**NATIONAL UNIVERSITY OF MEDICAL SCIENCES**

# IDENTIFICATION OF COMMON DISORDERS IN INDIVIDUALS WITH CHRONIC BACK PAIN THROUGH FOOT PRESSURE ASSESSMENT AND POSTURAL ANALYSIS

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DECLARATION

I hereby declare that in the preparation of this thesis, scientific ethical rules were adhered to, appropriate citations were made in accordance with scientific norms when utilizing the works of others, no falsification was made in the used data, and that no part of this thesis has been presented as another thesis at this university or any other university.

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## SUMMARY

In this study, the evaluation of the presence of gastrocnemius muscle shortness in people with chronic low back pain, the lower extremity biomechanics; This study was carried out to investigate the possible changes in function, posture, pain status and plantar pressure distribution parameters. In the study, the Silfverskiöld method was used to determine GK shortness. According to the measurement results, it was determined that there were male and female participants who may have gastrocnemius muscle shortness. A total of 50 individuals, female (n=33) and male (n=17), were included in the study. It was determined as female participants (mean age 38.27±6.96 years) and male participants (mean age 38.82±765 years). After recording the demographic information of all participants, belonging to both groups; Measurements were performed for parameters of lower extremity biomechanical evaluations.

These parameters are; Subtalar, ankle and knee joint range of motion angular values, knee joint valgite angle and Q angle measurements, knee flexors and hip flexors were determined as muscle shortness measurements and HVA, and measurements were performed using a goniometer. Functional measurements of the feet and ankles of the individuals were made by performing the Navicular Drop Test. Inclinometer was used during the measurements in order to evaluate the sacral inclination angle, which is another parameter. The Modified Schober Test method was preferred in the measurements of lumbar region extensor movements related to muscle shortness. Static plantar pressure measurements were performed to evaluate the plantar pressure distribution and general posture. Pedobarography device was used during the measurements. with these parameters. For comparison of foot posture, the American Society of Orthopedic Surgeons Ankle and Hindfoot Scale (AOFAS) was applied.

As a result of AOFAS, the physical and functional conditions of the foot were evaluated and the findings of the parameters related to the lower extremity were compared. First of all, the visual analog scale (VAS) was used to evaluate the low back pain of individuals. In order to support the data obtained, the Oswestry Disability Index assessment was made on the individuals. The results were used to compare lower extremity parameters and posture. As a result of the study, it was determined that the gastrocnemius muscle shortening was found in male and female participants with chronic low back pain, and this situation may cause limitation of movement while performing active and passive dorsi flexion of the ankle ($p<0.05$). The fact that most people experience pain during movement within the scope of the visual analog scale supports this situation. It was noted that most of the participants were in the "poor posture" class according to the total score, but there was no significant difference between the two groups ($p>0.05$). According to the Oswestry Disability Index, the mean of men was higher than that of women, but there was no significant difference ($p>0.05$). During this evaluation, it was determined that the participants were mostly in the "severely inadequate" category. It was determined that the values related to the amount of NDT, in which the functionality was evaluated, formed a significant relationship with the Q angle values and this relationship was realized in a positive direction ($p=0.000$). As a result, the data related to the Q angle; determined to measure its effect on posture, pain, ODI and foot functionality; Analysis of the New York Posture Questionnaire, AOFAS, ODI and VAS values was performed.

According to the results, it was determined that there was a moderate positive correlation between the ODI scores of the individuals and the measurement results of the Q angle. It was determined that the increase in the Q angle may also cause an increase in the ODI scores and that there is a statistically significant relationship between all parameters ($p<0.001$). The relationship between dorsi flexion of the ankle in knee extension connected to the lower extremity and AOFAS and ODI was evaluated. In conclusion; It was observed that there was a negative correlation between the ankle dorsi flexion parameter in extension and the total score of the ODI index, and a positive correlation between the AOFAS values. This situation was found to support the limitation of chronic low back pain ($p<0.001$). It was observed that the pressure distribution of the fore and hind legs directly affected the posture, and at the same time, there was a negative correlation between the postural data and the ODI values ($p<0.001$). According to the results, it was observed that the shortness of the gastrocnemius muscle affects the biomechanical and functional process of the lower extremity and this effect causes changes in the way the foot is loaded on the ground depending on the plantar pressure. It was concluded that these changes were directly related to the pain levels and posture of the individuals.

**Keywords:** Lower Extremity; Low Back Pain, Plantar Pressure Distribution, Functionality, Posture

# CONTENT

**CHAPTER TWO**

# LIST OF ACRONYMS

**%: Percent**

**° : Degree**

**AOFAS: American Association of Orthopaedic Surgeons Ankle and Hindfoot Scale**

**AT: Achilles Tendon**

**cm²: Square Centimetre**

**dk: Minutes**

**GC Gastrocnemius Muscle**

**GSSK Gastrocnemius-Soleus Muscle Complex**

**HVA : Hallux Valgus Angle**

**k/m²: Kilograms per Square Metre**

**LPKK Lumbo-Pelvic Hip Complex**

**ms: Milliseconds**

**N/cm²: Newton per Square Centimetre**

**N: Number of Individuals**

**S: Seconds**

**SD : Standard deviation**

**STE Subtalar Joint**

**STA: Subtalar joint angle**

**X: Average**

**M: Musculus**

**MG Metatarsal width**

**MLA: Mediallongitudinal arc**

**mm: Millimetre**

**n: Number of Cases**

**ND Amount of navicular drop N**

**NDT: Navicular drop test**

**ODI Oswestry Disability Index**

**p: Statistical error level**

**PTFL: Posteriortalofibular ligament**

**r: Correlation coefficient**

**SD: Standard deviation**

**SIAS: Spina Iliaca Anterior Superior**

**SIPS: Spina Iliaca Posterior Superior**

**Mr: Seconds**

**SPSS: Statistical Package Programme**

**STE Subtalar Joint**

**VAS Visual Analogue Scale**

## LIST OF TABLES

**LIST OF FIGURES**

# INTRODUCTION

Since the mid-1980s, the proliferation of technology and automation worldwide has begun to adversely affect public health. Work and home environments are now filled with automation, personal computers, mobile phones, and other technologies more than ever before. The prevalence of inactive lifestyles around us is increasing. People are less active and are no longer spending much of their leisure time engaging in physical activity. Physical education and after-school sports programs are being cut from school budgets, further reducing the amount of physical activity in children's lives. Currently, it is estimated that approximately one-third (33.8%) of adults in the United States are obese. This trend also affects the adolescent population, with over 18% of adolescents and youth being considered overweight. This new environment is producing increasingly sedentary, less healthy, and less functional individuals who are more prone to injury.

Low back pain is one of the leading musculoskeletal degenerations seen in the adult population, affecting approximately 80% of all adults. Studies have shown that among workers in enclosed workspaces (such as offices), those who spend 3 hours or more in a seated position without interruption and have altered reciprocal inhibition (ARI) of lumbar lordosis are more prone to low back pain than those engaged in manual labor (e.g., farming). More than one-third of all work-related injuries affect the trunk, with more than 60% of these involving the lumbar region. These work-related injuries result in approximately 9 days of restricted activity per person with back pain or more than 39 million days of limited activity in total. The annual cost attributable to low back pain in the United States is estimated to be more than $26 billion. Additionally, between 6-15% of athletes experience low back pain in an average year.

Chronic low back pain is defined as a problem affecting a large portion of society, being present in 85% to 90% of individuals. To describe conditions that are effective in the emergence of chronic low back pain, but whose pathoanatomy or pathology is not yet clearly known, the term "nonspecific" is used in the literature (McNab et al., 2022). Furthermore, MRI (magnetic resonance imaging) results in individuals with chronic low back pain with an unidentified cause have been evaluated for abnormalities associated with back pain. The results of this condition have shown that the data of pathology revealed by clinical assessments alone is not a strong parameter. Individuals with chronic low back pain are often highly affected by environmental conditions, similar to individuals with other chronic diseases (Robberecht et al., 2022).

Current research has focused more on this issue. These studies provide evidence that chronic low back pain may be a biopsychosocial disease. In the evaluation of chronic low back pain with a biopsychosocial approach, although the pain experience and limited abilities are initially defined with anatomical injury, many different psychosocial factors are effective. For example, it has been shown that individuals' pain and their experiences primarily affect general and subsequently psychological health, anxiety, and fear avoidance. This condition has been directly associated with chronic low back pain (Sulowska-Daszyk and Skiba, 2022).

Chronic low back pain occurs as a result of excessive loading on the lumbar region and, as a result, excessive use, injury, or formation of deformities in this region. Poor posture and faulty body mechanics in this specified region have been reported to have adverse effects on various parameters (Wilhelm et al., 2020). Among these parameters are a decrease in flexibility and strength. These conditions are associated with the occurrence of low back pain. The increasing trend towards sedentary lifestyles, the continuity of heavy lifting, the increase in deformities due to heavy physical loads, vibration, posture disorders, and abnormal plantar pressure distribution have been reported to directly cause low back pain (Zhang and Zhang, 2022). In this context, the continuity of a healthy musculoskeletal system is crucial, and it should not be forgotten that this can only be achieved with correct posture.

It has been suggested that muscle shortening may be effective in the formation of poor posture. Muscle shortening is a commonly encountered muscle dysfunction today. Muscle shortening in individuals directly leads to susceptibility to musculoskeletal injuries (Suga et al., 2021). Among the causes of musculoskeletal injuries are overuse, poor posture, decreased flexibility, and spasticity (Omar et al., 2023). When shortening occurs in the gastrocnemius muscle (GM), situations such as decreased flexibility, decreased ankle dorsiflexion, and decreased joint range of motion in knee extension may occur (Moon, 2019). It has been reported that muscle shortening may be the cause of lower extremity injuries such as plantar fasciitis, Achilles tendonitis, stress fractures, iliotibial band syndrome, and patellofemoral syndrome (Manojlović et al., 2022). This shortening in the gastrocnemius muscle (GM) directly affects flexibility and may cause a decrease or loss of flexibility (Salat et al., 2018). Additionally, it is considered an important parameter for the biomechanics of the body as it directly affects the knee, ankle, and subtalar joints (Moonot et al., 2022).

The aim of this study is to evaluate chronic low back pain in individuals by considering parameters related to muscle shortening and to determine the relationship with lower extremity biomechanical variables, plantar pressure distribution, functionality, and posture. The hypotheses proposed for this study are as follows;

1. H1 There is a significant difference in pain feedback (Visual Analog Scale) by gender in individuals with chronic low back pain.
2. H1 There are significant differences in Posture Assessment by gender in individuals with chronic low back pain.
3. H1 There is a significant difference in GM shortening by gender in individuals with chronic low back pain.
4. H1 There are significant differences in HVA values by gender in individuals with chronic low back pain.
5. H1 There is a significant difference in subtalar eversion-inversion angles by gender in individuals with chronic low back pain.
6. H1 There is a significant difference in angular values related to the knee joint by gender in individuals with chronic low back pain.
7. H1 There are significant differences in hip, knee, lumbar extensor shortening, and sacral inclination angle values by gender in individuals with chronic low back pain.
8. H1 There is a significant difference in foot functionality (AOFAS) values by gender in individuals with chronic low back pain.
9. H1 There is a significant difference in ND amounts between the right and left parameters in individuals with chronic low back pain.
10. H1 There are significant differences in ND values by gender in individuals with chronic low back pain.
11. H1 There is a significant difference by gender in "Static Pedobarographic Measurement" analyses in individuals with chronic low back pain.

12. H1 There is a significant difference in "Static Pedobarographic Measurement" analyses in individuals with chronic low back pain.
13. H1 There is a significant linear relationship between HVA right and left, ND right and left values, and Q angle values in individuals with chronic low back pain.
14. H1 There are weak, moderate, and strong positive significant relationships between Q angle and pain feedback, posture, and functionality assessment levels in individuals with chronic low back.

# CHAPTER 1 GENERAL INFORMATION

## 1.1. Anatomy of the Foot and Ankle

The structure and functions undertaken by the foot are quite complex. Functions evaluated regarding the foot actively function during both posture and walking (Barini et al., 2021). For instance, while creating a supportive surface to the body during posture, during active walking, sometimes stabilizing and sometimes mobilizing phases are performed, contributing to the body's development of adaptation to the environment. Among the most significant outcomes of this adaptation process is the distribution of load occurring in the foot. Therefore, the structure of the foot is crucial (Diniz et al., 2021). It is observed that the mentioned functions of the foot are facilitated by its elastic structure, contributing to various features of the adaptation process such as energy storage and release. The most important assistants in this biomechanically occurring energy cycle are intrinsic and extrinsic foot muscles. These muscles are effective in controlling the foot and carry out the control activity by facilitating the deformation and adaptation of the foot arches (Godoy-Santos et al., 2018; Cerezal et al., 2023).

Moreover, the foot has a role in supporting the generation of acceleration in individuals during walking through its demonstrated rigid lever arm effect. The presence of many bones and joint structures associated with the foot also brings about its flexibility (Hynes, 2021). This flexibility is responsible for absorbing shock forces during ground contact, increasing the ability to adapt to different surfaces. Dorsiflexion and plantar flexion movements examined within the scope of the ankle joint are among the most important parameters evaluated for the provision of foot function. It has been noted that the axis direction associated with these movements passes approximately through the level of the malleolus. The muscles effective in the formation of foot movements are divided into separate categories due to directional differences (Mansur et al., 2023). For example, while the main plantar flexors of the ankle are identified as the gastrocnemius and soleus muscles, the tibialis anterior and extensor digitorum longus muscles are classified as the basic dorsiflexors. The plantar and dorsal views of the foot's anatomical structure are presented in Figures 1.1 and 1.2.

When the anatomical structure related to the foot and ankle is examined, it is noted that this system, which bears all the weight of the human body, consists of the distal tibia and fibula as well as 7 tarsal, 5 metatarsal, and 14 phalangeal bones (Omar et al., 2023). This structure is considered the most important and complex system of the skeletal system. The bones constituting the skeletal part of the foot are classified into three groups. This classification is made in the form of the sequential arrangement of foot bones from back to front. This sequence is as follows (Salat et al., 2018):

- Ossa tarsi
- Ossa metatarsi
- Ossa digitorum pedis.

It is noted that ossa tarsi, which is at the beginning of the sequence, has a larger structure than the carpal bones and consists of a total of 7 bones. These 7 bones are listed as follows (Park et al., 2023):

- Talus
- Calcaneus

- Navicular bone
- Medial cuneiform bone
- Intermediate cuneiform bone
- Lateral cuneiform bone
- Cuboid bone.

Furthermore, due to its demonstrated rigid lever arm effect, it has a supportive role in supporting the generation of acceleration in individuals during walking. The presence of many bones and joint structures associated with the foot also brings about its flexibility (Younis et al., 2021). This flexibility is responsible for absorbing shock forces during ground contact, increasing the ability to adapt to different surfaces. Dorsiflexion and plantar flexion movements examined within the scope of the ankle joint are among the most important parameters evaluated for the provision of foot function (Lau et al., 2022). It has been noted that the axis direction associated with these movements passes approximately through the level of the malleolus. The muscles effective in the formation of foot movements are divided into separate categories due to directional differences (Mansur et al., 2023). For example, while the main plantar flexors of the ankle are identified as the gastrocnemius and soleus muscles, the tibialis anterior and extensor digitorum longus muscles are classified as the basic dorsiflexors. The plantar and dorsal views of the foot's anatomical structure are presented in Figures 1.1 and 1.2.

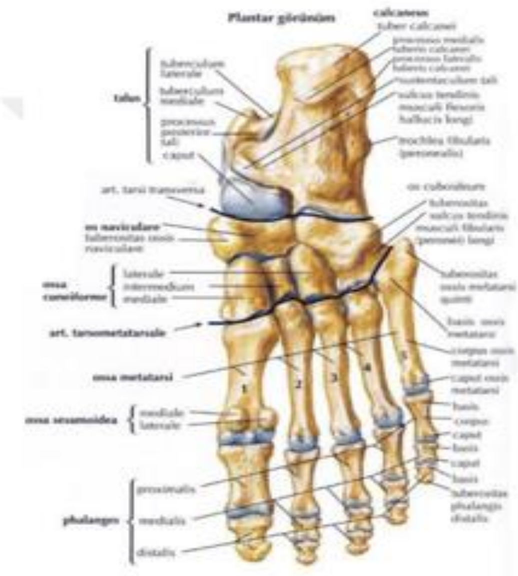


**Figure 1.1. The Plantar View of the Foot (Baumbach vd., 2022).**


**Figure 1.2. The Dorsal View of the Foot(Irajian, 2022).**

1.1.1. Foot and Ankle Bones The foot, considered as a comprehensive structure along with the ankle, consists of a total of 26 bones and is regarded as a part of the locomotor system. Anatomically, the structure of the foot is capable of supporting the entire weight of the human body and providing support during movement (Mayet et al., 2021). The foot bones, referred to as ossa pedis, are examined in three sections: tarsal bones, metatarsal bones, and phalanges (Omar et al., 2023). Upon examining the anatomical structure of the foot and ankle, it has been noted that this system, responsible for carrying the entire weight of the body, is comprised of 7 tarsal, 5 metatarsal, and 14 phalangeal bones. This structure is considered the most important and complex system of the skeletal system (Irajian, 2022). The ankle bones, categorized as the ossa tarsi class in the literature, consist of a total of 7 bones. These structures include the talus, calcaneus, navicular, and the I-II-III cuneiform and cuboid bones (Bayin and Yeşilaydın, 2022). The talus bone, in terms of its position, serves as a junction between the foot and the leg and is therefore frequently examined in the literature and referred to as a key bone. It has been reported that the talus bone has multiple ligament structures for attachment, but muscle groups do not exhibit attachment properties. The calcaneus, considered the largest bone structure of the foot, is also characterized as the point of attachment for foot muscles (Noey et al., 2022). The central position of the heel region in the anatomical structure of the foot has been emphasized, as it plays an active role in load transfer during physical activities. The navicular, classified in the ankle joint, is located in the medial portion between the proximal and distal tarsal bones. It is regarded as a pivot bone for the assessment of foot biomechanics, particularly for the medial longitudinal arch height parameter. Another ankle bone, the cuneiform, is examined in three separate classifications: medial, intermediate, and lateral. The combination of these three bones forms the transverse arch. Finally, the cuboid structure, located between the proximal and distal bones and in the lateral aspect, is identified as the apex of the lateral longitudinal arch (Gomes et al., 2023). A visual representation of the foot bone structure is provided in Figure 1.3.

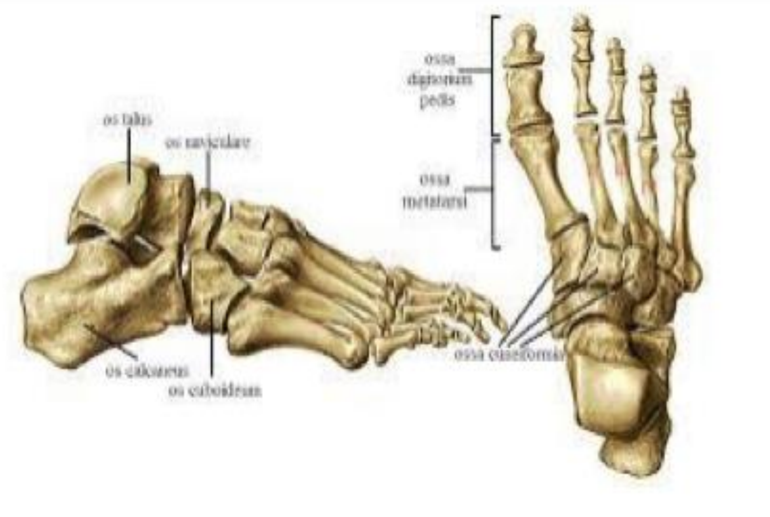


**Figure 1.3. Foot Bone Structure(Sripanich ve Barg, 2021).**

### 1.1.2. Foot and Ankle Joint and Ligaments

When a structural assessment of the bones is considered, the classification of the joints among them reveals six different classes: the ankle joint (talocrural joint), subtalar joint, midtarsal joint, tarsometatarsal joint, metatarsophalangeal joint, and interphalangeal joint (Gopinath et al., 2022). Among these classes, the ankle joint, which is characterized as a hinge-type joint located between the talus, fibula, and tibia bones (Hansford et al., 2019), stands out. It is observed that two different movements are prominent in the ankle joint: dorsiflexion and plantarflexion. These movements also occur in the sagittal plane. While the angular value of ankle dorsiflexion is typically determined to be between 10-30 degrees, the angular value for plantarflexion ranges between 30-50 degrees (Diniz et al., 2021; Cao et al., 2022). The degree of openness of the passive movement of inversion and eversion for the other ankle joint is determined to be between 5-15 degrees (Barini et al., 2021).

The subtalar joint, positioned between the calcaneus and talus bones, plays a crucial role in executing supination and pronation movements of the ankle (Godoy-Santos et al., 2018). Moreover, the main reason for highlighting ankle supination as the most important movement is its complex nature. This complex movement results in plantarflexion, adduction, and inversion movements. Similarly, ankle pronation involves dorsiflexion, abduction, and eversion movements occurring simultaneously (Gomes et al., 2023). Another class, the midtarsal joint, is a structure located in the middle section of the calcaneus, talus, navicular, and cuboid bones. This joint is also referred to as the "Chopart" joint, and its role is significant during walking. This is because during the walking phase, it facilitates the supination movement of the subtalar joint, allowing the ankle to lock and evenly distribute the load (Ledoux, 2023).

The tarsometatarsal joints are positioned between the I-V metatarsal bones and the I-III cuneiform and cuboid bones. This class is often referred to as the "Lisfranc" joint and is located in the middle of the foot region. Within this class, the metatarsophalangeal joint is positioned between the phalanges and metatarsal bones (Salat et al., 2018). Lastly, the interphalangeal joints are situated between the phalanx bones.


**Figure 1.4. Joint and Ligament Structure of the Foot and Ankle (Diniz vd., 2021).**

## 1.2 Foot Arches(arcus pedis)

1. For the continuation of daily physical activities and the sustenance of life, four important functions of the anatomical structure of the foot need to occur. These functions are listed as follows (Vopat et al., 2022):
2. Providing mobility adaptation with the ground area,
3. Conducting shock absorption against reactions for integrated adaptation, Formation of support area, For all the mentioned activities to be carried out, it is necessary for the foot to fulfill the role of a rigid lever.

The foot structurally consists of a total of three different arch structures. These arch types are respectively; medial longitudinal arch, lateral longitudinal arch, and transverse arch (Figure 1.5). The most important feature of these arches related to the foot is their ability to complement each other (Moonot et al., 2022). This aspect is the greatest influence in the formation of the foot's dynamic structure. The muscle type referred to as tibialis posterior is shown as the most important structure actively supporting the arch structures (Wilhelm et al., 2020). Additionally, the plantar fascia and spring ligaments are described as structures that passively support the foot (Younis et al., 2021). The general characteristics of the foot arch structures and these structures are detailed below.

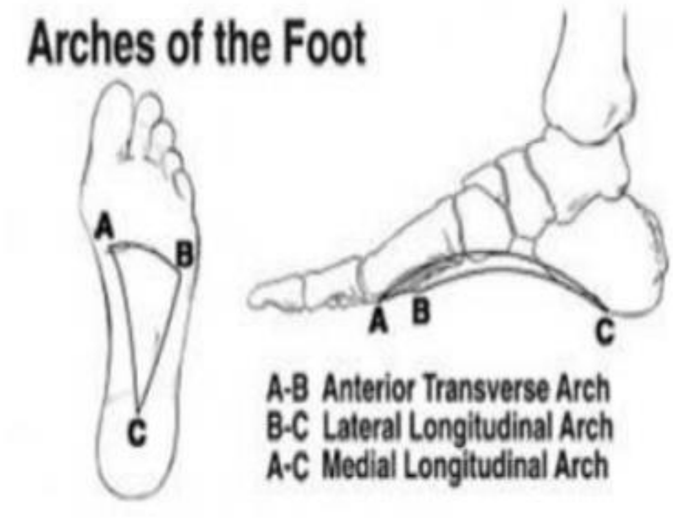


**Figure 1.5. Foot Arches (Zeng vd., 2022).**

### 1.2.1 Medial longitudinal ark (MLA)

The medial longitudinal arch, one of the arch structures of the foot, extends along the I, II, and III metatarsals, the I, II, and III cuneiforms, the navicular, calcaneus, and talus bones. The apex is considered to be the navicular bone. Studies in the literature have found its height from the ground to be between 15 - 18 mm, which is considered normal from an anatomical perspective.

#### 1.2.2. Lateral longitudinal ark (LLA)

The lateral longitudinal arch, classified in the anatomy of the foot arches, is located along the IV-V metatarsals, cuboid, and calcaneus bones. The apex is considered to be the cuboid bone. Studies in the literature have indicated that the height from the ground should be between 3-5 mm, and these boundary values are considered anatomically normal.

#### 1.2.3 Tranvers ark (TA)

In the classification of foot arches, the transverse arch is positioned in the rear part of the foot, consisting of the talus, calcaneus, navicular, and cuboid bones. This type of arch is highest in the rear portion of the foot. The structures forming the transverse arch are the I-II-III cuneiform and cuboid bones in the middle part of the foot. The structures in the front part of the foot that contribute to the transverse arch are referred to as the metatarsal heads. The positioning of the metatarsal heads parallel to the ground occurs during weight-bearing activities of the foot. (Vopat vd., 2022).

### 1.3. Foot Muscles and Nerves

Foot Anatomy includes the classification of muscle types into two main categories: plantar surface muscles and dorsal surface muscles. According to this classification, there are eight muscles located on the plantar surface of the foot, while two muscle groups are found on the dorsal surface (Zhang & Zhang, 2022). The classification of plantar surface muscles and nerves related to foot anatomy is presented in Classification 1. The other muscle group, dorsal surface muscles, and nerves are provided in Table 2.2.

**Tablo 1.1. Ayağın Plantar Yüzeyinde Bulunan Kaslar ve Sinir Yapıları**

| MUSCLE TYPE | NERVE TYPE |
|---|---|

| | |
|---|---|
| M.abductor hallucis | İnervasyonu N.plantaris medialis |
| M.flexor hallucis brevis | İnervasyonu N.adductor hallucis |
| M.flexor digitorum brevis | İnervasyonu N.plantaris medialis |
| M.quadratus plantae | İnervasyonu N.plantaris laterali |
| M.adductor hallucis | N.plantaris lateralis |
| Mm. Lumbricales I-IV | İnervasyonu I. N.plantaris medialis II.-III.-IV. N.plantaris lateralis |
| Mm.interossei plantares I-III | İnervasyonu N.plantaris lateralis |
| Mm. İnterossei dorsales I-IV | İnervasyonu N.plantaris lateralis |

**Source:** Sripanich ve Barg, 2021.

**Tablo 1.2. Ayağın Dorsal Yüzeyinde Bulunan Kaslar ve Sinir Yapıları**

| KAS TÜRÜ | SİNİR TÜRÜ |
|---|---|
| M.extensor hallucis brevis | İnervasyonu N.fibularis profundus |
| M.extensor digitorum brevis | İnervasyonu N.fibularis profundus |

**Kaynak:** Boey vd., 2022.

The plantar fascia plays an important role in the normal biomechanics of the foot and consists of three segments, all arising from the calcaneus. The fascia itself is important in providing support for the arch and shock absorption.

Plantar fascia release is an accepted and widely used surgical method to reduce heel pain. It is important to analyse the load-bearing mechanism of the foot during the stance (stand) phase of the gait cycle. It has been shown that the plantar fascia carries up to 14% of the total load on the foot. Surgical release reduces the dynamic load on the ankle by only 10%. It has also been found that lowering the arch impairs the load-bearing capacity of the foot. Therefore, the plantar fascia plays an important role in load bearing of the foot and its release by inhibition should be carefully considered.

### 1.4. Patellofemoral Joint Biomechanics

When the anatomical formation of the knee joint is examined, it is seen that it is a structure formed by the combination of three different bones, namely femur, tibia and patella. This joint type is characterised as a hinge type (art. Ginglymus) joint in some studies (Zhu and

Forman, 2022). When the definitions in the literature were analysed, it was observed that the most frequently used nomenclature was bicondylar type (art. Bicondylaris) and this definition was accepted according to the common opinion (Moon, 2019). However, it has been reported that the tibiofemoral joint, as a synovial joint, is formed at the femur and tibia, while the patellofemoral joint is formed between the patella and femur in this region (Malakoutikhah & Latt, 2023). When the position of the patellofemoral joint is examined, it is seen that it is formed in the position between the posterior aspect of the patella and the femoral condyles (Gopinath et al., 2022). The reason why the patellar joint is characterised as the most maladaptive joint in the body is that its surface is smaller than the femoral joint surface (Boey et al., 2022). However, while classifying its anatomical structure, it was stated that it was categorised as a separate synovial joint due to the absence of a joint capsule in its structure (Baumbach et al., 2022).

This type of angle was first described by Brattström. The location of the Q angle includes a region extending from the spina iliaca anterior superior (SIAS) to the midpoint of the patella and extending from the midpoint of the patella to the tuberositas tibia (Robberecht et al., 2022). Spatially, this angle refers to the formation of deflection values that pass over the patella, including the quadriceps femoris muscle. The Q angle, which expresses the deflection values of these forces, also expresses the angle value located at the outer part of both the proximal and distal tensile forces acting on the patella (Park et al., 2023; Varytis and Giannouli, 2023). In the studies, it has been reported that the normal range of this angle value is approximately 15±5 degrees and these values vary depending on gender. Due to this change, it is seen that the Q angle is 1-2 degrees less in men than in women (Zhu & Forman, 2022). In studies related to the literature, normal ranges of the Q angle according to gender have been reported, and it has been reported to be 8-10 degrees on average in men and 15-20 degrees in women (Hansford et al., 2019).

It has been reported that after the medial rotation of the femur, the patella moves medially according to the SIAS and accordingly its angular value increases. As a result, this situation is characterised by the formation of knee valgus in individuals. After the increase of varus in the knee structure, it has been reported that the Q angle decreases as the patella moves to the same position with the SIAS (Alesi et al., 2022). As a result, with lateral rotation of the tibia, the tuberositas tibia moves laterally and a noticeable decrease in the Q angle is observed. On the contrary, medial rotation of the tibia results in a significant increase in the values of the Q angle (Gong et al., 2022).

## 1.5. Muscle Flexibility

The elasticity factor, which is considered as the most important feature of the muscle structure, is a condition characterised by the ability of the muscle to elongate against the tensile force (Grantham et al., 2023). It is seen that the muscle length returns to its previous state during the resting process that occurs with the disappearance of the force that creates this situation. There are many factors that affect the realisation of flexibility, which is shown as a feature of muscle structure. Among these factors are the length of the muscle and different types of loads applied to the muscle (Colaprico et al., 2023). It has been reported that the specified load and length factors directly affect the elasticity of the muscle, but the surface area of the muscle functions in inverse proportion. In a study evaluating this situation regarding muscles, it was reported that if the stretching property is realised within normal limits, it can stretch up to 1.6 times its own length. It was stated that the stretching force that develops due to the stretching factor exceeding a certain limit will cause sprain damage or even rupture in the muscle (Boey et al., 2022).

In studies in which many factors related to muscle flexibility were evaluated, the main ones were listed as follows (Cerezal et al., 2023):

Hereditary conditions that differ from person to person,

1) Effective role of reciprocal coordination of muscles,

2) The viscosity that the muscle has,

3) The state of elasticity that develops in the connective tissues related to the muscle,

4) Different temperature values of muscles and joints,

5) Gender factor,

6) Parameters such as age have been shown to be the main factors that directly affect muscle flexibility.

It has been stated that any unfavourable situation that may occur in one or more of these factors is effective in shortening the length of the muscle and as a result of this situation, decreases in the flexibility of the muscle may occur.

Considering the evaluations regarding the shortness of the muscles, it has been reported that the muscle types in which this situation is most common are the muscles called posterior chain (Kalender et al., 2022). These muscles are mostly muscle types that develop an active resistance movement against gravity that occurs by stabilising the position in the upright posture. The muscles that realise this situation show a chain effect by providing a movement development starting directly from the foot and continuing along the spine (McNab et al., 2022). This chain effect helps to support the body from the back surface and prevents movements that may occur in the flexion direction. Shortness in any of these muscles will negatively affect the chain effect that is released and maintains stability (Robberecht et al., 2022). Failure to realise the chain effect will affect the functional status of other muscles and cause dysfunctions in all other body mechanics. The basic muscle types that provide the formation of this chain system are; erector spina, gluteus maximus, hamstring muscle complex and gastrocnemius-soleus muscle complex (GSKK) (Varytis and Giannouli, 2023).

**1.6. Gastrocnemius-Soleus Muscle Complex (GSCC)**

This holistic structure with this chain effect, referred to as the GSCT, forms the posterior part of the leg in position. Since it is also characterised as the largest muscle of the posterior part of the foot, it is a very important muscle group for the general biomechanics of the body (Zan et al., 2022). In position, its structure starting from the distal femur merges with the GC. On the other hand, the part starting from the proximal tibia and fibula joins with the soleus muscle. As a result of the fusion of both parts, GSKK is formed (Mo et al., 2022). This complex muscle group is connected to the heel of the foot via the AT (Achilles tendon). A visual of the formation of the GSCT is presented in Figure 1.6.

GSKK, which plays an active role in the evaluation of parameters related to flexibility by stabilising the body significantly during upright posture, is effective in providing flexion movement in the knee and plantar flexion in the ankle thanks to the structure of the GK starting from the knee joint and connecting to the heel with the AT (Monsur et al., 2023). It also plays an active role in the formation of STE (subtalar joint) eversion and inversion movements of the ankle part of the foot. Considering that other muscles provide the ability to move only a single joint, it is seen that the movement that the GSCT makes to many joints is quite important and this situation is characterised by a complex anatomical structure (Gomes et al., 2023). According to these results, it is concluded that the biomechanics of the GSCT should be understood in order to make a detailed evaluation of the entire lower extremity, especially the foot and ankle.

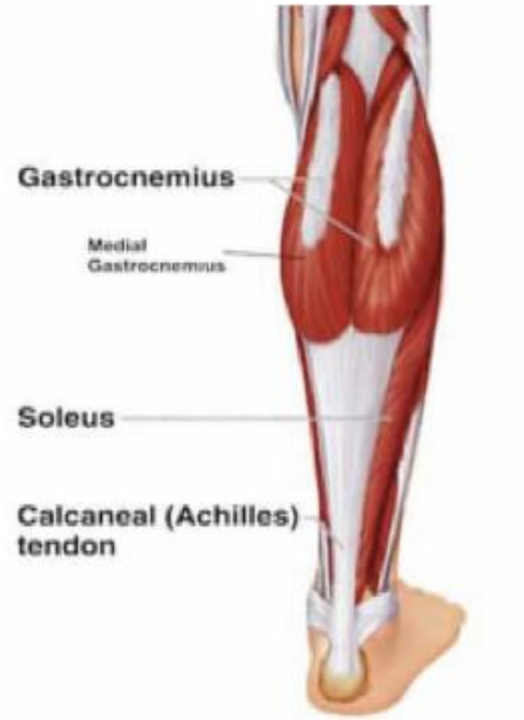


**Figure 1.6. Gastrocnemius-Soleus Muscle Complex (GSCC) Structure (Malakoutikhah and Latt, 2023).**

### 1.6.1. Gastrocnemius Muscle (GC)

As the gastrocnemius muscle is located in the back of the leg, it is also characterised as the most superficial and widest muscle type related to this part. It has two separate head structures within itself. These heads are named as lateral head and medial head (Diniz et al., 2021). The medial head section of the gastrocnemius muscle starts from the posterior of the medial femoral epicondyle. The lateral head, which is considered as the other part, has been reported to start from the posterior of the lateral femoral epicondyle (Hansford et al., 2019). When a comparison is made between the two parts, it is stated that the medial head is larger than the lateral head. As a result of the evaluation of the part where these two heads are located, it has been reported that both of them extend distally from the popliteal fossa. However, it has been reported that they merge distally from the popliteal fossa and form an integral muscle body with innervation to the tibial nerve (Suga et al., 2021). It has been reported in studies that the examined GC is located in the middle of the leg in position and thus forms a wide aponeurosis (Tozim et al., 2021). As a result of this situation, it has been observed that the GC extends distally and merges with the tendon of the soleus muscle and forms the AT structure (Wilhelm et al., 2020). This complex structure is visually presented in Figure 1.7.


**Figure 1.7. Structure of the Gastrocnemius Muscle (Suga et al., 2021).**

### 1.6.2. Soleus Muscle

The location of the soleus muscle, which is very important for the stretching factor, is the inner part of the SC. Due to its location in the inner part of the SC, the soleus muscle has the ability to protrude from both sides due to the wider muscle body. With this situation, it is also seen that it has the ability to be palpable from the sides, especially at the fingertip and standing position (Uzer et al., 2023). When the soleus muscle is examined anatomically, it is stated that it starts from the proximal parts of the fibula and tibia, and then from the 1/3 of the upper body of the fibula, it shows a formation from the fibres of the muscle made by the tibial nerve with the innervation movement from the linea musculi solei in the posterior part of the tibia. The soleus muscle structurally ends with an aponeurosis on the posterior surface where the muscle fibres are located. It has been stated that this aponeurosis situation shows an extension by narrowing towards the distal and then merges with the GC tendon (Moon, 2019).

This situation is characterised by the formation of the AT. A visual of the soleus muscle is presented in Figure 1.8.

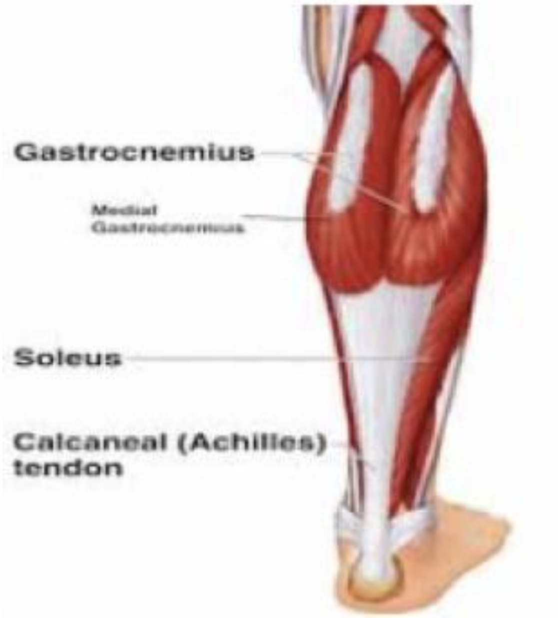


**Figure 1.8. Structure of the Soleus Muscle (Uzer et al., 2023).**

### 1.6.3. Achilles Tendon (AT)

The AT is structurally characterised as the thickest and strongest tendon of the body. When evaluated anatomically, it is defined as a structure formed distally by the fusion of the GSC tendons. According to the studies, it has been determined that the length of the AT varies between 4-8 cm (Zhu & Forman, 2022). However, it has been reported that the AT adheres to the calcaneal tubercle after a counterclockwise bending movement. Depending on the type of bending, AT has been categorised into three different groups as Type 1 (less), Type 2 (moderate) and Type 3 (more). The bending shape of the fibres attached to the tendon is related to the calcaneus affected depending on the position of origin. The same biomechanical phenomenon is seen to occur in all three different categories in which bending is defined, with the surface area being small or varying in position (Sulowska-Daszyk and Skiba, 2022). This process is characterised by the adhesion of the soleus muscle fibres to the medial calcaneal tubercle and the GC fibres to the lateral calcaneal tubercle (Richie, 2022). The realisation of this situation in relation to this anatomical structure of both the GSC and the AT has been stated to allow the movements specified as flexion in the knee, plantar flexion in the ankle and supination/

pronation in the STE to be seen in three different joints (Park et al., 2023). The structural representation of the Achilles tendon is shown in Figure 1.9.

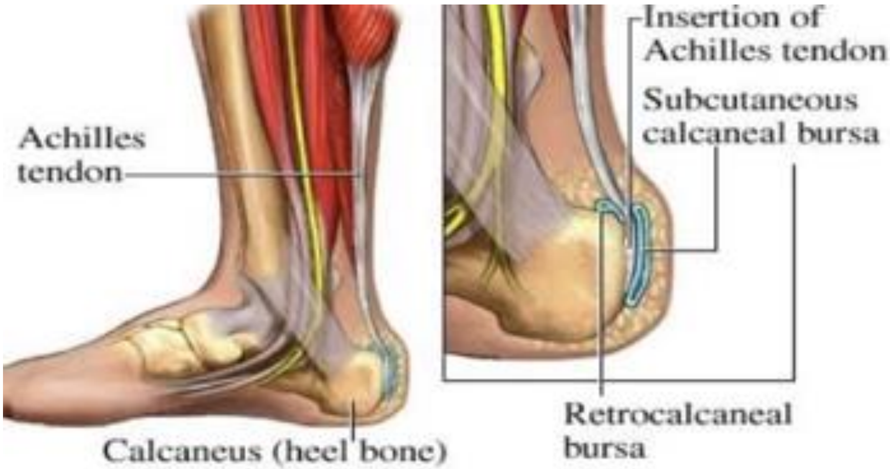


**Figure 1.9. Structure of the Achilles Tendon (Sulowska-Daszyk and Skiba, 2022).**

## 1.7. Plantar Pressure Distribution

The foot is structurally defined as the region of our body that has the highest load-bearing capacity and where all the muscle activity required to maintain the balance at the optimum level occurs most intensively (Grozier et al., 2021). For this reason, the process of the sole of the foot interacting with the ground is of great importance in terms of biomechanics. The distribution of forces is determined by evaluating this biomechanical process in the foot. The evaluation of the effect of forces on the sole of the foot is possible by examining the plantar pressure distribution (Bac et al., 2022). It has been reported that 61% of the weight given to the foot in a healthy individual is carried in the posterior part, 35% in the anterior area and 4% in the middle area (Aji-Putra et al., 2021).

### 1.7.1. Plantar Pressure Distribution Analysis

The concept of pedobarography is defined as a method of assessment that presents the conditions characterised by dynamic or pressure changes in many different areas of the sole of the foot with numerical data (Masłoń et al., 2022). These numerical data are recorded at the end of the assessment, divided into different categories. Dynamic changes in the ankle, especially in the subtalar joint with the sole of the foot and the subtalar joint, as well as in the standing position with walking are measured by pedobarography (Ledoux, 2023). During load carrying and the realisation of the load transfer of the foot and ankle, changes occur in terms of strength. These changes are basically evaluated as a result of numerical data in which the effects of many different factors such as providing the necessary contact area with the ground and flexibility are calculated (Khan et al., 2023).

The device used during the evaluation as a pedobarographic method has highly sensitive sensors. For this reason, it allows the detection of the ground reaction force on the foot, the dynamic pressure force that occurs during the contact of the foot with the ground, spatial differences and objective data on the elapsed time (Hansford et al., 2019). The ability to compare these data is very important in making evaluations. Pedobarographic evaluations can be performed as static and dynamic. With these methods, force changes related to the contact of both foot and ankle with the ground can be understood (Varytis & Giannouli, 2023).

### 1.7.2. Static Pedobarographic Assessments

The effectiveness and efficiency of the force relationship between the foot and the ground when people are in the standing upright position is very important in determining the characteristics of the anatomical structure of the foot. However, the activity surface formed between the foot and the ground may increase or decrease depending on the change in the structure of this ground (Zhang et al., 2023). When this situation is evaluated in today's conditions, it is seen that the changes in the anatomy of the feet of people who actively move mostly on flat ground are very important. When people are in standing and upright posture, the contact areas of the foot with the ground are analysed in two separate parts as forefoot and hindfoot (Chen et al., 2022). These two separate parts are directly related to each other and their proportional level is a criterion for evaluation. When using the static pedobarographic method as an evaluation method, the percentage values of the numerical data related to the pressure area created by the foot in the flat sensorised ground are taken as basis. This data obtained provides the determination of the effect of the foot with the ground and the factors that vary depending on this effect. At the same time, a detailed analysis of foot problems is carried out by obtaining objective data (Lin et al., 2023) (Figure 2.10). In addition, the representation of the percentage distributions of the forefoot and hindfoot regions related to the static pedobarographic analysis is presented visually in Figure 1.11.

**Figure 1.10. Image of the Static Pedobarographic Analyser (Ledoux, 2023).**

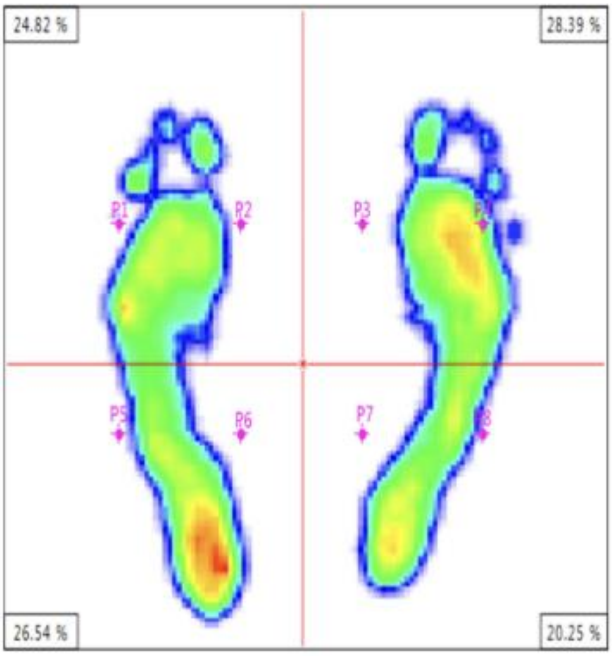


**Figure 1.11. Plantar Pressure Related to Static Pedobarographic Assessments Measurement Results of Percentages (Moon, 2019).**

**1.8. Definition of Posture**

The concept of posture is also named as posture in the literature. As a definition, it is seen that 'It is the positions that define the harmony of the body parts with each other and the relationships on the line that develop in the body depending on gravity' (Khan et al., 2023). The static concept related to the evaluation of posture is a situation characterised by the fixed and immobile body position. Against the reaction forces due to the upright posture and gravity in the body, the specified constant state occurs. In addition to this situation, it has been stated that muscles play a very effective role in stabilising the joints (Moon, 2019). However, the necessary condition for these muscles to provide joint stabilisation is that they perform isometric contraction. On the other hand, the dynamic posture examined is defined as a combination of movement patterns that occur along a sequence (Salat et al., 2018). It is responsible for the formation of motor responses to all kinds of forces that can disturb the balance of the body. The movements depending on these motor responses provide the adaptation factor to the environmental conditions that are actually desired to be formed. For this reason, it has been stated that the main factor aimed to be formed is adaptation, and the structure that provides this is posture (Robberecht et al., 2022).

### 1.8.1. Evaluation of Posture

In general, during the evaluation of posture, the person should be in a static state and the body should be in accordance with normal mechanical principles. However, the appropriateness of posture is a critical factor in the mobility process related to the dynamic situation (Mo et al., 2022). As an example of this situation, it can be given that the anatomical position should be taken as a basis when standing in a standing position and the head should be on the midline, arms open to the side, palms facing forward, legs straight, hips and feet shoulder-width apart (Malakoutikhah & Latt, 2023). This example shows that the compatibility between the parameters analysed according to the situation can directly affect the result of the posture. When performing the analysis, the person should be in clothes suitable for the evaluation, stand barefoot and without disturbing the pose as in daily life. If these conditions are met, posture analysis is performed (Grozier et al., 2021).

The methods used for posture analysis are given in the literature and it is stated that many different methods are used. Among these methods; direct observation, goniometric measurement, video-computer analyses, subjective measurement, posturography and different types of electromyography measurements were shown as examples (Fritz & Fritz, 2023). A visual of the posturography method used in posture assessment is given in Figure 1.12.

**Figure 1.12. Posturography Method (Khan et al., 2023).**

### 1.8.2. The Relationship Between Posture and Plantar Pressure Distribution and Chronic Low Back Pain

In order for the upright standing position to occur in healthy people, the load distribution must be evenly distributed. In the realisation of this distribution; the realisation of the subtalar and midtarsal joints working together has been shown as the most important condition (Zan et al., 2022). In the case of this condition, the joints move together and a high level of stabilisation and mobilisation is achieved in the foot. During the implementation of physical activities, the subtalar joint is pronated until the heel touches the ground and the sole and the ground come into contact (Uzer et al., 2023). With this pronation movement, the midtarsal joint and the forefoot are brought into a flexible state. The subtalar joint becomes supinated in the process of contact of the sole and the toe lift that is activated with it (Zhu and Forman, 2022). In the foot part, it is seen that the rigid lever position is dominant. All this process is accompanied by the art. talocalcaneonavicularis and art. cuneonavicularis joints, and the formation of the longitudinal arch, which is one of the basic arches that provide the load of the body at a high rate (Vopat et al., 2022). During this increase in load, the stability of the foot is also impaired. Different conditions, such as uneven floors, cause the load to be placed on the back of the foot during walking (Omar et al., 2023). Especially with the development of varus or valgus stress, it is seen that movements are repeated in the anterior aspect of the art. talocruralis joint and accordingly, pain sensation increases during movement (Lin et al., 2023).

Static and dynamic changes, which are characterised by deterioration due to increased load, bring about many unfavourable conditions. These conditions include osteoarthritis development in art. talocruralis, art. tarsometatarsales and art. subtalaris by increasing cartilage damage. With the increase in pronation in the foot, problems such as increased flexibility, impaired load distribution, hallux valgus stress and pes planus can be seen (Robberecht et al., 2022). These problems are characterised by the formation of pöstural disorders involving the leg, knee, hip and waist (Sulowska-Daszyk and Skiba, 2022). It has been stated that people use their muscles more in order to stand upright due to posture deterioration and accordingly, they experience a feeling of fatigue quickly (Malakoutikhah & Latt, 2023). Frequent repetition of this formation in people triggers the formation of negative conditions such as low back, neck and back pain (Varytis & Giannouli, 2023). In the studies conducted, it has been determined that 80% of low back, neck and back pain in people is caused by posture that is impaired in childhood. For this reason, it has been stated that it is very important to take precautions in childhood to prevent the formation of these common problems. If these measures are not taken in childhood, it has been reported that treatment will become quite difficult in the future (Mansur et al., 2023).

## 1.9. Low Back Pain

### 1.9.1. Definition of Low Back Pain

Low back pain is a type of disease that can be effective in people for a long time and is characterised by the emergence of pain factor during movement. In studies related to low back pain, it has been reported that the incidence and prevalence of low back pain is high in the elderly population and the incidence of low back pain has increased by 50% in the last 20 years in these countries (Russo et al., 2018). In terms of population density, it is assumed that the elderly population will be higher and this rate will increase approximately 1.4 times by 2050 (Fatoye et al., 2019).

According to the results of studies related to the literature, it has been reported that the effect of the trauma factor on the occurrence of low back pain is 15%, however; infection, rheumatoid arthritis, tumour, vasculopathy, etc. It has been reported that it is seen in people due to many different specific causes such as infection, rheumatoid arthritis, tumour, vasculopathy, etc., and 75% of them occur without any provable organic cause (Shiri et al., 2019).

In the Health and Ageing Report published by the World Health Organisation (WHO), in this study, in which low back pain in the elderly population was examined, people were classified as middle age between 45-59 years, old age between 60-74 years, old age between 75-89 years, old age between 75-89 years, and 90 and over, and it was tried to determine which category had more people. According to the findings of this report, it was observed that the people with low back pain who participated in the study were mostly included in the old age category. With this situation, it has been reported that the higher incidence of chronic diseases in the elderly reduces the quality of life, and as a result, this situation has become a global health problem (Sulowska-Daszyk & Skiba, 2022). The most important result of this study is that the level of disability in the functional area increases due to the increase in the prevalence of low back pain.

### 1.9.2. Review of Functional Anatomy of LPCC

The lumbo-pelvic hip complex (LPKK) is a region that has a great influence on the structures above and below the body. The LPKK has between 29 and 35 muscles that attach to the lumbar spine or pelvis. The LPCC is directly related to both the lower and upper extremities of the body. Therefore, dysfunction of both lower limbs and upper limbs can cause dysfunction of the LPKK and vice versa.

LPKK has a major influence on the rest of the kinetic chain. Many bones, joints and muscles are involved in the dysfunction of the LPKK.

### 1.9.3. Bones and Joints

Especially in the region of the LPCC, the femur and pelvis form the iliofemoral joint and the pelvis and sacrum form the sacroiliac joint (Fig. 2.13). The lumbar spine and sacrum form the lumbosacral connection (Figure 2.14). Collectively, these structures form the attachment site for most of the major myofascial tissues, which have a functional influence on the arthrokinematics of the structures above and below.

Above the LPCC are the thoracic and cervical spine, rib cage, scapula, humerus and clavicle. These structures form the thoracolumbar and cervicothoracic junctions of the spine and the scapulothoracic, glenohumeral, acromioclavicular (AC) and sternoclavicular (SC) joints (Figure 2.15).

Below the LPCC, the tibia and femur form the tibiofemoral joint, while the patella and femur form the patellofemoral joint (Figure 2.15). The fibula is also noted as it is the attachment site of the biceps femoris, which starts from the pelvis.

The tibia, fibula and talus help to form the talocrural (ankle) joint (Figure 2.15). Collectively, these structures form the attachment site for the myofascial tissues of the LPKK, such as the biceps femoris, medial hamstring complex and rectus femoris. These bones and joints are important in corrective exercise because they will also have a functional impact on the arthrokinematics of the LPCR.

### 1.9.4. Muscles

There are many muscles in the upper and lower limbs whose function may be related and may affect LPCR (Table 2.3.). As with all muscles, it is important to maintain normal muscle movement and strength and to maintain normal ranges of movement to ensure optimal joint function. See Chapter 2 for a detailed review of the location and function of these muscles.

**Table 1.3 Key Muscles Associated with LPCC**

| | |
|---|---|
| • Gastroknemius / soleus | • Erektör spina |
| • Addüktör kompleksi | • İntrinsik core stabilizatörleri |
| • Hamstring kompleksi | • Latissimus dorsi |
| • Kalça fleksörleri | • Tensör fasya lata / IT bandı |
| • Abdominal kompleks | • Gluteus medius ve maksimus |

**Sources:** Powers CM. *J Orthop Sports Phys Ther.* 2003;33(11):639-646.

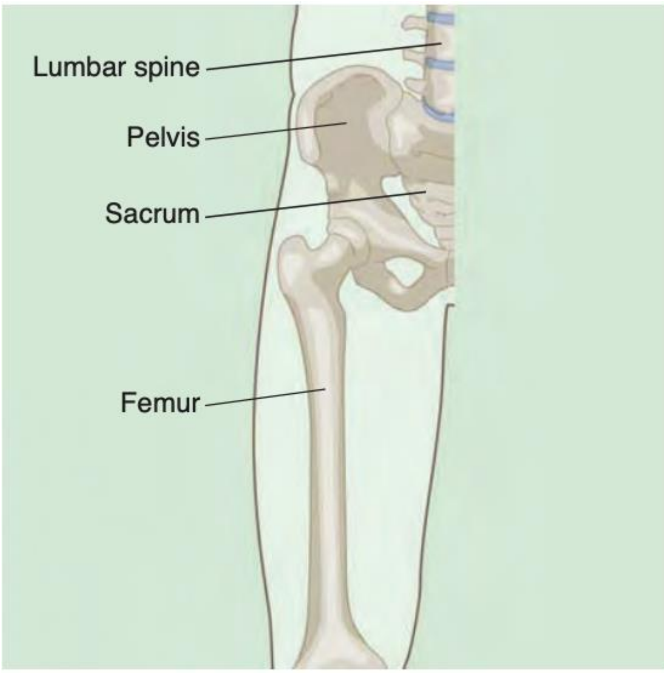


**Figure 1.13. Bones of the LPKK.**
**(NASM Essentials of Corrective Exercise Training.,2014)**

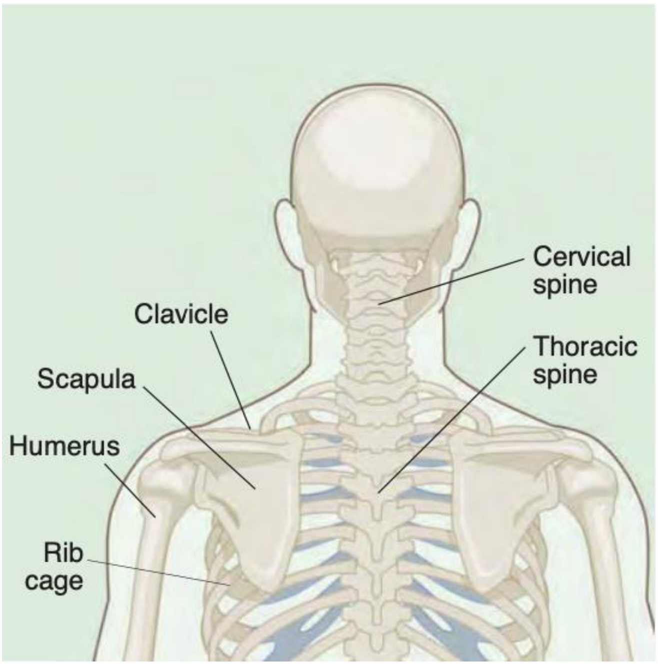


**Figure 1.14. Bones on the upper side of the LPCC.**
**(NASM Essentials of Corrective Exercise Training.,2014)**

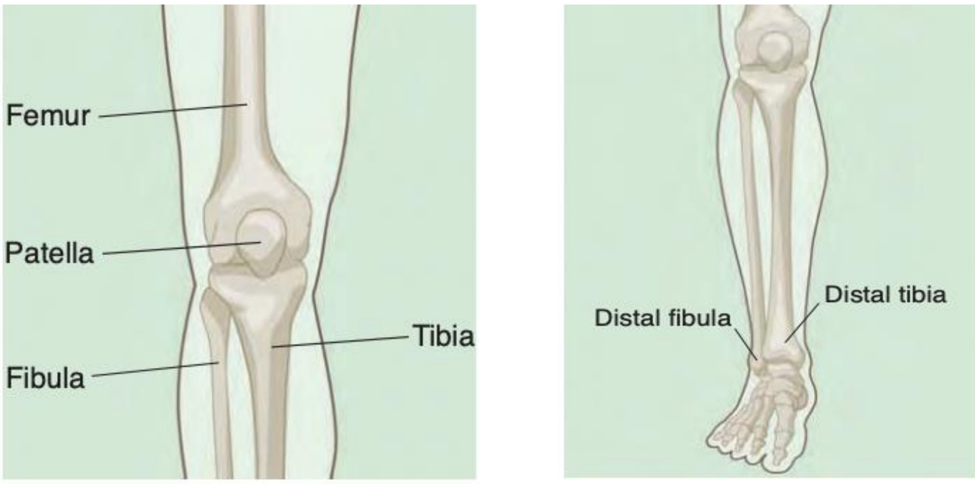


**Figure 1.15 Bones on the Lower Side of the LPCC**

**(NASM Essantials of Corrective Exercise Training.,2014)**

### 1.9.5. Risk Factors Affecting the Occurrence of Chronic Low Back Pain

In societies where low back pain is more common, the causes of this condition are very important, but the main factor that may cause low back pain or the main factor in the increase in pain is still not completely clear (Suga et al., 2021). Considering the results of studies and reviews conducted in relation to this; psychosocial factors such as depression, anxiety, occupational dissatisfaction, lifestyle and harmful habits such as obesity, abdominal fat, heavy lifting, smoking and alcohol use, vitamin D deficiency, protein-deficient nutrition and genetic predisposition have been accepted as risk factors for chronic low back pain (Richie, 2022). However, the cause of low back pain, which is frequently seen in the lumbar spine of individuals, is accepted as a disc. However, it has been reported that 15%-45% of low back pain accompanying this disease is caused by the facet joint. Therefore, facet joint-related causes are risk factors for the occurrence of low back pain (Lin et al., 2023). For this reason, inflammatory conditions such as spondylolisthesis, septic facet arthritis, rheumatoid arthritis, ankylosing spondylitis, mainly degenerative osteoarthritis, are shown as risk factors for the occurrence of low back pain. The treatment of low back pain that may occur in individuals due to facet joint; medical, conservative methods, interventional techniques and surgical interventions (De Souza et al., 2019).

### 1.9.6. Evaluation in Chronic Low Back Pain

Clinically, the assessment of chronic low back pain and prevention of low back pain has become an important issue due to increasing complaints in the last decade (Boling et al., 2021). The causes of low back pain include a wide range of complicated conditions. For this reason, it is very important to take a detailed anamnesis from people. However, in the evaluation; the location of low back pain should be localised by performing physical examination and using radiographic methods if necessary.

As the cause of low back pain; a wide variety of diseases ranging from mild trauma, muscle strain, infectious diseases to malignancies can be given as examples (Fritz & Fritz, 2023). However, the most important condition here is to correctly distinguish whether the actual cause of low back pain is specific or nonspecific (Hansford et al., 2019). However, studies have reported that approximately 90% of the causes of low back pain are nonspecific (Yoshimoto et al., 2022). The first condition sought in the evaluation of low back pain is that people should not have severe pathologies of the spinal, thoracic, abdominal and pelvic regions, which are called ‘Red Flags’. For this reason, the factors indicated with red flags should be shown as exclusion criteria during diagnosis (Stevans & Barg, 2021). The factors characterised as red flags are shown in Table 1.4.

**Table 1.4. Red Flags**

| |
|---|
| Yaş>65 |
| Kanser hikayesinin olması |
| Ciddi travma öyküsünün bulunması |
| Yapısal deformite varlığının olması |
| Üriner veya fekal inkontinans varlığı |
| Osteoporoz hikayesinin olması |
| İmmunsupresyon varlığı |
| Şüpheli olarak tanımlanan bir inflamatuar hastalık durumunun olması |
| Kişilerin kortikosteroid kullanması |
| 6 haftalık bir süre içerisinde başlanan konservatif tedaviye cevapsızlık durumunun oluşması |

**Kaynak:** Richie, 2022.

# CHAPTER TWO

## MATERIALS AND METHODS

### 2.1. Bireyler

The sample of our study included individuals over the age of 25 who applied to Istanbul Gelisim University and Housefit Clinic as a member, who were diagnosed with chronic low back pain by a physician with physical examination and anamnesis. Firstly, demographic information of the participants included in the study was recorded. Afterwards, both physical tests and scales were applied. Participants were informed about the study in detail and informed consent form and inclusion criteria were presented. Participants who met the inclusion criteria were asked to sign the informed consent form. Fifty cases who signed the consent form and fulfilled the inclusion criteria were evaluated.

**Study Inclusion Criteria:**

1) To be over 25 years of age

2) Volunteering to participate in the research

3) No history of serious trauma related to the lower extremity in the last 6 months

4)Having chronic low back pain (at least 6 months)

5) No surgical operation related to the lower extremities and spine

6) Absence of known neurological, rheumatic and visual field loss diseases

**Study Exclusion Criteria:**

1) Lumbar spine surgery performed within the last 1 year

2) No communication problems

3)Failure to co-operate

4)Having any neurological or psychiatric disease

## 2.2. Methods

The application of all methods used in the evaluation of the participants within the scope of our study was mixed without any order among the individuals. The evaluation of the participants who met the inclusion criteria determined within the scope of the study was carried out on the same day. The evaluations were carried out in a total time interval of 45-60 minutes during the day. The evaluations of the participants were carried out in accordance with the method order determined in our study. There was no waiting situation during the evaluation of the participants. The methods used in the study were applied to all participants by the same researcher. These methods were carried out in accordance with the order given below:

1) Application of Pain Severity Visual Analogue Scale (VAS) Scale

2) Goniometric Measurement of Gastrocnemius Muscle Shortening by Silfverskiöld Method

3) Angular Measurement of Ankle Plantar and Dorsi Flexion Movements

4) Valgite Angle Measurement

5) Q Angle Measurement

6) Knee Joint Flexion Range of Motion Measurement

7) Knee Joint Hyperextension Range of Motion Measurement

8) Hip Flexor Muscles Shortness Evaluation

9) Knee Flexor Muscles Muscle Shortness Evaluation

10) Lumbar Extensor Muscle Shortness Evaluation

11) Sacral Inclination Angle Measurement

12) Assessment of Physical and Functional Status of the Foot

13) Implementation of the Navicular Drop Test

14) Hallux Valgus Angle (HVA) Measurement

15) Assessment of Functionality Level with Oswetry Low Back Pain Disability Questionnaire

16) New York Posture Assessment Questionnaire

17) Evaluation of Plantar Pressure Distribution

### 2.2.1. Visual Analogue Scale (VAS)

Using VAS, the pain intensity of individuals is measured with the help of numerical data. This scale used to measure pain consists of a 10 cm horizontal line. The two ends of the horizontal line contain numerical values for different parameters. The first end of the line is labelled ‘I usually do not have pain (0)’ and the other end is labelled ‘Unbearable pain (10)’. Participants are asked to tick one of these parameters according to their pain intensity. In addition to being a scale that expresses the pain intensity of individuals with numerical values, VAS is also used to measure whether additional pain has passed. However, it has been used in other studies in the literature in terms of test reliability and is a proven scale. For this reason, it is considered as an accepted pain assessment parameter in the world literature. Within the scope of our study, male and female participants were asked to find and tick the corresponding point according to their general pain intensity during the day (Figure 2.16.).

**0** **10**

**Figure 2.16. Representation of the Visual Analogue Scale**

### 2.2.2. Shortness Assessment of Gastrocnemius Muscle Shortness

According to the results of the evaluation of normal joint movement angles by Kendall & McCreary, it is reported that the average passive dorsi flexion angle of the ankle is 20° when the knee joint is in the extension position, and when the knee joint is flexed, the angle value approaches 30° due to the relaxation of the GK. In movements such as walking, running and mid-stance phase, it is seen that the ankle joint comes to 8-10° angles and allows dorsi flexion movement. In order for the GK muscle to be defined as an appendage, the specified angle values should be <5° in knee extension and <10° in passive dorsi flexion movement in 90° knee flexion. In our study, individuals with angle values of 5-20° when the knee was in knee extension and 10-30° when the knee was in 90° flexion in the ankle passive dorsi flexion movement were characterised as having DDH shortness. Silfverskiold method was used in our study for the evaluation of the shortening of the DDH of the participants. In addition, universal goniometer measurements were made and the subjects were asked to be in the supine position. In this way, this application was performed on both ankles. Knee joint evaluations were performed in the position of full extension and 90° flexion, and STE was ensured to be in the neutral position. In addition, ankle dorsi flexion movement was performed passively. The evaluation was performed by positioning the fixed arm of the universal goniometer on the fibula shaft and the movable arm on the fifth metatarsal shaft. The measurement results of the individuals were evaluated by taking the angle value and recording it in degrees (Figure 2.17.)

**Figure 2.17. Goniometric Measurement of Gastrocnemius Muscle Shortness by Silfverskiold Method**

**2.2.3. Angular Measurement of Ankle Plantar and Dorsi Flexion Movements**

In addition to the evaluation of muscle shortness of the participants, active and passive normal joint mobility of the ankle, which is frequently used in clinics as an evaluation method for ankle joint movements, was measured in our study. The evaluation is different from shortness measurements. The reason for this is that the effect of GK on the ankle is in the direction of both active and passive movement. In this way, active and passive movements are evaluated together. As a result of this evaluation, it was aimed to understand the biomechanical changes more clearly.

Firstly, the angular values of the plantar and dorsi flexion movements of both ankles of the participants were measured. These measurements were made with the participants in a sitting position and the knees should be relaxed. Measurement values were obtained when this position was created, and the 0° angle value at which the ankle was neutral was accepted as the starting point. A universal goniometer was used as a measurement tool and angular values were obtained after the centre was placed on the lateral malleolus. The proximal arm of the goniometer should follow the fibular head. The other distal arm is aligned parallel to the fifth metatarsal, and the person is instructed to perform active and passive movements. These movements are plantar and dorsi flexion to the specified end point. After the subjects were asked to move the goniometer to plantar and dorsi flexion, the results obtained were recorded in degrees, actively and passively (Figure 2.18.).

**Figure 2.18. Goniometric Measurement of Ankle Plantar and Dorsi Flexion Movements**

### 2.2.4. Subtalar Joint Inversion and Eversion Angle Measurement

The angular values for the inversion and eversion movements of the participants in STE were obtained both passively and actively. These angular values obtained from passive and active movements were measured in the prone position with the feet off the bed. The AT position of the participants is the main parameter for performing the alignment. After the AT alignment, the calcaneal tubercle and the midline of the leg are determined. A reference line is drawn at the point corresponding to this midline. The fixed arm of the goniometer used as a measuring device should be on this line. The other part is fixed with its centre just above the calcaneus. When the movable arm of the goniometer is brought to the centre of the calcaneal tubercle, the subjects are asked to perform inversion and eversion movements, which give angular values for both active and passive joint motion. The passive and active angular values obtained from participants performing both movements were converted into degrees and recorded (Figure 2.19.).

**Figure 2.19. Goniometric Measurement of Subtalar Joint Inversion and Eversion Movement**

### 2.2.5. Evaluation of Biomechanical Parameters of the Lower Extremity

#### 2.2.5.1. Valgite Angle Measurement

In the frontal plane, the anatomical axis of the femur forms an angle called valgite angle of 171º with the anatomical axis of the tibia (Figure 2.20). The anatomical axis of the femur and the transverse axis of the knee form an angle of 81º and 90º with the transverse axis of the tibia. The angle between the transverse axis of the knee and the mechanical axis of the femur is 87º. This angle decreases in genu valgum and increases in varus. The valgite angle of the participants was measured in the standing position with the hip and knee in the extension position. However, a midpoint line between the spina iliaca anterior superior and the patella was determined while the hip and knee were in extension. Along with this midpoint line, a line was drawn to the midpoint of the patella by taking the midpoint of the ankle (medial mallelol and lateral malleolus midpoint). An angle was formed between the three lines drawn in total and the value of this angle was measured with a universal goniometer. The results were taken as angle values and recorded after conversion to degrees.

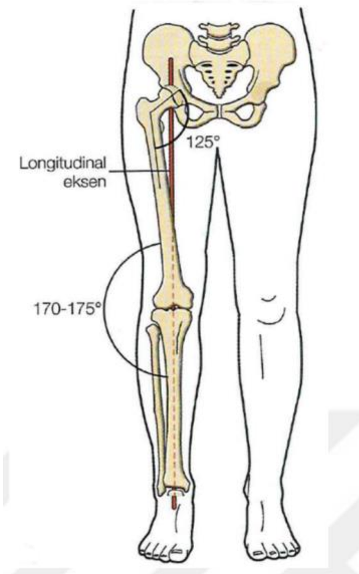


**Figure 2.20 Normal Lower Extremity Valgus Alignment (P.Pişirici, 2020)**

#### 2.2.5.2. Measurement of Q Angle

An equal amount of weight was transferred to both feet of the participants, both right and left. The Q angle was assessed predominantly while the subjects were in the standing position. The angular value of the region between the SIAS and the line drawn from the midpoint of the patella and the line connecting the midpoint of the patella and the tuberositas tibia was measured with a universal goniometer. The angular values of the participants were converted into degrees and recorded (Figure 2.21.).

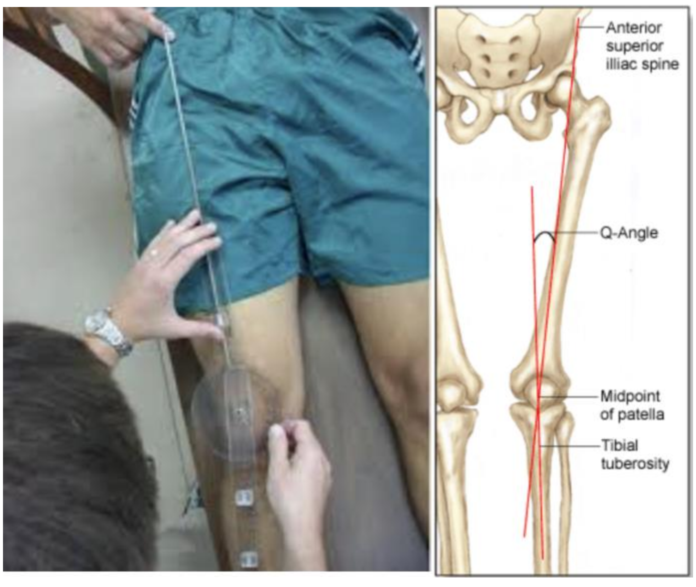

**Figure 2.21. Goniometric Measurement of Angle Q**

### 2.2.5.3. Knee Joint Flexion Range of Motion Measurement

The participants were asked to lie face down and move their knee joints on a hard mattress. They were asked to flex their knee joints to the last point they could reach. As a result, active knee joint flexion angular values were obtained. The fixed arm of the universal goniometer was moved to the thigh bone line when the participants were able to make the maximum bending movement. The centre of the goniometer was moved to the knee joint and the movable arm was moved over the fibula line and then the measurement was made. The angular values obtained were recorded after being converted to degrees (Figure 2.22.).

**Figure 2.22. Goniometric Measurement of Knee Joint Flexion Range of Motion**

### 2.2.5.4. Knee Joint Hyperextension Range of Motion Measurement

The measurement of the range of motion of the knee joint hyperextension of the participants was performed while standing in a standing position. Individuals were asked to maximally squeeze and push back the thigh muscles positioned at the knee joints. As a result, the knee joint was kept stationary and the outline of the thigh bone was traced through the fixed arm of the goniometer. On this line, the central knee joint is determined. Afterwards, the movable arm of the goniometer was fixed on the fibula line and the angle value in between was measured. This measured angle was converted into degrees and recorded (Figure 2.23.).

**Figure 2.23. Goniometric Measurement of Knee Joint Hyperextension Range of Motion**

### 2.2.6. Muscle Shortness Measurements

#### 2.2.6.1. Hip Flexor Muscle Shortness Assessment

During the measurement of muscle shortness for the evaluation of hip flexor muscles, the participants are placed on a hard bed and on their backs. The participants are asked to hang both their right and left legs from the edge of the bed. One side of the leg is pushed from the knee to the chest. The thigh on the opposite side is left in a stable position from the hip joint. In this way, an assessment is made that there is no shortness. However, if there is any flexion movement in the opposite hip joint, this is assessed as shortness. The fixed arm of the goniometer is left at the hip joint and the movable arm is left at the thigh bone. The angular value was recorded in degrees (Figure 2.24).

**Şekil 2.24. Kalça Fleksor Kaslarının Gonyometrik Ölçümüne İlişkin Kısalık Değerlendirmesi**

#### 2.2.6.2. Diz Fleksor Kasları Kısalık Değerlendirmesi

When assessing the muscle shortness of the knee flexors of the participants, the measurements are performed in the supine position. The position of the hip joint is positioned in a flexion movement at an angle of 90° to the floor. After achieving this position, the subjects were asked to extend the knee joint as far as they could, keeping the pelvis and opposite thigh in a neutral position. The hamstring muscle group takes an active role during this movement. From the point where a myoclonus started to appear in this muscle group, the knee joint angle was measured with a goniometer. If the knee joint is fully extended, an assessment is made as 'no shortness'. If the knee joint is not fully extended, the flexion angle is measured with a goniometer. This measured value was recorded as the degree of shortness (Figure 2.25.).

**Figure 2.25. Goniometric Measurement of Knee Flexor Muscles and Shortness Evaluation**

### 2.2.6.3. Lumbal Extensor Muscles Shortness Evaluation

Modified Schober Test method was used to evaluate the lumbar flexion flexibility of the participants. Individuals were measured within the scope of this method. Among the criteria for the evaluation of the test, a difference of 0-5 cm decreases flexion flexibility and a difference of more than 10 cm increases flexibility. If the angle measurement results are between 5-10 cm, muscle shortness of these individuals is considered normal. In terms of position, the individuals should be standing and both spina iliaca posterior superior should be determined. During this determination, 10 cm above and 5 cm below the marked point were determined by marking. After marking these points, the individuals are asked to release their arms to the sides and lean forwards. The 15 cm part of this position is considered as the starting point. From this point onwards, the value of the difference that occurred during the forward bending of the individuals was recorded in cm (Figure 2.26.).

**Figure 2.26. Lumbar Extensor Muscles Using Modified Schober Test Shortness Tests**

### 2.2.7. Sacral Inclination Angle Measurement

In our study, an inclinometer (Baseline® Bubble) was used to measure the sacral inclination angle of the participants. During the measurements of the inclinometer, a flat wall is taken as a reference. The counter axis, which is horizontal to this flat wall, is set to 0. The measurement was performed with the inclinometer while the individuals were standing and in an upright posture. The measurement was made at the junction of the spina iliaca posterior superior and the sacrum. Angular values were recorded in degrees (Figure 2.27.).

**Figure 2.27. Sacral Inclination Angle Measurement with Inclinometer**

### 2.2.8. Evaluation of Physical and Functional Status of the Foot

Within the scope of our study, the Turkish version of the AOFAS (American Association of Orthopaedic Surgeons Ankle and Rearfoot Scale), which is frequently preferred in the evaluation of the functional status of the hindfoot and ankle in the clinic, was used. AOFAS consists of a total of 9 items. However, it is a questionnaire with 3 sub-dimensions. Each sub-dimension is evaluated within itself; 1 item is scored as pain (40 points), 7 items are scored as function (50 points), 1 item is scored as foot smoothness (10 points). The value of the total score obtained by the participants within the scope of AOFAS is between 0-100. A high AOFAS total score provides a 'good' assessment of the functional status of the foot and a low AOFAS total score provides a 'poor' assessment of the functional status of the foot.

### 2.2.9. Implementation of Navicular Drop Test

NDT was performed to determine the value of the flexibility of the MLA in both feet of the participants and to determine the position of the navicular. After the participants were firstly supported on the floor, the subtalar joint neutral position was ensured in the sitting position within the scope of flexion movement so that the hip and knee angle was 90 degrees. Subsequently, the subtalar neutral position was achieved and the medial and lateral heads of the talus were palpated equally. After fixing the position of the subtalar joint, which was evaluated together with the foot, the navicular bone was palpated and marked. Taking the last position as reference, the distance of the navicular bone to the ground was measured with a digital caliper. Afterwards, both male and female participants were placed in a standing position by finding the point where they put equal weight on both their right and left foot. In this position, the navicular bone was palpated again. In this position, the distance between it and the ground was again measured and recorded with a digital caliper (Figure 2.28).

**Figure 2.28. Navicular Drop Test**

### 2.2.10. Hallux Valgus Angle (HVA) Measurement

Within the scope of our study, HVA measurements of the individuals were performed with reference to the long axes of the 1st metatarsal and proximal phalanx of both feet. The angular value between these parts was measured with a goniometer and recorded as 'degrees'.

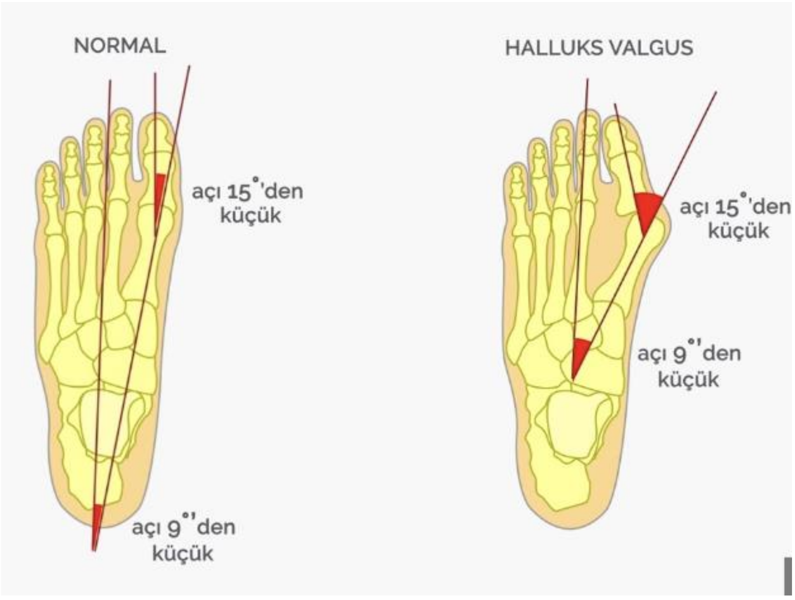


**Figure 2.29 Hallux Valgus Angle (https://www.youtube.com/watch?v=Mhs1fyNyVK0)**

### 2.2.11. Oswetry Low Back Pain Disability Questionnaire and Functionality Level Evaluation

The Oswestry scale, whose reliability and validity have been proven by studies conducted in the literature, enables the evaluation of activities of daily living in 10 different aspects. It is characterised as a very important scale for determining the level of functional disability of individuals. This scale consists of different sub-headings such as severity of pain, personal care, lifting, walking, sitting, sitting, standing, sleeping, degree of change in pain, social life, travelling A score between 0-5 is given for each section in the scale. There are 6 options in total.

The total score that people get from this scale is between 0 and 50. The evaluation varies depending on whether the score increases or decreases. If there is an increase in the score, this indicates an increase in inadequacy. When the score received according to other categories is evaluated; 0-4 range shows no disability, 5-14 range shows mild disability, 15-24 range shows moderate disability, 25-34 range shows severe functional disability, and 35-50 range shows full functional disability.

### 2.2.12. New York Posture Evaluation Questionnaire

This posture assessment questionnaire, developed by Magee (1987), is a system consisting of a scoring system based on posture. People's body is divided into 13 different compartments in total and scored. According to this scoring, five (5) points are given if the person's posture is correct, three (3) points if it is moderately impaired, and one (1) point if it is severely impaired. The maximum score is 65 and the minimum score is 13. According to the criteria in the classification of the total score; if the score is >=45, it is evaluated as ‘very good’, 40- 44 as ‘good’, 30-39 as ‘moderate’, 20-29 as ‘poor’ and <=19 as ‘bad’.

### 2.2.13. Plantar Pressure Distribution Analysis

Pedobarographic analysis was performed statically using the RSscan International Footscan® 7 software platform (RSscan International, Olen, Belgium). The static plantar pressure distribution parameters of the individuals participating in the study were measured on the surface where the sensors were located. As a result, the values constituting 50% of the pressure falling on one foot and the pressure on the total weight were measured while the subjects were standing and in static posture. The pressure values obtained for the analysis were recorded as ($N/cm^2$) (Figure 2.30.).

**Figure 2.30. Static Plantar Pressure Distribution Analysis**

### 2.2.14. Statistical Analysis

Statistical Package For The Social Sciences Software (SPSS 26.0 Inc, Chicago, Illinois) was used to analyse the data of the participants. While performing the analyses, 95% confidence interval was accepted as standard and the results were evaluated at $p<0.05$ significance level. During the analyses, whether the data related to the sample were suitable for normal distribution was tested in accordance with the 'One Sample Kolmogorov-Smirnov Test' and Shapiro Wilk analyses. According to the results, all of the data were found to be suitable for normal distribution. For this reason, Independent Sample T Test was used to analyse whether the comparison between the groups was significant, and Paired Sample T Test was used to determine the significance level of the differences within the group. The significance level of the relationship between the two groups was determined by Pearson Correlation analysis.

# CHAPTER THREE

# RESULTS

## 3.1. Findings Related to Demographic Information

The demographic characteristics of the individuals who participated in our study are shown in detail in Table 1. The average age of the female group is 38.27 and the standard deviation is 6.96. The mean age of the male participants was 38.82 and the standard deviation was 7.65. As a result of the analysis, it was determined that the data of the age distribution of the two groups were close to each other, so there was no statistically significant difference ($p>0.05$). The mean body weight of the individuals in the female group was 71.00±6.90. The mean body weight of the individuals in the male group was found to be 84.35±5.93. It was determined that there was a statistically significant difference between the data on body weight distribution between the two groups participating in our study ($p<0.05$). The mean height of the individuals in the female group participating in the study was found to be 164.72±5.10. The mean height of the individuals in the male group was 175.41±74.55. In this study, in which female and male participants took part, it was determined that there was a statistically significant difference between the height distributions of the two groups ($p<0.05$).

**Table 3.1. Distribution of Participants According to Demographic Characteristics**

| | Female (n=33) | Male (n=17) | p |
|---|---|---|---|
| | X ±SS | X ±SS | |
| **Age (year)** | 38,27±6,96 | 38,82±7,65 | 0,799 |
| **Weight (kg)** | 71,00±6,90 | 84,35±5,93 | **0,000*** |
| **Height (cm)** | 164,72±5,10 | 175,41±4,55 | **0,000*** |

***p<0,05** statistically significant difference, X ± SD: Mean ± Standard Deviation Independent Group T test

When the data on the marital status of the male and female participants were analysed, it was found that 22 (44.0%) were single, 24 (48.0%) were married, 2 were widowed (4.0%) and the other 2 were divorced (4.0%). As a result of the analysis of marital status, no statistically significant difference was found between the two groups (p>0.05). When the data related to educational status were analysed, it was found that the majority of the individuals who participated in the study completed their education at the undergraduate level (34.0%), and the lowest rate was master's degree (16.0%). As a result of the analysis of education levels, it was determined that there was no significant difference between the two groups (p>0.05). When the data on the income levels of the participants were analysed, it was found that the group of 5 participants (7.501-10.000 TL) had the lowest frequency (10%) and the group of 18 participants (12.501-15.000 TL) had the highest frequency (36,0%). It was determined that there was a significant difference between the two groups in terms of income levels. It was observed that 47 out of 50 individuals defined their right side as more dominant and 3 individuals defined their left side as more dominant. When the findings related to smoking and alcohol use were analysed, it was found that 42 people answered 'yes' to this question and the remaining 8 people answered 'no'. It was observed that there was no significant difference in smoking and alcohol use between these two groups included in the study (p>0.05). When the findings related to the duration of low back pain were analysed, it was determined that 14 participants (10-20 months), 14 participants (21-31 months), 12 participants (32-42 months), 8 participants (43-53 months) and 2 participants (54-64 months) had ongoing pain. It was observed that there was a statistically significant difference between the data related to the duration of low back pain of the groups included in the study (p<0.05).

**Table 3.2. General Characteristics of the Participants**

| Characteristics of the Participants n (%) p | | | Characteristics of the Participants n (%) p |
|---|---|---|---|
| Gender Female 33 66,0 | | Gender Female 33 66,0 | |
| 0,799 | | 0,799 | Male 17 34.0<br>Total 50 100.0 |
| | Male 17 34.0 | | |
| | Total 50 100.0 | | |
| Marital Status Single 22 44,0<br>0,535 | | Marital Status Single 22 44,0 | Married 24 48.0 |
| | | 0,535 | |
| | Married 24 48.0 | | |
| | Widow 2 4.0 | | Widow 2 4.0 |
| | Divorced 2 4,0 | | Divorced 2 4,0 |
| | Total 50 100.0 | | Total 50 100.0 |
| Educational Status Illiterate 0<br>0.0<br>0,190 | | Educational Status Illiterate 0 0.0 | |

| | | |
|---|---|---|
| | | 0,190 |
| | Primary School 0 0,0 | Primary School 0 0,0 |
| | Secondary School 0 0,0 | Secondary School 0 0,0 |
| | High school 11 21,6 | High school 11 21,6 |
| | Associate Degree 14 27,5 | Associate Degree 14 27,5 |
| Smoking and Alcohol Use Yes 42 84.0 | | |
| | | Smoking and Alcohol Use Yes 42 84.0 |
| | No 8 16.0 0.824 | No 8 16.0 0.824 |
| | Total 50 100.0 | Total 50 100.0 |
| Duration of Low Back Pain (Month) 10-20 months 14 28.0 | | |
| | | |
| | | Duration of Low Back Pain (Month) 10-20 months 14 28.0 |
| | 21-31 months 14 28.0 | 21-31 months 14 28.0 |
| | 32-42 months 12 24.0 0.032* | 32-42 months 12 24.0 0.032* |

***p<0,05** i statistically significant difference, X ± SD: Mean ± Standard Deviation
Independent Group T test

### 3.2. Results of Evaluation of Pain and Symptoms of Participants

#### 3.2.1. Visual Analogue Scale

In the analysis performed depending on the pain intensity of the participants, no statistically significant difference was found in terms of other VAS values (p>0.05) except for the pain intensity at rest (p=0.019). However, it was observed that women had higher mean pain intensity at rest, movement and night than men. However, the increase in this mean did not create a significant difference between the participants (p>0.05). The results regarding the participants are presented in detail in Table 4.3.

**Table 3.3. Evaluation of Visual Analogue Scale Pain Severity Levels of the Participants**

| | **Experiment Group (n=50)** | **Minimum** | **Maksimum** | **X ±SD** | **t** | **p** |
|---|---|---|---|---|---|---|
| **VAS (Rest) (cm)** | **Female** | 4,00 | 8,00 | 5,75±1,00 | 1,329 | **0,019*** |
| | **Male** | 4,00 | 7,00 | 5,35±1,05 | | |
| **VAS (Movement) (cm)** | **Female** | 5,00 | 9,00 | 7,96±1,18 | 0,843 | 0,403 |
| | **Male** | 5,00 | 9,00 | 7,64±1,45 | | |
| **VAS (Night) (cm)** | **Female** | 3,00 | 8,00 | 4,75±1,50 | 0,628 | 0,533 |
| | **Male** | 3,00 | 8,00 | 4,47±1,58 | | |

***p<0,05** statistically significant difference, VAS: Visual Analogue Scale, X ± SD: Mean ± Standard deviation, Independent Group T test

According to the New York Posture Evaluation Questionnaire conducted among the participants, it was found that the posture evaluation scores of both women (26.33±5.69) and men (26.82±5.43) were in the 'poor' category. In the posture comparison between the two groups, it was found that the posture evaluation results of men were higher than those of women. However, it was determined that the results of the evaluation between the two groups were similar, and therefore there was no statistically significant difference (t=-,293; p=0,771>0,05). The evaluation results obtained regarding the categorisation of the participants according to the New York Posture Evaluation Questionnaire are shown in Table 3.4 and Table 3.5.

**Table 3.4. Evaluation Results of Participants' New York Posture Evaluation Questionnaire Scores**

| Experiment Group (n=50) | X ±SD | t | p |
|---|---|---|---|
| **Female** | 26,33±5,69 | -,293 | 0,771 |
| **Male** | 26,82±5,43 | | |

***p<0,05** statistically significant difference, X ± SD: Mean ± Standard Deviation Independent Group T test

Within the scope of our study, subcategories related to the New York Posture Evaluation Questionnaire were determined and the scores obtained according to these categories were again evaluated between the groups. According to the results regarding the categorisation of the participants according to the total score they received, it was seen that the majority of the participants had poor posture. It was determined that there were no participants in the very good posture category. Among the female participants, 24 were in the category of 'poor', 8 were in the category of 'moderate' and 1 was in the category of 'good', while among the male participants, 12 were in the category of 'poor' and 5 were in the category of 'moderate'. The findings related to the participants are shown in Table 3.5 and presented visually in Figure 3.1.

**Table 3.5. Distribution of Participants' New York Posture Evaluation Questionnaire Scores According to Subcategories** n: number of people included, Independent Group T test

| New York Posture Evaluation Questionnaire Subcategories | Female (n=33) | | Male (n=17) | |
|---|---|---|---|---|
| | **n** | **%** | **n** | **%** |
| **Poor (20-29)** | 24 | 48,0 | 12 | 24,0 |
| **Medium (30-39)** | 8 | 16,0 | 5 | 10,0 |
| **Good (40-44)** | 1 | 2,0 | 0 | 0,0 |
| **Very Good (45+)** | 0 | 0,0 | 0 | 0,0 |
| **Toplam (n=50)** | 33 | 66,0 | 17 | 34,0 |

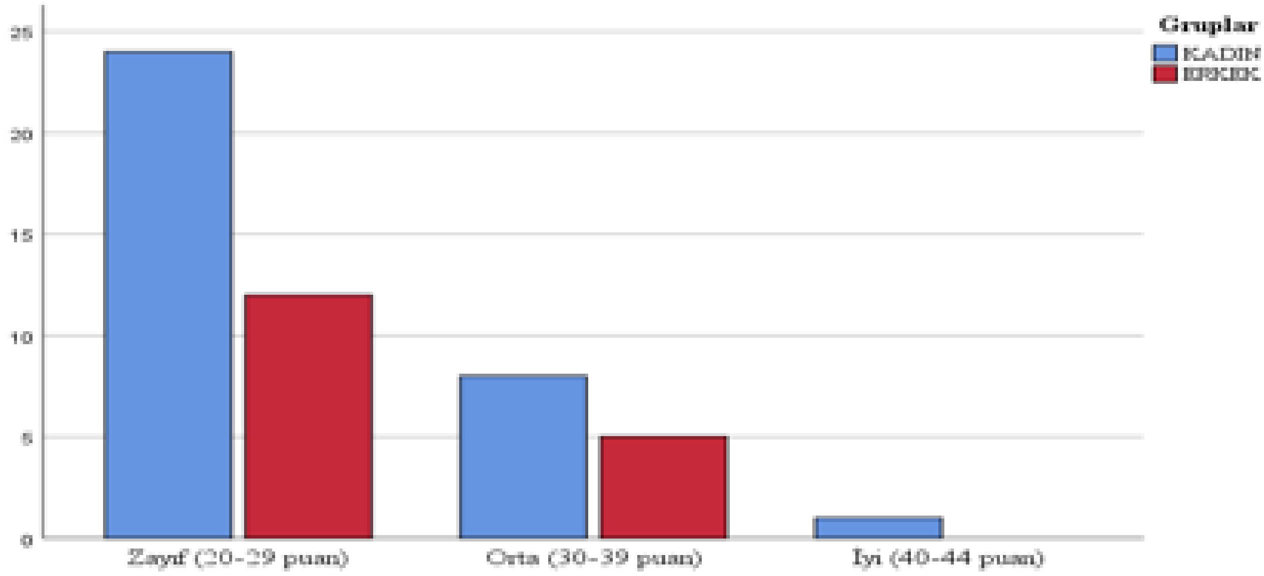


**Figure 3.1. Classification of the Participants According to the New York Posture Evaluation Questionnaire Scores**

The results of the Oswestry Disability Index, which was performed to evaluate the general functionality levels of the participants with chronic low back pain, are given in Table 4.6. According to the results, both female and male participants were found to be at the level of ‘severe disability’ (respectively: 28.96±7.26; 29.35±7.82). The results of Oswestry Disability Index according to the participants are given in Table 3.6.

**Table 3.6. Evaluation Results Regarding the Oswestry Disability Index Scores of the Participants**

| Experiment Group (n=50) | X ±SD | t | p |
|---|---|---|---|
| **Female** | 28,96±7,26 | -,172 | 0,864 |
| **Male** | 29,35±7,82 | | |

***p<0,05** statistically significant difference, X ± SD: Mean ± Standard Deviation Independent Group T test

An evaluation was also made in accordance with the subcategories of the Oswestry Disability Index, which enables the functional evaluation of participants with chronic low back pain. At this stage, the participants were categorised according to their scores. It was determined that the participants who were categorised into subcategories by evaluating the total scores mostly (84%) showed severe disability. When the mean total scores of male and female participants were analysed, it was seen that there was no significant difference between them (t=-,172;Jp=0,864>0,05). The distribution percentages of the participants to the subcategories of the Oswestry Disability Index are shown in Table 3.7.

**Table 3.7. Distribution of Participants According to Oswestry Disability Index Scores and Subcategories**

| Oswestry Disability Index Subcategories | Female(n=33) | | Male(n=17) | |
|---|---|---|---|---|
| | n | % | n | % |
| **Mild Disability (-19)** | 1 | 2,0 | 0 | 0,0 |
| **Moderate Deficiency (20-29)** | 8 | 16,0 | 6 | 3,0 |
| **Severe Functional Disability (30-39)** | 20 | 40,0 | 7 | 3,5 |
| **Complete Functional Disability** | 4 | 8,0 | 4 | 0,0 |
| **Total (n=50)** | 33 | 66,0 | 17 | 34,0 |

***p<0,05** statistically significant difference, X ± SD: Mean ± Standard Deviation Independent Group T test

### 3.3. Results of the Evaluation of the Participants Regarding Lower Extremity Biomechanics

Silfverskiöld method was used to measure the values of gastrocnemius muscle (GC) shortness of the individuals participating in the study. Male and female participants were evaluated according to the measurement results obtained according to the Silfverskiöld method. As a result of the evaluations, it was observed that the dorsi flexion values of the gastrocnemius muscle decreased in both male and female participants. However, when the data of knee extension ankle dorsi flexion were analysed, it was seen that the decrease in women was more than in men, but a similar decrease was observed in both groups. For this reason, no statistically significant difference was found between male and female participants (p>0.05). The limitation in dorsi flexion was maximised when the knee was in the extension position. As a result of this situation, flexion of the knee causes anatomical changes in the SC. As a result of the flexion of the SC muscle, lengthening occurred. This situation showed that the participants experienced limitations when performing dorsi flexion movement. In the results of the analysis, it was seen that the female and male participants were not within the normal joint movement limits and the dorsi flexion limitation was caused by the GC. The distributions of the results of the SC muscle measurements for male and female participants are shown in Table 3.8.

**Table 3.8. Comparison of the Measurement Values Obtained from Silfverskiöld Method Used for Determination of Gastrocnemius Muscle Shortness of the Participants**

| GKK Values (°) | | Female (n=33) X ±SS | Male (n=17) X ±SS | p |
|---|---|---|---|---|
| **Ankle Dorsi Flexion in Knee Extension** | **Right** | 15,84±3,75 | 16,41±4,39 | 0,127 |
| | **Left** | 16,27±3,90 | 16,80±4,33 | 0,229 |
| **Ankle Dorsi Flexion in Knee Flexion** | **Right** | 26,21±2,86 | 26,27±2,87 | 0,547 |
| | **Left** | 26,71±2,86 | 26,67±2,83 | 0,460 |

***p<0,05** statistically significant difference, X ± SD: Mean ± Standard Deviation

Independent Group T test

Angular measurement results of the ankle of male and female individuals were obtained and evaluated. The evaluation was made by comparing the angular measurement results of the two groups. The main criterion that allowed us to see that the chronic low back pain of the participants caused a limitation in the measurement results of normal joint movements was the ankle dorsi flexion movement. It was found that men had a greater range of motion in the ankle dorsi flexion direction in knee extension than women. This situation also affected the angular values of the plantar flexion movement of the men, resulting in a higher value than the women. However, these values did not show a significant difference between the two groups ($p>0.05$). This condition, which is characterised by a decrease during knee extension, is an important parameter about the presence of limitation. For this reason, it can be hypothesised that the level of limitation in women may increase more than in men. The fact that women have a higher range of motion in the ankle dorsi flexion direction in knee flexion compared to men caused an increase in the measurement results in the dorsi flexion direction. However, it was determined that this increase in women was similar to that in men and therefore there was no significant difference between them ($p>0.05$) (Table 3.9).

**Table 3.9. Participants' Ankle Dorsi and Plantar Flexion Movement Comparison Results of Angular Values**

| Ankle Angular Values (°) | | Female (n=33) X ±SS | Male (n=17) X ±SS | t | p |
|---|---|---|---|---|---|
| Active Plantar Flexion | Right | 20,47±2,26 | 19,94±1,98 | ,810 | 0,422 |
| | Left | 21,01±2,86 | 20,27±2,15 | 1,126 | 0,266 |
| Passive Plantar Flexion | Right | 23,57±6,01 | 20,97±5,75 | 1,470 | 0,148 |
| | Left | 24,14±6,00 | 22,40±4,00 | 1,076 | 0,287 |
| Active Plantar Flexion | Right | 49,27±5,23 | 49,58±2,06 | -,236 | 0,814 |
| | Left | 49,83±5,14 | 50,12±1,84 | -,231 | 0,818 |
| Passive Plantar Flexion | Right | 54,33±6,73 | 55,30±2,20 | -,570 | 0,571 |
| | Left | 54,99±6,59 | 56,03±2,28 | -,627 | 0,534 |

X ± SD: Mean ± Standard Deviation Independent Group T test

The measurement results of hallux valgus angles of male and female participants are shown in Table 4.10. The mean of the right foot hallux valgus angle of the female participants was (20.33±3.69) and the mean of the male participants was (19.11±3.83). According to this result, the right foot hallux valgus angle of women is higher than that of men. However, this difference was not statistically significant ($p>0.05$). The mean left foot hallux valgus angle of female participants was found to be (19.94±3.60). The mean left foot hallux valgus angle of male participants was found to be lower (18,67±3,66). It was observed that there was no significant difference between these averages related to the left foot hallux valgus angle ($p>0.05$). After this analysis between the two groups, intra-group comparison was also performed.

**Table 3.10. Comparison Results of Hallux Valgus Angle Measurement Values Between Groups**

| | Experiment Group | n=50 | X ±SS | t | p |
|---|---|---|---|---|---|
| **Halluks valgus angle (º) (RİGHT)** | **Female** | 33 | 20,33±3,69 | 1,090 | 0,281 |
| **Halluks valgus angle (º) (RİGHT)** | **Male** | 17 | 19,113±3,83 | | |
| **Halluks valgus angle (º) (LEFT)** | **Female** | 33 | 19,943±3,60 | 1,178 | 0,244 |
| **Halluks valgus angle (º) (LEFT)** | **Male** | 17 | 18,673±3,66 | | |

X ± SD: Mean ± Standard Deviation Independent Group T test

In order to determine whether the height of the angle values of all participants constituted a significant difference in both extremities, an intragroup comparison was made. The mean of the right hallux valgus angle of women and men was found to be (19.91±3.69) and the mean of the left hallux valgus angle was found to be (19.51±3.63). As a result, it was observed that the means of the female and male participants regarding the right hallux valgus angle were higher than the means of the left hallux valgus angle. The difference in the means of the participants in the right and left extremities was found to be statistically significant (p=000). The findings of the intra-group comparison of the goniometric measurement results of the right and left hallux valgus angle of the participants are shown in Table 3.11.

**Table 3.11. In-group Comparison Results of Hallux Valgus Angle Measurement Values**

| Experiment Group (n=50) | X ±SS | t | p |
|---|---|---|---|
| **Hallux valgus angle (º) (RIGHT)** | 19,91±3,69 | 34,077 | **0,000*** |
| **Halluks valgus angle (º) (LEFT)** | 19,51±3,63 | | |

***p<0,05** statistically significant difference, X ± SD: Mean ± Standard Deviation, Paired Sample T test

The evaluation results for the comparison of STE angular values of the participants are given in Table 3.12. According to the comparison between the groups, it was observed that the range of motion of the right and left STE active passive inversion and eversion of the female and male participants decreased, but this decrease did not cause a significant difference during the comparison (p>0.05).

**Table 3.12. Subtalar Joint Inversion and Eversion Movement Angular Values in Groups**

**Results of Comparison Between**

| Subtalar Joint Angular Values (°) | | **Female (n=33) X ±SS** | **Male (n=17) X ±SS** | **t** | **p** |
|---|---|---|---|---|---|
| Active STE Inversion | **Right** | 19,27±1,58 | 18,38±1,41 | 1,954 | 0,056 |
| | **Left** | 19,15±3,40 | 18,90±1,54 | ,296 | 0,769 |
| Passive STE Inversion | **Right** | 24,33±5,56 | 23,32±2,48 | ,710 | 0,481 |
| | **Left** | 24,81±5,58 | 23,97±2,28 | ,599 | 0,552 |
| Active STE Eversion | **Right** | 11,83±1,69 | 11,94±1,22 | -,226 | 0,822 |
| | **Left** | 12,13±1,71 | 12,42±1,23 | -,612 | 0,544 |
| Passive STE Eversion | **Right** | 15,91±1,36 | 15,78±1,08 | ,349 | 0,729 |
| | **Left** | 16,29±1,47 | 16,28±1,22 | 0,035 | 0,972 |

X ± SD: Mean ± Standard Deviation Independent Group T test

While the decrease in the active inversion and eversion values of the participants' right and left STE compared to the passive inversion and eversion values did not cause a significant difference between the groups, it was determined that this decrease caused a significant difference as a result of the analysis within the group ($p<0.05$). As a result, it was noted that active inversion and eversion values of both female and male participants decreased significantly compared to passive inversion and eversion values ($p=0,000$) (Table 3.13).

**Table 3.13. Comparison Results of Subtalar Joint Inversion and Eversion Movement Angular Values Between Groups**

| Subtalar Joint Angular Values (°) | | **Experiment Group (n=50)** | **t** | **p** |
|---|---|---|---|---|
| | | **X ±SS** | | |
| Active STE Inversion | **Right** | 18,97±1,57 | 85,194 | **0,000*** |
| | **Left** | 19,07±2,88 | 46,680 | **0,000*** |
| Passive STE Inversion | **Right** | 23,99±4,73 | 35,804 | **0,000*** |
| | **Left** | 24,53±4,71 | 36,808 | **0,000*** |
| Active STE Eversion | **Right** | 11,87±1,53 | 54,626 | **0,000*** |
| | **Left** | 12,23±1,56 | 55,359 | **0,000*** |
| Passive STE Eversion | **Right** | 15,87±1,26 | 88,781 | **0,001*** |
| | **Left** | 16,29±1,38 | 83,256 | **0,001*** |

***p<0,05** statistically significant difference, X ± SD: Mean ± Standard Deviation Paired Sample T test

The measurement results of the knee joint angular values of the participants were compared. When the results of the valgite angle values of the participants were analysed, it was found that the measurement results of women were lower than those of men. However, it was noted that this result did not create a significant difference between the two groups ($p>0.05$). When the results of the evaluation of the Q angle of the female and male participants were analysed, it was found that the angular values of the women increased significantly compared to the men ($p<0.05$). It was hypothesised that the increase in this value may cause the valgite angle to be lower in women than in men. It was determined that hyperectension and flexion angle decreased in both groups and this decrease was more significant in women than in men. However, this decrease did not cause a significant difference between the groups ($p>0.05$) (Table 3.14).

**Table 3.14. Intergroup Comparison Results of Angular Values Related to Knee Joint**

| Angular Values of the Knee Joint (°) | | **Female (n=33) X ±SS** | **Male (n=17) X ±SS** | **t** | **p** |
|---|---|---|---|---|---|
| Valgite | **Right** | 9,91±1,41 | 9,67±1,61 | ,545 | 0,588 |
| | **Left** | 10,21±1,31 | 10,11±1,41 | ,241 | 0,810 |
| Q Angle | **Right** | 21,98±2,73 | 15,70±1,53 | 8,745 | **0,000*** |
| | **Left** | 24,34±2,72 | 15,17±1,28 | 8,816 | **0,000*** |
| Hyperectension Angle | **Right** | 5,85±,89 | 5,88±,99 | -,109 | 0,914 |
| | **Left** | 6,27±,90 | 6,18±1,01 | ,300 | 0,766 |
| Flexion Angle | **Right** | 131,81±5,56 | 135,05±5,44 | -1,361 | 0,180 |
| | **Left** | 133,94±5,31 | 135,85±5,40 | -1,194 | 0,238 |

***p<0,05** statistically significant difference, X ± SD: Mean ± Standard Deviation Independent T test

Hip flexors, knee flexors, lumbar extensor muscle shortness and sacral inclination angle measurements were performed and it was analysed whether the difference between and within the groups was statistically significant. According to the results obtained as the comparisons of the two groups, it was determined that the knee flexors and hip flexors of both female and male participants were shortened in both extremities, and since the measurement results were similar, the shortening did not cause a significant difference between the groups (p>0.05). When the findings related to lumbar extensor shortness and sacral inclination angular values of male and female participants were analysed, it was observed that there was a similarity between the groups (p>0.05) (Table 4.15).

**Table 3.15. Hip flexor shortness, knee flexor shortness, lumbar extensor shortness Results of Intergroup Comparison of Sacral Inclination Angle and Sacral Inclination Angle Measurements**

| | | Female (n=33) X ±SS | Male (n=17) X ±SS | t | p |
|---|---|---|---|---|---|
| Hip Flexors Shortness Values (°) | **Right** | 8,44±2,00 | 8,23±2,30 | ,334 | 0,740 |
| | **Left** | 8,03±2,01 | 7,95±2,32 | ,131 | 0,896 |
| Knee Flexors Shortness Values (°) | **Right** | 26,53±7,40 | 25,92±8,05 | ,268 | 0,790 |
| | **Left** | 26,18±7,21 | 25,59±8,12 | ,264 | 0,793 |
| Lumbar Extensor Shortness Values (cm) | | 5,56±1,48 | 5,76±1,65 | -,109 | 0,914 |
| Sacral Inclination Angular Values (°) | | 19,07±4,31 | 20,65±4,49 | -1,361 | 0,180 |

***p<0,05** statistically significant difference, X ± SD: Mean ± Standard Deviation Independent T test

Since the shortening of the knee flexors and hip flexors in both extremities was significant in both men and women according to the comparisons made between the two groups, the significance level of this shortening was evaluated by performing intragroup analysis in our study. According to the results of the analysis, it was determined that the angular values of the knee flexors and hip flexors decreased with a statistically significant difference ($p<0.05$) along with the lumbar extensor shortening and sacral inclination angular values of all participants (Table 3.16).

**Table 3.16. In-group Comparison Results of Hip Flexor Shortness, Knee Flexor Shortness, Lumbar Extensor Shortness and Sacral Inclination Angle Measurements**

| | Experiment Group (n=50) | | t | p |
|---|---|---|---|---|
| | X ±SD | | | |
| **Hip Flexor Shortness Values (°)** | **Right** | 8,37±2,08 | 28,364 | **0,001*** |
| | **Left** | 8,00±2,10 | 26,896 | **0,001*** |
| **Knee Flexor Shortness Values (°)** | **Right** | 26,33±7,55 | 24,647 | **0,000*** |
| | **Left** | 25,98±7,46 | 24,630 | **0,000*** |
| **Lumbar Extensor Shortness Values (cm)** | 5,63±1,52 | | 26,067 | **0,000*** |
| **Sacral Inclination Angular Values (°)** | 19,61±4,39 | | 31,559 | **0,000*** |

***p<0,05** statistically significant difference, X ± SD: Mean ± Standard Deviation Paired Sample Test

### 3.4. Functional Evaluation Results of Participants

The comparison results of the total scores of the foot function index, which was performed to determine the foot posture of male and female participants, are shown in Table 3.17. In this questionnaire, in which the foot posture of the participants is evaluated with various parameters, the minimum score that the participants can get is 0 and the maximum score is 100 points. This questionnaire shows that the foot function is good as the score approaches from 0 to 100, and the function decreases as the score decreases. When the results regarding the AOFAS scores between the groups were analysed, it was found that the mean score of women (59.36±8.96) was lower than that of men (60.39±9.59), but there was no statistically significant difference between them (p>0.05). Functional losses were observed in both feet of the participants with posture disorders. In our study, the fact that the AOFAS results applied to the participants were in a low score range was consistent with posture and functional losses.

**Table 3.17. Comparison Results of Participants' Foot Function Index Total Scores (AOFAS)**

| Experiment Group (n=50) | Ayak Fonksiyon İndeksi Puanı (0-100) | | | |
|---|---|---|---|---|
| | **n** | **X±SS** | **t** | **p** |
| **Female** | 33 | 59,36±8,96 | -,340 | 0,736 |
| **Male** | 17 | 60,39±9,59 | | |

***p<0,05** statistically significant difference, X ± SD: Mean ± Standard Deviation Independent T test

The values of the navicular drop test for male and female participants were obtained for both feet in the weight transfer positions. The results of the comparison between groups regarding the amount of ND are given in Table 3.18. After the analysis, it was seen that the ND measurement results of the female participants for both right and left extremities were higher than the male participants. However, it was concluded that this difference was not statistically significant (p>0.05). In accordance with the result of this comparison between the groups, the data related to the averages were re-evaluated by within-group analysis.

**Table 3.18. Comparison of Navicular Drop Test Results Between Groups**

| | **Experiment Group** | **n=50** | **X±SS** | **t** | **p** |
|---|---|---|---|---|---|
| **Naviküler düşme miktarı (Ağırlıklı) (°) (RİGHT)** | **Female** | 33 | 16,28±3,13 | ,191 | 0,850 |
| **Naviküler düşme miktarı (Ağırlıklı) (°) (RİGHT)** | **Male** | 17 | 16,09±3,75 | | |
| **Naviküler düşme miktarı (Ağırlıklı) (°) (LEFT)** | **Female** | 33 | 15,93±3,08 | ,287 | 0,775 |
| **Naviküler düşme miktarı (°) (Ağırlıklı) (LEFT)** | **Male** | 17 | 15,65±3,61 | | |

X ± SD: Mean ± Standard Deviation Independent T test

Intra-group comparison was made to evaluate whether the difference in the ND values of the participants in the right and left extremity averages was significant. According to the results of this comparison, it was determined that the higher weighted right ND values of the participants compared to the weighted left ND values caused a significant difference ($p<0.05$).

**Table 3.19. Intragroup Comparison Results of Navicular Drop Test Results**

| Experiment Group (n=50) | X ±SS | t | p |
|---|---|---|---|
| **Naviküler düşme miktarı (Ağırlıklı) (°) (RİGHT)** | 16,22±3,31 | 31,257 | **0,000** * |
| **Naviküler düşme miktarı (Ağırlıklı) (°) (LEFT)** | 15,83±3,23 | | |

***p<0,05** statistically significant difference, X ± SD: Mean ± Standard Deviation Paired Sample T test

When the results of the static pedobarographic measurements performed among the participants were analysed, no statistically significant difference was found between the female and male groups in terms of the percentage of weight on the left forefoot, percentage of weight on the left rear foot and percentage of weight on the left foot ($p>0.05$). No statistically significant difference was found between the percentage of weight on the right forefoot and the percentage of weight on the right rear foot ($p>0.05$). As a result, it was found that the mean of the percentage of weight on the right foot of the female participants was higher than that of the male participants, and this height created a statistically significant difference ($p=0.003$) (Table 3.20

**Table 3.20. Comparison of Participants' Data on Static Pedobarographic Measurement Analysis**

| | **Female (n=33) X ±SS** | **Male (n=17) X ±SS** | **t** | **p** |
|---|---|---|---|---|
| **Percent weight on the left forefoot** | 73,01±7,37 | 74,77±5,96 | -,852 | 0,399 |
| **Percent weight on the left hind leg** | 24,47±5,31 | 23,22±5,91 | ,761 | 0,450 |
| **Percent weight on the left foot** | 49,76±1,33 | 50,07±1,90 | -,662 | 0,511 |

| | | | | |
|---|---|---|---|---|
| **Percentage weight on the right forefoot** | 72,06±5,65 | 72,44±5,14 | -,227 | 0,822 |
| **Percentage weight on the right hind leg** | 26,96±5,72 | 26,61±5,20 | ,207 | 0,837 |
| **Percentage weight on the right foot** | 49,23±1,33 | 48,92±1,90 | ,622 | **0,003*** |

***p<0,05** statistically significant difference, X ± SD: Mean ± Standard Deviation Independent T test

However, as a result of the in-group analysis, it was observed that the pressure value for the forefoot was higher than the hindfoot in the right and left extremities of the participants and this created a statistically significant difference (p<0.000) (Table 3.21).

**Table 3.21. In-group Comparison Results of Data Related to Static Pedobarographic Measurement Analysis**

| Working Group (n=50) | X ±SS | t | p |
|---|---|---|---|
| **Percent weight on the left forefoot** | 49,56±11,51 | 30,440 | **0,000*** |
| **Percentage of weight on the left hind leg** | | | |
| **Percentage of weight on the right forefoot** | 42,29±10,77 | 29,77 | **0,000*** |
| **Percentage of weight on the right hind leg** | | | |

***p<0,05** statistically significant difference, X ± SD: Mean ± Standard Deviation Paired Sample T test

### 3.5. Correlation Analysis Results

#### 3.5.1. Relations with Q Angle

It was observed that there was a moderate positive correlation between Q angle values and HVA values of the right foot (r=0,569; p=0,000) and left foot (r=0,578, p=0,000). It was found that there was a very strong positive correlation between the results of all ND measurements and Q angle (r=0,863; p<0,002, r=0,861; p<0,001, respectively). However, all results were found to be statistically significant (p<0.001) (Table 3.22).

**Table. 3.22. Q Angle Values of the Participants and HVA and Navicular Drop Test Relationship between Total Score Distribution**

| | Q Açısı (°) | |
|---|---|---|
| | **r** | **p** |
| **Hallux valgus angle (º) (RIGHT)** | 0,569 | **0,000*** |
| **Hallux valgus angle (º) (LEFT)** | 0,578 | **0,000*** |
| **Amount of navicular drop (Weighted) (°) (RIGHT)** | 0,863 | **0,002*** |
| **Amount of navicular drop (Weighted) (°) (LEFT)** | 0,861 | **0,001*** |

Pearson Correlation Analysis, r: correlation coefficient,* **p< 0,001**.

A positive correlation was found between the results of the participants' VAS (rest) (r=0,484; p=0,000), VAS (movement) (r=0,496, p=0,000), VAS (night) (r=0,422, p=0,001) scores and the mean Q angle. This result was also statistically significant (p<0.001). It was observed that there was a significant decrease in the total AOFAS score of the participants. This decrease is a factor that is negatively evaluated in terms of foot biomechanics. The relationship between Q angle and AOFAS values was found to be negative, very strong and statistically significant (p=0.001). For this reason, it was thought that an increase in Q angle may cause a decrease in AOFAS values. As another parameter, the increase in ODI index scores indicates an increase in functional disability. In this context, the relationship between them and Q angle was analysed. According to the results, it was found that there was a moderate positive correlation between ODI scores and Q angle measurement results. This showed that an increase in Q angle may cause an increase in ODI scores. This relationship between the two parameters was statistically significant (p<0.001) (Table 3.23).

**Table: 3.23. Relationship between Q Angle and Visual Analogue Scale, New York Posture Assessment Questionnaire, AOFAS and Oswestry Disability Index**

| | Q Angle (°) | |
|---|---|---|
| | **r** | **p** |
| **NYPD** | -0,390 | **0,001*** |
| **VAS (Rest)** | 0,484 | **0,000*** |
| **VAS (Movement)** | 0,496 | **0,000*** |
| **VAS (Night)** | 0,422 | **0,001*** |
| **AOFAS** | -0,872 | **0,001*** |
| **ODI** | 0,502 | **0,001*** |

VAS: Visual Analogue Scale NYPD: New York Posture Evaluation Questionnaire ODI: Oswestry Disability Index, Pearson Correlation Analysis, r: correlation coefficient,*** p< 0,001**.

### 3.5.2. Evaluation of Parameters Related to Lower Extremity Biomechanics

It was found that there was a moderate to strong positive correlation between the ankle dorsi flexion in knee extension parameter used in the evaluation of gastrocnemius muscle shortness and AOFAS values. At the same time, this relationship was found to be statistically significant (r=0.493, p=0.000). This result showed that the increase in the ankle dorsi flexion parameter in extension due to the decrease in gastrocnemius muscle shortness caused an increase in AOFAS scores. It was determined that an increase in the ankle dorsi flexion value in extension with decreased limitation could also increase the AOFAS values of the participants. It was found that there was a negative and moderate relationship between the ankle dorsi flexion in extension parameter and the total score related to the ODI index (r=-0.613). This explains the increased ODI scores of the participants due to the limitation caused by the decrease in the ankle dorsi flexion parameter in extension. At the same time, this relationship between the two parameters was found to be statistically significant (p<0.001) (Table 3.24).

**Table: 3.24. The Relationship Between Ankle Dorsi Flexion in Knee Extension and AOFAS and Oswestry Disability Index**

| | Ankle Dorsi Flexion at Knee Extension (°) | |
|---|---|---|
| | **r** | **p** |
| **AOFAS** | 0,653 | **0,000*** |
| **ODI** | -0,613 | **0,000*** |

Pearson Correlation Analysis, r: correlation coefficient,* **p< 0,001**.

There was a moderate to strong negative correlation between active dorsi flexion movement and ODI scores (r=-0.690). This result showed that an increase in ODI scores may be associated with a decrease in the angular values related to active dorsi flexion of the ankle. Because a decrease in the angular values related to the active dorsi flexion of the participants will lead to an increase in the limitation. However, it was concluded that AOFAS values showed a positive and medium strong relationship (r=0,631), and there was a negative and medium strong relationship between them and Q angle (r=-0,531). This result showed that the limitation levels of the participants increased depending on the increase in Q values. The relationship between the NDT and HVA angles and the active dorsi flexion movement of the ankle was found to be negative and of moderate strength (r= -0,634, r=-0,629, respectively). This result shows that the decrease in the amount of navicular drop is related to the increase in the active dorsi movement of the ankle. However, it was determined that the ankle active dorsi flexion value decreased with the increase in the HVA values of the participants and accordingly, the functional status of the participants could be negatively affected. In the correlation analysis, it was found that the relationship between all parameters and ankle active dorsi flexion was statistically significant (p<0.001) (Table 3.25).

**Table: 3.25. The Relationship Between Ankle Active Dorsi Flexion Movement and ODI, AOFAS, Q Angle, Valgite, NDT and HVA Values**

| | Ankle Active Dorsi Flexion (°) | |
|---|---|---|
| | **r** | **p** |
| **ODI** | -0,690 | **0,000*** |
| **AOFAS** | 0,631 | **0,000*** |
| **Q Angle (º)** | -0,531 | **0,000*** |
| **Valgite (º)** | 0,513 | **0,000*** |
| **Navicular drop amount (º)** | -0,634 | **0,000*** |
| **Hallux valgus angle (º)** | -0,629 | **0,000*** |

Pearson Correlation Analysis, r: correlation coefficient,* **p< 0,001**.

### 3.5.3. Relationships with the New York Posture Evaluation Questionnaire

The relationship between the static sole pressure data and ODI scores of the participants and the New York Posture Evaluation Questionnaire, in which static posture was evaluated, was analysed. In this way, it was aimed to evaluate both general and foot posture in the same process. In our study, it was found that there was an increase in pressure due to the increased load on the forefoot and a decrease in pressure values by increasing the degree of pronation in the hindfoot. The significance of these changes between the New York Posture Evaluation Questionnaire and ODI was determined by correlation analysis. According to the correlation analysis, it was observed that the pressure values of the forefoot and ODI scores decreased with the increase in the score of the individuals from the New York Posture Assessment Questionnaire. This shows that there is a negative and moderate relationship between the New York Posture Assessment Questionnaire and ODI and forefoot pressure values (r=-572, r=-0,581, respectively). However, it was found that the pressure in the hindfoot increased with the increase in the score values in the New York Posture Assessment Questionnaire. This showed that there was a positive and strong correlation with the New York Posture Assessment Questionnaire (r=805). It was concluded that the relationship between all parameters was statistically significant ($p<0.001$) (Table 3.26).

**Table: 3.26. The Relationship Between New York Posture Evaluation Questionnaire and Percentage of Weight on Forefoot and Rearfoot and ODI Values**

| | **New York Posture Assessment Survey** | |
|---|---|---|
| | **r** | **p** |
| **Percentage of weight on the forefoot** | -0,581 | **0,000*** |
| **Percentage of weight on the hind leg** | 0,805 | **0,000*** |
| **ODI** | -0,572 | **0,000*** |

Pearson Correlation Analysis, r: correlation coefficient,* **p< 0,001**

## CONCLUSIONS AND SUGGESTIONS

Shortening of a muscle or muscle group in individuals and consequently increasing its tension is a common condition. As a result of this situation, individuals experience many different biomechanical changes due to muscle shortness (Salat et al., 2018). Due to the negative effect of these changes, the incidence of the risk of injury or injury among individuals increases. People with muscle shortness are therefore more prone to injury and disability (Sulowska-Daszyk & Skiba, 2022). It has been reported that people with gastrocnemius muscle shortness have decreased range of motion in the ankle and knee joint, resulting in unfavourable biomechanical changes. The most important reason for this is that the parameters related to gastrocnemius muscle shortness are directly related to the knee joint, ankle and STE. The gastrocnemius muscle, which is considered as one of these parameters, participates in the biochemical process related to gastrocnemius muscle shortness (Yoshimoto et al., 2021).

In this biomechanical process, the gastrocnemius muscle is accompanied by important functions such as performing contracture and participating in dorsi flexion limitation. For this reason, gastrocnemius muscle shortness that may occur in individuals is responsible for limited ankle dorsi flexion movement, but it is also considered as a risk factor in the formation of many different lower extremity problems such as increased pronation of the hindfoot, plantar fasciitis, Achilles tendinopathy and stress fractures that may occur due to this, iliotibial band syndrome and patellofemoral pain syndrome (Zan et al., 2022). For this reason, both in our study and in other studies in the literature, it has been stated that the negative foot biomechanics process may be accompanied by shortness of the gastrocnemius muscle and soleus muscles of individuals and that this has different clinical effects. For this reason, it is very important to make a detailed distinction regarding the anatomical structure of the muscles in order to make an assessment of shortness. Thus, it will be easier to determine the methods to be used during the evaluation of individuals, and a more accurate result can be obtained from the treatment protocols that can be applied. There are some parameters for the evaluation of the limitation of the dorsi flexion movement in the ankle due to the decrease in angular values. Among these parameters; ankle dorsi flexion in knee extension should not be less than 5° and ankle dorsi flexion in knee flexion should not be less than 10°. If these conditions are fulfilled in individuals, the ankle is evaluated as a joint (Zeng et al., 2022). When the ankles are evaluated as equinus, it means that there is an indication for surgery. It is thought that shortness in individuals may be directly related to the gastrocnemius muscle. It has been reported that the lower extremities, pelvis and lumbar region are also affected due to shortening of the gastrocnemius muscle. For this reason, it has been stated that it is very important to evaluate the functionality of individuals due to shortening of the gastrocnemius muscle together with these parameters (Vopat et al., 2022). Together with all these results, studies show that there is a change in plantar pressure values depending on the shortness of the GC. The first symptom of plantar pressure is pronation of the hindfoot and increased pressure. It has been reported that this situation may negatively affect foot biomechanics and trigger the formation of other foot problems (Stevans et al., 2021). In our study, the Silfverskiold test was performed on healthy individuals with chronic low back pain, and according to the results, it was determined that they had a risk for shortening of the SC. After this test, comparisons were made with other survey data. For this reason, attention was paid to the homogeneity of the demographic information of the individuals participating in our study. Ensuring homogeneity in our study paved the way for a more accurate determination of the effects of LB shortness and an objective evaluation of other populations without chronic low back pain.

In this study, it was found that the shortening of the ROM in participants with chronic low back pain caused a significant change in plantar pressure distributions by affecting both lower extremity biomechanics and functionality in this region. The Silfverskiold method used in our study was used to evaluate the dorsi flexion limitation, and it was concluded that the main source of this effect was GK. This method for determining the shortening of the SC is very important for understanding the pathomechanical conditions that occur in individuals and determining the treatment programmes that can be applied subsequently. In particular, the ability to distinguish whether the condition related to muscle shortness that may occur in individuals is caused by GK plays an effective role in the treatment process. This effective role is to determine the physiotherapy treatment programmes that can be applied in individuals and the method of surgical applications. According to the findings obtained within the scope of our study, the shortening of the GK caused an increase in the pronation of the participants to the back, as stated in other studies in the literature. This increase in pronation in the posterior part of the foot negatively affected the foot and ankle. As a result, according to this finding evaluated in our study, it was determined that the short DD shortening changed the foot posture in the pronation direction. This change in the pronation direction causes the STE joint opening parameter evaluated in the foot posture to be limited in the inversion direction. The ankle dorsi flexion movement of the subjects was analysed in two separate sections as active and passive. It was observed that the participants had a limited movement in both active and passive positions. This increase in limitation caused the participants to be restricted when performing knee joint flexion movement. As a result, it was observed that this situation negatively affected the participants functionally.

The difficulty experienced by individuals during a squat-like activity is associated with ankle dorsi flexion and knee and hip flexion movements. This movement mechanism, which occurs due to the shortness of the SC during the performance of the specified activities, affects other joints and causes a limited joint range of motion. In our study, the observed lack of motion due to the decrease in the angular value of knee flexion of the participants was consistent with this situation. In conclusion, the DD identified among the participants was characterised by pronation of the foot posture, resulting in dorsi flexion of the ankle, inversion of the STE and flexion limitation of the knee. In addition to these conditions, it was determined that there was a loss of function due to muscle shortness detected in the measurement results of the knee and hip flexors of the participants, resulting in a decrease in the AOFAS survey results of the participants, but an increase in ODI scores.

In the static pedobaragraphic analyses performed in our study, it was determined that the GA values of the participants changed the pressure distribution in the forefoot and hindfoot.

The negative effect of the short GK while the individuals are standing and in the stance position is due to the fact that it plays an active role in changing the pressure between the ground and the foot. The effect here is to increase the pressure in the forefoot and decrease the pressure in the hindfoot. In our study, it was determined that the pressure difference in the forefoot of the participants was significantly higher than the hindfoot. In this case, it is seen that the load on the forefoot is higher. It is thought that if this situation lasts for a long period of time, it may cause the formation of pathologies in the forefoot. Considering the functional status of the hindfoot in terms of foot biomechanics, it can be said that the stabilisation of the hindfoot is significantly reduced, thus preparing the ground for the formation of a weakened hindfoot. In the light of all these data, in our study, it was concluded that the shortening of the GK was effective in the change of the pressure distribution in the forefoot and hindfoot.

The findings related to the lower extremity angular and shortness values evaluated within the scope of our study were obtained as a result of goniometric measurement. In the evaluation of the lumbar extensor muscle shortness of the participants, the Modified Schober Test method, which is frequently used in studies and considered reliable, was used. In addition to this method, inclinometer was used to evaluate the sacral inclination angle of the participants because it is fast and practical. The evaluation of the foot posture of the participants was performed with the AOFAS questionnaire and the findings were compared as numerical data. This provides a clearer evaluation of foot posture and enables comparison between groups. Foot posture, which was evaluated with chronic low back pain in our study, is very important for understanding the parameters related to foot dynamics. In a study, it was found that low scores were obtained when evaluating the foot and ankle mechanics of individuals within the scope of AOFAS values, and it was found that situations in which shortness of DDH was observed were effective (Richie, 2022). In particular, it has been stated that the reason for this is the increased duration and amount of pronation movement that occurs in the hindfoot due to shortening of the ROM.  In another study, it was reported that increased pronation movement in the hindfoot flexes the foot, thus creating a low medial longitudinal arch and increasing HVA values (Oliveira et al., 2018).

Basically, AOFAS is a questionnaire that evaluates the pain, function, alignment and their total scores that may occur in people's feet. When the literature on the studies conducted within the scope of AOFAS was examined, it was found that AOFAS values decreased due to people's short DDL lives and related chronic low back pain (Verdu Roman et al., 2022). For this reason, it was found that DD values directly affect the total score of the AOFAS and there is an inverse proportion between them. When a comparison was made between the VA values evaluated in our study and the AOFAS total scores, it was found that individuals had shortened VA and low AOFAS values. This decrease in the AOFAS values of the individuals showed that the function perceived directly by the individuals and the alignment characteristics of the foot were negatively affected. Another result obtained within the scope of our study was compared with the findings in the literature on ankle and STE movements. This study in the literature was conducted by KİM VD and it was found that ankle and STE movements caused a decrease in AOFAS values. Increased pronation of the hindfoot was shown as the reason for the decrease in AOFAS values. In our study, it was determined that the total pressure of the forefoot increased and the pronation of the hindfoot was higher than the expected level due to the shortness of the GA. At the same time, AOFAS values were found to be below the desired level (Cho et al., 2022). This situation is similar to the result of the study conducted in the literature, showing that the foot biomechanics of the individuals are negatively affected and that the situations that develop as a result of this effect are an expected result. In another study by Bento et al. (2020), the AOFAS total score of individuals related to GK shortness and Q angle was evaluated. An increase in Q angle due to genu valgum was observed in the majority of the people included in the study. This increase in Q angle changes in the direction of increasing the angle of the patella sliding towards the lateral part. With this increase in the Q angle, it was determined that the shortening of the DD shortening occurred, the pain levels increased in the individuals and accordingly, a decrease in the AOFAS values occurred. In order to reduce this increase in Q angle and pain levels, treatment programmes for GK stretching exercises were applied to the patients. At the end of this treatment programme, it was reported that there was a significant decrease in the Q angle values of the participants and an increase in the AOFAS score. In our study, when the increasing Q angles of the participants were evaluated, it was concluded that there was a decrease in AOFAS values similar to this study, and it was also concluded that the shortness of the SC may be effective in the formation of this situation. In a different study conducted on sedentary individuals diagnosed with chronic low back pain and pes planus, an evaluation was made regarding the amount of NDT depending on the high HVA values. A comparison was made for AOFAS total scores in relation to the results. At the same time, a comparison was made regarding the parameters related to the total pressure on the back and front of the foot and the GK and Q angle values. As a result, it was found that a significant increase in HVA values occurred with the amount of ND of the participants, and accordingly, MLA levels decreased in people (Grantham et al., 2023).

In a study by Gong et al. (2022), it was reported that a significant decrease occurred in the AOFAS scores of people with exacerbated chronic low back pain. It was found that there was a significant increase in Q angle and the rate of genu valgum was higher among the participants. At the same time, in the evaluation of the shortness of the SC, it was observed that significant limitations occurred in individuals and this was characterised by increased pressure in the forefoot. The results of this study, in which the effects of multiple parameters on foot and low back biomechanics were examined, were consistent with the findings in our study. In our study, it was found that the AOFAS values decreased due to chronic low back pain, but there was no significant difference between the two groups. This showed that the total score values were close between the participants. The low AOFAS scores evaluated in our study and the parameters related to the shortness of the GK showed that it may negatively affect foot health by causing an increase in Q angle and HVA values and a decrease in MLA levels accordingly. It is thought that these findings obtained in our study may contribute to the literature.

Our results showed that the data related to GA evaluated in our results showed a significant restriction in the range of motion of the ankle in the dorsi flexion direction. In addition, it has been observed that people develop forefoot, midfoot and hindfoot pathologies that may adversely affect foot functionality due to DDH and this is characterised by deterioration in gait dynamics. In many different studies conducted in the literature, pathological conditions associated with muscle shortness were evaluated (Fritz & Fritz, 2023). In this evaluation, static plantar pressure distribution analyses were used. In a study conducted by Citko et al. (2018), an evaluation of the pressure difference in the forefoot and hindfoot of people with low MLA was performed using the static plantar pressure distribution analysis method. The relationship between the results of the evaluation and foot functionality was examined and a comparison was made with the parameters for post-treatment. As a result, it was determined that the presence of DD among the participants was associated with an excessive load on the forefoot and a significant increase in the low MLA. In a study by Olafsson et al. (2018), individuals underwent GA recession surgery and the results were compared with pedobarographic evaluations. After the treatment, it was found that the load on the forefoot was significantly reduced. In another study, the effect of this situation on the sole of the foot pressure was investigated by stating that the reduction due to GK was at a noticeable level. Long-term running programmes requiring GK activity were applied to the participants and the results obtained were compared. As a result of the pedobarographic measurements of the participants after running, it was reported that the loads on the forefoot and heel medial increased before running and caused a decrease in MLA levels. This showed that the GC has an important role as the dominant plantar flexor and can cause significant changes even in plantar pressure (Wilhelm et al., 2020). In another study, individuals with increased hindfoot pronation were intervened using insoles. The main purpose here is to examine the change in foot posture using insoles and to evaluate the static sole pressure after the intervention. As a result of this study, it was reported that the load on the forefoot decreased and the load on the hindfoot increased with the use of insoles and the low MLA level decreased significantly (Machado et al., 2018).

When the common result of these studies in which people with DDH shortness were examined internationally, the load on the hindfoot decreased and the load level on the forefoot increased significantly. In our study, it was determined that the participants may have short stance and static sole pressure analysis was performed and the findings were evaluated with other parameters. As a result, it was found that the pressure area in the left forefoot of both men and women was high. In another study, static foot pressure changes were evaluated in individuals in whom an increase in the Q angle was observed, as well as in individuals in whom DD shortening occurred. It was observed that the pressure of the right forefoot increased in individuals due to the shortening of the GK, but the pressure area of the left hindfoot decreased (Moon, 2019). In our study, a similar situation occurred, the left hindfoot pressure decreased and the pressure in the right forefoot increased in participants with parameters related to DDH shortness. However, it was observed that these two data did not create a statistically significant difference in the female and male groups. As a result, it was determined that there was an increase in pressure in both forefeet and a decrease in pressure in both hindfeet depending on the shortness of the DD. It was concluded that the results of the studies in the literature on this subject in which pedobarographic changes were examined depending on the shortness of the SC were compatible with the findings obtained in our study.

There are many studies examining the changes in knee flexors, hip flexors, lumbar extensors and sacral inclination angle measurements in relation to short DDH. As a common result of these studies, it has been observed that many pathological conditions occur in a way characterised by DD shortness (Suga et al., 2021). For this reason, it can be said that pathological conditions and findings related to DD shortness occur simultaneously. In a study, it was reported that the risk of plantar fasciitis in individuals increased the incidence of hamstring shortness 8.7 times. In another study, it was reported that 105 individuals who participated voluntarily had plantar fasciitis and hamstring shortening was seen in all of these individuals. In another study conducted on participants aged 20-35 years, it was reported that as a result of functional tests, individuals had DD shortness and accordingly, hip flexors and knee flexors were shorter than healthy individuals. In another study, NDT and star balance test were applied to individuals with low MLA and short ROM. It was found that the increase in angular values related to the amount of NDT increased the risk of falls. As a result of the other star balance test used for the evaluation of balance and functionality, it was found that the dorsi flexion was significantly decreased during forward movements and this was characterised by a limited throw. This limitation was reported to be significant (Morris et al., 2018). When the results of other studies were examined, it was concluded that the GC and hamstring muscles are very important in creating knee joint flexion movement and that these two muscle groups function together (Niederer & Mueller, 2020). For this reason, it is thought that shortness in individuals related to both GK and hamstring muscles can usually occur at the same time. At the same time, it has been reported in the results of studies that shortness in these two muscle groups may be accompanied by shortness in the hip flexors (Khan et al., 2023). The reason for this is that the connections between the fasciae, which are shown to be a factor in the formation of shortness, should act like chain links and extend to the proximal parts. After the biomechanical process related to this shortness, significant changes are also observed in the sacral inclination angle of individuals. The most important of these changes is the restriction that occurs during the forward bending of the trunk. Limitations related to muscle shortness in individuals have been proven in the literature (Ledoux, 2023). For this reason, it is thought that the formation of a shortness chain related to the SC and hamstring muscles may be a factor for the lumbar region problems shown as a risk for low back pain in our study. In a study conducted by Dodelin et al. (2020) on individuals with low back pain, the effect of exercises in which GK and stretching movements were performed on hamstring and iliopsoas muscles was examined. As a result of the study, it was noted that low back pain decreased significantly in the group in which exercises were applied. In our study, it was found that individuals with low back pain had short hip flexors and knee flexors in accordance with the findings of other studies in the literature. This situation showed that shortness of all muscle groups extending from distal to proximal may be a factor in the formation of ankle, knee, hip, pelvis and lumbar region pathologies, especially the foot.

It was determined that all the findings obtained in our study and the parameters formed during the examination of muscle group shortness were related to each other. It was concluded that many multidisciplinary parameters are effective during the evaluation of the factors causing muscle shortness and for this reason, the findings obtained from our study are very important. In the studies conducted in the literature, it was reported that the parameters related to sacral inclination and lumbar extensor shortness were evaluated together with hamstring shortness and a significant relationship was found between these muscle groups. No significant difference was found between the results of the evaluation of sacral inclination angle and lumbar extensor shortness between male and female individuals with chronic low back pain who participated in our study. However, it was determined that the angular values were found to be in a chain movement and showed shortness at the same time. However, the fact that the parameters related to sacral inclination angle and lumbar extensor shortness did not show a significant difference suggests that the proximal effect in the shortness chain is less in individuals with chronic low back pain.

In our study, the angular values of the knee joint were analysed and the level of relationship with other parameters within the scope of foot biomechanics was examined. It was found that both ankle and knee joints could be affected due to the shortening of ROM during the evaluation of the participants within the scope of ROM. As a result, it was concluded that the shortening of the ROM has effects on both joints. When other studies in the literature were examined, it was reported that DD shortness may also have an effect on knee joint valgite angle measurement values (Fatoye et al., 2019). However, it is seen that these evaluations on DD shortness and valgite angle are quite limited. In a different study in which the dynamic structure of the knee joint of people with short DDH was examined with the amount of NDT, it was found that the values related to the amount of NDT increased and dorsi flexion limitation occurred in people due to DDH. It was reported that knee joints go more in the valgus direction during squatting due to the increase in Q angle in individuals, resulting in a decrease in the valgite angle (Hansford et al., 2019). In another study, it was observed that the increase in Q angle changes caused a decrease in valgite angular values, resulting in a significant increase in the limitation of dorsi flexion in individuals and characterised by the frequency of genu valgum (Machado et al., 2018). In another study, it was reported that pes planus deformity increased due to a significant increase in the Q angle in people with DD shortness, and accordingly, there was a statistically significant decrease in valgite angular values and AOFAS scores (Mo et al., 2022). In our study, it was observed that the Q angle of female and male participants was high, but there was no significant difference between them. However, the Q angle values of women were found to be higher than those of men. In a study, it was stated that having a large pelvis in women is characterised by an increase in Q angle and this may cause a difference between both sexes. This result was similar to the finding of our study.

In studies in the literature, it has been reported that in groups with increased genu valgum rates, DD shortness also increases and this causes limitation in knee joint flexion movement (Olafsson et al., 2018). This situation reveals that both knee joint flexion and squatting movement are more limited in individuals with DDH shortness compared to other healthy individuals without DDH shortness. In our study, it was observed that there was no significant difference in terms of knee joint hyperextension between individuals with chronic low back pain who had parameters related to DDH shortness. However, it was observed that there was a significant increase in Q angles due to the decrease in valgite angle, but this did not create a significant difference between the groups. We think that the static measurements used in our study may be effective in the similar values between the groups. The results of knee joint flexion angle measurements, which were evaluated within the scope of our study, were consistent with the findings of other studies in the literature showing range of motion. For this reason, it was concluded that shortness of ROM may be effective in the negative evaluation of the parameters related to knee joint range of motion in our study.

In the literature, it is seen that many methods are used for posture evaluation. In our study, the New York Posture Assessment Questionnaire was used as one of the static posture assessment tools. With the New York Posture Evaluation Questionnaire, participants are evaluated from the side and back and a general conclusion is reached about a general posture. In this method, which was carried out with the aim of evaluating general posture, it was observed that the participants were mostly at the poor posture level. In this context, in a study conducted among people aged 30-45 years with chronic low back pain, the results of the New York Posture Assessment Questionnaire were evaluated and it was determined that the participants were in the poor posture class due to the low scores (Gajšek et al., 2022). It was observed that there was a compatible result between this situation and the findings of our study. In another study in which the results of the New York Posture Assessment Questionnaire and ODI scores of a group with an increase in the duration of low back pain were examined, it was found that there was an increase in ODI scores and a decrease in the scores of the New York Posture Assessment Questionnaire (Bureta et al., 2022). In this case, it was reported that the increase in ODI scores negatively affected the general posture. In our study, the direction of the correlation between the results of static pedobarographic measurement analyses for both forefoot and hindfoot and the New York Posture Assessment Questionnaire was determined in order to evaluate foot and general posture. The results showed that the increase in the scores obtained from the New York Posture Assessment Questionnaire had an effect on decreasing the increased pressure in the forefoot and increasing the decreased pressure in the hindfoot. However, it was determined that the increase in scores caused a decrease in ODI scores, which were evaluated negatively, and these results were similar to the studies in the literature.

Among the limitations of our study, it was assumed that more effective results could be obtained in the comparison of parameters by including a different group in the study in which dynamic exercises were performed because both groups had similar characteristics. However, it is thought that a study in which measurement methods more sensitive to muscular and postural changes are used and in which a larger number of individuals are included may be more effective in observing the differences. It was concluded that the study should be extended over a longer period of time and that it would make a significant difference in the monitoring of the results and that more studies are needed for this reason.

When the results of our study were evaluated, it was shown that changes were observed in the lower extremities due to DD and these changes may adversely affect foot, ankle, knee and hip mobility, which were examined among the biomechanical parameters. In line with the findings obtained, it should be taken into consideration that these biomechanical changes observed in individuals may be a factor in the emergence of many different pathological conditions originating from the lower extremities and this risk may increase due to DD.

In our study, it was revealed that the pathomechanical effect of DD by increasing the pronation of the foot observed in individuals caused the other parameters to be adversely affected functionally. The subtalar joint of the individuals was evaluated and increased pronation of the hindfoot was found. This situation proved that the shortness of the gastrocnemius muscle was effective as stated in other studies in the literature. In conclusion, it has been proved that the shortness of the gastrocnemius muscle should be evaluated in cases of increased hindfoot pronation and that this parameter is effective in the formation of many lower extremity pathomechanics.

The working principle of all joints evaluated in the lower extremity consists of kinetic chain logic. This situation shows that joints can affect each other among themselves. Considering this situation, it is hypothesised that DD directly leads to biomechanical changes in other parameters such as knee and hip joints. For this reason, knee and hip were evaluated in our study and it was found that DD caused limitation in flexion of the knee joint and shortening of the knee flexor and hip flexor muscles. This showed that DD may limit the normal movement of the joints. For this reason, it was revealed in our study that gastrocnemius muscle evaluation performed specifically in individuals diagnosed with chronic low back pain who have problems in the knee and hip regions where GC shortness is evaluated is very important.

According to the findings obtained, it can be said that the postural changes in the foot region, which was evaluated within the scope of our study, may occur due to GC. The posture formed by the pronation movement in the foot is seen as a biomechanical change. This change negatively affects the direct functionality of the individuals. For this reason, the functional status of the participants was also examined in our study and it was aimed to determine the relationship with low back pain. As a result, when foot posture and foot functionality were evaluated, it was observed that the scores decreased significantly due to increased pronation. This once again demonstrated the necessity of assessing the presence or absence of DDH.

The results of the pedobarographic analysis performed statically were evaluated negatively when compared with the references of the angular values. However, the negative biomechanical changes in the other parameters analysed related to the lower extremity supported the findings of the data. The high sensitivity of the plantar pressure distribution analyses evaluated in our study makes the findings of our study important.

If we list the situations that can be recommended as a result of our study; it is aimed to make an evaluation to cover all compartments related to the foot and waist. In this respect, it is thought that the data we have obtained can be effective in the evaluation of people, including healthy individuals, who have problems related to pathomechanics in their lower extremities and in advancing the necessary treatment approaches.

In addition, it was observed that changes in posture and plantar pressure may cause low back pain. The fact that there are few studies on the evaluation of posture and plantar pressure distribution in the literature reveals the importance of the findings of our study.

Assuming that the movement systems of individuals produce functional work as a kinetic chain, a dysfunction in any part of the body will negatively affect other parts of the body and may put the tissues into a cumulative injury cycle and lead to injury. In this context, after detailed analyses, predictions can be made about the functioning of the movement system of individuals and preventive exercise programmes can be designed and this negative situation can be prevented.

As a result, it is predicted that significant results can be obtained if this study is continued in patient groups with a larger sample size. Our study may be a source for future academic studies on the subject. Since the study is a determination study, it can be developed with a specific clinical practice and observation model in the process.

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**APPENDICES**

**ANNEX-1: Demographic Information Form**

**1) Your age**

**18-24 ( ) 25-34 ( ) 35-44 ( ) 45-54 ( ) 65 and over**

**2) Gender**

**Female ( ) Male ( ) Other ( )**

**3) Marital Status?**

**Single ( ) Married ( ) Widowed ( ) Divorced ( )**

**4) Education Status?**

**( ) Primary Education**

**( ) High school**

**( ) Associate Degree**

**( ) Undergraduate**

**( ) Master's Degree**

**( ) Doctorate**

**5) Do you have children?**

**Yes ( ) No ( )**

**6) Do you currently have a regular job?**

**Yes ( ) No ( )**

**7) How many years have you been working?**

**Less than 1 year ( ) Between 1-5 years ( ) Between 5-10 years ( ) 11 years and over ( ) Not working ()**

**8) How many hours a day do you work?**

**1-4 hours ( ) 4-6 hours ( ) 6-8 hours ( ) 8-10 hours ( ) 10 hours or more ( ) Not working ()**

**9) What is your monthly income?**

**5.000 TL ( )**

**5.001-7.500 TL ( )**

**7501-10.000 TL ( )**

**10.001-12.500 TL ( )**

**12.501-15.000 TL ( )**

**15.000TL and above ( )**

**10) Dominant side**

**-Right () -Left ()**

**11) Smoking-alcohol use:**

**-Yes () No ()**

**12) Diagnosis:**

**Duration of Low Back Pain:**

**Standing Time(s/g):**

**ANNEX 2: AOFAS Ankle-Backfoot Scale**

AOFAS skorlaması

| Özellik | Puan |
|---|---|
| **Ağrı (40 puan)** | |
| Yok | 40 |
| Hafif | 30 |
| Orta | 20 |
| Ciddi | 0 |
| **Fonksiyon (50 puan)** | |
| **Aktivite kısıtlamaları,destek gereksinimi** | |
| Kısıtlılık yok, destek yok | 10 |
| Günlük aktivitelerde kısıtlılık yok, rekreasyonel aktivitelerde kısıtlılık,destek yok | 7 |
| Hem günlük hem de rekreasyonel aktivitelerde kısıtlılık var, baston kullanımı | 4 |
| Ciddi kısıtlılık, walker,tekerlekli sandalye kullanımı vb kullanımı | 0 |
| **Maksimum yürüme mesafesi (blok olarak)*** | |
| 6'dan fazla | 5 |
| 4-6 | 4 |
| 1-3 | 2 |
| 1'den az | 0 |
| **Yürüme yüzeyleri** | |
| Her yüzeyde yürüyebiliyor | 5 |
| Merdiven ve eğimlerde hafif zorlanma | 3 |
| Ciddi zorlanma | 0 |
| **Yürüme bozukluğu** | |
| Yok, hafif | 8 |
| Belirgin | 4 |
| Önemli derecede | 0 |
| **Sagittal hareket (fleksiyon + ekstansiyon)** | |
| Normal veya hafif kısıtlılık (30° ve üstü) | 8 |
| Orta kısıtlılık (15°-29°) | 4 |
| Ciddi kısıtlılık (15° ve altı) | 0 |
| **Arka ayak hareketi (inversiyon + eversiyon)** | |
| Normal veya hafif kısıtlılık (normalin % 75-%100 ) | 6 |
| Orta derecede kısıtlılık (%25-%74) | 3 |
| Ciddi derecede kısıtlılık (% 25'den az) | 0 |
| **Ayak bileği – arka ayak stabilitesi (anteroposterior, varus-valgus)** | |
| Stabil | 8 |
| Anstabil | 0 |
| **Aligment (10 puan)** | |
| İyi, plantigrad ayak, ayak bileği- arka ayak aligmenti iyi | 10 |
| Orta, plantigrad ayak, ayak bileği- arka ayak aligmenti hafif bozuk, semptom yok | 5 |
| Zayıf, nonplantigrad ayak, ciddi malaligment, semptom var | 0 |

(* 1 blok = 50 metre olarak değerlendirilmiştir.)

**ANNEX-3: Pain-Visual Analogue Scale (VAS)**

**Tick the severity of your low back pain during movement for the last six months.**

**(0 = no pain, 10 = unbearably severe pain)**

**0 ____________________________________________ 10**

**Tick the severity of your back pain at rest for the last six months.**

**(0 = no pain, 10 = unbearably severe pain)**

**0 ____________________________________________ 10**

**Tick the severity of your back pain at night for the last six months.**

**(0 = no pain, 10 = unbearably severe pain)**

**0 ____________________________________________ 10**

## Annex 4: Oswetry Low Back Pain Questionnaire

# Oswestry Low Back Pain Disability Index 2.1

**Directions**
- Use a #2 soft pencil for marking.
- Text answers must be entered with the web interface.
- All questions must be answered unless otherwise indicated.
- Completely fill in boxes to record answers.

*Internal Use Only*
*Not read by scanner*

| Last name | First name | Gender |
|---|---|---|
| Street | | M.R.N. |
| Country code Zip code | City | |
| Social security number (ADI no.) | | Birthdate (DD.MM.YYYY) |

Mandatory information

**This questionnaire is designed to give us information as to how your back (or leg) trouble has affected your ability to manage in every day life.**
**Please answer every section. Mark one box only in each section that most closely describes you today.**

**Examination date**

Day 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Month 1 2 3 4 5 6 7 8 9 10 11 12
Year 04 05 06 07 08 09 10 11 12 13 14 15 16

**Examination interval, after..**

- before intervention
- 6 weeks
- 3 months
- 6 months
- 9 months
- 1 year
- 2 years
- 3 years
- 4 years
- 5 years
- 6 years
- 7 years
- 8 years
- 9 years
- 10 years
- 11 years
- 12 years
- 13 years
- 14 years
- 15 years
- >15 years ............................

**Pain intensity**
- I have no pain at the moment.
- The pain is very mild at the moment.
- The pain is moderate at the moment.
- The pain is fairly severe at the moment.
- The pain is very severe at the moment.
- The pain is the worst imaginable at the moment.

**Personal care (washing, dressing, etc.)**
- I can look after myself normally without causing extra pain.
- I can look after myself normally but it is very painful.
- It is painful to look after myself and I am slow and careful.
- I need some help but manage most of my personal care.
- I need help every day in most aspects of self care.
- I do not get dressed, wash with difficulty and stay in bed.

**Walking**
- Pain does not prevent me from walking any distance.
- Pain prevents me from walking more than one mile.
- Pain prevents me from walking more than a quarter of a mile.
- Pain prevents me from walking more than 100 yards.
- I can only walk using a stick or crutches.
- I am in bed most of the time and have to crawl to the toilet.

**Lifting**
- I can lift heavy weights without extra pain.
- I can lift heavy weights but it gives extra pain.
- Pain prevents me from lifting heavy weights off the floor but I can manage if they are conveniently positioned, e.g. on a table.
- Pain prevents me from lifting heavy weights but I can manage light to medium weights if they are conveniently positioned.
- I can only lift very light weights.
- I cannot lift or carry anything at all.

### Sitting

- I can sit in any chair as long as I like.
- I can sit in my favourite chair as long as I like.
- Pain prevents me from sitting for more than 1 hour.
- Pain prevents me from sitting for more than half an hour.
- Pain prevents me from sitting for more than 10 minutes.
- Pain prevents me from sitting at all.

### Standing

- I can stand as long as I want without extra pain.
- I can stand as long as I want but it gives me extra pain.
- Pain prevents me from standing for more than 1 hour.
- Pain prevents me from standing for more than half an hour.
- Pain prevents me from standing for more than 10 minutes.
- Pain prevents me from standing at all.

### Sleeping

- My sleep is never disturbed by pain.
- My sleep is occasionally disturbed by pain.
- Because of pain I have less than 6 hours sleep.
- Because of pain I have less than 4 hours sleep.
- Because of pain I have less than 2 hours sleep.
- Pain prevents me from sleeping at all.

### Sex life *(if affected by pain)*

- My sex life is normal and causes no extra pain.
- My sex life is normal but causes some extra pain.
- My sex life is nearly normal but is very painful.
- My sex life is severly restricted by pain.
- My sex life is nearly absent because of pain.
- Pain prevents any sex life at all.

### Social life

- My social life is normal and causes me no extra pain.
- My social life is normal but increases the degree of pain.
- Pain has no significant effect on my social life apart from limiting my more energetic interests, e.g. sports, etc.
- Pain has restricted my social life and I do not go out as often.
- Pain has restricted social life to my home.
- I have no social life because of pain.

### Traveling

- I can travel everywhere without pain.
- I can travel everywhere but it gives extra pain.
- Pain is bad but I manage journeys over two hours.
- Pain restricts me to journeys of less than one hour.
- Pain restricts me to short necessary journeys under 30 minutes.
- Pain prevents me from traveling except to receive treatment.

## Annex 5: New York Posture Analysis