectively. Moreover, functional performance was evaluated using the timed up and go test, 10 m. walking test, stair up and down test, Short Form Health Survey Questionnaire (SF-36), The International Physical Activity Questionnaire (IPAQ) before and after intervention. The findings of the study indicated that Foot Core exercises led to statistical differences VAS degree, knee flexion ROM, ankle plantarflexion and inversion ROM upon conclusion of the study in experimental groups ($p<0.05$). The change in Timed up and go (CG: 4.02±0.99; EG: 4.28±1.13), 10 meter walking (CG: 10.04±2.86; EG:10.35±3.12) and stair up and down (CG: 11.34±2.64; SG: 11.24±2.71), was higher at the end of the intervention in EG. However, there was a significant difference in SF-36 and IPAQ Tests between groups ($p<0.05$). Lastly, it was observed that Foot Core Exercise Groups were higher positively difference, than the CG, ($p<0.05$). In conclusion, we might consider that foot core exercise training can improve pain, functional performance and quality of life in patients with the patellofemoral pain syndrome. We may suggest that attending foot core exercise training may slow the progression of problems caused by PFPS and reduce pain in patients who had PFPS for at least 2 years.

Keywords: Foot Core, Patellofemoral pain, Functional Performance, Quality of Life

ÖZET

Budak, Z. (2023). Patellofemoral Ağrı Sendromlu Hastalarda Foot Core Egzersizlerinin Ağrı ve Fonksiyonel Performans Üzerine Etkileri.

Yeditepe Üniversitesi Sağlık Bilimleri Enstitüsü, Genel Fizyoterapi Anabilim Dalı Yüksek Lisans Tezi, İstanbul.

Bu çalışmanın amacı, patellofemoral ağrı sendromlu hastalarda Foot Core egzersizlerinin ağrı ve fonksiyonel performans üzerindeki etkilerini değerlendirmektir. Mart 2023 - Ağustos 2023 arasında bu çalışmaya dahil edilen toplam 30 gönüllü patellofemoral ağrı sendromlu hasta bulunmaktadır. Randomize olarak 2 gruba ayrılan hastalar; Foot Core egzersiz grubu (n=15) ve kontrol grubu (n=15) olarak belirlendi. Tüm katılımcılara günde 2 defa sırtüstü pozisyonda kuadriseps izometrik egzersizler, 20 dk nöromüsküler elektrik akımı, yumuşak doku tedavisi-patella mobilizasyonu 4 hafta boyunca uygulandı. Tüm gönüllüler, sırasıyla VAS anketi, diz fleksiyon ve extansiyon eklem hareket açıklığı dereceleri, kalça iç ve dış rotasyon eklem hareket açıklığı dereceleri, ayak bileği; dorsifleksiyon, plantarfleksiyon, inversiyon ve eversiyon eklem hareket açıklığı dereceleri gonyometre kullanılarak ölçüldü ve bazı kas kuvvet testleri yapıldı; diz fleksiyon ve extansiyon, kalça iç ve dış rotasyon, ayak bileği dorsifleksiyon, plantarfleksiyon, inversiyon, eversiyon. Ayrıca, fonksiyonel performansı değerlendirmek için zamanla yürü kalk testi, 10 metre yürüme testi ve merdive inip çıkma testi, yaşam kalitesi anketi (SF-36) ve fiziksel aktivite anketi (IPAQ) kullanıldı. Çalışma sonuçları, Foot Core egzersizleri yapılan grupta VAS değerinde, diz fleksiyon, ayak bileği plantarfleksiyon ve ayak bileği inversiyon eklem hareket açıklığı değerlerinde istatistiksel olarak fark görüldü ($p<0.05$). Egzersiz grubuna dahil olan katılımcıların süreli kalk yürü testi (CG: 4.02±0.99; EG: 4.28±1.13), 10 metre yürüme testi (CG: 10.04±2.86; EG:10.35±3.12) ve merdiven inip çıkma testindeki (CG: 11.34±2.64; SG: 11.24±2.71) sonuçlar daha yüksek bulundu. Ayrıca 2 grup arasındaki SF-36 ve IPAQ testlerinde de anlamlı bir fark gözlendi ($p<0.05$). Bunlarla birlikte, Foot Core egzersizi yapılan grubun sonuçları ile kontrol grubunun sonuçları kıyaslandığında egzersiz yapılan grubun daha iyi sonuçlar verdiği gözlemlenmiştir ($p<0.05$). Sonuç olarak, patellofemoral ağrı sendromlu hastalarda Foot Core egzersiz eğitiminin ağrı, fonksiyonel performans ve yaşam kalitesini iyileştirebileceğini düşünebiliriz. En az 2 yıldır patellofemoral ağrı sendromu olan hastalarda Foot Core egzersiz eğitimi almanın patellofemoral ağrı sendromunun neden olduğu problemlerin ilerlemesini yavaşlatabileceğini ve ağrıyı azaltabileceğini söyleyebiliriz.

Anahtar Kelimeler: Foot Core, Patellofemoral ağrı, Fonksiyonel Performans, Yaşam Kalitesi

1.INTRODUCTION AND PURPOSE

Patellofemoral pain (PFP) is described as pain around and near the patella that is provoked by activities loading the patellofemoral joint in the lack of other different pathology (1). Patellofemoral pain is among the frequently encountered musculoskeletal conditions, accounting for approximately 9-10% of all musculoskeletal complaints and 20-40% of all knee problems, and has been defined as the the primary reason for pain in the front of the knee that occurs most frequently (2). PFP is more common in adolescents, particularly young adolescents aged 12 to 17 years, with a higher prevalence of PFP (3). Recent studies show that yearly incidence for patellofemoral pain in the common population was recorded as 22.7% and adolescents as 28.9% (3). The yearly incidence in females 29.2% and males 15.5%. In the United States over the past eight years, the diagnosis of patellofemoral pain has been identified in a range of 1.5% to 7.3% among all patients seeking therapeutic treatment (4). The prevalence of patellofemoral pain increased with advancing age, with the highest number of cases occurring in the 50-59-year-old age group. When comparing different age groups, it was evident that the incidence of PFP grew as individuals aged, with the 50-59-year-old group having the highest number of cases. The age brackets of 50-59, 40-49, and 30-39 exhibited the highest prevalence, with the 10-19 age group coming next in line (5). Among orthopedic conditions, PFPS is the most commonly encountered one in the field of sports medicine. PFPS may result from patellar injury, but it typically arises from a combination of various factors. These multifactorial causes include excessive use and strain on the patellofemoral joint, anatomical or biomechanical irregularities, muscle weakness, as well as imbalances and dysfunction (7). Indications of this condition encompass discomfort located either behind or around the patella, which intensifies during activities like running or any movements involving knee flexion, such as squatting or ascending and descending stairs. Typical symptoms observed in individuals with PFPS consist of pain, crepitus (crackling or grinding sensation), episodes of catching, moments of the knee giving way, and occasionally experiencing stiffness and swelling (8). Another commonly mentioned reasons for PFPS encompass instances of trauma (9). On the other hand, most patients with PFPS do not have a history of trauma. (10). Because of the high ratio of PFPS, protection methods are important. As a first step, possible risk factors should be considered and a process should be followed accordingly (8). Recent research indicates that physical therapy is a successful approach for managing PFPS.

Surgery should only be contemplated if a comprehensive rehabilitation program proves ineffective (11). In general, manual therapy approaches, exercises, stretching, strengthening, patellar taping and orthotics are used in physical therapy (6).

The Foot Core system consists of a sophisticated foot structure that encompasses active, passive, and neural components, ensuring stability and adaptability while managing varying demands placed on the foot (9). The active component comprises the muscles and tendons that connect to the foot. The passive component of the foot's core includes the bones, ligaments, and joint capsules responsible for supporting the different arches of the foot. The neural component comprises the sensory receptors within the plantar fascia, ligaments, joint capsules, as well as the muscles and tendons engaged in both the active and passive subsystems (9). Reduced sensorimotor function in the foot and ankle has been associated with diminished functional capabilities and an increased risk of injuries related to weight-bearing activities (10). For this reason, Foot Core exercises are performed for the rehabilitation of patients after lower extremity injuries such as knee, foot and ankles. During these exercises, foot functions are regulated and the foot sole receives information gathered from the surroundings through sensory perception through mechanoreceptors, this afferent information is conveyed to regions higher in the spinal cord and brain through peripheral nerves, leading to the activation of a widespread cortical network within the brain (11). Foot Core exercises are described 4 main exercise types which are short foot exercise, heel raise exercises, tibialis posterior exercises and balance board training (12).

In the literature, comparative studies with knee and foot exercises in patellofemoral pain syndrome show that foot targeted exercises seem to be more effective than knee targeted exercises in individuals with PFP (13). Thus, the study aims to investigate the effects of Foot Core exercises on pain and functional performance in patients with patellofemoral pain syndrome. Two hypotheses were identified in the study:

Hypothesis 0 (H0): Foot Core exercises have no effect on pain levels and functional performance in people with patellofemoral pain syndrome.

Hypothesis 1 (H1): Foot Core exercises have an effect on pain levels and functional performance in people with patellofemoral pain syndrome.

2. THEORETICAL INFORMATION AND LITERATURE

2.1. Anatomy of the knee joint

The knee serves as the articulation point linking the upper thigh with the lower leg and is the largest joint within the human body. Knee joint is connected with bone structures. These are femur, tibia, fibula and patella as well as its muscles, tendons, ligaments and joint capsule (14). The knee joint is a variation of a hinge-type joint. It facilitates flexion and extension movement at the sagittal plane, varus and valgus rotation at the frontal plane, medial rotation at last of the knee flexion movement and the lateral rotation at the terminal extension movement of the knee both about the transverse plane (15). The knee joint consists of two articulations; the tibiofemoral joint and the patellofemoral joint and these joints permit the knee to move in three different planes (16).

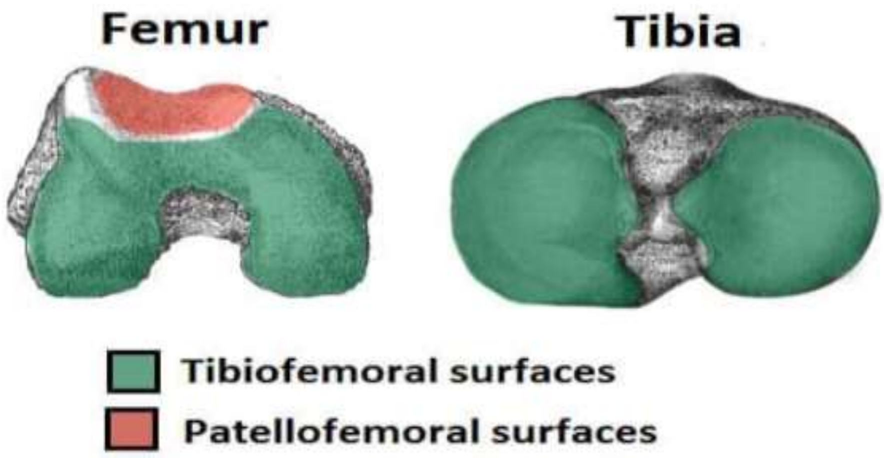

Figure 2.1. The Tibiofemoral and the Patellofemoral Joint Surfaces (16)

2.1.1. The Tibiofemoral Joint

The tibiofemoral joint is where the lower end of the femur connects with the top of the tibia, involving the lateral and medial condyles of the femur and the tibial plateaus (17) and this joint is the weight bearing joint of the knee (18). This comprises internal components like the meniscus (specifically the medial meniscus) and cruciate ligaments (the anterior cruciate ligament (ACL) and the posterior cruciate ligament (PCL), as well as external components like the collateral ligaments (the medial collateral ligament (MCL) and the lateral collateral ligament (LCL). (19).

During different kinematic events, the knee operates with three distinct axes of motion within the tibiofemoral joint. These three axes include: one passing through the medial (MCL) and lateral collateral ligaments (LCL), intersecting with the cruciate ligaments; this axis, known as the posterior condyle axis, plays a role in knee flexion within the range of 15° to 150°. Second, when the knee transitions into extension, the center of movement changes from the posterior condylar pivot to the distal condylar pivot. The straightened distal femoral condyles are in connection with the tibial plateau as the knee extends. Furthermore, the primary influence on the knee's longitudinal axis of rotation is the ligaments and the knee's tibial structure rather than the femoral structure (20).

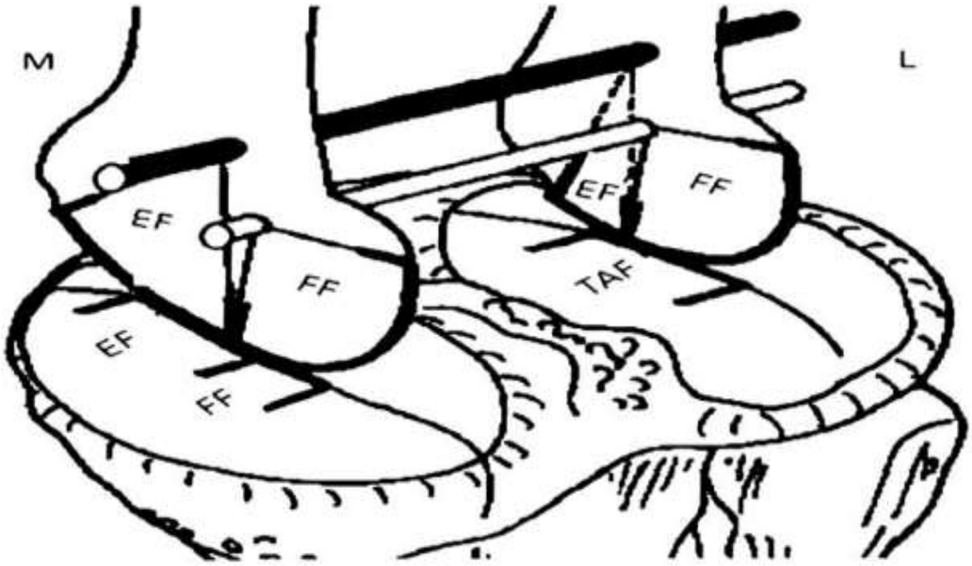

Figure 2.1.1. Two Flexion Axes of the Knee (20)

(EF; extension facet, with the corresponding distal condylar facet, FF; flexion facet, with the corresponding posterior condylar axis, TAF; tibial articular facet, where the lateral femoral condyle articulates with the tibia, M; medial, L; lateral)

2.1.2. The Patellofemoral Joint

The front and lower section of the femur connects with the patella to create the patellofemoral joint and this joint as an complementary part of the knee joint (21). Static and dynamic structures are very important in stabilizing the patellofemoral joint. The patellar tendon, joint capsule, and ligamentous elements collectively contribute to the stability of the patellofemoral joint when at rest.

The medial components play a key role in reducing lateral movement, with the primary structure responsible for constraining lateral motion being the medial patellofemoral ligament. The ligament stretches from the adductor tubercle to the medial edge of the patella. On the patellofemoral joint's outer side, stability for the lateral section is maintained by the lateral patellofemoral ligament, joint capsule, iliotibial band, and lateral retinaculum. The lateral retinaculum is comprised of two layers: a thinner outer layer that extends from the iliotibial band to the patella and the expansion of the quadriceps, and a thicker inner layer that meshes with the vastus lateralis, patellofemoral ligament, and patella-tibial ligament. At a flexion angle of under 20-30 degrees, the joint relies on the medial and lateral retinaculum as well as the joint capsule for support, as there is little to no bone stability. Contractile structures provide the stability as dynamically. These are generally including the extensor and flexor muscle groups of the knee (22).

2.1.3. Extensor Muscles of the Knee

The quadriceps femoris consists of four separate muscle groups, with three originating from the femur; the vastus intermedius, vastus medialis, and vastus lateralis. The fourth muscle, the rectus femoris, originates from the hip bone. These four muscles come together at the quadriceps tendon and make up the primary mass of the thigh, collectively ranking among the body's most potent muscles. The quadriceps plays a crucial role in extending the knee joint. It collaborates with synergistic muscles, including the iliotibial band (ITB), which assists in knee extension but its effectiveness depends on the knee joint position. The iliotibial band (ITB) plays an active role in extending the knee, beginning at around 20 to 30 degrees of flexion and continuing all the way to full extension. Additionally, the tensor fasciae latae (TFL) complements the ITB to provide knee stability when the knee is completely straightened (23).

2.1.3.1. M. Rectus Femoris

The rectus femoris muscle is a lengthy muscle located in front of the quadriceps muscle, spanning two joints. The importance of such muscles is to perform movements that require high shortening speed. The femoral nerve provides innervation to this muscle. It has its origin directly from the anterior inferior iliac spine and indirectly from the superior acetabular ridge. The two heads combine to form the attached tendon just below their point of origin.

It attaches to the patella through the quadriceps femoris tendon, and the patella is subsequently connected to the tibial tuberosity (24). The rectus femoris, in conjunction with the iliopsoas, is primarily responsible for hip flexion, particularly when the knee is in a flexed position. During gait, as a hip flexor, it acts with the iliopsoas in "Toe off" phase, During the terminal swing phase, the rectus femoris functions as a knee extensor, serving as one of the muscles in the quadriceps group, to produce the force required for loading during the foot flat phase in the stance phase. The rectus femoris is most effective in movement when it combines hip hyperextension with knee flexion or when it starts from a position of knee extension and hip flexion (25).

2.1.3.2. M. Vastus Lateralis

The vastus lateralis muscle is situated on the outer side of the thigh. The vastus lateralis muscle has its starting point at the upper inter-trochanteric line and attaches to the lateral quadriceps tendon, which in turn connects to the tibial tubercle. The posterior division of the femoral nerve provides innervation to this muscle (L3,4) (26). Functionally, the most important task of the vastus lateralis muscle is knee extension. Vastus lateralis muscle contracts with vastus medialis muscle stabilizing the knee joint (27).

2.1.3.3. M. Vastus Medialis

The vastus medialis muscle contributes to the patella's medial stabilization and the function of the oblique portion of the vastus medialis muscle in regulating the typical movement of the patellofemoral joint. The vastus medialis muscle has its point of origin at the lower section of the intertrochanteric line, extending along the spiral line to reach the medial lip of the linea aspera, and it inserts into the quadriceps tendon at the base of the patella and the tibial tuberosity. Its primary function is to extend the knee. This muscle is innervated by the posterior division of femoral nerve (L2,3,4) (28).

2.1.3.4. M. Vastus Intermedius

The vastus intermedius is positioned in the middle, beneath the rectus femoris muscle, within the front section of the thigh. The vastus intermedius muscle originates from the front and outer surfaces of the femur's shaft, and it inserts into the quadriceps tendon at the base of the patella and the tibial tuberosity. Working in conjunction with other muscles belonging to the quadriceps femoris group, it enables the extension of the knee. A division of the femoral nerve, which originates from the nerve roots of lumbar 2, 3, and 4, provides innervation to the vastus intermedius muscle (29).

2.1.4. Flexor Muscles of the Knee

The muscles responsible for knee flexion encompass the hamstrings, gracilis, sartorius, gastrocnemius, plantaris, and popliteus, with the hamstring muscles taking on the primary role in knee flexion. Many of these knee flexor muscles additionally contribute to the internal or external rotation of the knee. The hamstring muscle group consists of the semitendinosus, semimembranosus, and both the long and short heads of the biceps femoris (30). The semitendinosus and semimembranosus muscles work synergistically. The back part of the thigh shares structural and functional similarities with the front part of the upper arm (31).

2.1.4.1. M. Biceps Femoris

The biceps femoris muscle is situated in the posterior section of the thigh and is located in the back and side regions. It arises proximally by two 'heads', termed the 'long head' (superficial) and the 'short head' (deep). The biceps femoris muscle originates ischial tuberosity in long head and linea aspera and lateral supracondylar line of the femur in short head. It attaches to the outer part of the fibular head. The biceps femoris muscle is innervated by sciatic nerve. The long head's functions include knee flexion, hip extension, lateral leg rotation when the knee is slightly flexed, and aiding in hip external rotation when the hip is extended. The short head's functions encompass knee flexion and lateral leg rotation when the knee is slightly flexed (32).

2.1.4.2. M. Semitendinosus

The semitendinosus muscle, located in the posterior thigh compartment, is a spindle-shaped muscle situated along the inner side of the popliteal fossa. It curves around the inner condyle of the tibia, crosses over the medial collateral ligament of the knee joint, and inserts into the upper portion of the inner surface of the tibia, extending almost as far forward as its front edge. The semitendinosus muscle primarily begins at the lower, inner part of the ischial tuberosity and attaches on the inner side near the tibial tuberosity. Its tendon inserts on the upper section of the inner surface of the tibia, positioned behind the connection point of the sartorius muscle and slightly in front of where the gracilis muscle attaches (33).

2.1.4.3. M. Semimembranosus

The semimembranosus muscle begins at a small surface area on the upper and outer side of the ischial tuberosity. The tendon of the semimembranosus becomes visible around the mid-thigh region and extends downward to where it inserts at the medial condyle of the tibia. Actually, the origin of the semimembranosus had two directions of orientation: Firstly, the major part redirected vertically towards the tendon of the muscle and the second and minor part redirected posteriorly towards the tendon (34). The semimembranosus muscle is responsible for knee flexion and inward rotation of the leg on the thigh. When a person stands in a balanced position, the semimembranosus and the other muscles in the back of the thigh remain at rest. Innervation of the semimembranosus muscle is provided by the L5, S1, and S2 nerve roots. (35).

2.1.4.4. M. Plantaris

The plantaris muscle is situated in the sural region (calf) of the back of the leg. Alongside the gastrocnemius and soleus muscles, it constitutes the superficial group within the posterior compartment of the leg. The plantaris muscle receives innervation from the tibial nerve. Within the plantaris muscle, the tibial nerve splits into two branches: one is the medial plantar nerve and the other is the lateral plantar nerve (36). The plantaris muscle has its starting points at the lateral supracondylar line of the femur and the oblique popliteal ligament of the knee, and it attaches to the rear surface of the calcaneus (37). The primary role of this muscle is to perform plantar flexion of the foot at the ankle joint and flexion of the knee at the knee joint (38).

2.1.4.5. M. Popliteus

The popliteus muscle, categorized as one of the muscles in the deep posterior leg group, is a small, dense muscle located at the bottom of the popliteal fossa. It has its origins at the lateral condyle of the femur and the rear part of the lateral meniscus within the knee joint. It then inserts into the posterior surface of the upper tibia. Popliteus muscle is innervated by the tibial nerve (L4-S1). The function of this muscle is crucial in initiating knee flexion when the knee is completely extended (39).

2.2. Biomechanics of Patellofemoral Joint

The patellofemoral joint is a distinct and intricate arrangement composed of stationary components (bones and ligaments) as well as active components (the neuromuscular system). It completes the movement of the patellofemoral joint at certain angles so that it works in harmony with each other. At full knee extension, the quadriceps muscle is not actively engaged, and the patella rests on top of the suprapatellar fat pad. As the knee begins to flex, the patella gradually moves downward. Specifically, at a flexion angle of 20-30 degrees, the patella shifts downward and settles into the shallower section of the intercondylar groove. This explains why lateral patella dislocations are more likely to occur within this range. As the knee continues to flex to 60-90 degrees, the patella fully occupies the intercondylar groove, establishing maximal contact between the patella and the groove, which covers approximately one-third of the patella's posterior surface area. Around 135 degrees of knee flexion, which is close to full knee flexion, the patella makes contact with the femur using its upper end and settles beneath the intercondylar groove. This position subjects the patellofemoral joint to substantial compression forces, with these forces being influenced by both the strength of the quadriceps muscles and the degree of knee flexion. In men, the contact surfaces within the patellofemoral joint increased in size when the knee was bent beyond 30 degrees of flexion. Women exhibited a notable increase in average patellofemoral contact pressures compared to men at 0° and 30° knee flexion. Additionally, women's knees displayed a more pronounced variation in contact pressures under varying vastus medialis loads at knee flexion angles of 0°, 30°, and 60°. In the range of knee flexion from 60 to 90 degrees, the patellofemoral joint encounters its peak compression forces, accompanied by maximal contact between the patella and the femur. This increased contact area helps safeguard the joint from the elevated compression forces. Consequently, as the degree of knee flexion increases, so does the compression force within the patellofemoral joint (41).

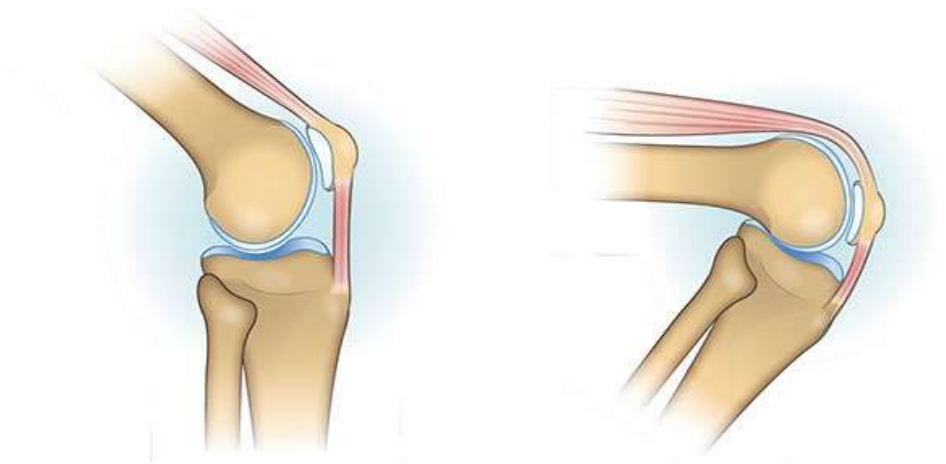

Figure 2.2. Compression of the Patellofemoral Joint (41)

The assessment of patellar position is a static process that can be performed at various knee flexion angles, whether or not the quadriceps are engaged. In contrast, patellar tracking pertains to the dynamic movement of the patella across a range of knee motions. Patellar alignment can be assessed in two aspects, which include medial-lateral displacement and medial-lateral tilt (42).

The alignment and tracking patterns of the patella were examined and most of imaging techniques used: 1 radiographic study (43), 4 CT studies (42), 3 MRI studies (44), 3 kinematic MRI studies (45), and in a more recent investigation, three-dimensional patellofemoral movements were recorded using a motion capture system (46).

2.3. Patellofemoral Pain Syndrome (PFPS)

Patellofemoral pain syndrome is a general expression used to characterize discomfort located in the front part of the knee, often surrounding the patella. It's occasionally referred to as "runner's knee" or "jumper's knee" due to its prevalence among athletes, especially in females and young adults. However, PFPS can also affect individuals who are not involved in athletic activities. It’s seen in 22/1,000 persons per year. The pathogenesis of PFPS is complex, involving multiple factors and various functional abnormalities in the lower limb (47). The reason of PFP is not openly understood. Under the general definition of patellofemoral pain syndrome, chondromalacia patella, patellofemoral arthralgia, anterior knee pain and patellar tendinitis are mentioned (48).

2.3.1. Etiology of Patellofemoral Pain Syndrome

While patellar trauma can contribute to PFPS, it typically results from a blend of various factors, characterized as multifactorial causes. These encompass the overuse and excessive strain placed on the patellofemoral joint, anatomical or biomechanical irregularities, muscular weaknesses, as well as imbalances or dysfunction. Studies indicate that the primary drivers of PFP symptoms are the excessive load on the joint and the abnormal tracking of the patella (49). PFPS can also result from factors such as excessive knee extension, lateral twisting of the tibia, genu valgum or varus, an elevated Q-angle, and tightness in the iliotibial band, hamstrings, or gastrocnemius muscles. Pes planus (pronation) and pes cavus (supination) can provoke PFPS. When the foot pronates, it causes a compensatory inward rotation of either the tibia or femur, which can disrupt the patellofemoral mechanism. Conversely, when the foot undergoes supination, it offers less shock absorption upon ground impact, resulting in greater strain on the patellofemoral mechanism. Furthermore, the way the hips move can impact the knees and trigger PFPS. Research has revealed that individuals with PFPS exhibited weaker hip abductor muscles, which were linked to an increase in hip adduction during running (50).

2.3.2. The Association Between Patellofemoral Pain Syndrome and Lower Extremity

PFPS is linked to various biomechanical characteristics in the lower extremities, and potential risk factors include atypical foot structure, insufficient strength in the hamstring, quadriceps, and gastrocnemius muscles, a shortened iliotibial tract, overall joint weakness, an excessive quadriceps angle, patellar compression or misalignment, and irregular response rates of the vastus lateralis and vastus medialis oblique muscles. Diverse biomechanical agents of the lower extremity limbs have been worked as possible risk factors of PFPS for a long time however there is an ongoing discussion about how much each factor influences PFPS (51). PFPS is associated with several biomechanical characteristics in the lower limbs, and potential risk factors include abnormal foot structure, inadequate strength in the thigh's hamstring and quadriceps muscles, along with the gastrocnemius muscle, a shortened iliotibial tract, generally weakened joints, an exaggerated quadriceps angle, patellar compression or misalignment, and irregular response patterns of the vastus lateralis and vastus medialis oblique muscles. Researchers have long examined various biomechanical factors in the lower limbs as potential contributors to PFPS, but there is ongoing debate regarding the extent to which each factor influences the condition (52).

2.3.3. Signs and Symptoms of PFPS

As in all orthopedic disorders, certain signs and findings are present in patellofemoral pain syndrome. While the symptoms of patellofemoral pain syndrome can differ from individual to individual, they typically include the following: discomfort beneath or around the kneecap, particularly when ascending or descending stairs, kneeling, and squatting; a sensation of tightness in the calves and thighs; clicking and grinding sensations in the knee; feelings of the knee giving way or a sensation of instability; pain that arises after sitting for an extended duration, such as when driving or watching a movie; and swelling. Individuals may encounter any combination of these symptoms (53).

2.3.4. Evaluation of Patellofemoral Pain Syndrome

A comprehensive patient history and a well-directed physical examination are essential for confirming the diagnosis of patellofemoral pain syndrome, identifying the exact anatomical origin of the symptoms, and identifying all relevant risk factors. An accurate diagnosis is crucial for devising an appropriate treatment plan (53).

2.3.4.1. History

The aims of the history are to remove the mechanism of injury and the direct location of the pain. It is also important to discrete patients who have pain only from those who have both pain and instability, because they require various treatment approaches (53).

2.3.4.2. Physical Examination

The aims of the physical examination are to approve the determining the presence of PFPS, determine the source of the discomfort and define the mechanism of injury by screening for power and lack of flexibility and lower extremity malalignment (53).

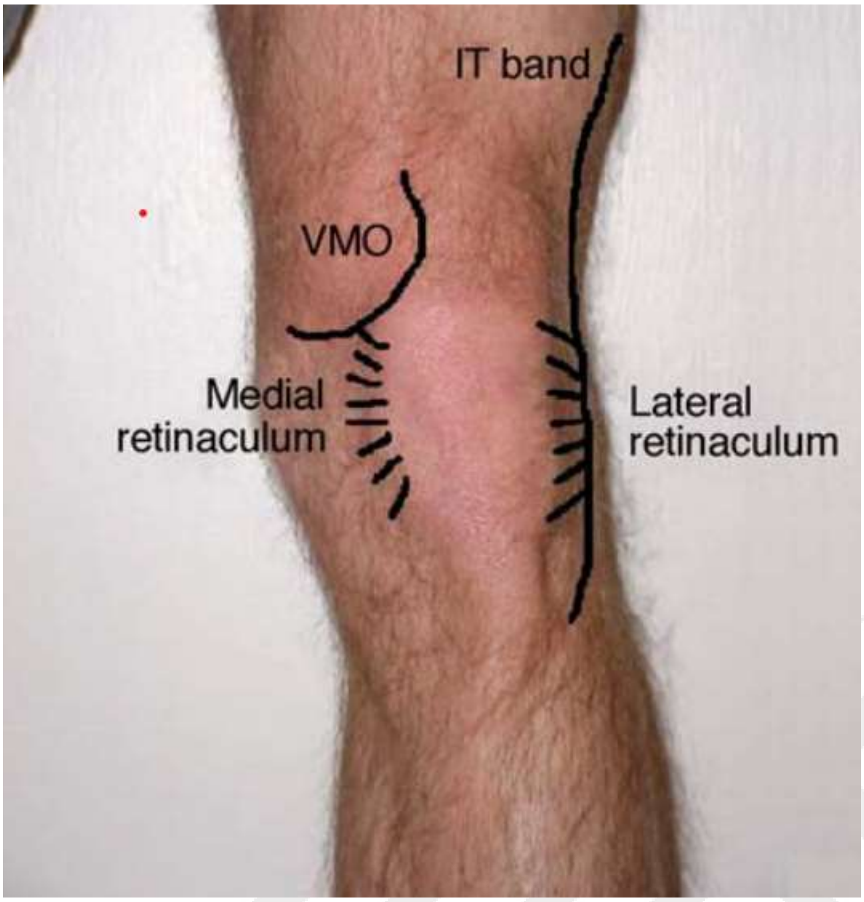

Figure 2.3.4.2. Significant Anatomic Structures in the Assessment of Anterior Knee Pain (53)

Physical examination should start with the patient standing to evaluate lower extremity alignment. In standing position, circumference measurements are made and it is evaluated whether there is any atrophy, Q angle can be measured, Length measurements can be made to observe any unevenness in the lower extremity, it is checked if there is any increased varus, valgus, supination, pronation in the foot and the patient's posture can be observed from the anterior, posterior, medial and lateral and inferences can be made accordingly. Functionally, movements of the patella are observed during squatting and walking. In supine position, firstly the knee and its surroundings are examined with palpation and then range of motion is checked actively and passively, other lower extremity joint ranges of motion are also checked for control purposes. Shortness and flexibility tests of gastrocnemius, hamstring, iliotibial band and iliopsoas muscles are examined. There are also some tests to evaluate the patellofemoral joint; active quadriceps pulling tests, patellofemoral grinding test, patellar apprehension test, sage's sign, passive patellar slip test, passive patellar tilt test.

In addition, imaging modalities such as conventional radiographs, MRI, radionuclide bone scanning, dynamic magnetic resonance imaging and CT are used to evaluate the patellofemoral joint (53).

2.3.5. Treatment Protocols of Patellofemoral Pain Syndrome

The goal of rehabilitation is to reduce inflammation, irritation, and pain. At the same time, the aim is to eliminate or control and to prevent muscle atrophy. The rehabilitation process may vary according to the acute, subacute and chronic period. Generally, the treatment approach involves regaining patellar and lower extremity mobility, which includes the hip and ankle, restoring the ability to tolerate a full range of motion, educating the patient, minimizing factors that worsen the condition, applying techniques like soft tissue mobilization and patellar taping, implementing controlled training, dry needling, nerve mobilization, joint mobilization or manipulation, enhancing muscle strength and flexibility, transitioning to weight-bearing activities that do not excessively flex the knee, developing the capacity for closed-chain strengthening without overloading the knee joint in flexion, ensuring the patient can independently follow an advanced home exercise program, engage in daily activities, and achieve their functional goals while maintaining tolerance to closed-chain knee joint loading with appropriate eccentric control (54) and recently, research is being conducted on the potential impact of foot interventions on patellofemoral pain. As a result, Foot Core exercises gained importance and started to be used in treatments (51).

2.3.5.1. Foot Core Exercises

Foot Core exercises are contained short foot exercise, heel raise exercises, tibialis posterior exercises and balance board training. Traditionally, Foot Core exercises are referred to as intrinsic foot muscle flexion exercises and are employed to enhance the sensory and motor capabilities of the foot. A more suitable exercise program would be a combined intervention to improve both the intrinsic and extrinsic foot muscles of the Foot Core system, which can improve foot function in static posture and dynamic activities (55).

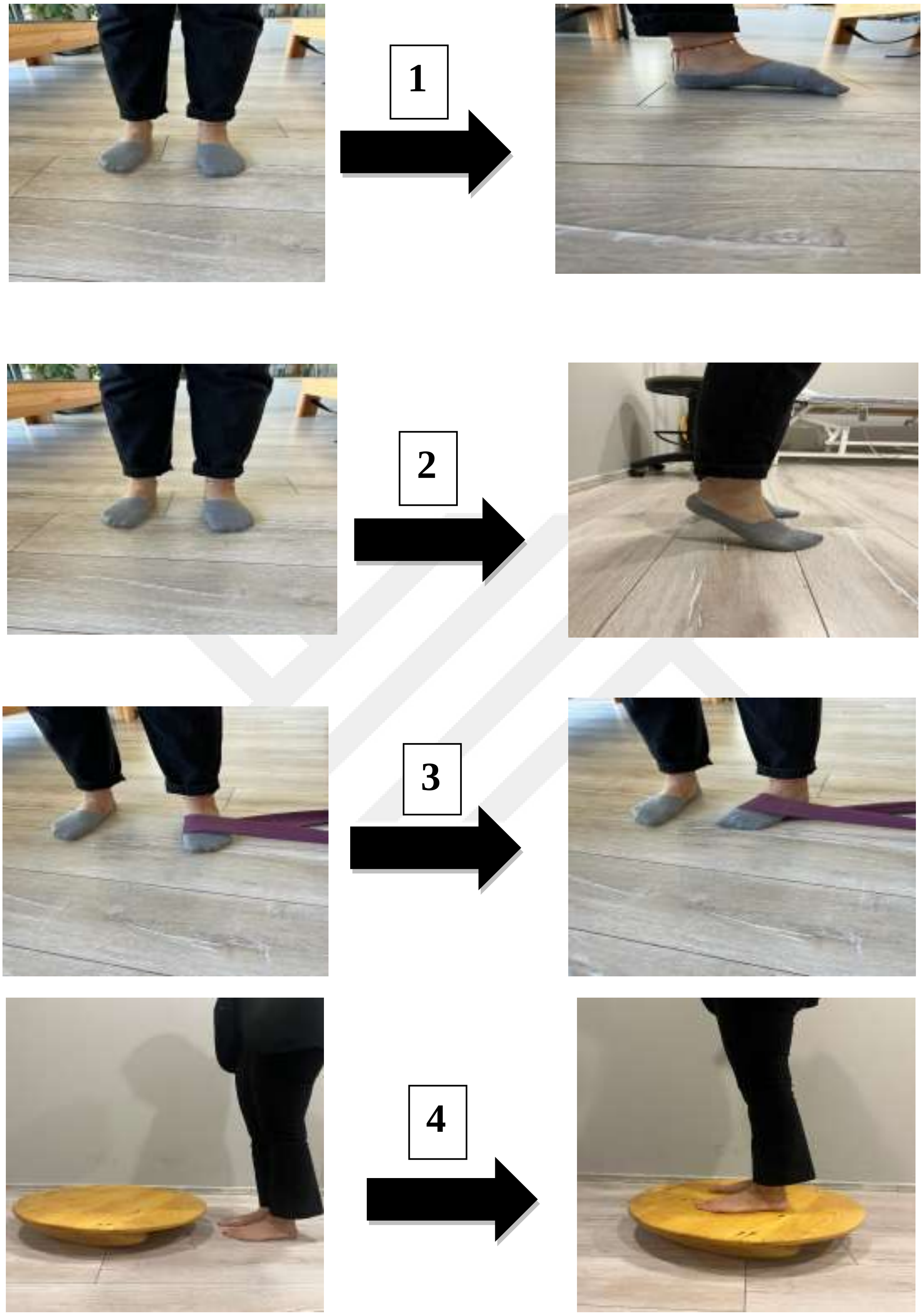

Figure 2.3.5.1. Foot Core exercises; (1) short foot exercise; (2) heel raise exercises, (3) tibialis posterior exercises; and (4) balance board training

3. MATERIAL AND METHODS

3.1. Subjects

This randomized controlled study included 30 volunteers who were assigned to Foot Core Exercise Group (n=15, 43,67±10,11 years old) or Control Group (n=15, 44,13±8,50 years old) according to patients who have patellofemoral pain syndrome. Yeditepe University's Ethical Committee granted approval for the study protocol (protocol number: E.83321821-805.02.03-114). The study was also registered on ClinicalTrials.gov (NCT05884710). The goal and plan of the study were explained and informed written consent was obtained from each patient. We analyzed the power using G*Power version 3.1.9.4 (Heinrich-Heine-Universität Düsseldorf, Düsseldorf Germany) software. The inclusion and exclusion criteria of the study are indicated below.

3.1.1. Inclusion Criteria

- Voluntary participation in research.

- Individuals aged between 20 and 59 years who had patellofemoral pain syndrome were incorporated into the study.

- Provided they experienced front of the knee discomfort for a minimum of two months during a minimum of two functional activities such as step-up, step-down, prolonged sitting, squatting, kneeling, jumping, or running.

- The diagnosis of patellofemoral pain syndrome was confirmed by an orthopedist through a positive patellar grind test and tenderness in both the medial and lateral patellar facets.

- Patients diagnosed with Chondromalacia Patella Grade 1-2-3 were included.

- Patients diagnosed with Lateral Patellar Compression Syndrome were included.

3.1.2. Exclusion Criteria

- Recent injuries to musculoskeletal structures in other lower limb joints that have impacted joint function and stability within the past 4 months.

- Balance or vestibular disorder.

- Patients with neurological problems who cannot follow commands and have Turkish language and speech disorders and do not understand.

3.1.3. Flow Chart of the Study Process

Participants were recruited for the study between January 2023 and March 2023 among the Medical Park Hospital clients. We invited all the clients who applies to our Physical Therapy center were invited to study. Clients who agreed to voluntarily participate to study were assessed for eligibility (n=40). We included 15 Control and 15 Experimental who met inclusion criteria to the study. Each volunteer was briefed on the study's objectives and approach, and written consent was obtained after ensuring they were informed.

The volunteers were assessed in terms of pain using a VAS scale, Range of Motion and muscle strength test, including goniometer and manually, respectively. Moreover, functional performance, quality of life and physical activity were evaluated using the time up and go test, 10-MWT, stair up and down test, SF-36, IPAQ Questionnaire before and after interventions. These tests were measured before and the tests were repeated after 4 week later for understand and compare the effects of treatment (Figure 3.1.3)

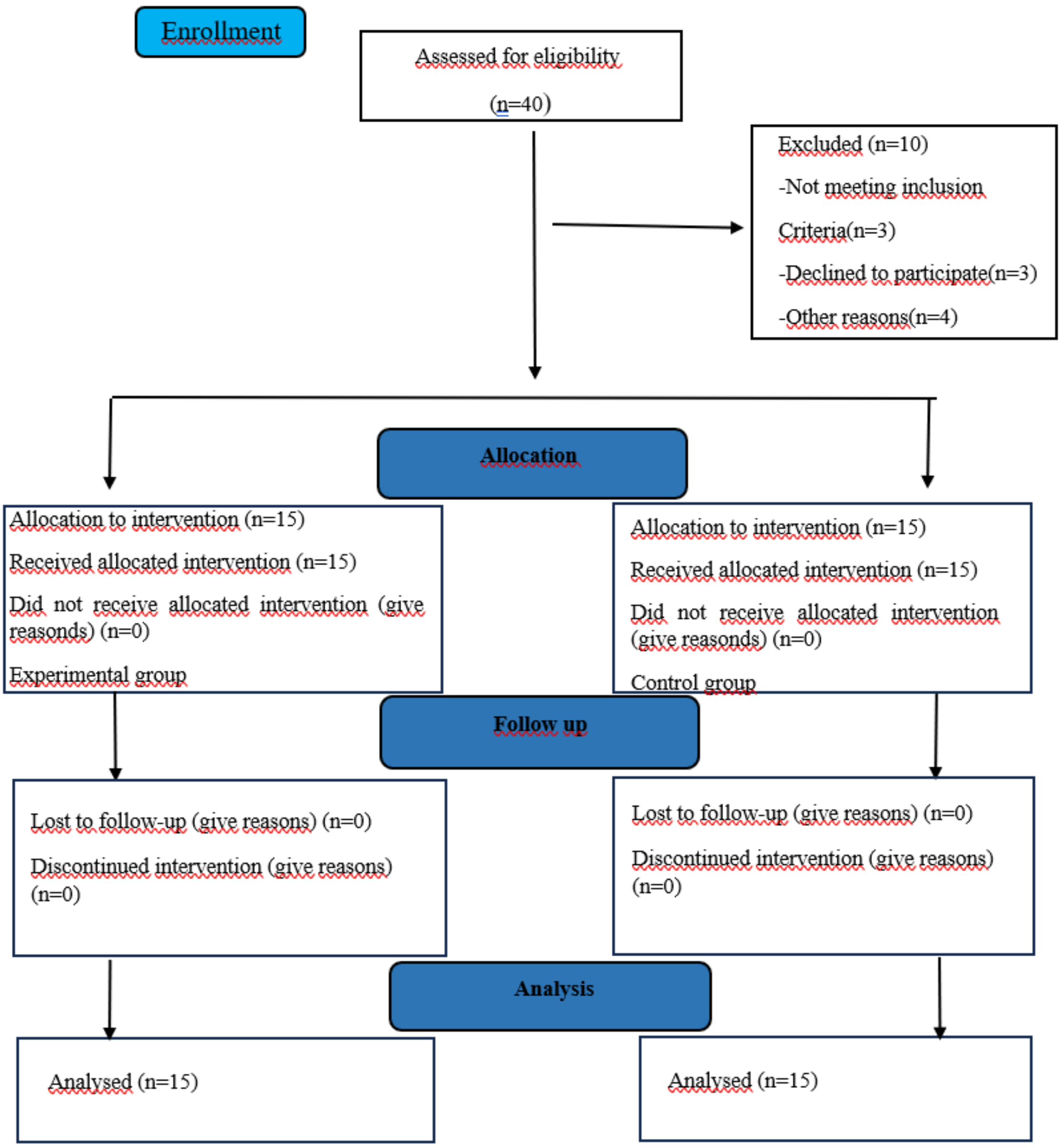

Figure 3.1.3. Flow Chart of The Study

3.1.4. Study Protocol

All participants did quadriceps isometric exercises in the bed, neuromuscular electrical stimulation (NMES) for 20 minutes and patellar mobilization; in addition to these, Foot Core exercises were added to the Experimental Group throughout twice a day for four weeks. We teach the exercise program to each participant and exercise sessions were done synchronously using video conference and reminder images. At the end of four weeks, all tests were re-administered and re-analyzed for both groups.

CONTROL GROUP	EXPERİMENTAL GROUP
Quadriceps isometric exercises in supine position	Quadriceps isometric exercises in supine position
Neuromuscular electrical current	Neuromuscular electrical current
Soft tissue therapy-Patellar mobilization	Soft tissue therapy-Patellar mobilization
	Foot Core exercises

Table 3.1.4. Interventions of Control Group and Experimental Group

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, medications, exercise status, and smoking/alcohol use, patellofemoral pain level were questioned. (APPENDIX C)

3.2.2. The Visual Analogue Scale (VAS)

The Visual Analogue Scale 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 (56). We assessed the alterations in pain experienced during matches over a four-week intervention period in both the CG and the EG. Participants were asked to rate the changes in both numerical and verbal terms.

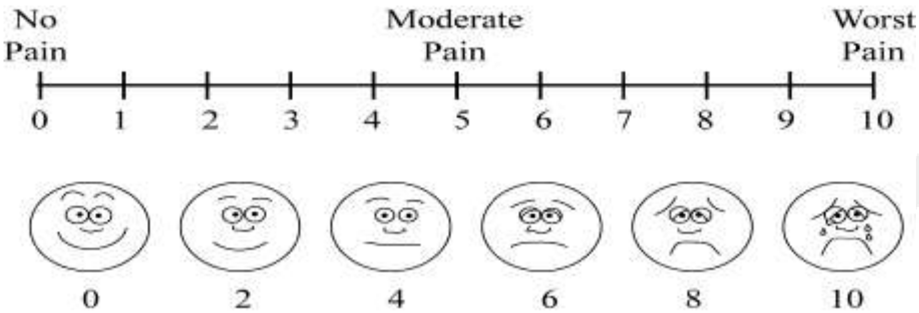

Figure 3.2.2. Vas Score for Pain (56)

3.2.3. Range of Motion Measurement Tests

We evaluated the range of motions with goniometer device. Already, it is the most common instrument used to measure range of motion. We used to measure in each plane of the joint. Especially, we measured knee flexion, knee extension, hip internal rotation and external rotation, ankle dorsiflexion, ankle plantarflexion, ankle inversion, ankle eversion ROM. It employs a fixed arm and a mobile arm to gauge joint angles relative to the joint's axis (57). The study recorded and documented the maximum angle achieved by the participant at the conclusion of their range of motion, with a focus on the most noteworthy outcomes. (Fig.3.2.3.)

The patient requested to sit in a semi-upright position. The pivot point of the goniometer was placed at the lateral malleolus, the fixed arm aligned with the fibula's lateral midline and the movable arm was positioned on the lateral midline of the 5th metatarsal bone. The patient was then asked to push their ankle forward. (Figure 3.2.3.)

Figure 3.2.3. Measurement of Ankle Dorsiflexion and Plantarflexion ROM

3.2.4. Muscle Strength Tests

We evaluated the muscle strength with manually. The function of muscle strength testing is to evaluate the weakness. We used the five-point scale when doing the manual muscle strength test (58).

0/5: We cannot generate any discernible muscle contraction in a particular muscle.

1/5: Muscle contraction is observed, yet there is no accompanying movement.

2/5: A muscle has the ability to contract, but it lacks the capacity to fully move the body part against the force of gravity.

3/5: We can achieve complete muscle contraction and move a body part through its entire range of motion while overcoming the force of gravity.

4/5: The muscle can contract and offer opposition.

5/5: The muscle is operating in a typical manner and can sustain its position even when subjected to maximum resistance.

We measured knee; flexion and extension, hip; internal rotation and external rotation, ankle; dorsiflexion, plantarflexion, inversion and eversion muscle strength.

The patient was asked to sit. The physiotherapist placed one hand on the sole of the foot and the other on the ankle to stabilize it. The patient was instructed to push their hand as strongly as possible. The test was repeated 3 times and the highest score was recorded. Afterward, in the opposite manner, the patient's hand was placed on the metatarsals and they were asked to push forcefully. After 3 repetitions, the highest score was recorded. (Figure 3.2.4.)

Figure 3.2.4. Manual Muscle Strength Tests of Ankle Dorsiflexion and Ankle Plantarflexion

The technique was initially introduced in 1943 and later detailed by Seddon in the Special Report Series of the British Medical Research Council (MRC) as a means to assess the recovery of a peripheral nerve in terms of overall limb function. Although the MRC system was originally designed to evaluate muscle groups, in clinical settings, it is more frequently used to assess individual muscles (59). The alteration of the MRC scale includes the use of "+" and "–" to the numerical point to contain additional reviewing subdivisions (60) but, we used the other numerical one.

3.2.5. Time Up and Go Tests

The timed up and go test is a simple evaluative test used to measure patients' functional mobility. Initially, the patient begins in a seated posture, and upon the therapist's instruction, the patient rises to their feet. They proceed to walk a distance of 3 meters, then turn around and return to the chair, where they sit down. The timing concludes when the patient is comfortably seated, and we document this duration (61). The durations are important in terms of the risk of falling but we applied this test to evaluate the duration in terms of pain. Certain studies have documented that the TUG Test may not reliably forecast fall occurrence, whereas others have found it to possess a moderate to high level of predictive accuracy for falls when using cutoff times of 10-12 seconds. Several studies have examined the factors influencing Timed Up and Go (TUG) Test performance. In one study involving healthy older individuals who had not experienced falls, Daubney and Culham identified that the key factors in predicting TUG Test durations were the strength of ankle plantar flexion and inversion, rather than the strength of hip or knee muscle groups. These factors explained 48% of the variability in TUG Test durations. Additionally, Manckoundia et al. found that among a substantial group of community-dwelling older adults, extended TUG Test durations (exceeding 12 seconds) were strongly associated with subpar performance on the Clock Drawing Test, self-reported health problems, and increasing age (62).

The patient was positioned in a seated position on a chair. Then, they were instructed to walk along the designated 3-meter area and return to sit while the stopwatch measured and recorded the time. (Figure 3.2.5.)

Figure 3.2.5. Time Up and Go Test

3.2.6. 10 Meter Walk Test

The 10 Meter Walk Test (10MWT) is a commonly employed assessment for gauging an individual's walking speed (63). This test involves determining speed and tallying the number of steps taken within a specified time frame. The evaluation procedure entails walking a specific segment along a level pathway at either a typical or maximal pace, with subsequent measurement of the time it takes to walk that distance and the number of steps taken (64). Our aim in this test is to measure functional performance. Before each walking test, standardized instructions and a demonstration were provided. In the case of the 10-MWT, the time, in seconds, taken to traverse the central 10 meters of a 14-meter corridor was utilized to calculate the individual's comfortable walking speed. Timing commenced when the participant's leading foot crossed the 2-meter mark and concluded when the same foot crossed the 12-meter mark, even though the participant continued walking until reaching the 14-meter mark (65). (Figure 3.2.6.)

We conducted this study this study in a 14-meter corridor. We left a 2-meter gap at the beginning and end. When the patient crossed the first 2 meters, the physiotherapist started the timer and we stopped it at the end of 10 meters, recording the time and the result. (Figure 3.2.6.)

Figure 3.2.6. 10 Meter Walk Test

3.2.7. Stair Up and Down Test

In the other word is stair climb test. Stair climbing is one of the significant functional activities of daily living to maintain mobility and independence. Having sufficient muscle strength and joint range of motion for walking on flat surfaces doesn't guarantee a patient's ability to ascend and descend stairs. The patient's time to go up and down 9 stairs determine the score of the test. The test is started with both feet side by side and the time is started. The normal completion time was determined as 2.6 seconds. In the literature, the desired stair step spacing for this test should be in the range of 16-20 cm (66). (Figure 3.2.7.)

We instructed the patient to go to the top of the stairs. We asked the patient to climb up and down 9 steps. When the practitioner started the timer, we told the patient they could start climbing the stairs and when they finished, we stopped the timer. We recorded the time for going up and down the stairs. (Figure 3.2.7.)

Figure 3.2.7. Number of Steps of the Stair Up and Down Test

3.2.8. International Physical Activity Questionnaire (IPAQ)

The development of the IPAQ was based on the need to enhance global population assessment for evaluating "total physical activity" across various areas such as work, household chores, active commuting, and leisure time, given the anticipation that activity patterns across these domains would vary significantly from one country to another. The IPAQ was enhanced to facilitate cross-country comparisons and to enable international monitoring of physical activity. It was designed in two distinct formats.

The abbreviated version of IPAQ, known as IPAQ short, consisted of seven sections encompassing all activity domains with intensity-specific questionnaire items. In contrast, the extensive IPAQ, comprising 27 sections, evaluated activity within specific domains for each level of intensity. The evaluation of IPAQ in 12 different nations confirmed that this instrument exhibited reliability and validity comparable to other self-reported physical activity surveys. Additionally, it was determined that the abbreviated version was appropriate for monitoring physical activity at the population level, while the extended version, tailored for particular domains, proved to be highly suitable for research endeavors. The IPAQ short form offers several benefits to individuals aiming to implement population-wide physical activity monitoring, such as its brevity and the ability to provide an overall estimate of physical activity levels (67).

The brief version documents activity across four intensity tiers, which include: 1) Vigorous activities such as aerobics, 2) Moderate activities like leisurely cycling, 3) Walking, and 4) Inactive behavior. The initial authors suggested using the "last 7-day recall" variant of the IPAQ-SF for research focused on monitoring physical activity. This recommendation is partly due to the minimal burden it places on participants when reporting their activity. (68).

3.2.9. SF-36 Questionnaire

The Short Form 36 Health Survey Questionnaire, known as the SF-36, was developed in the United States specifically for utilization in the Rand Corporation's Health Insurance Experiment. This originates from a research endeavor known as the Medical Outcomes Study, aimed at objectively assessing the quality of life.

It comprises a set of 36 questions that span eight health-related domains, encompass restrictions in physical activities arising from health problems, limitations in social engagement due to physical or emotional factors, hindrances in typical role-related activities stemming from physical health issues, physical discomfort, and an individual's overall mental well-being, which includes aspects like psychological distress and positive emotions, constraints in usual role-related activities due to emotional issues, vitality involving energy levels and fatigue, and overall perceptions of general health. The SF-36 is frequently utilized as a gauge of an individual's or a population's quality of life (QOL) (69).

4. INTERVENTION

All volunteers with patellofemoral pain syndrome participating in our study did quadriceps isometric exercises in supine position, neuromuscular electrical current, soft tissue therapy-patellar mobilization twice a day for four weeks under the guidance of a physiotherapist. In addition, Foot Core exercises were added to the Experimental Group at the same frequency. The Foot Core exercise programme included exercises were short foot exercises, towel curls, toe spreading and squeezing, and balance board training.

4.1. Quadriceps Isometric Exercises

The robustness of the quadriceps muscles is an internal factor known to influence knee joint performance. This underscores the significance of lower limb strength in absorbing the shock on the knee joint during weight-bearing activities. Therapeutic exercises have 3 basic types There are three types of exercise: isotonic, isokinetic, and isometric. Among these, isometric exercise may be the most suitable and straightforward for patients to comprehend and can be performed easily and safely at home with little or no equipment required. Moreover, isometric exercise results in minimal intraarticular inflammation, compression, and bone degradation. Norden, Leventhal, and Schumacher found that "isometric exercises" are both uncomplicated and cost-effective, leading to a rapid improvement in strength (70). There are 3 basic quadriceps isometric exercises that are basically done on the supine position (71). Firstly, put the rolled towel under patients' knee. Press their knee toward the towel, straightening their knee joint. Secondly, put the rolled towel between their knees and try to compress the towel with both knees. Thirdly, place the rolled towel between their legs and the wall. Press their leg into the towel by pushing it against the wall. Hold it for 3 to 5 seconds in these positions (72). (Figure 4.1.) Research in existing literature indicates that comprehensive strengthening of the quadriceps has proven effective for individuals with patellofemoral pain syndrome. Weakness in the quadriceps, particularly in the vastus medialis obliquus when compared to the vastus lateralis, can result in the lateral movement of the patella, thereby shifting the compression force towards the lateral facet (73). For these reasons, quadriceps isometric exercises are suitable for all ages in terms of practice and beneficial for patellofemoral pain syndrome.

We asked the patient to sit in a long sitting position in bed. We rolled up a towel and placed it under the patient's knees then instructed them to press the towel towards the bed and said 'squeeze the towel'. We told them to hold this position for 5 seconds with each press and repeated it 10 times. After that, we placed the towel between their knees, asked them to bring their knees closer together and said 'squeeze the towel' again, instructing them to hold it for 5 seconds, repeating this 10 times. For the other in bed exercise, we asked the patient to place the towel on the outside of their knee then instructed them to push outward against the resistance isometrically for 5 seconds and repeated this 10 times. (Figure 4.1. Quadriceps Isometric Exercises)

Figure 4.1. Quadriceps Isometric Exercises

4.2. Neuromuscular Electrical Current (NMES)

NMES is electrical stimulation above the motor threshold applied to the muscle to magnify or replace muscle contraction. Muscle by stimulating motor nerves creates or increases muscle contraction. NMES, muscle fiber by mimicking the innervating motor nerve and indirectly through the motor nerve to the muscle stimulates muscle contraction. NMES creates an artificial muscle activity by replacing the process associated with voluntary contraction. Stimuli above the motor threshold are required to stimulate the muscle fiber (74). Clinicians often consider neuromuscular electrical stimulation (NMES) to be a beneficial adjunctive treatment alongside quadriceps strengthening.

Previous research has indicated that rehabilitation training programs combining NMES with voluntary muscle contraction are more effective in addressing muscle weakness compared to programs utilizing either NMES or voluntary contraction in isolation (75). It was applied for 20 minutes, twice a day and for 4 weeks as a treatment period (76). A handheld 2-channel NMES device was employed, delivering a stimulation frequency of 50 Hz and generating biphasic symmetrical square pulses with a duration of up to 400 μs. The device had an on-off cycle ratio of 10 seconds on and 20 seconds off, along with 1-second ramp-down times.

4.3. Soft Tissue Therapy-Patellar Mobilization

The patient was instructed to assume a half-lying position with their knees extended, after which the patella underwent medial and lateral gliding, as well as superior and inferior gliding (77). Patellar mobilization is a technique that can be employed to restore the suppleness and pliability of the patellofemoral joint. By gently repeating passive gliding movements until encountering initial resistance, this method enhances nutrition, blood circulation, and joint lubrication, thereby aiding in the improvement of joint mobility. Passive mobilization serves the purpose of restoring regular gliding and rolling motions within the joint's kinematics. Additionally, mobilization has a neurophysiological impact. Two studies have indicated decreased patellar mobility among individuals with PFPS. Witvrouw (2000) found that medial and lateral patellar mobilization showed some utility in PFPS, although the outcomes did not reach statistical significance. The primary goal of passive mobilization is to reestablish the typical gliding and rolling movements within the joint's mechanics. Furthermore, mobilization has neurophysiological effects. Two studies have highlighted reduced patellar mobility in individuals with PFPS. In a study by Witvrouw (2000), it was noted that medial and lateral patellar mobilization offered some benefits for PFPS, although the results did not achieve statistical significance (78). As demonstrated in the literature, patellar mobilization was found to be effective in reducing pain and improving the functionality of the patellofemoral joint after just one to three sets during the treatment session. We applied twice a day for 4 weeks as a treatment period and in terms of duration, it was applied by a physiotherapist for 5 minutes.

4.4. Foot Core Exercises

Foot Core exercises are contained short foot exercise, heel raise exercises, tibialis posterior exercises and balance board training (55).

4.4.1. Short Foot Exercise

The short-foot exercise is a widely employed balance training technique that has been recently enhanced to enhance ankle proprioception and bolster the intrinsic foot muscles. This aims to elevate and stabilize the medial longitudinal arch of the foot and enhance dynamic standing balance. SFE is executed by endeavoring to draw the first metatarsal head closer to the calcaneus without flexing the toes (79). Short foot exercise, as an active approach, may be of important benefit in patients with PFP. The objective of the short foot exercise is to contract the intrinsic muscles, causing the foot to "shorten" and lifting the arch while pulling the first metatarsophalangeal joint closer to the calcaneus (80).

We asked the patient to sit up and place their foot on the ground then we placed a towel under their foot. We instructed the patient to pull the towel towards them using their toes and raise the arch of their foot. We asked them to repeat this movement 10 times.

4.4.2. Heel Raise Exercises

Heel raises, often known as "calf raises," are frequently incorporated into resistance training routines. The heel raise is a lower body exercise that mainly focuses on calf muscles, including the gastrocnemius and soleus. This movement is highly functional and develops lower body strength and endurance. This exercise can be performed in different positions: sitting, standing on the floor, or standing on a step. Heel raises are commonly employed as exercises to strengthen the gastrocnemius and soleus muscles, and they are often executed in three distinct foot positions: neutral, internal rotation and external rotation (81). We prefer sitting position as neutrally.

We instructed the patient to stand up. We had them assume a position as if wearing high-heeled shoes, raising onto their tiptoes and asked them to repeat this movement 10 times. For patients who had difficulty maintaining their balance while performing this exercise, we provided support or had them do it while sitting.

4.4.3. Tibialis Posterior Exercises

The tibialis posterior plays a crucial role in stabilizing the foot while standing and walking. It provides dynamic support to the underside of the foot and the arch through its tendon. When there is a deficiency in the muscle or tendon, it can result in a reduction of longitudinal arch height, potentially causing flat feet. Its function plantarflex and invert the ankle (82). Jafarnezhadgero and colleagues conducted a study to investigate the impact of elastic band resistance training on walking kinetics. Their research demonstrated the effectiveness of resistance exercises for the tibialis posterior, particularly among male adults with genu valgus disorder. Taking into account the available research, there is a significant volume of literature addressing the utilization of exercises designed to enhance the strength of the tibialis posterior muscle in knee-related conditions as a whole.

We instructed the patient to stand up. We asked them to place their foot inside a resistance band and without lifting the heel, we instructed them to move their foot outward against the resistance. We asked the patient to repeat this movement 10 times. For patients who had difficulty maintaining their balance while performing this exercise, we provided support or had them do it while sitting.

4.4.4. Balance Board Training

Balance board workouts entail a regimen of standing and weight-bearing exercises performed on an unsteady surface. Our goal is to strengthen the muscles surrounding the ankle and enhance balance. Balance exercises emphasizing knee alignment play a crucial role in modifying hip and knee biomechanics, particularly in relation to adduction and internal rotation movements. Nonetheless, certain research outcomes fail to offer definitive proof that balance exercises emphasizing knee alignment are superior in reducing pain and improving function compared to conventional balance exercises (83). Several studies have examined balance among individuals with PFP, but the findings have been inconclusive. It's likely that individuals with PFP experience disruptions in their balance compared to those without symptoms. However, there is insufficient evidence to confirm the effectiveness of interventions aimed at improving or altering balance in individuals with PFP. Additionally, there is a lack of substantial evidence supporting the efficacy of balance exercises in alleviating pain and improving function in individuals with PFP (84).

We asked the patient to stand up and step onto the balance board. We instructed them to stay on the board for about 20-30 seconds and then asked them to step off. We repeated this process 10 times, which took a total of 2-3 minutes to complete the exercise.

Foot Core exercises, like other exercises, were applied 2 times a day, 10 repetitions for 4 weeks.

5. RESULTS

The study included 30 patients with patellofemoral pain syndrome who divided into two groups. The patients with patellofemoral pain syndrome in the Experimental Group (EG; n=15; 43.67±10.11 years old) participated the Foot Core exercise program twice a day for 4 weeks duration. The patients with patellofemoral pain syndrome in the Control Group (CG; n=15 44.13±8.50 years old) just participate ordinary exercise program.

5.1. Comparison of demographic and anthropometric characteristics between groups

Demographics and anthropometric characteristics have been analyzed and according to the outcomes of the independent sample t-test, there was no statistically noteworthy distinction between the groups. Demographics and anthropometric characteristics at baseline have been shown in Table 5.1. ($p>0.05$)

Table 5.1. Comparison of demographic and anthropometric characteristics between groups

Variables	Experimental (n=15)	Control (n=15)	t value	p value
	Mean±SD	Mean±SD		
Age(years)	43.67±10.11	44.13±8.509	0.137	0.892
Weight(kg)	73.45±15.436	81.73±14.959	1.493	0.147
Height(m)	1.66±0.061	1.71±0.10	1.632	0.114

Independent Samples t test, SD: Standard Deviation, BMI: Body Mass Index, kg: kilogram, m: meter

5.2. Comparison of Pain Assessment Between Groups at Baseline

Independent samples t-test was used to evaluate the difference between groups pain degrees value of the participants have been shown in Table 5.2. No statistically meaningful distinction existed between the groups.

Table 5.2. Comparison of Pain Assessment Between Groups at Baseline

Variables	Control (n=15)	Experimental (n=15)	Z	p value
	Mean±SD	Mean±SD		
VAS	6.13±1.88	6.80±1.82	-0.966	0.334

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

5.3. Comparison of ROM and Muscle strength between groups at baseline

The independent samples t-test was used to evaluate the difference in the range of motion for knee flexion and extension, hip internal and external rotation, ankle dorsiflexion and plantarflexion, ankle inversion and eversion, as well as the strength of knee flexion and extension, hip internal and external rotation, and ankle dorsiflexion, plantarflexion, inversion, and eversion among the participants. The corresponding values are presented in Table 5.3. There was no meaningful difference observed between the groups in terms of statistical significance.

Table 5.3. Comparison of ROM and Muscle strength between groups at baseline

Variables	Control	Experimental	Z	p value
	Mean±SD	Mean±SD		
Knee Flex. ROM	105.47±13.03	109.47±10.113	-0.81	0.41
Knee Ext. ROM	-	-	-	-
Hip Int. Rot. ROM	27.53±6.44	39.60±6.81	-3.73	**0.00**
Hip Ext. Rot. ROM	26.93±6.96	33.60±10.36	-2.16	0.03
Ankle Dorsiflex. ROM	24.33±5.46	21.00±5.41	-1.27	0.20
Ankle Plantarflex. ROM	19.67±8.56	22.40±8.50	-1.19	0.23
Ankle Inversion ROM	27.67±7.15	27.13±5.95	-0.21	0.83
Ankle Eversion ROM	22.47±4.82	19.47±4.95	-1.92	0.05
Knee Flex. Strength	4.66±0.61	4.80±0.41	-0.50	0.61
Knee Ext. Strength	4.73±0.59	4.80±0.41	-0.08	0.92
Hip Int. Rot. Strength	4.60±0.63	4.53±0.51	0.55	0.57
Hip Ext. Rot. Strength	4.53±0.63	4.53±0.51	-0.19	0.84
Ankle Dorsiflex. Strength	4.80±0.56	4.86±0.35	-0.07	0.94
Ankle Plantarflex. Strength	4.80±0.56	4.93±0.25	-0.63	0.52
Ankle Inversion Strength	4.80±0.56	5.00±0.00	-1.43	0.15
Ankle Eversion Strength	4.80±0.56	4.73±0.45	-0.77	0.43

Data expressed as mean ±standard deviation, $p<0.05$ = statistically significant different, ROM: Range of Motion, Flex: Flexion, Ext: Extension, Int. Rot.: Internal Rotation, Ext. Rot.:External Rotation, Dorsiflex.:Dorsiflexion, Plantarflex.: Plantarflexion

5.4. Comparison of the TUG Test, the 10-MWT, Stair Up and Down Test Assessment between groups at baseline

Independent samples t test was employed to evaluate the difference between groups TUG Test,10 m. Walk Test, Stair Up and Down Test value of the participants have been shown in Table 5.4. No statistically meaningful distinction was observed between the groups.

Table 5.4. Comparison of the TUG Test, the 10-MWT, Stair Up and Down Test Assessment between groups at baseline

Variables	Control	Experimental	Z	p value
	Mean±SD	Mean±SD		
Timed Up and Go	4.03±1.01	4.67±1.16	-1.618	0.106
10 m. Walk	10.01±2.86	11.11±2.99	-1.224	0.221
Stair Up and Down	11.42±2.64	11.89±2.50	-0.518	0.604

Data expressed as mean ±standard deviation, m.:Meter

5.5. Comparison of IPAQ and SF-36 Questionnaire assessment between groups at baseline

The independent samples t-test was utilized to examine the contrast between the groups in terms of their IPAQ and SF-36 Questionnaire assessment values, which are displayed in Table 5.5. The analysis revealed that there was no statistically noteworthy distinction among the different groups.

Table 5.5. Comparison of IPAQ and SF-36 Questionnaire assessment between groups at baseline

Variables	Control	Experimental	Z	p value
	Mean±SD	Mean±SD		
IPAQ				
Vigorous MET	424.0±698.0	149.33±412.23	-1.315	0.189
Moderate MET	160.0±267.0	130.67±290.99	-0.871	0.384
Walking MET	1271.6±1375.6	864.6±727.3	-1.022	0.307
Sitting	460±193.3	508±223.19	-0.169	0.866
SF-36				
Physical Functioning	71.00±23.76	57.66±19.98	-1.709	0.088
Physical Health	61.66±39.94	38.33±41.04	1.588	0.112
Emotional Problems	60.00±47.47	33.33±41.78	-1.580	0.114
Energy	55.00±20.17	40.33±21.83	-2.061	0.039
Emotional Wellbeing	60.00±17.03	54.93±17.20	-0.771	0.441
Social Functioning	72.50±27.62	60.00±19.01	-1.387	0.166
Pain	56.50±20.48	49.50±17.27	-0.922	0.357
General Health	61.00±23.69	47.00±19.71	-1.497	0.134
Health Change	40.00±15.81	36.66±22.88	-0.612	0.541

Data expressed as mean ±standard deviation, MET: Metabolic Equivalent of Task

5.6. Pain assessment of the Control Group at baseline and after the intervention

Table 5.6 presents the comparison of pain assessment values for the Control Group before and after the intervention. The analysis indicated that there was no statistically significant alteration in pain levels.

Table 5.6. Pain assessment of the Control Group at baseline and after the intervention

Variables	Baseline	After	Z	p value
	Mean±SD	Mean±SD		
VAS	6.13±1.88	5.40±2.35	-1.653	0.098

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

5.7. Pain assessment of the Experimental Group at baseline and after the intervention

Table 5.7 displays the comparison of pain assessment values for the Experimental Group before and after the intervention. There was statistically important increase in pain value. ($p<0.05$)

Table 5.7. Pain assessment of the Experimental Group at baseline and after the intervention

Variables	Baseline	After	Z	p value
	Mean±SD	Mean±SD		
VAS	6.80±1.82	4.13±2.23	-3.438	**0.001**

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

5.8. ROM and Muscle Strength Test assessment of the Control Group at baseline and after the intervention

Range of motion measurements for knee flexion and extension, hip internal and external rotation, ankle dorsiflexion and plantarflexion, as well as ankle inversion and eversion range of motion and knee flexion muscle strength, knee extension muscle strength, hip internal rotation muscle strength, hip external muscle strength, ankle dorsiflexion muscle strength, ankle plantarflexion muscle strength, ankle inversion muscle strength, ankle eversion muscle strength comparison of the Control Group before and after the intervention has shown in Table 5.8. There was no statistically significant any change.

Table 5.8. ROM and Muscle Strength Test assessment of the Control Group at baseline and after the intervention

Variables	Baseline Mean±SD	After Mean±SD	Z	p value
Knee Flex. ROM	105.47±13.03	106.0±13.29	-1.518	0.129
Knee Ext. ROM	-	-	-	-
Hip Int. Rot. ROM	27.53±6.44	28.0±6.083	-1.089	0.276
Hip Ext. Rot. ROM	26.93±6.96	27.53±6.89	-1.717	0.086
Ankle Dorsiflex. ROM	24.33±5.46	24.47±5.449	-0.577	0.564
Ankle Plantarflex. ROM	19.67±8.566	20.93±8.908	-2.032	0.042
Ankle Inversion ROM	27.67±7.158	28.00±7.00	-1.134	0.257
Ankle Eversion ROM	22.47±4.824	22.53±4.882	-0.447	0.655
Knee Flex. Strength	4.666±0.617	4.866±0.351	-1.732	0.083
Knee Ext. Strength	4.733±0.593	4.866±0.351	-1.414	0.157
Hip Int. Rot. Strength	4.60±0.632	4.80±0.414	-1.732	0.083
Hip Ext. Rot. Strength	4.53±0.639	4.73±0.457	-1.732	0.083
Ankle Dorsiflex. Strength	4.80±0.56	4.93±0.258	-1.414	0.157
Ankle Plantarflex. Strength	4.80±0.56	4.93±0.258	-1.414	0.157
Ankle Inversion Strength	4.80±0.56	4.93±0.258	-1.414	0.157
Ankle Eversion Strength	4.80±0.56	4.93±0.258	-1.414	0.157

Data expressed as mean ±standard deviation, ROM: Range of Motion, Flex: Flexion, Ext: Extension, Int. Rot.: Internal Rotation, Ext. Rot.:External Rotation, Dorsiflex.:Dorsiflexion, Plantarflex.: Plantarflexion

5.9. ROM and Muscle Strength Test Assessment of the Experimental Group at baseline and after the intervention

Table 5.9 presents a comparison of range of motion (ROM) measurements for knee flexion and extension, hip internal and external rotation, ankle dorsiflexion and plantarflexion, as well as ankle inversion and eversion, along with muscle strength assessments for knee flexion and extension, hip internal and external rotation, ankle dorsiflexion and plantarflexion, and ankle inversion and eversion in the Experimental Group before and after the intervention. There was no statistically significant change in knee extension ROM, hip internal rotation ROM, hip external rotation ROM, ankle dorsiflexion ROM, ankle eversion ROM and knee flexion muscle strength, knee extension muscle strength, hip internal rotation muscle strength, hip external muscle strength, ankle dorsiflexion muscle strength, ankle plantarflexion muscle strength, ankle inversion muscle strength, ankle eversion muscle strength but knee flexion ROM, ankle plantarflexion ROM and ankle plantarflexion muscle strength values have shown a statistically significant increase.

Table 5.9. ROM and Muscle Strength Test Assessment of the Experimental Group at baseline and after the intervention

Variables	Baseline	After	Z	p value
	Mean±SD	Mean±SD		
Knee Flex. ROM	109.47±10.113	114.67±9.484	-3.210	**0.001**
Knee Ext. ROM	-	-	-	-
Hip Int. Rot. ROM	39.60±6.812	44.80±15.223	-2.536	0.011
Hip Ext. Rot. ROM	33.60±10.363	35.80±10.631	-2.375	0.018
Ankle Dorsiflex. ROM	21.00±5.412	21.53±4.734	-1.342	0.180
Ankle Plantarflex. ROM	22.40±8.50	26.47±8.576	-3.128	**0.002**
Ankle Inversion ROM	27.13±5.951	29.80±5.532	-2.971	**0.003**
Ankle Eversion ROM	19.47±4.955	20.60±5.902	-1.787	0.074
Knee Flex. Strength	4.80±0.414	4.93±0.258	-1.414	0.157
Knee Ext. Strength	4.80±0.414	4.866±0.351	-1.414	0.157
Hip Int. Rot. Strength	4.533±0.516	4.93±0.258	-2.449	0.014
Hip Ext. Rot. Strength	4.533±0.516	4.93±0.258	-2.449	0.014
Ankle Dorsiflex. Strength	4.86±0.351	5.00±0.00	-1.414	0.157
Ankle Plantarflex. Strength	4.80±0.56	5.00±0.00	-1.000	0.317
Ankle Inversion Strength	4.80±0.56	5.00±0.00	0.000	1.000
Ankle Eversion Strength	4.80±0.56	5.00±0.00	-2.000	0.046

Data expressed as mean ±standard deviation, p<0.05 = statistically significant different, ROM: Range of Motion, Flex: Flexion, Ext: Extension, Int. Rot.: Internal Rotation, Ext. Rot: External Rotation, Dorsiflex.: Dorsiflexion, Plantarflex.: Plantarflexion

5.10. The TUG Test, the 10-MWT, Stair Up and Down Test Assessment of the Control Group at baseline and after the intervention

The Timed Up and Go Test, the 10-meter Walk Test, Stair Up and Down Test Assessment comparison of the Control Group before and after the intervention has shown in Table 5.10. There was no statistically significant any change.

Table 5.10. The TUG Test, the 10-MWT, Stair Up and Down Test Assessment of the Control Group at baseline and after the intervention

Variables	Baseline	After	Z	p value
	Mean±SD	Mean±SD		
Timed Up and Go	4.03±1.01	4.02±0.99	-0.526	0.599
10 m. Walk	10.01±2.86	10.04±2.86	-0.818	0.413
Stair Up and Down	11.42±2.64	11.34±2.64	-0.473	0.636

Data expressed as mean ±standard deviation, m: Meter

5.11. The TUG Test, the 10-MWT, Stair Up and Down Test Assessment of the Experimental Group at baseline and after the intervention

The TUG Test, the 10-MWT, Stair Up and Down Test Assessment comparison of the Experimental Group before and after the intervention has shown in Table 5.11. The TUG Test, the 10-MWT, Stair Up and Down Test Assessment values have shown a statistically significant increase. ($p<0.05$)

Table 5.11. The TUG Test, the 10-MWT, Stair Up and Down Test Assessment of the Experimental Group at baseline and after the intervention

Variables	Baseline	After	Z	p value
	Mean±SD	Mean±SD		
Timed Up and Go	4.67±1.16	4.28±1.13	-3.295	**0.001**
10 m. Walk	11.11±2.99	10.35±3.12	-3.408	**0.001**
Stair Up and Down	11.89±2.50	11.24±2.71	-3.297	**0.001**

Paired sample t test, Data expressed as mean ±standard deviation, $p<0.05$ = statistically significant different, m: Meter

5.12. IPAQ and SF-36 Questionnaire assessment of the Control Group at baseline and after the intervention

IPAQ and SF-36 Questionnaire assessment comparison of the Control Group before and after the intervention has shown in Table 5.12. There was no statistically significant any change.

Table 5.12. IPAQ and SF-36 Questionnaire assessment of the Control Group at baseline and after the intervention

Variables	Baseline Mean±SD	After Mean±SD	Z	p value
IPAQ				
Vigorous MET	424.0±698.0	424.0±698.0	-	1.000
Moderate MET	160.0±267.0	160.0±267.0	-	1.000
Walking MET	1271.6±1375.6	1218.8±1410.6	-0.816	0.414
Sitting	460±193.3	503.3±166.9	-1.876	0.061
SF-36				
Physical Functioning	71.00±23.76	72.00±24.03	-1.000	0.317
Physical Health	61.66±39.94	61.66±39.94	-	1.000
Emotional Problems	60.00±47.47	60.00±47.47	-	1.000
Energy	55.00±20.17	54.33±21.11	-0.816	0.414
Emotional Wellbeing	60.00±17.03	60.00±17.50	-	1.000
Social Functioning	72.50±27.62	72.50±25.53	-	1.000
Pain	56.50±20.48	56.50±22.43	-	1.000
General Health	61.00±23.69	61.66±23.80	-1.414	0.157

Health Change	40.00±15.81	41.66±18.093	-1.000	0.317

Data expressed as mean ±standard deviation, MET: Metabolic Equivalent of Task

5.13. IPAQ and SF-36 Questionnaire assessment of the Experimental Group at baseline and after the intervention

IPAQ and SF-36 Questionnaire assessment comparison of the Experimental Group before and after the intervention has shown in Table 5.13. There was no statistically significant change in IPAQ values and SF-36 subgroups of emotional problems, energy, emotional wellbeing, social functioning, general health and health change but SF-36 Questionnaire subgroups of physical functioning and pain values have shown a statistically significant improvement. ($p<0.05$)

Table 5.13. IPAQ and SF-36 Questionnaire assessment of the Experimental Group at baseline and after the intervention

Variables	Baseline	After	Z	p value
	Mean±SD	Mean±SD		
IPAQ				
Vigorous MET	149.33±412.23	149.33±412.23	-	1.000
Moderate MET	130.67±290.99	146.67±289.89	-1.000	0.317
Walking MET	864.6±727.3	1086.63±984.23	-1.783	0.075
Sitting	508±223.19	472.00±214.98	-2.460	0.014
SF-36				
Physical Functioning	57.66±19.98	71.33±18.75	-2.810	**0.005**
Physical Health	38.33±41.04	65.00±38.72	-2.558	0.011
Emotional Problems	33.33±41.78	51.11±46.91	-2.032	0.042
Energy	40.33±21.83	47.66±19.26	-2.501	0.012
Emotional Wellbeing	54.93±17.20	56.53±15.10	-0.736	0.462
Social Functioning	60.00±19.01	66.66±13.08	-2.126	0.033

Data expressed as mean ±standard deviation, $p<0.05$ = statistically significant different, MET: Metabolic Equivalent of Task

Pain	49.50±17.27	63.50±16.81	-3.236	**0.001**
General Health	47.00±19.71	52.66±18.69	-2.555	0.011
Health Change	36.66±22.88	43.33±22.09	-2.000	0.046

5.14. Comparison of Pain assessment between groups at the baseline and after the intervention

A repeated measures general linear model was employed to assess pain levels in both the EG and the CG. Results are shown in Table 5.14. There were statistically significant changes in VAS degree between groups.

Z	p value
-3.626	**0.000**

Table 5.14. Comparison of Pain assessment between groups at the baseline and after the. intervention

Variables	CONTROL			EXPERİMENTAL		
	Baseline	After	Δ	Baseline	After	Δ
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
VAS	6.80±1.82	4.13±2.23	-2.66±1.71	6.13±1.88	5.40±2.35	-0.73±1.70

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

5.15. Comparison of ROM and Muscle Strength Test Assessment Between Groups at the Baseline and After the Intervention

A repeated measures General Linear Model was employed to assess various parameters, including knee flex. and ext. range of motion, hip inter. and exter. rotation range of motion, ankle dorsiflexion and plantarflexion range of motion, ankle inversion and eversion range of motion, as well as knee flexion and extension muscle strength, hip internal and external rotation muscle strength, and ankle dorsiflexion, plantarflexion, inversion, and eversion muscle strength. A comparison between groups before and after the intervention is shown in Table 5.15. There were statistically significant changes in knee flexion ROM, ankle inversion ROM degree between groups ($p<0.05$). There were no statistically significant changes in knee extension ROM, hip internal rotation ROM, hip external rotation ROM, ankle dorsiflexion ROM, ankle plantarflexion ROM, ankle eversion ROM and knee flexion muscle strength, knee extension muscle strength, hip internal rotation muscle strength, hip external muscle strength, ankle dorsiflexion muscle strength, ankle plantarflexion muscle strength, ankle inversion muscle strength, ankle eversion muscle strength scores in between groups($p>0.05$).

Table 5.15. Comparison of ROM and Muscle Strength Test Assessment Between Groups at the Baseline and After the Intervention

Variables	CONTROL			EXPERİMENTAL			Z	p value
	Baseline	After	Δ	Baseline	After	Δ		
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD		
Knee Flex. ROM	105,4±13,03	106,0±13,29	0,53±1,35	109.4±10.11	114.6±9.48	5,20±3,94	-3.519	**0,000**
Knee Ext. ROM	0,00±0,00	0,00±0,00	0,13±0,35	0,00±0,00	0,00±0,00	0,13±0,35	-	1.000
Hip Int. Rot. ROM	27,53±6,44	28,0±6,083	0,46±1,50	39,60±6,81	44,8±15,22	5,20±15,26	-1.702	0.089
Hip Ext. Rot. ROM	26,93±6,96	27,53±6,89	0,60±1,18	33,60±10,3	35,80±10,63	2,20±3,42	-0.860	0.390
Ankle Dorsiflex. ROM	24,33±5,46	24,47±5,44	0,16±0,91	21,00±5,41	21,53±4,73	0,53±1,45	-0.543	0.587
Ankle Plantarflex. ROM	19,67±8,56	20,93±8,90	1,26±2,76	22,40±8,50	26,47±8,57	4,06±2,73	-2.799	**0.005**
Ankle Inversion ROM	27,67±7,15	28,00±7,00	0,33±1,17	27,13±5,95	29,80±5,53	2,66±2,41	-2.964	**0.003**
Ankle Eversion ROM	22,47±4,82	22,53±4,88	0,06±0,59	19,47±4,95	20,60±5,90	1,13±2,35	-0.482	0.630
Knee Flex. Strength	4,66±0,61	4,86±0,35	0,20±0,41	4,80±0,41	4,93±0,25	0,13±0,35	-	1.000
Knee Ext. Strength	4,73±0,59	4,86±0,351	0,13±0,35	4,80±0,41	4,93±0,25	0,13±0,35	0,000	1.000
Hip Int. Rot. Strength	4,60±0,63	4,80±0,41	0,20±0,41	4,53±0,51	4,93±0,25	0,40±0,50	-1.175	0.240
Hip Ext. Rot. Strength	4,53±0,63	4,73±0,45	0,20±0,41	4,53±0,51	4,93±0,25	0,40±0,50	-1,175	0.240
Ankle Dorsiflex. Strength	4,80±0,56	4,93±0,25	0,13±0,35	4,86±0,35	5,00±0,00	0,13±0,35	-	1.000
AnklePlantarflex. Strength	4,80±0,56	4,93±0,25	0,13±0,35	4,93±0,25	5,00±0,00	0,06±0,25	-0.598	0.550
Ankle Inversion Strength	4,80±0,56	4,93±0,25	0,13±0,35	5,00±0,00	5,00±0,00	0,00±0,00	-1.439	0.150
Ankle Eversion Strength	4,80±0,56	4,93±0,258	0,13±0,35	4,73±0,45	5,00±0,00	0,26±0,45	-0,898	0,369

Data expressed as mean ±standard deviation, $p<0.05$ = statistically significant different, ROM: Range of Motion, Flex: Flexion, Ext: Extension, Int. Rot.: Internal Rotation, Ext. Rot.:External Rotation, Dorsiflex.:Dorsiflexion, Plantarflex.: Plantarflexion

5.16. Comparison of the TUG Test, 10-MWT, Stair Up and Down Test Assessment Between Groups at the Baseline and After the Intervention

A repeated measures General Linear Model was utilized to assess the Timed Up and Go Test, 10 m. Walking Test, and Stair Up and Down Test. The comparison of scores before and after the intervention between the groups is presented in Table 5.16. Statistically significant alterations were observed in the scores of the TUG Test, 10-MWT, and Stair Up and Down Test between the groups ($p<0.05$).

Table 5.16. Comparison of the TUG test, 10-MWT, Stair Up and Down Test Assessment Between Groups at the Baseline and After the Intervention

Variables	CONTROL			EXPERİMENTAL			Z	p value
	Baseline	After	Δ	Baseline	After	Δ		
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD		
Timed Up and Go	4.03±1.01	4.02±0.99	-0.01±0.11	4.67±1.16	4.28±1.13	-0.38±0.32	-3.783	**0.000**
10 m. Walk	10.01±2.86	10.04±2.86	0.02±0.17	4.67±1.16	4.28±1.13	-0.76±0.35	-4.408	**0.000**
Stair Up and Down	11.42±2.64	11.34±2.64	-0.07±0.27	11.89±2.50	11.24±2.71	-0.64±0.51	-3.618	**0.000**

Data expressed as mean ±standard deviation, $p<0.05$ = statistically significant different, m: Meter

5.17. Comparison of SF36 AND IPAQ Questionnaire Test Between Groups at the Baseline

A General Linear Model Repeated Measures Test is employed to assess IPAQ and SF-36 Questionnaire Test. A comparison between groups before and after the intervention is shown in Table 5.17. No statistically significant alteration occurred in IPAQ subgroups of vigorous MET, moderate MET, walking MET values and SF-36 subgroups of emotional problems, energy, emotional wellbeing, social functioning, general health, health change ($p>0.05$); but IPAQ subgroups of sitting values, SF-36 Questionnaire subgroups of physical functioning, physical health, energy and pain values have shown a statistically significant increase. ($p<0.05$)

Table 5.17. Comparison of SF-36 and IPAQ Questionnaire Test Between Groups at the Baseline and After the Intervention

Variables	CONTROL			EXPERİMENTAL			Z	p value
	Baseline	After	Δ	Baseline	After	Δ		
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD		
IPAQ								
Vigorous MET	424,0±698,0	424,0±698,0	0,00±0,00	149,3±412,2	149,3±412,2	0,00±0,00	-	1.000
Moderate MET	160,0±267,0	160,0±267,0	0,00±0,00	130,6±290,9	146,6±289,8	16,0±61,9	-1,000	0.317
Walking MET	1271,6±1375,6	1218,8±1410,6	-52,8±332,3	864,6±727,3	1086,6±984,2	222±708,6	-2.801	0.005
Sitting	460±193,3	503,3±166,9	43,33±69,04	508±223,1	472,0±214,9	-36,0±44,2	-3.275	**0,001**
SF-36								
Physical Functioning	71,00±23	72,00±24,03	1,00±3,87	57,66±19,98	71,33±18,75	13,66±13,42	-3.292	**0.001**
Physical Health	61,66±39,9	61,66±39,94	0,00±0,00	38,33±41,04	65,00±38,72	26,6±29,07	-3.204	**0.001**
Emotional Problems	60,00±47,4	60,00±47,47	0,00±0,00	33,33±41,78	51,11±46,91	17,7±30,5	-2.396	0.017
Energy	55,00±20,1	54,33±21,11	-0,66±3,19	40,33±21,83	47,66±19,26	7,33±9,23	-2.649	0.008
Emotional Wellbeing	60,00±17,03	60,00±17,50	0,00±1,51	54,93±17,20	56,53±15,10	1,60±7,82	-0.746	0.455
Social Functioning	72,50±27,62	72,50±25,53	0,00±4,72	60,00±19,01	66,66±13,08	6,66±10,4	-2.138	0.033
Pain	56,50±20,48	56,50±22,43	0,00±7,37	49,50±17,27	63,50±16,81	14,0±8,06	-3.909	**0.000**
General Health	61,00±23,69	61,66±23,80	0,66±1,75	47,00±19,71	52,66±18,69	5,66±7,28	-2.436	0.015
Health Change	40,00±15,81	41,66±18,09	1,66±6,45	36,66±22,88	43,33±22,09	6,66±11,4	-1.445	0.148

Data expressed as mean ±standard deviation, $p<0.05$ = statistically significant different, MET: Metabolic Equivalent of Task

6. DISCUSSION

The findings of this study showed that participating in Foot Core Exercises change pain intensity, increase knee flexion range of motion, ankle plantar flexion ROM, ankle inversion ROM, improve walking tests score, stair up and down score, sitting duration on the physical activity scale and quality of life in the Experimental Group after four weeks of intervention in patients with patellofemoral pain syndrome.

The research findings demonstrated a statistically significant reduction in pain levels following Foot Core exercises in the EG, whereas no statistically significant difference in pain was observed in the CG. Moreover, there was a statistically greater change in pain severity in the Experimental Group comparing both groups. Pain in patients with PFPS affects daily life after a while and they have difficulty in continuing their daily work. When we review the literature on this subject Hyun-Joong Kim et al. demonstrated the effects of four weeks of Foot Core strengthening forty-eight patients with PFPS aged between 40–60. They found significant changes in pain and improve mobility and function for individuals with PFPS and they suggested that Foot Core strengthening may have improved the function as well as postural control of lower extremity, which might have led to a decreased patellofemoral pain and also controlled pain (85). Another study included 30 participants between 25 to 55 years of age and given short foot exercises for two times per week for 6 weeks. The short foot exercise in this article is one of the exercises in the Foot Core and they found statistically significant improvement and positive effects on knee pain (86). While we applied classical physical therapy to the Control Group in our study, we also supported the Experimental Group with Foot Core exercises in addition to these. However, classical physical therapy was not effective and sufficient in patients with PFPS. However, when we looked at the results of our study, which we examined in the literature, it was seen that Foot Core exercises were effective on pain in these patients. Foot Core exercises train the small intrinsic muscles of the foot to help support the arch and promote stability of the foot. The purpose of these exercises is to improve foot/ankle strength and restore normal mobility (87). The purpose of our use of Foot Core exercises in patients with PFPS is to reduce pain by increasing the range of motion of the joint by using the knee-ankle biomechanical relationship.

The study indicated that knee flexion ROM degree, ankle plantar flexion ROM degree and ankle inversion ROM degree statistically increased after the Foot Core exercises in the Experimental Group but in the Control Group, no significant difference was observed in the previous and subsequent ROM values. The knee needs to be able to bend and straighten so we can walk, run, stair up and down, support our body weight, control our balance and is an important shock absorber for our body. When knee movement is limited, it causes pain, impairs function and makes us predisposed to knee injuries (88). Several muscles control plantar flexion and inversion. Any injury to these muscles can limit patients range of motion and affect their ability to do activities that require plantar flexion (89). Patients use plantar flexion most when patients are stretching, stand on their tiptoes, like when they're trying to reach something on a high shelf, press down on the gas pedal of their car, ballet dance on the tips of your toes and to a lesser degree, they also use plantar flexion while walking, running, swimming, dancing, and riding a bicycle. Plantar flexion involves a coordinated effort between several muscles in the ankle, foot, leg and knee because of these involves gastrocnemius, soleus, plantaris, tibialis posterior, peroneus longus, peroneus brevis and the other muscle groups (90). If a connection is established with the origin insertion of these muscles, this will affect the range of movements and alignment of the lower extremity, as it affects the traction angle of the patella (91). Ju Sang Kim and colleagues showcased the impacts of short foot exercises on knee joint mobility. They accepted 30 participants and they separated to the 2 groups: the flexible flatfoot group (n=15) and normal foot group (n=15). All participants did the short foot exercise with visual feedback and short foot exercise trainings were applied 20 minutes a day, 5 times a week, for 5 weeks. The results of this study show that the conventional therapeutic exercise group demonstrated no important healings in both the affected and the non-affected side about range of motion but the short foot exercise with conventional therapeutic exercise group demonstrated important healings just in the affected side concerning range of motion (92). In another study, Nia Majcen et al. showed the effects of Wii balance board exercises on knee range of motion. Participants performed on Wii balance board exercises and they applied for 6 times per week, 30–45 min per day and throughout 4 weeks (93). The patients accepted to our study had limited movements in their daily life activities because they had knee pain, and therefore their joint range of motion was limited. In this study, we adapted the Foot Core exercises to our patient and made various changes in the Experimental Group. In these patients, flexion angles increased along with the decrease in pain. Plantarflex and inversion movements were not very limited in our first measurement, but we achieved an increase in the Experimental Group with foot core exercises, especially heel raise and tibialis posterior exercises.

In addition, we observed a significant increase in the values of the Timed Up and Go Test, the 10-meter Walk Test, and the Stair Up and Down Test within the Experimental Group. Generally, these tests are used to evaluate the time spent walking before and after exercise in the literature. These tests are quick measurement of balance, movement ability and functional mobility (94). The increase in the walking speed of these patients and the decrease in the time of going up and down the stairs show us that there is an increase in functionality. Sung Shin Kim and colleagues illustrated the impact of ankle strengthening exercises when combined with motor imagery training on the score of the Timed Up and Go Test. They accepted 30 stroke patients and they separated to the 2 groups: the Experimental Group, consisting of 15 patients, and the Control Group, also comprising 15 patients. The Experimental Group engaged in a 15-minute session of motor imagery training along with 15 min. of ankle joint strengthening exercises, while the Control Group solely performed 30 minutes of ankle joint strengthening exercises. Both the time duration and training regimen were administered four times per week over the course of four weeks and both groups displayed improvement in their performance on the Timed Up and Go Test and an increase in weight-bearing percentage. (95). It is clear from this that ankle strengthening exercises improve the time in the time up and go test. The study of Sahan et al. shows us that comparison of short-term effects of virtual reality and short foot exercises in pes planus. We know that short foot exercises are one of the Foot Core exercises and in this study, we will examine what kind of result we encountered in the test of timed up and down the stairs by performing short foot exercises. 40 people participated within this research investigation and they divided them into 2 groups. This study involves two groups: one is the short foot exercise group, which includes 20 participants, and the other is the virtual reality exercise group, also consisting of 20 participants. Each of the two groups did the exercise in their own group three times a week for four weeks and their results show that short foot exercise reduced time for functional activity and increased performance in participants. With the Foot Core exercises, we obtained positive results in functional tests simultaneously with the decrease in pain and the increase in the degree of knee flexion in the Experimental Group.

Another finding of this study showed that IPAQ subgroups of sitting values, SF-36 Questionnaire subgroups of physical functioning, physical health, energy and pain values have shown a statistically significant increase in the Experimental Group after four weeks of intervention. Simon et al. show us that association between physical activity and pain processing in adults with chronic low back pain compared to pain-free controls. This study involved a total of seventy participants, who were divided into two groups: one comprising individuals with low back pain (n = 49), and the other consisting of pain-free individuals (n = 21). The severity of physical activity was determined using the IPAQ Questionnaire and they found about this study that higher physical activity grades are connected with improved pain modulation among pain-free participants (96). The another study shows that to Examine the physical activity levels in a group of South African individuals experiencing chronic pain in comparison to a matched Control Group. A total of 24 participants volunteered for this study. 12 participants with chronic pain and 12 participants in the Control Group matched for same age, gender and residential area. The IPAQ were used as measures of physical activity and pain levels and found a direct association between chronic pain and physical activity. Participants with chronic pain had a decreased capacity for physical activity. Likewise, it has been observed that there is a relationship between a decrease in the level of pain and raise in the level of physical activity (97). A study of the SF-36 Questionnaire shows that quality of life in individuals with patellofemoral pain. This study is a systematic review including meta-analysis. It contained five databases and for studies reporting quality of life in individuals with patellofemoral pain and their age ranges under 50 years. This systematic review aims to firstly define quality of life in individuals with patellofemoral pain compared to pain-free controls and population norms; secondly evaluate whether intervention is associated with improved quality of life in individuals with PFP; and thirdly define factors associated with quality of life in individuals with PFP. As a result of this systematic review Individuals with PFP aged under 50 years, have evidently decreased knee and health concerned quality of life compared to pain-free controls and population models (98).

STRENGTHENS

Participants were distributed homogeneously among the groups. This practice is applicable anywhere online without needing an exercise mat or any material, which makes it convenient and shows that this study is applicable to a much larger sample size.

LIMITATIONS

The study included a few limitations. The limitations of this study were that we gave one of the exercises that should be done twice a day and they performed one set of these exercises in the clinic and the other set at home. As a result of G*power analysis, we reached 14 people in total and we would like to reach more people but we had difficulty in accessing patients during the earthquake and so we had a relatively small sample size. In addition, there was no follow-up study where we collected long-term effects. We believe that studies with more patients with patellofemoral pain syndrome and where Foot Core exercises are widespread and known will contribute to the literature for future studies.

7. CONCLUSION

In conclusion, as far as we know this study is the first study that compared the effects of Foot Core exercises on pain level and functional performance in patients with patellofemoral pain syndrome. We believe that exercises to promote the foot muscles to retrain dynamically may increase knee and ankle muscles strength and muscles range of motion and reduces the degree of pain. Foot Core training can improve SF-36 and IPAQ because of decreasing pain. Thus, we conclude that patients with patellofemoral pain syndrome should be assessed with an ankle and foot approaching and physiotherapists should advise Foot Core exercises.

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APPENDIX A: ETHICAL COMMITTEE APPROVAL

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

Sayı : E.83321821-805.02.03-114
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:	Patellofemoral Ağrı Sendromlu Hastalarda Foot Core Egzersizlerinin Ağrı ve Fonksiyonel Performans Üzerine Etkileri
Araştırmacılar:	Fzt.Zeynep Budak,Dr.Öğr.Üys.Elif Develi,Op.Dr.Ali Göçer
Başvuru Numarası:	202212Y0327

TOPLANTI BİLGİLERİ			
Toplantı Tarihi:	13.01.2023	**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

Bu belge, güvenli elektronik imza ile imzalanmıştır.

Belge Doğrulama Adresi : http://belgedogrulama.yeditepe.edu.tr/bg.aspx?id=D948F18B-8D73-4F67-A309-0C29219A49D9

Yeditepe Üniversitesi 26 Ağustos Yerleşimi, İnönü Mahallesi Kayışdağı Caddesi 34755
Ataşehir / İSTANBUL
Telefon No: (0216) 578 00 00 Faks No : (0216) 578 02 99
İnternet Adresi www.yeditepe.edu.tr
Kep Adresi : yeditepeuniversitesi@hs03.kep.tr

Bilgi İçin: Sevgi BAYRAKTAR
Unvan: Uzman Yardımcısı
Telefon No:

APPENDIX B: INFORMED WRITTEN CONSENT

YEDİTEPE ÜNİVERSİTESİ

Araştırmanın Adı: Patellofemoral ağrı sendromlu hastalarda foot core egzersizlerinin ağrı ve fonksiyonel performans üzerine etkileri.

Sayın Katılımcı,

Yukarıda adı yazılı araştırmaya katılmak üzere davet edilmiş bulunmaktasınız. Çalışmaya katılıp katılmama kararı 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 patellofemoral ağrı sendromlu bireylerde foot core egzersizlerinin ağrı ve fonksiyonel performans üzerine etkisinin araştırılması amaçlanmıştır. Fonksiyonel performansınızı değerlendirmek için 10 m. yürüme testi, süreli kalk-yürü testi, merdiven inip çıkma testi, uluslararası fiziksel aktivite anketi, günlük yaşam aktivitesi durumunuzu ölçmek için sf-36 anketi ve demografik bilgileriniz için demografik onam formunu doldurmanız istenecektir.Patellofemoral ağrınız için 20 dakika diz çevresine NMES akımı, günde 2 set 10 tekrar yatak-içi kuadriseps izometrik egzersizleri,yumuşak doku mobilizasyonu diz kapağına. Seçilmiş olduğunuz gruba bağlı olarak foot core egzersizleri (1.Tibialis Posterior Egzersizleri 2.Denge Egzersizleri 3. Topuk kaldırma egzersizleri 4- Kısa ayak egzersizleri) 2 set 10 tekrar şeklinde uygulanacaktır. Araştırma için Yeditepe Üniversitesi'nden ve Mersin Medikalpark Hastanesinden izin alınmıştır. Sizden bu çalışmaya 6 hafta 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 olumlu veya olumsuz şekilde istenmeyecektir. 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

telefondan ulaşabilirsiniz.

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

Katılımcı;	**Tanık**	**Araştırma Yürütücüsü;**
İmza/Tarih:	İmza/Tarih:	İmza/Tarih:
Adı-Soyadı:	Adı-Soyadı:	Adı-Soyadı:Zeynep Budak
Telefon No:	Telefon No:	Telefon No:05350138233

APPENDIX C: STRUCTURED QUESTIONNAIRE

DEMOGRAFİK VE KLİNİK BİLGİLER

1)Hastanın Adı Soyadı:
2)Yaş:
3) Cinsiyet: ( ) Kız ( ) Erkek
4) Boy uzunluğu (cm):
5) Vücut ağırlığı (kg) :
6) Dominant taraf:
El ( ) Sağ ( ) Sol
Ayak ( ) Sağ ( ) Sol
7)Medeni Durumunuz:
( ) Hiç evlenmemiş
( ) Evli
( ) Boşanmış
( ) Ayrı yaşıyor
( ) Eşi ölmüş
8)Eğitim durumunuz
( ) Okuryazar değil
( ) İlköğretim
( ) Lise
( ) Üniversite ve üzeri
9) Mesleğiniz:
10) Çocuğunuz :
( ) Var Varsa kaç çocuğunuz var ?....................
( ) Yok
11) a) Sigara kullanıyor musunuz?
( ) Hiç içmedim ( ) Sigara içtim ama bıraktım ( ) Halen içiyorum
b) Günde kaç adet sigara içiyorsunuz?.....................adet/gün
12) Alkol kullanıyor musunuz?
( ) Evet Hangi sıklıkla?...........
( ) Hayır
13) 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 : ....
14) Düzenli olarak kullandığınız bir ilaç var mı?
( ) Evet Nedir ? ....
( ) Hayır
15)Şu an herhangi bir ağrı kesici ilaç kullanıyor musunuz?
( ) Evet Ne zamandır?.................................
( ) Hayır
16)Herhangi bir ameliyat geçirdiniz mi? ( ) Evet............................ Belirtiniz
( )Hayır
17)Hiç kaza geçirdiniz mi ? ( ) Evet....................Belirtiniz ( ) Hayır
18)Spor yapıyor musunuz? Yapıyorsanız ne sıklıkta?
( ) Yapmıyorum ( ) Ayda bir kez den az ( ) Ayda 2 kez ve fazla
( ) Haftada 1 kez ( ) Haftada 2-3kez ( ) Haftada 4-5 kez ( ) Her gün
19) Egzersiz yapanlar için yaptığınız egzersiz her seferinde kaç dakika sürüyor ?
( ) 20 dk az ( ) 20-30 dk ( ) 30 – 60 dk ( ) 60 dk. dan fazla
20) Ne zamandır Patellofemoral ağrı sendromuna sahipsiniz?
( ) 2 yıldan az
( ) 2-3 yıl
( )3 yıldan fazla
21) Hangi tarafta patellofemoral ağrı sendromu tanısına sahipsiniz?
( ) Sağ
( ) Sol
( ) Her iki diz

DİZ VE AYAK BİLEĞİ ROM DEĞERLERİ

	DİZ				AYAK BİLEĞİ			
	FLEX.	EXT.	İNT.ROT	EXT.ROT	DORSİFLEX.	PLANTARFLEX.	İNVERSİYON	EVERSİYON
ÖNCESİ								
SONRASI								

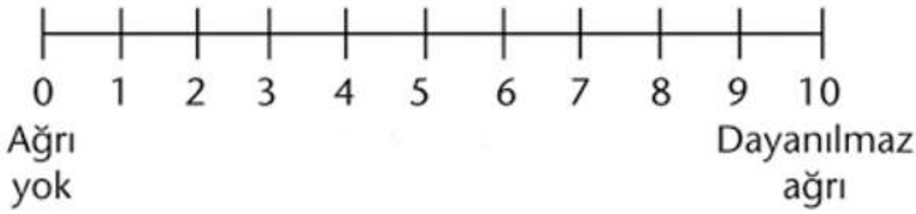
KAS GÜCÜ DEĞERLENDİRMESİ

	DİZ				AYAK BİLEĞİ			
	FLEX.	EXT.	İNT.ROT	EXT.ROT	DORSİFLEX.	PLANTARFLEX.	İNVERSİYON	EVERSİYON
ÖNCESİ	5/	5/	5/	5/	5/	5/	5/	5/
SONRASI								

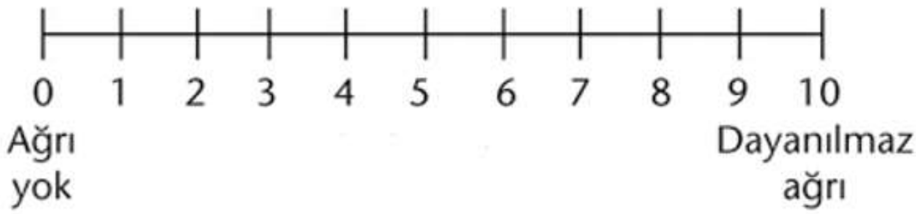
AĞRI DEĞERLENDİRME SKALASI

Diz Ağrısı

ÖNCESİ



SONRASI



SÜRELİ KALK-YÜRÜ TESTİ

Geçen Süre: .... saniye Yaşlı bir birey bu testi 12 saniyeden daha uzun sürede tamamlıyorsa düşme riski vardır	Var olanları işaretleyin:	
	❑ Yavaş ve değişken tempo	❑ Denge kaybı
	❑ Kısa adım aralığı	❑ Kol sallama kısa ya da yok
	❑ Duvara tutunuyor.	❑ Ayaklarını sürüyor
	❑ Kalıp gibi dönüyor	❑ Yürüme araçlarını düzgün kullanmıyor

10 METRE YÜRÜME TESTİ

Geçen Süre:

MERDİVEN İNİP ÇIKMA TESTİ

Hastanın Adı Soyadı: .... Tarih: ..../..../......

Hastanın merdiven inip çıkma aktivitesini, alt ekstremite gücünü, dinamik balansını değerlendiren bir testtir. İdeal olarak istenen 9 basamağı inip çıkma süresi testin sonucunu verir.

<u>Gerekli ekipmanlar:</u>

Bir kronometre. İki kat arasındaki 9 merdiven basamağı ideal test mekanıdır.

Merdiven basamak yüksekliklerinin 16-20cm arasında olması yeterlidir.

Merdivenin tırabzanı (korkuluk, tutamak) olmalıdır.

Hastanın 9 basamak merdiveni inip çıkma süresi (sn.) testin skorunu belirler.

Hasta ihtiyaç duyuyorsa merdiven tırabzanına tutunabilir ya da baston, kanedyen gibi yardımcı yürüme araçlarını kullanabilir.

<u>Hastaya okunacak yönerge:</u>

Teste başladığınızda yapabildiğiniz en hızlı şekilde önümüzdeki merdiveni (kat arası basamak sayısı 9'dan fazla ise 9. basamağa işaret konarak) işaretli yere kadar inip çıkın.

Ancak dengenizi bozacak kadar kendinizi aşırı zorlamayın.

Her iki ayağınız yan yana iken test başlayacak. İhtiyaç duyarsanız tırabzana tutunabilirsiniz.

Hazırsanız başlayalım. "Başla"

<u>Kesme değer:</u>

Normal tamamlama süresi 2.6 sn iken ileri kalça ve diz osteoartritinde süre 5.6 sn ve üzerindedir.

World Health Organization. International Classification of Functioning, Disability, and Health: ICF. Geneva, Switzerland 2001
Dobson F, Hinman RS et al. Osteoarthritis Cartilage 2012;20:1548-62

Toplam Süre (saniye): ....

ULUSLARARASI FİZİKSEL AKTİVİTE ANKETİ-KISA FORM

Hastanın Adı Soyadı: .... Tarih: ..../..../......

İnsanların günlük yaşayış içinde yaptıkları fiziksel aktiviteler hakkında bilgi edinmek istiyoruz. Aşağıda son 7 gün içinde fiziksel olarak harcanan zaman hakkında sorular bulunmaktadır. Lütfen, kendinizi çok hareketli bir kişi olarak görmeseniz bile her soruyu cevaplayın. Ev ve bahçe işlerinizi, işyerinde yaptığınız aktiviteleri, bir yerden bir yere gitmek için yaptıklarınızı, boş zamanlarınızda yaptığınız egzersiz veya spor gibi aktiviteleri düşünün.

Son 7 gün içinde 10 dakika veya üstünde süren, nefesinizi hızlandıran, kuvvet gerektiren tüm yoğun faaliyetleri göz önünde bulundurun.

1	Son bir hafta içinde kaç gün ağır kaldırma, kazma, aerobik, basketbol, futbol veya hızlı bisiklet çevirme gibi şiddetli bedensel güç gerektiren faaliyetlerden yaptınız?		
	❑ Şiddetli fiziksel aktivite yapmadım. (3. Soruya Geçiniz)		Haftada ...... gün
2	Bu günlerin birinde şiddetli fiziksel aktivite yaparak genellikle ne kadar zaman harcadınız?		
	❑ Bilmiyorum/Emin değilim	Günde ...... dakika	Günde ...... saat

Geçen bir hafta içinde yaptığınız orta dereceli fiziksel aktiviteleri düşünün. Bunlar 10 dakika veya daha uzun süren, orta derece fiziksel güç gerektiren ve normalden biraz sık nefes almaya neden olan aktivitelerdir.

3	Son bir hafta içinde kaç gün hafif yük taşıma, normal hızda bisiklet çevirme, halk oyunları, dans, bowling veya tenis gibi orta dereceli bedensel güç gerektiren faaliyetlerden yaptınız? (Yürüme hariç.)		
	❑ Orta dereceli fiziksel aktivite yapmadım. (5. Soruya Geçiniz)		Haftada ...... gün
4	Bu günlerin birinde orta dereceli fiziksel aktivite yaparak genellikle ne kadar zaman harcadınız?		
	❑ Bilmiyorum/Emin değilim	Günde ...... dakika	Günde ...... saat

Geçen bir hafta içinde yürüyerek geçirdiğiniz zamanı düşünün. Bu; işyerinde, evde, bir yerden bir yere ulaşım amacıyla veya sadece dinlenme, spor, egzersiz veya hobi amacıyla yaptığınız yürüyüş olabilir.

5	Geçen 7 gün içerisinde, bir seferde en az 10 dakika yürüdüğünüz gün sayısı kaçtır?		
	❑ Yürümedim. (7. Soruya Geçiniz)		Haftada ...... gün
6	Bu günlerden birinde yürüyerek genellikle ne kadar zaman geçirdiniz?		
	❑ Bilmiyorum/Emin değilim	Günde ...... dakika	Günde ...... saat

Son soru, son bir hafta içinde oturarak geçirdiğiniz zamanlarla ilgilidir. İşte, evde, çalışırken ya da dinlenirken geçirdiğiniz zamanlar dahildir. Bu masanızda, arkadaşınızı ziyaret ederken, okurken, otururken veya yatarak televizyon seyrettiğinizde oturarak geçirdiğiniz zamanları kapsamaktadır.

7	Son bir hafta içinde günde oturarak ne kadar zaman harcadınız?		
	❑ Bilmiyorum/Emin değilim	Günde ...... dakika	Günde ...... saat

YAŞAM KALİTESİ ÖLÇEĞİ (KISA FORM - SF 36)

Hastanın Adı Soyadı: .... Tarih: ..../..../......

Aşağıdaki sorular sizin kendi sağlığınız hakkındaki görüşünüzü, kendinizi nasıl hissettiğinizi ve günlük aktivitelerinizi ne kadar yerine getirebildiğinizi öğrenmek amacındadır. Size en uygun yanıtı verin.

B1

1) Genel olarak sağlığınız için aşağıdakilerden hangisini söyleyebilirsiniz?

Mükemmel	Çok iyi	İyi	Orta	Kötü
☐1	☐2	☐3	☐4	☐5

B2

2) Bir yıl öncesi ile karşılaştırdığınızda şu anki genel sağlık durumunuzu nasıl değerlendirirsiniz?

	Çok daha iyi	Biraz iyi	Hemen hemen aynı	Biraz daha kötü	Çok daha kötü
Bir yıl öncesinden	☐1	☐2	☐3	☐4	☐5

B3

Aşağıdaki sorular bir gün içinde yapabileceğiniz işlerle (aktivitelerle) ilgilidir. Sağlığınız bu aktiviteleri kısıtlıyor mu? Eğer kısıtlıyorsa, ne kadar?

	Evet, Çok Kısıtlı	Evet, Biraz Kısıtlı	Hayır, Hiç Kısıtlı Değil
3) Koşmak, ağır kaldırmak, ağır sporlara katılmak gibi ağır etkinlikler	☐1	☐2	☐3
4) Bir masayı çekmek, elektrik süpürgesini itmek ve ağır olmayan sporları yapmak gibi orta dereceli etkinlikler	☐1	☐2	☐3
5) Market poşetlerini kaldırmak veya taşımak	☐1	☐2	☐3
6) Birkaç kat merdiven çıkmak	☐1	☐2	☐3
7) Bir kat merdiven çıkmak	☐1	☐2	☐3
8) Eğilmek, diz çökmek, çömelmek, diz çökmek	☐1	☐2	☐3
9) Bir kilometreden fazla yürümek	☐1	☐2	☐3
10) Birkaç yüz metre yürümek	☐1	☐2	☐3
11) Yüz metre yürümek	☐1	☐2	☐3
12) Kendi başına banyo yapmak ve giyinmek	☐1	☐2	☐3

B4

Son 4 hafta boyunca bedensel sağlığınızın sonucu olarak, işiniz veya diğer günlük etkinliklerinizde, aşağıdaki sorunlardan biriyle karşılaştınız mı?

	Evet	Hayır
13) Çalışma yaşamınızda veya diğer aktivitelerinizde geçirdiğiniz zamanı kısalttınız mı?	☐1	☐2
14) Arzu ettiğinizden daha az şeyi mi tamamlayabildiniz?	☐1	☐2
15) Çalışma veya diğer yaptığınız işlerin çeşidinde kısıtlama yaptınız mı?	☐1	☐2
16) Çalışma yaşamınızda veya diğer aktivitelerinizi yapmakta güçlük çektiniz mi? (Aşırı efor - çaba sarf ettiniz mi?)	☐1	☐2

B5

Son 4 hafta boyunca, duygusal sorunlarınızın (örneğin çökkünlük veya kaygı) sonucu olarak işiniz veya diğer günlük etkinliklerinizle ilgili aşağıdaki sorunlarla karşılaştınız mı?

	Evet	Hayır
17) Çalışma yaşamınızda veya diğer aktivitelerinizde geçirdiğiniz zamanı kısalttınız mı?	☐1	☐2
18) Arzu ettiğinizden daha az işi mi tamamlayabildiniz?	☐1	☐2
19)İşinizle veya diğer aktivitelerinizle ilgili işleri her zamanki kadar dikkat ederek yapamadınız mı?	☐1	☐2

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B6

20) Son 4 hafta boyunca bedensel sağlığınız veya duygusal sorunlarınız, aileniz, arkadaş veya komşularınızla olan olağan sosyal etkinliklerinizi ne kadar etkiledi?

Hiç Etkilemedi	Çok Az	Orta Derecede	Epeyce	Çok Fazla
☐1	☐2	☐3	☐4	☐5

B7

21) Son 4 hafta içinde vücudunuzda ne kadar ağrı oldu?

Hiç Olmadı	Çok Az	Hafif	Orta	Çok	Pek Çok
☐1	☐2	☐3	☐4	☐5	☐6

B8

22) Son 4 hafta boyunca ağrınız, normal işinizi (hem ev işlerinizi hem ev dışı işinizi düşününüz) ne kadar etkiledi?

Hiç Etkilemedi	Biraz etkiledi	Orta Derecede	Epey Etkiledi	Çok Etkiledi
☐1	☐2	☐3	☐4	☐5

B9

Aşağıdaki sorular sizin son 4 hafta boyunca neler hissettiğinizle ilgilidir. Her soru için, sizin duygularınızı en iyi karşılayan yanıtı, son 4 haftadaki sıklığını göz önüne alarak seçiniz.

	Sürekli	Çoğu zaman	Epey zaman	Bazen	Ara sıra	Hiç bir zaman
23) Kendinizi yaşam dolu olarak hissettiniz mi?	☐1	☐2	☐3	☐4	☐5	☐6
24) Çok sinirli biri oldunuz mu?	☐1	☐2	☐3	☐4	☐5	☐6
25) Hiçbir şeyin sizi neşelendiremeyeceği kadar moraliniz bozuk ve kötü oldu mu?	☐1	☐2	☐3	☐4	☐5	☐6
26) Kendinizi sakin ve huzurlu hissettiniz mi?	☐1	☐2	☐3	☐4	☐5	☐6
27) Çok enerjik oldunuz mu?	☐1	☐2	☐3	☐4	☐5	☐6
28) Kendinizi kalbi kırık ve üzgün hissettiniz mi?	☐1	☐2	☐3	☐4	☐5	☐6
29) Kendinizi yıpranmış, bitkin hissettiniz mi?	☐1	☐2	☐3	☐4	☐5	☐6
30) Mutlu, sevinçli bir insan oldunuz mu?	☐1	☐2	☐3	☐4	☐5	☐6
31) Yorgunluk hissettiniz mi?	☐1	☐2	☐3	☐4	☐5	☐6

B10

32) Son 4 hafta boyunca bedensel sağlığınız veya duygusal sorunlarınız sosyal etkinliklerinizi (arkadaş veya akrabalarınızı ziyaret etmek gibi) ne sıklıkta etkiledi?

Sürekli	Çoğu zaman	Bazen	Ara sıra	Hiç bir zaman
☐1	☐2	☐3	☐4	☐5

B11

Aşağıdaki her bir ifade sizin için ne kadar doğru veya yanlıştır? Her bir ifade için en uygun olanını işaretleyiniz.

	Kesinlikle doğru	Çoğunlukla doğru	Emin değilim	Çoğunlukla yanlış	Kesinlikle yanlış
33) Ben diğer insanlara göre daha kolay hastalanıyorum	☐1	☐2	☐3	☐4	☐5
34) Tanıdığım kişiler kadar sağlıklıyım.	☐1	☐2	☐3	☐4	☐5
35) Sağlığımın kötüleşmekte olduğunu sanıyorum.	☐1	☐2	☐3	☐4	☐5
36) Sağlığım mükemmeldir.	☐1	☐2	☐3	☐4	☐5

Ware JE Jr, Sherbourne CD (1992) Med Care. 1992 Jun;30(6):473-83

APPENDIX D: CONSENT FORM OF HOSPITAL

MLPCARE

Tarih : 04.11.2022

Konu :Veri kullanım izni hakkında Ön Onay

Yeditepe Üniversitesi Girişimsel Olmayan Klinik Araştırmalar Etik Kurulu Başkanlığı'na,

Yeditepe Üniversitesi Fizik Tedavi ve Rehabilitasyon Yüksek Lisans Programı bünyesinde halen yüksek lisansını yürütmekte olan Sn. Zeynep Budak tarafından, MLP Sağlık Hizmetleri A.Ş. merkez yönetim ofisi bünyesindeki hekimlik hizmetleri direktörlüğüne verilmiş olan dilekçede, yürütmekte olduğu "Patellofemoral Ağrı Sendromlu Hastalarda Foot Core Egzersizlerinin Ağrı ve Fonksiyonel Performans Üzerine Etkileri" başlıklı çalışması kapsamında, MLP Sağlık Hizmetleri A.Ş. veya MLPCARE çatı markası altında hizmet veren sağlık kurumlarında kaydı olan hastaların veri toplama bilgilerine ihtiyacı olduğuna dair talebi, Mersin Medikalpark Hastanesinde görev alan Fzt. Zeynep Budak tarafından tarafımıza iletilmiştir. Talep incelenmiş olup, gerekli olan bu verilerin, anonimleştirilmiş biçimi ile kendilerine sağlanabileceği konusunda kanaat oluşmuştur. *Etik Kurul Kararının tarafımıza ulaştırılması, MLPCARE Merkez Hukuk Müşavirliği ve MLPCARE Bilgi Sistemleri Koordinatörlüğü görüş ve onayları sonrasında* verilerin, araştırmacı Sn. Fzt. Zeynep Budak'a iletilmesi uygundur.

Dr. Şerif Köksal

MLP Sağlık Hizmetleri A.Ş.

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